

Article

Quantile-VAR Approach to Spillovers and Connectedness Among Real-Financial Aggregates and Economic Freedom in Tunisia

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Abstract

This study investigates the time-varying connectedness between economic freedom and key real-financial aggregates in Tunisia, including GDP, money supply, interest rate, exchange rate, inflation, labor force, and the stock market index, using a quantile-based connectedness framework and quarterly data over the period 2010–2024. Unlike previous connectedness studies that mainly focus on macroeconomic and financial variables, this paper explicitly incorporates economic freedom as an institutional determinant within a quantile connectedness framework, thereby extending the literature on macro-financial interconnectedness in emerging economies. The empirical results reveal strong regime dependence, as the Total Connectedness Index (TCI) is substantially higher under extreme market conditions than at the median quantile. In bearish states (quantile = 0.05), economic freedom behaves primarily as a net receiver of spillovers from GDP, labor force, and interest rates, highlighting the reactive nature of institutional quality during periods of economic stress. By contrast, in bullish states (quantile = 0.95), economic freedom becomes a net transmitter of shocks, influencing money supply, inflation, and stock market dynamics, suggesting that institutional conditions amplify macro-financial interactions during expansionary phases. Under normal economic conditions (quantile = 0.50), connectedness remains moderate and relatively balanced, reflecting weaker systemic interdependence. From a theoretical perspective, the findings support the view that institutional quality is not neutral over the business cycle but evolves asymmetrically with macro-financial conditions. The study therefore contributes to the literature by demonstrating the procyclical and state-dependent role of economic freedom in shaping macro-financial spillovers in an emerging economy context. These findings also provide important policy implications for strengthening institutional resilience and macroeconomic stability in Tunisia.

Keywords: real-financial aggregates; economic freedom; QVAR model; connectedness; Tunisia



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1. Introduction

In empirical literature, real and financial aggregates are intrinsically linked to the quality of a country's economic institutions. Economic freedom, widely regarded as a

proxy for institutional quality (Hall et al., 2019; Sharma, 2020), reflects the extent to which institutions and public policies are market-oriented (Stroup, 2007; Angulo-Guerrero et al., 2017). Dimensions such as property rights, contractual freedom, monetary stability, limited government intervention, trade openness, and financial freedom are commonly recognized as important drivers of real and financial economic performance (Friedman, 1962; Hayek, 1944; Barro, 1996; Levine, 1997; Gwartney et al., 2023). Theoretically, economic freedom can influence both real and financial development through several transmission channels. Well-defined property rights and strong legal institutions reduce information asymmetries and transaction costs, thereby improving the availability and efficiency of external financing (Fernández & Tamayo, 2017; Fergusson, 2006; Beck & Levine, 2005). Likewise, trade openness contributes positively to real and financial development (Huang & Temple, 2005), while monetary stability enhances the real return on assets and mitigates adverse selection problems by maintaining low and stable inflation (Fernández & Tamayo, 2017; Feldstein, 1980). A substantial body of empirical literature has investigated the relationship between economic freedom and various socio-economic outcomes, including economic growth (Gwartney et al., 1999; Bergh & Bjørnskov, 2021), entrepreneurship (Nyström, 2008; Sweidan, 2021), corruption (Graeff & Mehlkop, 2003; Thach & Ngoc, 2021), education (Feldmann, 2017), and health (Stroup, 2007; Sharma, 2020)¹. However, empirical studies specifically examining the connectedness between economic freedom and real-financial aggregates remain relatively scarce (Enowbi-Batuo & Kupukile, 2010; Hafer, 2013; Khan, 2021), particularly in emerging economies.

The interconnectedness between macro-financial aggregates and economic freedom constitutes an important issue for both policymakers and investors. Although existing research has extensively analyzed macro-financial relationships (Jamaludin et al., 2017; Abbas et al., 2019; Adu-Asare Idun et al., 2022; Shah et al., 2024; Bigerna, 2024), relatively few studies explicitly incorporate economic freedom into connectedness analyses (Dawson, 2010; Smimou & Karabegovic, 2010).²

Tunisia represents a particularly relevant case study for this analysis due to the profound political, institutional, and macroeconomic transformations experienced since the Arab Spring. Over the last decade, the Tunisian economy has faced several major shocks, including political instability, inflationary pressures, exchange rate depreciation, the COVID-19 pandemic, and external geopolitical tensions, all of which have significantly affected both institutional quality and macro-financial stability (Achy, 2013). These characteristics make Tunisia an appropriate emerging economy framework for examining how economic freedom dynamically interacts with real and financial aggregates under different economic regimes. Accordingly, this study addresses the following central research question: *How does economic freedom dynamically interact with real and financial aggregates across different economic conditions in Tunisia, and to what extent does this connectedness vary between bearish, normal, and bullish economic regimes?*

Previous studies suggest that improvements in economic freedom tend to attract foreign investment and stimulate financial development (Levine, 2005; Bjørnskov, 2016), whereas periods of economic and financial instability associated with deteriorating institutional quality may amplify spillover effects and weaken market resilience (Diebold & Yilmaz, 2012). In the economic literature, economic freedom is commonly measured using composite indices developed by institutions such as the Fraser Institute and the Heritage Foundation. The Economic Freedom of the World Index proposed by the Fraser Institute (Gwartney et al., 2023) captures five major dimensions: the size of government, legal institutions and property rights, sound money, freedom to trade internationally, and regulation of labor and business markets. Similarly, the Heritage Foundation's Index of

Economic Freedom evaluates twelve components grouped into four pillars: rule of law, government size, regulatory efficiency, and market openness.

This paper provides an empirical analysis of the time-varying interconnectedness between real-financial aggregates and the Economic Freedom Index in Tunisia using quarterly data covering the period 2010–2024. Specifically, the study investigates the connectedness among inflation, money supply (M2), labor force, GDP, exchange rate (Dinar/USD), interest rate, stock market performance, and economic freedom under different economic conditions. To this end, we employ a Quantile Vector Autoregression (Q-VAR) framework, which allows the analysis of nonlinear and asymmetric spillover dynamics across different quantiles of the conditional distribution. Numerous empirical studies based on conventional Vector Autoregressive (VAR) models have explored the interactions between macroeconomic variables and financial aggregates (Kim et al., 2009; IMF, 2007)³. However, standard VAR approaches generally rely on the assumption of linear and constant relationships, which may become inappropriate during periods of financial stress, economic crises, or extreme market conditions (Koenker & Bassett, 1978). In contrast, the Q-VAR methodology captures state-dependent connectedness dynamics and tail-risk behavior, thereby providing a more comprehensive understanding of spillover transmission mechanisms across bullish and bearish economic regimes (Adrian et al., 2019).

The main contribution of this study is multifold. First, unlike most previous connectedness studies focusing mainly on macroeconomic or financial variables, this paper explicitly integrates economic freedom as an institutional determinant within a macro-financial connectedness framework, an area that remains relatively underexplored in emerging economies (North, 1990; Acemoglu et al., 2005). In doing so, the study contributes theoretically to the institutional economics and macro-financial literature by showing that economic freedom should not be viewed solely as a long-run structural determinant of growth and development, but also as a dynamic and regime-dependent component of macro-financial interactions. More specifically, the findings highlight the procyclical nature of economic freedom, whose sensitivity to macro-financial spillovers intensifies during expansionary periods and weakens under stressed or normal conditions. Second, by employing a quantile-VAR framework, the study captures the asymmetric and state-dependent transmission of shocks across different economic conditions, thereby extending the literature on financial contagion and systemic risk (Diebold & Yilmaz, 2012; Adrian & Brunnermeier, 2016). From a methodological perspective, the paper contributes to the growing literature on nonlinear connectedness by demonstrating that the role of institutional variables may vary substantially across market regimes, an aspect that conventional linear connectedness approaches are unable to fully capture. Third, the paper contributes to the limited empirical literature on North African economies by providing new evidence on Tunisia, a country characterized by important institutional, political, and macroeconomic transformations since the post-2011 reform period. In the context of emerging economies, where institutional fragility, financial vulnerabilities, and external shocks often interact simultaneously, understanding the dynamic interconnectedness between economic freedom and macro-financial variables becomes particularly relevant. Overall, the study provides important policy implications for emerging economies such as Tunisia. The procyclical behavior of economic freedom suggests that institutional reforms and liberalization policies may increase the economy's exposure to macro-financial shocks during expansionary periods, thereby requiring stronger macroprudential oversight and financial regulation. The findings also highlight the importance of adopting a regime-dependent policy framework, as the transmission of shocks and the role of economic freedom vary significantly across bullish, bearish, and normal market conditions.

The remainder of this study is organized as follows: Section 1 presents theoretical Foundations, research hypotheses and literature review related to the connectedness among certain macroeconomic variables, economic freedom and the stock market. Section 2 presents the data and methodology employed in this study. Section 3 interprets the relevant findings. Section 4 concludes the paper.

1.1. Theoretical Foundations, Research Hypotheses, and Literature Review

1.1.1. Theoretical Foundations

The theoretical foundations of this study can be understood through several complementary perspectives that explain the dynamic interactions between macroeconomic variables, financial aggregates, and institutional quality. In this context, macroeconomic theory, the Quantity Theory of Money, and neoclassical growth theory provide the main conceptual framework for analyzing the connectedness between economic freedom and real-financial variables in Tunisia.

Macroeconomic Theory

Macroeconomic theory emphasizes the strong interdependence between real activity, monetary conditions, and financial markets. According to Keynesian and modern macroeconomic frameworks, variables such as GDP, inflation, interest rates, exchange rates, and stock market performance are dynamically connected through transmission mechanisms affecting aggregate demand, investment, employment, and financial stability (Mundell, 1963; Bernanke & Gertler, 1995). For instance, an increase in interest rates may reduce investment and output, while exchange rate depreciation may stimulate exports but simultaneously generate inflationary pressures in import-dependent economies. Within this framework, economic freedom occupies a central institutional role because it shapes the efficiency of markets and the quality of macroeconomic adjustments. Greater economic freedom through trade openness, regulatory efficiency, sound monetary policy, and the protection of property rights can improve resource allocation, stimulate private investment, and strengthen financial market development (Hayek, 1944; Friedman, 1962; Levine, 1997). Conversely, poor institutional quality, excessive regulation, and macroeconomic instability may amplify financial fragilities and increase systemic risk, particularly during crisis periods.

This theoretical perspective is particularly relevant for emerging economies such as Tunisia, where institutional reforms, exchange rate pressures, inflationary episodes, and political instability strongly interact with macro-financial dynamics. In such economies, shocks affecting one macroeconomic variable may rapidly propagate to other sectors of the economy through multiple transmission channels. Consequently, macroeconomic theory provides a strong justification for examining the dynamic connectedness between economic freedom and real-financial aggregates across different economic regimes.

Quantity Theory of Money

The Quantity Theory of Money, initially formalized by Fisher (1911) and later developed by Friedman (1968), argues that inflation is fundamentally linked to variations in money supply. The classical identity $MV = PY$ suggests that, assuming velocity and output remain relatively stable in the long run, an excessive increase in money supply translates into higher price levels. This theory constitutes one of the main foundations for understanding inflationary dynamics and monetary spillovers within the macro-financial system. Beyond inflation, modern monetary theory emphasizes that changes in money supply also affect interest rates, exchange rates, asset prices, and financial market conditions through the monetary transmission mechanism (Mishkin, 1996). An expansionary monetary policy may initially stimulate economic activity by lowering interest rates and increasing liquidity.

However, in small open economies characterized by external vulnerabilities and structural imbalances, such expansion may also generate exchange rate depreciation, inflationary expectations, and financial instability. The theory is particularly important for connectedness analysis because monetary shocks tend to propagate throughout the entire economic system. Inflationary pressures generated by excessive money growth can influence stock market performance, purchasing power, investment decisions, and exchange rate stability. Moreover, the “sound money” dimension included in economic freedom indices directly reflects monetary stability. Consequently, deterioration in inflation and exchange rate conditions may weaken perceptions of economic freedom and institutional quality.

In the Tunisian context, where inflationary pressures, exchange rate fluctuations, and monetary policy adjustments have intensified since the post-Arab Spring period, the Quantity Theory of Money provides a useful framework for explaining the strong spillovers observed between money supply, inflation, exchange rates, and economic freedom under both tranquil and turbulent economic conditions.

Neoclassical Growth Theory

Neoclassical growth theory, developed by Solow (1956) and extended by Mankiw et al. (1992), highlights the importance of capital accumulation, labor force growth, technological progress, and institutional quality in determining long-run economic growth. According to this framework, sustainable growth depends on the efficient allocation of resources and on institutions capable of encouraging investment, productivity improvement, and innovation. Within this perspective, economic freedom plays a crucial role because institutional quality directly affects economic incentives and market efficiency. Secure property rights, financial liberalization, trade openness, low regulatory burdens, and stable macroeconomic policies encourage domestic and foreign investment, facilitate technological diffusion, and improve productivity (North, 1990). In contrast, excessive government intervention, weak governance, and institutional inefficiencies may distort resource allocation and hinder long-term economic development. Neoclassical growth theory also emphasizes the bidirectional relationship between labor markets and output growth. Expansions in the labor force contribute positively to GDP growth by increasing productive capacity, while higher economic growth generates employment opportunities and stimulates financial development. These mechanisms explain why GDP and labor force variables often emerge as important transmitters and receivers of spillovers in connectedness analyses.

Furthermore, stronger economic growth may gradually improve institutional quality by increasing the demand for better governance, financial reforms, and market-oriented policies. This dynamic interaction supports the idea that economic freedom and macro-financial aggregates evolve jointly over time and that their relationships are likely to be nonlinear and regime-dependent. Consequently, neoclassical growth theory provides a strong theoretical foundation for analyzing the asymmetric and time-varying connectedness between economic freedom and real-financial variables in Tunisia.

1.2. Research Hypotheses

Based on the theoretical foundations and the existing empirical literature on macro-financial and institutional spillovers, this study formulates several hypotheses regarding the dynamic connectedness between economic freedom and real-financial aggregates in Tunisia. First, we hypothesize that the connectedness between macroeconomic, financial, and institutional variables is strongly regime-dependent. More specifically, in line with the literature on asymmetric connectedness and systemic risk (Diebold & Yilmaz, 2012; Baruník & Křehlík, 2018), we expect spillovers to become significantly stronger during periods of crisis, uncertainty, or economic stress than during normal economic conditions.

In the Tunisian context, characterized by post-revolution political instability, inflationary pressures, the COVID-19 pandemic, and international geopolitical shocks, the interactions between real, financial, and institutional aggregates are expected to intensify under extreme economic regimes. Second, we hypothesize that economic freedom exhibits an asymmetric and procyclical behavior. During economic downturns or crisis periods, economic freedom is expected to act mainly as a receiver of spillovers originating from macro-financial aggregates, reflecting the vulnerability of institutions to macroeconomic and financial instability in emerging economies. Conversely, during expansionary phases, economic freedom may become a transmitter of spillovers by influencing monetary, financial, and real conditions through channels related to regulation, trade openness, and monetary stability. This hypothesis is consistent with the institutional literature suggesting that institutions are not neutral over the business cycle but evolve dynamically with macroeconomic conditions (Acemoglu et al., 2005). Third, consistent with the Quantity Theory of Money and the literature on monetary transmission mechanisms, we hypothesize that money supply, inflation, and the exchange rate play a central role in propagating spillovers within the Tunisian economic system. Excessive monetary expansion may generate inflationary pressures, exchange rate depreciation, and financial instability, thereby strengthening the degree of connectedness among the different variables. This hypothesis is particularly relevant for a small open economy such as Tunisia, which remains highly exposed to external imbalances and imported shocks. Fourth, in line with neoclassical growth theory, we postulate that GDP and labor force dynamics constitute major channels through which spillovers are transmitted between the real, financial, and institutional spheres. Economic growth and labor market conditions directly influence financial markets, policy decisions, and institutional quality, while financial and institutional conditions simultaneously affect real economic activity. Accordingly, GDP and labor force are expected to emerge as net transmitters of spillovers within the connectedness framework.

Finally, we hypothesize that the degree of connectedness observed under extreme quantiles will be substantially higher than that observed at the median quantile, reflecting strong asymmetry in shock transmission mechanisms. This hypothesis suggests that the relationships between economic freedom and real-financial aggregates become particularly sensitive during periods of economic stress, whereas they remain relatively moderate and segmented under stable macroeconomic conditions.

1.3. Literature Review

The dynamic connectedness between real-financial macroeconomic variables such as inflation, money supply (M2), labor force, GDP, exchange rates, stock market performance, and economic freedom varies significantly across normal and extreme economic conditions. From a theoretical perspective, these interactions reflect the transmission mechanisms linking monetary conditions, real activity, financial markets, and institutional quality. Macroeconomic theory suggests that shocks affecting one component of the system may propagate to other aggregates through channels related to investment, liquidity, inflation expectations, trade competitiveness, and financial confidence. Empirical evidence further indicates that the intensity of these linkages depends not only on the level of market development but also on external disturbances such as financial crises, pandemics, or geopolitical tensions.

A substantial body of empirical research, based on traditional econometric approaches rather than connectedness-based methodologies, has examined the relationship between economic freedom and various socio-economic outcomes, including economic growth (Gwartney et al., 1999; Bergh & Bjørnskov, 2021), entrepreneurship (Nyström, 2008; Sweidan, 2021), corruption (Graeff & Mehlkop, 2003; Thach & Ngoc, 2021), education (Feldmann,

2017), and health (Stroup, 2007; Sharma, 2020).⁴ These studies generally argue that economic freedom improves market efficiency by strengthening property rights, reducing regulatory distortions, and enhancing resource allocation. Through these channels, institutional quality may influence investment decisions, monetary stability, and financial development. However, studies exploring the interrelationships between economic freedom and real-financial aggregates through connectedness techniques remain scarce (e.g., Enowbi-Batuo & Kupukile, 2010; Hafer, 2013; Khan, 2021). To provide a comprehensive overview of prior empirical findings on the link between economic freedom and macro-financial variables, we review both strands of the literature: those employing conventional econometric models and the few studies adopting connectedness approaches.

Shah et al. (2024) provide empirical evidence on the impact of various dimensions of economic freedom on stock market volatility in emerging economies using panel data from 2000 to 2017. Employing pooled OLS, fixed and random effects models, as well as the system GMM approach, their findings indicate that strong property rights are associated with lower market volatility, while higher levels of financial freedom contribute to greater market stability. These results support the theoretical argument that institutional quality reduces uncertainty and improves investor confidence, thereby limiting financial fragility. In a complementary vein, Mawardi et al. (2024) show that institutional quality and economic freedom significantly contribute to the development of Islamic financial systems in OIC countries. Their findings suggest that institutional reforms and technological advancement may reinforce financial intermediation and market efficiency, particularly in emerging economies characterized by structural constraints.

As a continuation of the literature review, we now turn our attention to studies examining the connectedness between real and financial variables, which may themselves constitute transmission channels through which economic freedom affects macroeconomic performance. In particular, dimensions such as sound money, trade openness, regulatory quality, and financial freedom are theoretically expected to influence inflation dynamics, exchange rate stability, stock market development, and economic growth.

Abbas et al. (2019) examine the interconnectedness among stock market returns, volatility, and macroeconomic indicators in G7 countries using the Diebold and Yilmaz spillover index. Their findings reveal that macroeconomic instability amplifies market volatility and systemic risk, especially after the 2008 global financial crisis. These results are consistent with macro-financial theories emphasizing that uncertainty and deteriorating economic conditions strengthen cross-market spillovers during crisis periods. Similarly, Thai Hung (2022) finds that stock returns influence macroeconomic fundamentals in the long run, whereas short-term stock market dynamics are largely driven by macroeconomic conditions. This bidirectional relationship supports the view that financial markets both react to and transmit macroeconomic shocks.

Expanding the analysis to emerging economies, Adu-Asare Idun et al. (2022) report strong interactions between stock market indicators and banking sector conditions in Ghana, particularly following banking sector reforms. Their findings suggest that institutional and monetary changes may significantly alter the transmission of financial shocks in developing economies. Likewise, N. Kyriazis et al. (2024b), using a quantile-VAR framework, show that the relationships between inflation, commodity prices, and economic policy uncertainty are highly state-dependent. Their results indicate that uncertainty becomes a dominant driver of macroeconomic volatility during crisis periods, highlighting the asymmetric nature of macro-financial spillovers.

Further emphasizing the importance of nonlinear dynamics, Ben Haddad et al. (2024) demonstrate that uncertainty shocks exert stronger effects during periods of financial stress than during normal conditions. Similarly, Ngo et al. (2023) show that the relationship

between stock markets and macroeconomic conditions varies across economic regimes. Bullish markets tend to generate lower sensitivity to macroeconomic risk due to investor optimism, whereas bearish phases amplify the effects of uncertainty and reduce the effectiveness of monetary expansion. These findings provide additional support for quantile-based approaches, which allow connectedness dynamics to differ across market conditions.

Baruník and Křehlík (2018) introduce a frequency-domain connectedness framework capable of capturing time-frequency spillovers across economic variables. Their methodology demonstrates that macro-financial interactions differ across business cycle horizons, suggesting that spillovers may intensify during periods of systemic stress. Building on this perspective, Ghulam et al. (2019) reveal strong interactions between stock market returns, volatility, and macroeconomic fundamentals in G7 economies, particularly after the global financial crisis. Finally, Shang and Hamori (2024), using the quantile time-frequency connectedness approach proposed by Chatziantoniou et al. (2022), show that systemic risk and cross-market spillovers intensify under extreme market conditions. Their findings further indicate that commodity prices, especially crude oil, play a dominant role in transmitting shocks across macro-financial systems, while gold behaves differently depending on the time horizon and market regime. These results collectively support the idea that connectedness dynamics are asymmetric, nonlinear, and strongly dependent on both economic regimes and institutional conditions.

2. Data and Methodology

2.1. Data

This study utilizes data on economic freedom and key real and financial aggregates. As said above, measures of economic freedom are sourced from two major institutions: the Fraser Institute and the Heritage Foundation. Given its methodological robustness and widespread use in literature (e.g., Easton & Walker, 1992; Angulo-Guerrero et al., 2017), this research primarily relies on the Economic Freedom Index published by the Fraser Institute. Table 1 presents data description, sources and transformation of the data used in the present paper.

Table 1. Data description, sources and transformations.

Variable	Description	Source/Provider	Frequency	Transformation	Unit of Measurement
ECOFREEDOM	Economic Freedom Index	Fraser Institute	Quarterly	Growth rate	Index value (transformed)
GDP	Gross Domestic Product	Likely National Institute of Statistics (Tunisia) or IMF	Quarterly	Growth rate	Constant local currency unit (transformed)
M2	Money Supply (Broad Money)	Central Bank of Tunisia (BCT)	Quarterly	Growth rate	Tunisian Dinar (TND) (transformed)
INTRATE	Interest Rate (Money Market Rate)	Central Bank of Tunisia (BCT)	Quarterly	Growth rate	Percentage (%) (transformed)
EXCHRATE	Exchange Rate (TND/USD)	Central Bank of Tunisia (BCT)	Quarterly	Growth rate	TND per 1 USD (transformed)
CPI	Consumer Price Index (proxy for Inflation)	National Institute of Statistics (Tunisia)	Quarterly	Growth rate	Index (2010 = 100, transformed)

Table 1. Cont.

Variable	Description	Source/Provider	Frequency	Transformation	Unit of Measurement
TUNINDEX	Stock Market Index (Tunis Stock Exchange)	Tunis Stock Exchange (BVMT)	Quarterly	Growth rate	Index points (transformed)
FORCETRAV	Labor Force	National Institute of Statistics (Tunisia) or ILO	Quarterly	Growth rate	Number of persons (transformed)

Notes: Period: This study uses quarterly data covering the period 2010–2024 (59 observations, as noted in the descriptive statistics). Transformation Details: All variables are converted into their growth rate. The Consumer Price Index (CPI) growth rate is explicitly noted as the measure of inflation. The Economic Freedom Index is sourced primarily from the Fraser Institute (the study notes it relies on this index “given its methodological robustness”). Units after transformation: After taking their growth rate, all variables become unitless (approximating percentage changes).

This paper provides an empirical analysis of the time-varying interconnectedness between real-financial aggregates and the Economic Freedom Index in Tunisia using quarterly data covering the period 2010–2024. Although the study relies on a relatively limited sample of 59 quarterly observations, this constraint mainly reflects data availability in the Tunisian context, particularly for institutional indicators. Specifically, the study investigates the connectedness among inflation, money supply (M2), labor force, GDP, exchange rate (Dinar/USD), interest rate, stock market performance, and economic freedom under different economic conditions. All economic variables are converted into their growth rate. In particular, the Consumer Price Index (CPI), which reflects the general price level in Tunisia, was used. Its growth rate is widely recognized and commonly used as a reliable measure of inflation. Table 2 presents the descriptive statistics of the growth rate of real-financial aggregates and economic freedom in Tunisia.

Table 2. Descriptive statistics.

	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	JB	ADF	Obs.
M2	0.0221	0.0532	−0.0221	0.0139	−0.5280	3.6114	3.661	−3.542	59
INTRATE	0.0111	0.1581	−0.1155	0.0513	0.4105	4.8323	9.911	−4.025	59
EXCHRATE	0.0139	0.0833	−0.0415	0.0304	0.2194	2.5597	0.951	−3.587	59
Tun-Index	0.0146	0.1561	−0.1422	0.0599	0.0315	3.1847	0.094	−3.821	59
ECOFREEDOM	−0.0013	0.0043	−0.0138	0.0042	−0.5530	2.4309	3.804	−4.651	59
CPI	0.0140	0.0257	0.0056	0.0048	0.4113	2.8385	1.728	−4.025	59
GDP	0.0167	0.1717	−0.1444	0.0312	−0.2695	23.194	1003.3 ***	−3.854	59
FORCETRAV	0.0019	0.0280	−0.0274	0.0077	−0.7878	7.7812	62.299 ***	−3.891	59

*** indicates that the statistic is significant at 1%.

This table provides a statistical summary of eight economic and financial variables over 59 time periods, revealing distinct patterns in their growth and volatility. On average, most variables experienced positive growth, with GDP showing the highest mean increase (0.0167), followed by money supply (M2 at 0.0221), the stock market (Tun-Index at 0.0146), consumer prices (CPI at 0.0140), the exchange rate (EXCHRATE at 0.0139), and the interest rate (INTRATE at 0.0111), while labor force (FORCETRAV) was nearly stagnant and economic freedom (ECOFREEDOM) saw a slight decline. In terms of volatility, the interest rate and stock market index were the most unstable, exhibiting the highest standard deviations and wide ranges between their maximum and minimum values, indicating

significant fluctuations. Conversely, economic freedom and consumer prices were the most stable series. The Jarque–Bera tests for normality indicate that the distributions of GDP and labor force are decidedly non-normal, a conclusion strongly supported by GDP's extreme kurtosis value of 23.2, which signifies a distribution with very fat tails and a high peak, meaning it experienced extreme growth and contraction events far more frequently than a normal distribution would predict. The ADF test statistics confirm that all the variables considered are stationary after transformation into growth rates.

2.2. Econometric Methodology

The Quantile Vector Autoregression (QVAR) approach, proposed by Ando et al. (2022), combines quantile regression with the spillover framework of Diebold and Yilmaz (2012, 2014). It enables analyzing connectedness and contagion effects among economic and financial variables not only at the mean but across different points of the conditional distribution, especially in the tails (periods of stress or euphoria).

Let y_t be a K -dimensional vector of endogenous variables. The QVAR model of order p for a given quantile $\tau \in (0, 1)$ is:

$$y_t = \mu(\tau) + \sum_{j=1}^p \phi_j(\tau) y_{t-j} + \varepsilon_t(\tau)$$

where $\mu(\tau)$ is a vector of constants and $\phi_j(\tau)$ are coefficient matrices. Estimation is performed via quantile regression (Koenker & Bassett, 1978), imposing that the τ -th conditional quantile of the error term is zero. This yields coefficients that vary with τ and captures heterogeneity in dynamics across market regimes. To convert the QVAR(p) to its QVMA (∞) representation, we employ the Wold theorem:

$$y_t = \mu(\tau) + \sum_{j=1}^p \phi_j y_{t-j} + \varepsilon_t(\tau) = \mu(\tau) + \sum_{j=1}^{\infty} B_j(\tau) \varepsilon_{t-j}(\tau)$$

where $B_j(\tau) = \phi_1(\tau) B_{j-1}(\tau) + \phi_2(\tau) B_{j-2}(\tau) + \dots$. For $j = 1, 2, \dots$ with $B_0(\tau) = I_m$ and $B_j(\tau) = 0$ for $j < 0$. Subsequently, the H -step ahead Generalized Forecast Error Variance Decomposition (GFEVD) developed by Koop et al. (1996) and Pesaran and Shin (1998) is calculated to demonstrate the effect of a shock in series j on series i .

$$d_{j \leftarrow i}^{(h)}(\tau) = \frac{\sum_{\ell=0}^{h-1} \left(e_i' B_{\ell}(\tau) \Omega e_i \right)^2}{\sum_{\ell=0}^{h-1} \left(e_j' B_{\ell}(\tau) \Omega B_{\ell}'(\tau) e_j \right)}$$

where e_i represents a zero vector with unity on the i th position. $d_{j \leftarrow i}^{(h)}(\tau)$ assesses the propagation of shocks influencing variable i into variable j . The normalized variance decomposition matrix is defined by the formula:

$$\tilde{d}_{j \leftarrow i}^{(h)}(\tau) = \frac{d_{j \leftarrow i}^{(h)}(\tau)}{\sum_{j=1}^k d_{j \leftarrow i}^{(h)}(\tau)}$$

To get information on the overall impact variable i has on all other variables j , the total directional connectedness TO others is computed:

$$TO_{\leftarrow i}^{(h)}(\tau) = \sum_{j=1, j \neq i}^n d_{j \leftarrow i}^{(h)}(\tau)$$

On the other hand, the impact of shocks from all other variables j on variable i is estimated by the total directional connectedness FROM the others:

$$FROM_{i \leftarrow \cdot}^{(h)}(\tau) = \sum_{j=1, j \neq i}^n \tilde{d}_{i \leftarrow j}^{(h)}(\tau)$$

The differences between the total directional connectedness TO others and the total directional connectedness FROM others give the net total directional connectedness interpreted as the net influence variable i has on the analyzed network:

$$NET_i^{(h)}(\tau) = TO_{\cdot \leftarrow i}^{(h)}(\tau) - FROM_{i \leftarrow \cdot}^{(h)}(\tau)$$

Following Ando et al. (2022), the Total Connectedness Index (TCI), capturing the average cross-variable spillover intensity, is expressed as:

$$TCI(\tau) = \frac{\sum_{i,j=1, j \neq i}^n \tilde{d}_{j \leftarrow i}^{(h)}(\tau)}{n}$$

3. Empirical Analysis

This section examines the interconnectedness among real-financial aggregates and economic freedom. A Quantile Vector Autoregression (QVAR) model of Ando et al. (2022) with one lag is employed, and various measures of directional connectedness are derived using 2-quarter-ahead forecast error decompositions and a window size of 20 quarters.⁵ The analysis is conducted across three quantiles: the median ($\tau = 0.50$) representing normal conditions, the lower quantile ($\tau = 0.05$) capturing downturns, and the upper quantile ($\tau = 0.95$) reflecting extreme market fluctuations of the Tunisian economy.

3.1. Static Quantile Connectedness

Table 3 reports the static directional connectedness measures at the extreme quantiles (5% and 95%) and at the median. The results demonstrate that the Total Connectedness Index (TCI) rises markedly in both bearish and bullish market regimes compared to normal economic conditions. At the lower extreme quantile, the TCI peaks at 69.65%, signaling intensified systemic interdependence during downturns, while at the upper extreme quantile it reaches 64.74%, relative to only 49.19% under median, more stable conditions. This evidence suggests that real-financial aggregates and economic freedom become significantly more interconnected under extreme economic and financial conditions than under normal circumstances, thereby underscoring the usefulness of the QVAR framework in capturing tail-risk dynamics. These findings align with recent literature (e.g., Bouri et al., 2021; C. Y. H. Chen et al., 2022; N. Kyriazis et al., 2024a), which also highlight a significant increase in system-wide connectedness at extreme quantiles compared to average conditions.

Table 3. Static quantile connectedness results.

	M2	INT.RATE	USD.TND	TUNINDEX	Eco Freedom	CPI	GDP	FORCETRAV	FROM
PANEL A: Lower Quantile (q = 0.05)									
M2	29.73	8.55	12.89	8.55	11.18	7.90	9.53	11.68	70.27
INT.RATE	7.54	30.98	6.67	14.96	6.77	12.76	13.29	7.02	69.02
USD.TND	10.01	8.98	34.68	9.60	9.96	9.57	9.10	8.10	65.32
TUNINDEX	9.69	9.42	13.02	27.21	8.60	11.59	11.19	9.26	72.79

Table 3. Cont.

	M2	INT.RATE	USD.TND	TUNINDEX	Eco Freedom	CPI	GDP	FORCETRAV	FROM
PANEL A: Lower Quantile (q = 0.05)									
Eco. Freedom	11.36	9.09	11.43	8.97	33.07	10.09	6.74	9.25	66.93
CPI	9.94	13.26	10.13	10.79	9.39	24.46	11.84	10.19	75.54
GDP	9.93	10.91	9.36	11.39	7.07	8.98	27.52	14.84	72.48
FORCETRAV	11.65	8.30	9.78	9.81	8.79	6.15	10.34	35.18	64.82
TO	70.11	68.52	73.29	74.07	61.76	67.04	72.04	70.35	557.17
Inc. Own	99.83	99.50	107.98	101.28	94.83	91.50	99.55	105.53	TCI
NET	−0.17	−0.50	7.98	1.28	−5.17	−8.50	−0.45	5.53	69.65
NPT	4.00	5.00	6.00	4.00	1.00	2.00	2.00	4.00	
PANEL B: Medium Quantile (q = 0.50)									
M2	52.73	7.92	6.38	6.73	6.80	5.36	5.30	8.78	47.27
INT.RATE	4.44	52.15	5.19	7.83	5.34	9.31	10.85	4.87	47.85
USD.TND	8.77	5.57	51.81	4.90	6.18	7.02	6.01	9.75	48.19
TUNINDEX	10.02	5.24	8.05	46.88	8.26	5.83	8.32	7.40	53.12
Eco. Freedom	6.28	8.18	5.28	3.22	51.37	5.54	12.03	8.10	48.63
CPI	7.85	9.36	6.50	3.52	4.40	48.68	8.40	11.29	51.32
GDP	6.50	8.44	6.18	2.09	9.25	5.99	52.04	9.51	47.96
FORCETRAV	5.15	5.66	5.18	7.96	6.34	8.09	10.79	50.83	49.17
TO	49.01	50.37	42.75	36.26	46.57	47.14	61.71	59.70	393.52
Inc. Own	101.74	102.52	94.56	83.14	97.94	95.82	113.75	110.53	TCI
NET	1.74	2.52	−5.44	−16.86	−2.06	−4.18	13.75	10.53	49.19
NPT	4.00	5.00	2.00	2.00	3.00	3.00	5.00	4.00	
PANEL C: Upper Quantile (q = 0.95)									
M2	37.02	7.24	9.86	7.98	9.66	7.75	8.05	12.45	62.98
INT.RATE	7.51	34.05	11.42	11.03	7.71	13.29	9.75	5.24	65.95
USD.TND	10.38	8.78	34.94	7.81	11.06	12.20	7.58	7.24	65.06
TUNINDEX	8.89	8.78	9.39	32.03	9.49	11.62	13.81	6.00	67.97
Eco Freedom	9.10	10.85	11.00	9.73	32.96	8.40	8.76	9.20	67.04
CPI	8.92	10.57	14.27	5.67	6.32	32.02	13.08	9.13	67.98
GDP	9.55	13.49	6.49	6.04	5.34	9.62	36.24	13.23	63.76
FORCETRAV	9.62	7.52	6.46	7.83	6.39	5.55	13.81	42.83	57.17
TO	63.99	67.24	68.89	56.09	55.96	68.43	74.83	62.49	517.92
Inc.Own	101.01	101.29	103.84	88.12	88.91	100.45	111.07	105.32	TCI
NET	1.01	1.29	3.84	−11.88	−11.09	0.45	11.07	5.32	64.74
NPT	5.00	3.00	3.00	3.00	2.00	3.00	5.00	4.00	

3.1.1. Upper Regime

The empirical findings on spillover connectedness at the upper quantile, reported in Table 2, are broadly consistent with established macroeconomic theory and previous empirical evidence.⁶ In line with the Quantity Theory of Money (Fisher, 1911) and related empirical contributions (Frenkel, 1976; Dornbusch, 1976; Bahmani-Oskooee & Malixi, 1992; Rogoff, 1996; Alesina & Summers, 1993; Lawson & Murphy, 2020), the results suggest that

expansions in money supply generate inflationary pressures through several interconnected macro-financial transmission channels. This mechanism appears particularly relevant in the Tunisian context, where monetary conditions, exchange rate fluctuations, and institutional dynamics remain closely interconnected across different economic regimes.⁷

The spillover estimates at the 95th quantile, corresponding to bullish or recovery phases of the Tunisian economy, reveal that the exchange rate constitutes one of the most sensitive variables within the system. More specifically, the exchange rate is strongly affected by money supply shocks (10.38%), inflation (12.20%), and economic freedom (11.06%), highlighting its vulnerability to both monetary expansion and broader macro-institutional conditions. These findings are consistent with the literature on exchange rate determination in emerging economies, where inflationary pressures and institutional instability tend to amplify currency fluctuations. Inflation itself is mainly influenced by exchange rate movements (14.27%), confirming the existence of a strong exchange rate pass-through effect, which is a well-documented phenomenon in small open economies. The substantial effects of GDP (13.08%) and interest rates (10.57%) on inflation further indicate that both demand-side pressures and monetary policy conditions play an important role in shaping price dynamics in Tunisia. In turn, interest rates are predominantly affected by inflation (13.29%) and exchange rates (11.42%), reflecting monetary authorities' reactions to both domestic inflationary pressures and external macroeconomic shocks. Concerning financial markets, the Tun-Index is mainly influenced by GDP (13.81%) and inflation (11.62%), indicating that stock market dynamics remain strongly connected to macroeconomic performance and price stability. Economic freedom (9.49%) and exchange rate movements (9.39%) also exert significant effects on the Tunisian stock market, suggesting that institutional quality and external competitiveness remain important determinants of investor confidence and asset pricing during expansionary phases. Economic freedom itself appears highly sensitive to macro-financial conditions. In particular, it is primarily affected by exchange rates (11.00%) and interest rates (10.85%), while the influence of other macro-financial variables remains around 9%. This pattern reveals that institutional conditions and regulatory quality in Tunisia evolve closely with monetary and financial stability, especially during favorable economic periods. The results therefore suggest that economic freedom is deeply integrated into Tunisia's macro-financial system and reacts strongly to fluctuations in key economic aggregates. A particularly noteworthy result concerns the strong bidirectional relationship between GDP and labor force dynamics. On the one hand, GDP significantly affects labor force conditions (13.23%), supporting the traditional view that economic expansion stimulates employment opportunities and labor market activity. On the other hand, labor force dynamics constitute the most important contributor to GDP (13.81%), which strongly supports neoclassical growth theory emphasizing labor as a fundamental factor of production and long-term economic growth. From a broader systemic perspective, GDP (74.83%), the exchange rate (68.89%), inflation (68.43%), and interest rates (67.24%) emerge as the largest transmitters of spillovers across the network, confirming their dominant role in propagating macroeconomic shocks throughout the Tunisian economy. At the same time, inflation (67.98%), the Tun-Index (67.97%), economic freedom (67.04%), interest rates (65.95%), and exchange rates (65.06%) are also among the largest receivers of spillovers. This dual role of some variables, particularly inflation and exchange rates, highlights both their centrality and high sensitivity within the macro-financial system. During this recovery phase of the Tunisian economy, economic freedom behaves primarily as a net receiver of externalities generated by real and financial aggregates. Specifically, economic freedom absorbs significantly more spillovers (67.04) than it transmits (55.96). This asymmetry suggests that institutional and regulatory structures in Tunisia remain more reactive than proactive, mainly absorbing macro-financial shocks rather than trans-

mitting them to the broader economic system. This interpretation is consistent with the institutionalist literature emphasizing that institutional quality often evolves as a response to macroeconomic conditions rather than as an independent driver of shocks (Acemoglu et al., 2005; Gwartney et al., 2023). Earlier empirical studies support similar conclusions. For example, Bengoa and Sánchez-Robles (2003) show that economic freedom plays an important role in attracting foreign direct investment, although its broader economic effects depend heavily on institutional quality. Likewise, Dawson (1998) argues that economic freedom mainly strengthens the economy's absorptive capacity rather than acting as a direct source of spillover transmission.⁸

Finally, the net spillover analysis identifies GDP (11.07%), labor force (5.32%), and exchange rates (3.84%) as the principal net transmitters of shocks, underlining their structural importance in shaping macro-financial interactions and institutional dynamics. These findings are consistent with Diebold and Yilmaz (2012) and Baruník and Křehlík (2018), who emphasize the dominant role of macroeconomic fundamentals in transmitting systemic shocks. Conversely, the Tun-Index (−11.88%) and economic freedom (−11.09%) emerge as net receivers of spillovers, supporting the institutionalist perspective according to which economic freedom is largely conditioned by broader macroeconomic and financial developments Hayet and Naceur (2021).⁹

3.1.2. Normal Regime

Table 3 also reports the spillover connectedness estimates at the 50th quantile, corresponding to normal market conditions. Compared with the upper quantile, both transmitted (TO) and received (FROM) spillovers are substantially lower, fluctuating between 47.27 and 51.32, which explains the relatively weak Total Connectedness Index (TCI = 49.19). This result suggests that, under stable economic conditions, the interactions between real-financial aggregates and economic freedom remain relatively limited, indicating a more segmented macroeconomic structure. Consequently, shocks affecting one variable are less likely to propagate throughout the system. Another important result is the substantial increase in own-shock spillovers, which account for more than 50% of the forecast error variance decomposition. This finding indicates that macroeconomic fluctuations during tranquil periods are driven mainly by internal and variable-specific dynamics rather than by cross-variable spillover effects. These results support the state-dependent spillover hypothesis highlighted by N. A. Kyriazis et al. (2024)¹⁰. At a more disaggregated level, interest rates are mainly influenced by inflation (9.31) and GDP (10.85), while the effects of other variables remain relatively limited, consistent with conventional monetary policy frameworks where central banks primarily react to inflationary pressures and output dynamics. Similarly, inflation is largely driven by interest rates (9.36) and labor force dynamics (11.29), suggesting the coexistence of demand-pull and cost-push inflationary mechanisms. By contrast, the influence of money supply, exchange rates, the Tun-Index, and economic freedom on inflation remains relatively moderate, reinforcing the dominant role of domestic macroeconomic fundamentals during stable economic periods. The exchange rate also appears relatively insulated from most macroeconomic variables, except for moderate spillovers from money supply (8.77) and labor force dynamics (9.75). This result may reflect exchange rate management policies and Tunisia's relatively limited integration into international capital markets. Likewise, the Tunisian stock market exhibits only moderate sensitivity to macroeconomic fluctuations, with spillovers originating mainly from money supply (10.02%), GDP (8.32%), exchange rates (8.05%), and economic freedom (8.26%). The latter result underlines the importance of institutional quality in shaping investor confidence and financial market performance. Economic freedom itself is mainly influenced by GDP (12.03), labor force conditions (8.10), and interest rates (8.18), while the impact of

the remaining variables remains relatively weak. This finding suggests that institutional and regulatory conditions in Tunisia evolve more closely with real economic activity than with short-term financial fluctuations. GDP, in turn, is significantly affected by economic freedom (9.25) and labor force dynamics (9.51), highlighting the importance of long-run structural and supply-side factors in explaining economic activity.

Overall, these findings indicate that under normal economic conditions, the Tunisian macroeconomic system exhibits relatively weak interconnectedness and limited spillover propagation among real-financial aggregates and economic freedom. The predominance of self-induced spillovers suggests that domestic macroeconomic variables evolve relatively autonomously during tranquil periods. While such low connectedness may reduce contagion risks and enhance short-term macroeconomic stability, it may also reflect a certain degree of structural under-integration, potentially limiting the diffusion of policy measures, institutional reforms, and investment impulses throughout the economy.

3.1.3. Lower Regime

Table 3 also presents the spillover connectedness estimates at the lower quantile (5th percentile), corresponding to periods of economic stress and bearish market conditions. The results reveal a high degree of interconnectedness among real-financial aggregates and economic freedom, with all variables significantly influencing one another. This balanced pattern of transmission indicates the absence of a single dominant transmitter or receiver of shocks and suggests that spillovers propagate broadly and symmetrically across the system. Consequently, the Total Connectedness Index (TCI) reaches a high level of 69.65, reflecting substantial systemic interdependence during adverse economic conditions. The QVAR-based connectedness analysis further shows that most variables simultaneously act as transmitters and receivers of spillovers, confirming the strong circularity of macro-financial interactions in crisis regimes. Inflation emerges as the primary receiver of shocks, with a total received connectedness of 75.54. In particular, inflation is strongly affected by interest rates (13.26), GDP (11.84), the Tun-Index (10.79), exchange rates (10.13), labor force dynamics (10.19), money supply (9.94), and economic freedom (9.39). These findings support both monetarist and structuralist perspectives, according to which inflation is highly sensitive to monetary, financial, and real-sector disturbances (Friedman, 1968; R. E. Lucas, 1972; Bruno & Easterly, 1998; Bernanke et al., 2005). GDP also appears as a major recipient of spillovers (72.48), mainly driven by labor force dynamics (14.84), the Tun-Index (11.39), and interest rates (10.91), while spillovers from other variables remain close to 9%. By contrast, the contribution of economic freedom to GDP fluctuations is comparatively weaker (7.07). This result is consistent with growth and monetary transmission theories emphasizing the role of labor, financial markets, and monetary conditions in driving economic activity. Empirical evidence also confirms that in bank-dominated developing economies such as Tunisia, GDP fluctuations are more immediately linked to labor market conditions, financial market signals, and monetary policy than to institutional variables, whose effects generally materialize over the longer term.

The Tun-Index, representing the Tunis Stock Exchange, is another major recipient of spillovers (72.79), primarily influenced by exchange rates (13.02), inflation (11.59), and GDP (11.19). These findings are consistent with macro-financial theories emphasizing the sensitivity of stock markets to macroeconomic fundamentals (N. F. Chen et al., 1986; Fama, 1990). By contrast, economic freedom contributes relatively weakly to stock market spillovers (8.60), suggesting that institutional quality mainly affects long-run investment climate and market efficiency rather than short-term stock market fluctuations (Acemoglu et al., 2005; Gwartney et al., 2006). Money supply also absorbs substantial spillovers (70.27), particularly from exchange rates (12.80), inflation, and other financial variables. These

findings are broadly consistent with the Quantity Theory of Money and the monetary transmission mechanism literature (Fisher, 1911; Mishkin, 1996).¹¹ A particularly interesting result concerns the strong spillovers transmitted from economic freedom to money supply (11.18), which are larger than those directed toward most other variables. This suggests that institutional dimensions such as monetary stability, regulatory quality, and openness significantly influence monetary conditions during crisis periods. These findings align with Alesina and Summers (1993) and Gwartney et al. (2006), who argue that stronger economic freedom enhances monetary policy credibility and financial intermediation. Interest rates also receive substantial spillovers (69.02), although the distribution of these effects remains more heterogeneous, ranging from 14.96 from the Tun-Index to 6.67 from exchange rates. This uneven structure likely reflects the dual role of interest rates as both monetary policy instruments and market-based indicators of economic conditions (Taylor, 1993).¹²

On the transmission side, the main transmitters of spillovers are the stock market (74.07), exchange rates (73.29), and GDP (72.04), confirming their central role in propagating shocks throughout the Tunisian macro-financial system. These results are consistent with previous studies on spillover dynamics in emerging economies (Mensi et al., 2017; Burstein & Gopinath, 2014). Other variables, including inflation, money supply, interest rates, and economic freedom, also display substantial transmission power, generally close to 70%. Importantly, economic freedom appears strongly procyclical becoming more tightly connected with macroeconomic and financial aggregates during crisis periods. This result is consistent with theoretical and empirical studies showing that institutional variables, particularly sound money, regulatory quality, and trade openness, react more strongly during turbulent economic conditions (de Haan & Sturm, 2000; Bergh & Bjørnskov, 2021). In the Tunisian context, economic freedom also emerges as an important receiver of spillovers (66.93), highlighting the vulnerability of institutional and regulatory structures during downturns. This finding supports the institutionalist view according to which adverse macroeconomic conditions weaken institutional resilience and amplify systemic fragility (Acemoglu et al., 2003; Gani & Prasad, 2008).¹³

Overall, the lower-quantile results indicate that bearish economic regimes in Tunisia are characterized by intense and highly synchronized spillover dynamics between macroeconomic, financial, and institutional variables. During crisis periods, shocks become rapidly transmitted across the entire system, increasing systemic vulnerability and reducing the capacity of individual variables to evolve independently. These findings confirm that macro-financial connectedness in Tunisia is strongly regime-dependent, becoming substantially stronger during periods of economic and financial stress (Acemoglu et al., 2003; Gani & Prasad, 2008).

3.2. Dynamic Connectivity

The dynamic interconnectedness among Tunisia's key real-financial aggregates, including money supply, inflation, interest rates, GDP, exchange rate (TND/USD), labor force, the Tun-Index and components of economic freedom, displays strong regime-dependent behavior, as reflected by the evolution of the Total Connectedness Index (TCI) across different phases of the economy. Figures 1–3 display the dynamics of the total connectedness among real-financial aggregates and economic freedom at lower, medium and upper quantiles. A detailed analysis of TCI dynamics in a bearish economic context (see Figure 1) reveals a predominantly horizontal trend, punctuated by pronounced peaks during crisis periods, most notably in 2020. During major periods of economic stress (quantile = 0.05), such as the Arab Spring in 2011, the COVID-19 pandemic in 2020, the Russia–Ukraine conflict in 2022 and the Hamas–Israel conflict in October 2023, the TCI surged to high levels between 80% and 90%, indicating elevated systemic risk and profound connectedness among real-financial

aggregates and economic freedom. In 2011, following the political upheaval of the Arab Spring, the TCI approached 83%, highlighting widespread uncertainty and sectoral vulnerability. Similarly, during the COVID-19 pandemic in 2020, the TCI peaked at approximately 90%, reflecting the simultaneous collapse in output, labor markets, and financial stability (in 2021, the growth of domestic production in Tunisia was -8.4%). The 2022 Russia–Ukraine war maintained the TCI close to 82%, driven by global commodity price shocks, inflation surges, and exchange rate volatility, severely impacting Tunisia’s external and internal macroeconomic balances. Following the surprise attack by Hamas on 7 October 2023, international geopolitical tensions escalated, driving the TCI to nearly 85%. This surge is primarily attributed to disruptions in global commodity markets, particularly wheat and its derivatives, which are heavily imported by many developing countries, including Tunisia. These patterns align closely with Keynesian and monetarist theories, where during crises, output contraction, inflationary pressures, and exchange rate devaluations interact to amplify systemic risks (Okun, 1962; Friedman, 1968; Mundell, 1963). We conclude that the dynamic evolution of the TCI indicates that economic freedom is tightly integrated with Tunisia’s real-financial system in crisis regimes ($\text{TCI} \approx 80\text{--}90\%$). In periods of economic downturn, Arab Spring (2011), COVID-19 (2020), Russia–Ukraine shock (2022) and Gaza episode (October 2023), macroeconomic contractions, inflation spikes and exchange rate tensions synchronize with movements in the components of economic freedom (sound money, regulatory burden, openness), making economic freedom a highly reactive receiver and amplifier of shocks.

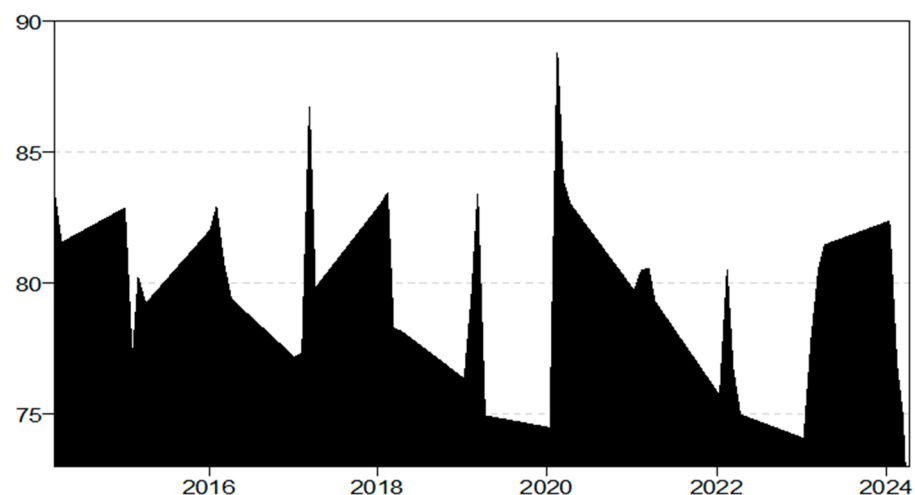


Figure 1. The dynamics of the total connectedness among real-financial aggregates and economic freedom in the lower quantile.

Interestingly, even during periods of economic expansion (quantile 0.95), the TCI remained exceptionally high, fluctuating near 90% (see Figure 2). This result suggests that Tunisia’s economy maintains significant interconnectedness among real-financial aggregates and economic freedom even in growth phases, consistent with structuralist and New Keynesian views emphasizing persistent linkages through credit markets, investment flows, and external sector vulnerabilities (Clarida et al., 1999; Barro, 1976). The dynamics of the TCI during the bullish phase of the Tunisian economy exhibit two distinct trends. The first is an upward trend from 2010 to 2020, during which the TCI rose from 82% in 2010 to a peak of 88% in 2020. This dynamic was driven by a combination of international and domestic factors, including the Arab Spring in Tunisia in 2011, persistent inflation in Tunisia (2017–2023), continuous depreciation of the Tunisian dinar against the dollar and euro, public debt crisis and IMF negotiations (2013–2023), and rising global commodity prices (oil,

cereals) after the war in Ukraine (2022). Together, these events intensified the connectedness among real-financial aggregates and the components of economic freedom. The second trend is a decline in the TCI from 2021 to 2024, marked by a drop to 74% in early 2023. Brief surges were observed in 2022 and late 2023, mainly triggered by the Russia–Ukraine conflict and the escalation of hostilities in Gaza. During these years, the TCI persisted at elevated levels around 87%, showing that regional geopolitical instability quickly transmits into Tunisia’s macro-financial system, reinforcing inflationary pressures and exchange rate tensions in line with the Mundell–Fleming framework (Mundell, 1963). More precisely, in 2022, Tunisia experienced an inflation rate of 9%, prompting policymakers to depreciate the national currency against the G7 currencies. This monetary adjustment resulted in a 5% increase in exports, which subsequently contributed to a 1.2% rise in the country’s gross domestic product and consequently a rise in connectedness between economic freedom and real-financial aggregates.

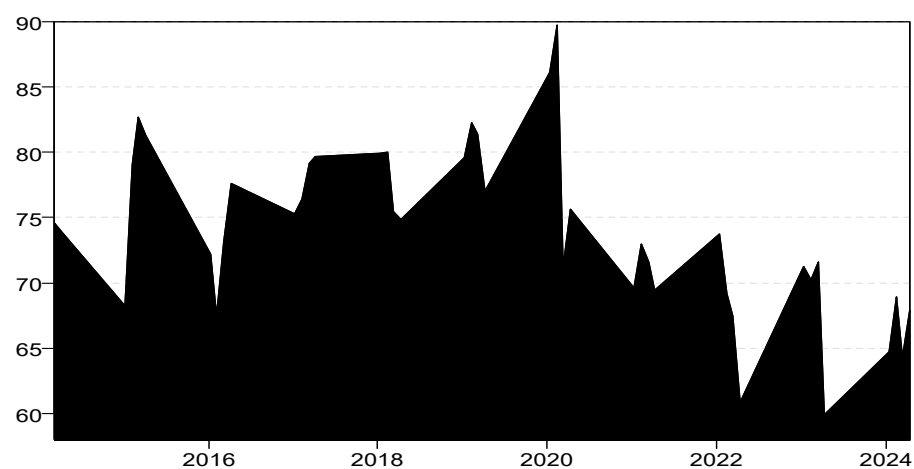


Figure 2. The dynamics of the total connectedness among real-financial aggregates and economic freedom in the upper quantile.

Furthermore, under normal economic conditions (quantile 0.5), the TCI stabilized between 50% and 65%, indicating significant but more moderate interconnectedness among real-financial aggregates and economic freedom (see Figure 3). Notably, in 2016, following the oil price collapse that benefited Tunisia as a net oil importer, the TCI declined to approximately 55%, suggesting improved macroeconomic resilience. However, in 2018, the TCI rose again to about 65%, coinciding with the U.S. Federal Reserve’s monetary tightening cycle, where successive interest rate hikes triggered global capital flow reversals and exchange rate pressures in emerging markets. The adverse effects of tighter U.S. monetary policy on Tunisia’s financial conditions and external balances are consistent with open-economy macroeconomic theories, which predict significant spillovers from global liquidity shocks (Obstfeld, 2015). These findings related to the connectedness under normal conditions in the Tunisian economy support the evidence of the intensification of interrelationships among real-financial aggregates and economic freedom during extreme economic and financial situations, and the high sensitivity of real-financial aggregates to economic freedom at the level of the fat tails.

Overall, these results reveal that connectedness among real-financial aggregates and economic freedom is characterized by persistent, high interconnectedness across crises and expansion phases, challenging traditional theories predicting decoupling during booms (R. Lucas, 1976). Our findings substantiate macroeconomic models suggesting that in emerging and financially integrated economies, structural vulnerabilities, external dependencies, and policy transmission frictions maintain strong inter-sectoral linkages throughout the

economic cycle. Consequently, maintaining robust macroprudential frameworks and proactive structural reforms is essential to mitigate systemic risks and strengthen Tunisia's economic resilience over time.



Figure 3. The dynamics of the total connectedness among real-financial aggregates and economic freedom in the medium quantile.

In conclusion, our empirical findings highlight that Tunisia's macroeconomic aggregates are characterized by a consistently high degree of dynamic interconnectedness across different phases of the economic cycle. The persistence of strong linkages during both adverse and favorable conditions challenges traditional macroeconomic theories that predict lower systemic integration during periods of economic expansion. Instead, the results support more recent structuralist and New Keynesian perspectives that emphasize the role of financial vulnerabilities, external sector dependencies, and policy transmission frictions in shaping macroeconomic dynamics. The elevated and resilient levels of the Total Connectedness Index (TCI) observed across various crises, global shocks, and domestic adjustments underscore the systemic nature of risk propagation within the Tunisian economy. These insights call for the implementation of robust macroprudential frameworks and proactive policy interventions aimed at strengthening economic resilience and minimizing systemic vulnerabilities.

Moreover, to capture the asymmetric dynamics of connectedness among real-financial variables and economic freedom, we compute the relative tail dependence (RTD hereafter), defined as the difference between the upper tail connectedness index TCI (0.95) and the lower tail connectedness index TCI (0.05). This measure directly quantifies how spillovers differ between expansionary and contractionary regimes and has been increasingly applied in the literature to study systemic risk and contagion under extreme states (Diebold & Yilmaz, 2014; Ando et al., 2022). The RTD provides useful insights into the asymmetric behavior of real-financial economic freedom connectedness across the business cycle. A positive RTD indicates that the Total Connectedness Index (TCI) is stronger in the upper quantile (0.95) than in the lower quantile (0.05), suggesting that linkages among macroeconomic aggregates, financial markets, and economic freedom become more intense during expansions. By contrast, a negative RTD implies that connectedness is more pronounced in bearish regimes, highlighting that downturns or crises amplify spillover transmission. In such contexts, shocks related to inflation, exchange rate pressures, or liquidity shortages spread more rapidly across markets and institutional dimensions, making the system more vulnerable and tightly synchronized under stress. Figure 4 illustrates the dynamics of the RTD, highlighting the asymmetric patterns of connectedness among real-financial aggregates and economic freedom, as RTD values fluctuate between positive and negative, with a clear predominance of negative ones. As just already said, the quarterly dynamics of the RTD reveal that positive values are relatively rare, occurring only in a few quarters, notably in 2015 (Q2–Q4), 2019 (Q1, Q2, Q4), and early 2020 (Q1–Q2). These findings

suggest that, during phases of recovery or relative expansion, the connectedness between economic freedom and real-financial aggregates in Tunisia is stronger in the upper tail of the distribution, consistent with the procyclical role of economic freedom documented in the literature (Gwartney et al., 1999; Williamson & Mathers, 2011). However, in most quarters, the RTD remains negative, implying that connectedness intensifies under bearish economic conditions. This pattern is particularly pronounced during major crisis episodes. For instance, during the COVID-19 shock, the RTD sharply declined from 11.63 in early 2020 to -12.65 in Q3-2020, before remaining negative at -7.38 in Q4-2020. Similarly, during the Russia–Ukraine conflict in 2022, the RTD reached -11.31 in Q2-2022 and -14.15 in Q4-2022, reflecting a substantial increase in downside spillovers. The asymmetry became even stronger in 2023 and 2024, with RTD values falling to -21.54 in Q4-2023 and -17.66 in Q1-2024, indicating extremely high levels of connectedness under adverse economic conditions. These findings resonate with prior evidence showing that financial and institutional linkages tend to strengthen during downturns and crises, reflecting heightened contagion and systemic vulnerability (Diebold & Yilmaz, 2014; Baruník & Křehlík, 2018). In the Tunisian context, macro-financial shocks such as political instability, persistent inflationary pressures, exchange rate depreciation, and external crises, including COVID-19 and the Russia–Ukraine conflict, appear to synchronize more strongly with institutional and economic freedom dynamics. This asymmetry highlights the differential responses of connectedness across the distributional tails, suggesting that negative shocks generate substantially stronger spillover effects than positive shocks of comparable magnitude.

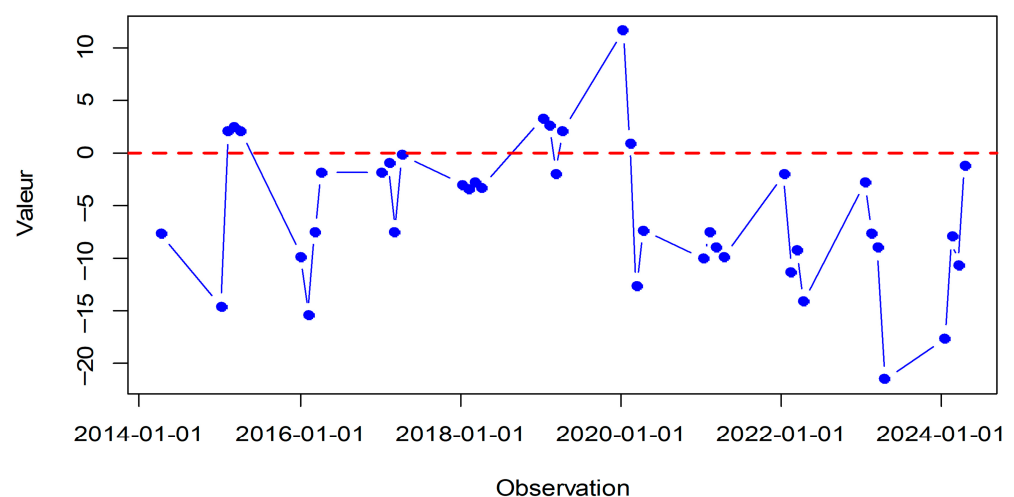


Figure 4. Relative tail dependence.

Figures 5–7 illustrate the net spillover effects of real-financial aggregates and economic freedom across the median and extreme lower and upper quantiles. As shown in Figure 5, under the median quantile, the net spillovers of real-financial aggregates and economic freedom display considerable fluctuations, with all variables oscillating around zero. In other words, each aggregate alternates between acting as a net receiver and a net transmitter of externalities. A closer examination of Figure 5 indicates that the labor force and GDP aggregates function predominantly as net transmitters of externalities to the rest of the system, displaying almost identical spillover curves (See Figure 5). This outcome is consistent with the notion that real economic activity constitutes a primary driver of systemic dynamics, as suggested by Diebold and Yilmaz (2012) and Baruník and Křehlík (2018), who emphasize the central transmitting role of output and labor markets in connectedness frameworks. By contrast, the exchange rate emerges as a variable that is almost always a net receiver of externalities, except during certain quarters in 2018. This

asymmetry reflects the vulnerability of small open economies with managed exchange rate regimes, in line with findings by [Dornbusch and Fischer \(1980\)](#) and [Bahmani-Oskooee and Kara \(2005\)](#), who show that exchange rates tend to absorb shocks transmitted by real and monetary fundamentals. Other aggregates, such as money supply, inflation, interest rates, and economic freedom, oscillate between being net receivers and net transmitters of externalities, consistent with the cyclical and regime-dependent behavior highlighted in recent spillover literature ([Bouri et al., 2021](#); [C. Y. H. Chen et al., 2022](#)). Economic freedom behaved predominantly as a net receiver of externalities from the beginning of the period until late 2017, after which it gradually shifted into a net transmitter of spillovers. This dynamic pattern reflects the evolving role of institutional and regulatory factors in Tunisia's economy. Under normal economic conditions (median quantile), interest rates and inflation acted as net receivers until 2019, reflecting their passive adjustment to macroeconomic dynamics. Their subsequent shift to net transmitters suggests that policy interventions and inflation persistence began generating wider spillovers even in stable times, consistent with [Fischer \(1993\)](#) and [Friedman \(1968\)](#). By contrast, the Tun-Index remained mostly a net receiver of shocks, highlighting the limited depth and resilience of Tunisia's financial market, as also observed in other emerging economies ([Bekaert & Harvey, 2003](#); [Alagidede & Panagiotidis, 2010](#)).

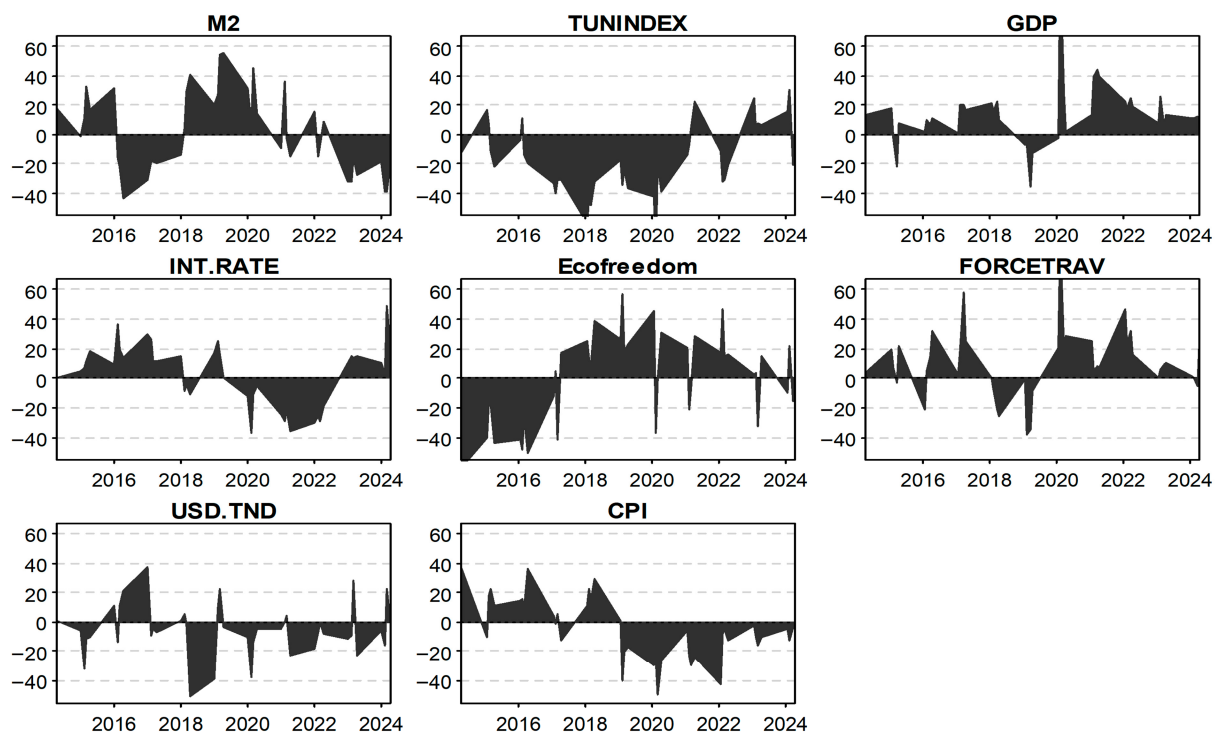


Figure 5. The net spillover effects of real-financial aggregates and economic freedom in the median quantile.

Figures 6 and 7 illustrate the dynamics of net spillovers among real-financial aggregates and economic freedom at the lower and upper extreme quantiles. The results reveal substantial differences depending on whether the Tunisian economy is in a bullish or bearish state. In line with the static analysis, during expansionary phases (see Figure 6), GDP and the labor force consistently generated positive net externalities, confirming their role as primary transmitters of macro-financial dynamics. This finding aligns with growth theory and empirical evidence ([Barro, 1991](#); [Acemoglu et al., 2005](#)), which emphasize the central role of output and labor in driving economic interconnections. By contrast, economic freedom behaved largely as a passive actor during this phase of expansion, consistently

absorbing more shocks than it transmitted. This pattern suggests that institutional and regulatory frameworks in Tunisia are more reactive than proactive, a feature documented in other developing economies (Carlsson & Lundström, 2002; Heckelman & Stroup, 2005a). The Tunis Stock Exchange (Tun-Index) also emerged as a persistent net receiver of negative spillovers, reflecting its limited depth, weak investor base, and vulnerability to macroeconomic fluctuations (Bekaert & Harvey, 2003; Alagidede & Panagiotidis, 2010). Meanwhile, money supply, interest rates, inflation, and the exchange rate alternated between transmitting and receiving externalities, thereby playing a more marginal role in shaping systemic connectivity. Overall, these findings suggest that, in periods of economic expansion in Tunisia, the connectivity among real-financial aggregates and economic freedom is predominantly driven by real-sector dynamics, particularly GDP and labor force, while economic freedom and financial markets remain secondary, more reactive channels.

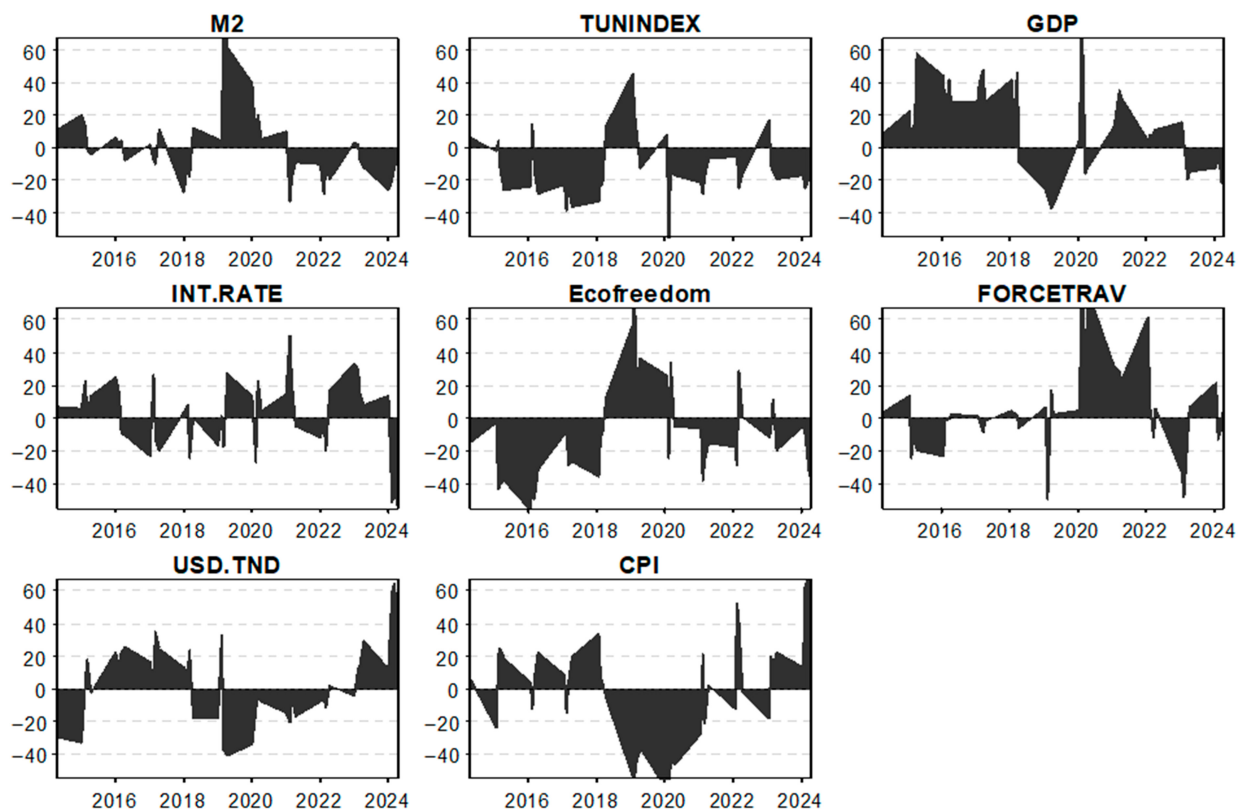


Figure 6. The net spillover effects of real-financial aggregates and economic freedom in the upper quantile.

Figure 7 depicts the dynamics of net externalities among real-financial variables and economic freedom when the Tunisian economy is in a bearish state. A key finding is that the exchange rate, the labor force, and GDP emerge as the main sources of positive net spillovers. For these three aggregates, the dynamics are predominantly positive, confirming their role as primary net transmitters of externalities to the rest of the system. The Tun-Index only begins to assume this transmitter role from certain quarters of 2021; prior to this, the stock market consistently absorbed more shocks than it generated, reflecting its limited depth and vulnerability to macroeconomic volatility. During this period of economic stress, economic freedom, by contrast, appears essentially as a net receiver of spillovers, suggesting that Tunisia's institutional and regulatory frameworks act more passively in the face of real-financial shocks, a feature consistent with findings in other emerging economies (Carlsson & Lundström, 2002; Heckelman & Stroup, 2005b). Even more pronounced is the case of inflation, which throughout the period absorbs far more externalities than it

transmits, making it the most important net receiver of spillovers, consistent with the literature highlighting inflation's role as a shock absorber in fragile economies (Friedman, 1977; Fischer, 1993). The remaining aggregates (money supply, exchange rate and interest rates) oscillate around zero, alternately acting as net transmitters and receivers, thus playing a secondary role in systemic connectivity. In conclusion, GDP and the labor force emerge as the main drivers shaping the connectivity between real-financial aggregates and economic freedom. This result aligns with the institutional literature emphasizing that real sector activity and human capital are key channels linking institutional quality to macro-financial performance (North, 1990; Acemoglu et al., 2005). Empirically, similar evidence from Dawson (1998) and Gwartney et al. (2023) supports the view that economic freedom in emerging economies like Tunisia evolves endogenously with real economic fundamentals rather than acting as an exogenous force.

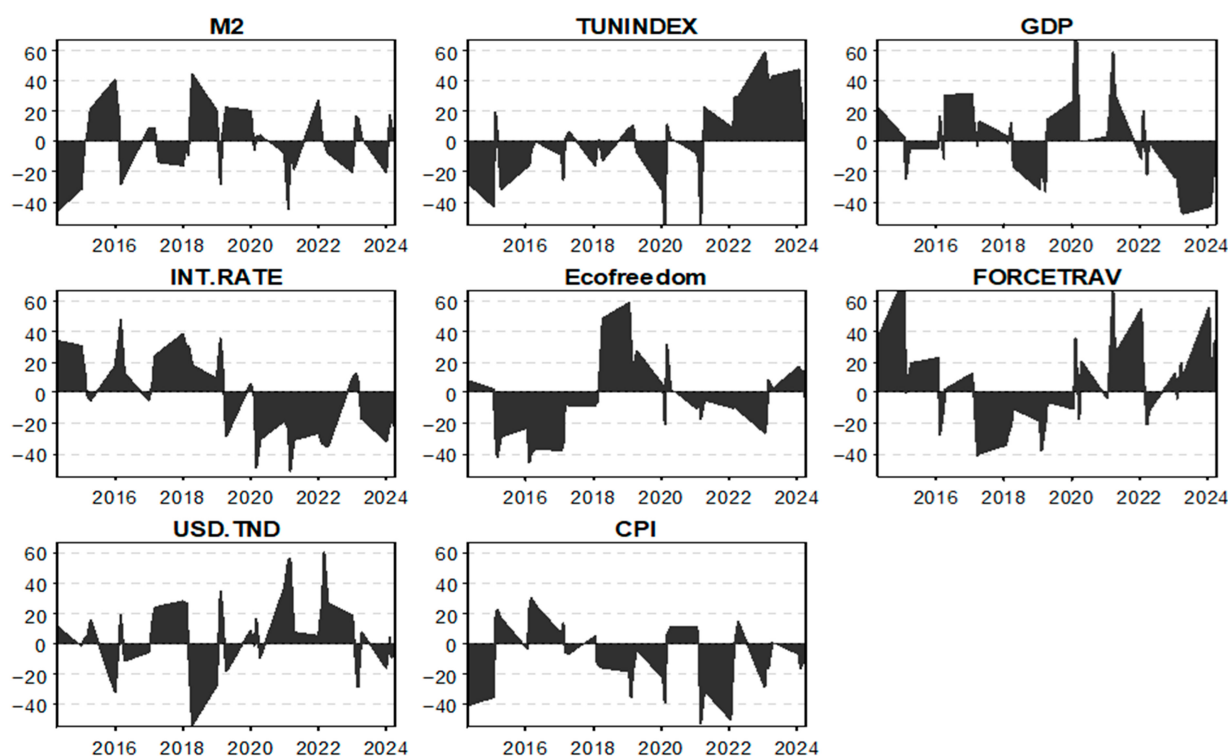


Figure 7. The net spillover effects of real-financial aggregates and economic freedom in the lower quantile.

3.3. Time-Varying Net Pairwise Spillovers Among Real-Financial Aggregates and Economic Freedom

In this section, we investigate the dynamic pairwise net externalities between economic freedom and each of the real and financial variables considered in this study, namely money supply, interest rate, exchange rate, inflation, Tun-Index, GDP, and labor force, focusing on Tunisia as a case study.¹⁴ This analysis delineates the pairwise net connectivity of these variables, distinguishing it from the total connectivity index that measures overall interdependence among all variables (Diebold & Yilmaz, 2014; Baruník & Křehlík, 2018). Such a distinction allows for a more granular understanding of the directional spillovers and specific channels through which economic freedom interacts with key macroeconomic indicators (Koop et al., 1996; Engle & Ng, 1993).

Figure 8 displays the net pairwise connectedness between economic freedom and each of the real-financial aggregates considered in the study under the stable regime (quantile = 0.50). The empirical results show that economic freedom was particularly

sensitive to interest rates, labor force dynamics, and inflation during the period 2014–2018. By contrast, it functions as a net transmitter of substantial externalities to the money supply (from 2021 until the end of the period), to the Tunis Stock Exchange (from late 2019 until the end of the sample), and to inflation (from late 2018 to early 2021). Overall, the bidirectional influence of economic freedom on real and financial aggregates underscores its significance as either a proactive or a reactive force, depending on Tunisia's socio-economic conditions. Moreover, during relatively stable phases of the economy (such as 2014, early 2017, and parts of 2023), its dual role as both a net transmitter and receiver of externalities in moderate and balanced proportions suggests a gradual co-evolution with macro-financial fundamentals, rather than a dominant or destabilizing effect.

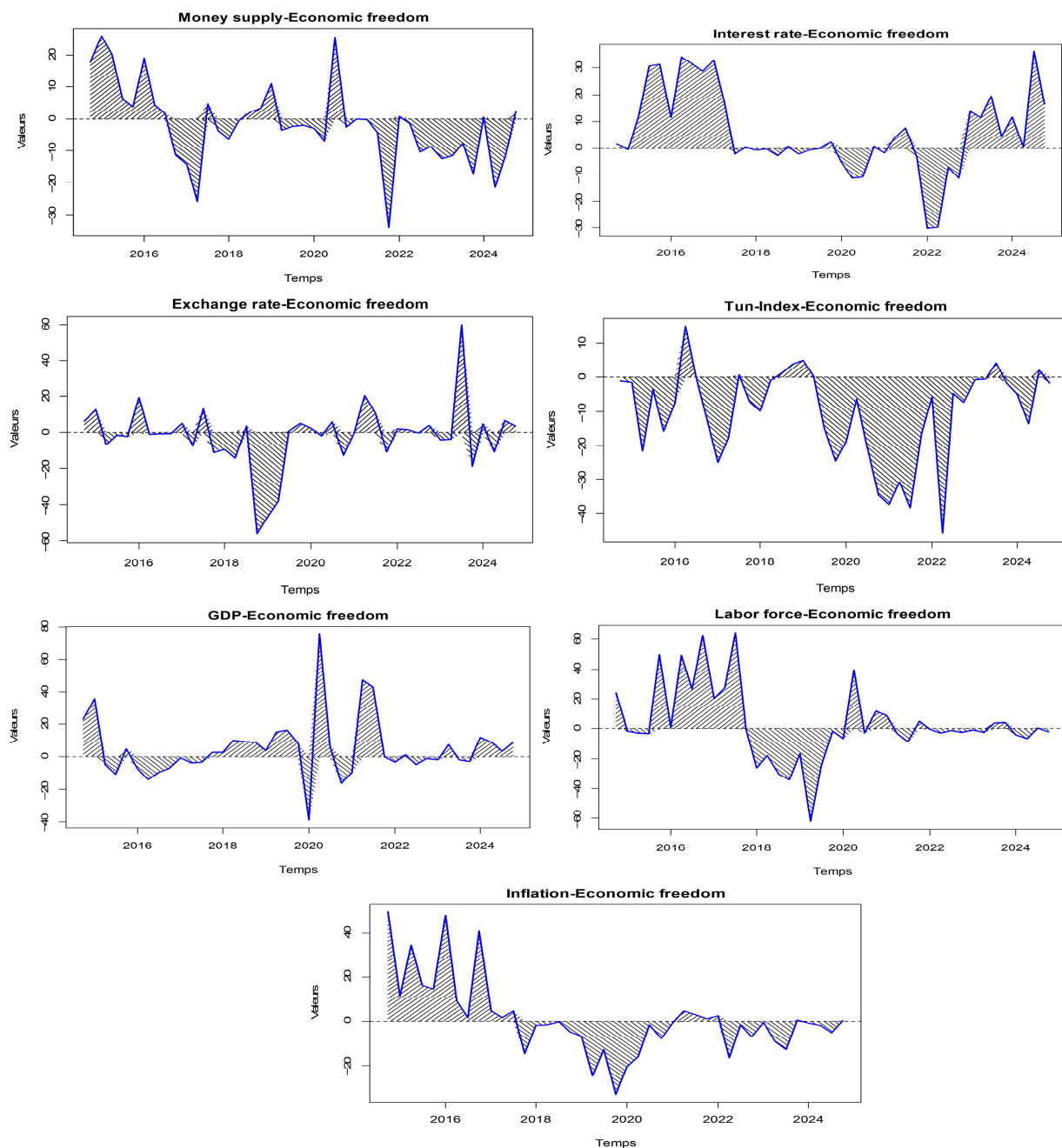


Figure 8. The net pairwise connectedness between economic freedom and each of the real-financial aggregates in the stable regime (quantile = 0.50).

Figure 9 plots the time-varying net pairwise spillovers between each real-financial aggregate and economic freedom under higher economic and financial states of the Tunisian economy. The empirical results indicate that during economic upswings (quantile = 0.95), economic freedom played a strong proactive role by transmitting externalities primarily to the money supply, the stock market, and inflation. This was particularly evident during episodes of partial recovery in Tunisia in 2017 (modest growth of 1.9% with a slight rebound in tourism), 2019 (a peaceful political transition marked by the election of Kaïs Saïed, which restored investor confidence), and 2021–2022 (a post-COVID-19 recovery of approximately 3%). In these years, externalities were largely transmitted to the money supply, suggesting that monetary interventions undertaken by the Tunisian authorities were central to this dynamic, in line with findings by Levine (1997) and Gwartney et al. (2023), which highlight the role of institutional quality in shaping monetary and financial outcomes. Likewise, the Tunis Stock Exchange Index and inflation were significantly influenced by economic freedom during the post-COVID-19 period, corroborating evidence from Beck and Levine (2005) and Fernández and Tamayo (2017), who show that stronger institutions tend to enhance financial market responses and price dynamics. By contrast, GDP, labor force, and the interest rate emerged as sources of externalities transmitted to economic freedom during the socio-economic crises of 2014–2018, a period characterized by the tourism collapse following terrorist attacks and widespread protests against inflation. This asymmetry suggests that in times of economic distress, institutions behave more reactively by absorbing shocks (Dawson, 1998; Diebold & Yilmaz, 2012), whereas in periods of socio-economic euphoria, economic freedom assumes a dominant, proactive role in regulating real and financial aggregates, consistent with the institutional development literature (North, 1990; Acemoglu et al., 2005).

In the downward phase (quantile = 0.05), Figure 10 indicates that economic freedom in Tunisia both receives and transmits net externalities vis-à-vis nearly all real and financial aggregates. However, a closer examination of the pairwise dynamics reveals that economic freedom predominantly absorbs shocks rather than generates them, particularly from inflation, money supply, the exchange rate, interest rates, and labor force.¹⁵ This asymmetry underscores the reactive nature of economic freedom under adverse macroeconomic conditions, consistent with the evidence of Dawson (1998), who finds that economic freedom reinforces absorptive capacity rather than acting as a driver during crises, and with Diebold and Yilmaz (2012, 2014), who show that systemic connectedness is amplified in downturns, with institutions largely behaving as receivers of external shocks in emerging economies. This result is especially evident during the security and social shocks of 2015–2018 (Bardo and Sousse terrorist attacks, protests against rising living costs), as well as during the historic 2020 recession triggered by the COVID-19 pandemic, in line with Dawson, Diebold and Yilmaz, who emphasize that institutions in emerging economies primarily absorb macro-financial shocks during downturns.

The differentiated dynamics highlight the dual role of economic freedom in Tunisia: it acts as a buffer absorbing externality from real and financial fundamentals during periods of slowdown, and as an amplifier of these interactions during phases of expansion. This dual behavior carries important implications for the design of economic policies and for strengthening institutional resilience.

This procyclical tendency of economic freedom suggests that institutions in Tunisia are highly sensitive to the broader real and financial environment rather than functioning as independent stabilizers. These results underscore the need for policy interventions that safeguard institutional quality during crises while mitigating excessive amplification effects during periods of expansion.

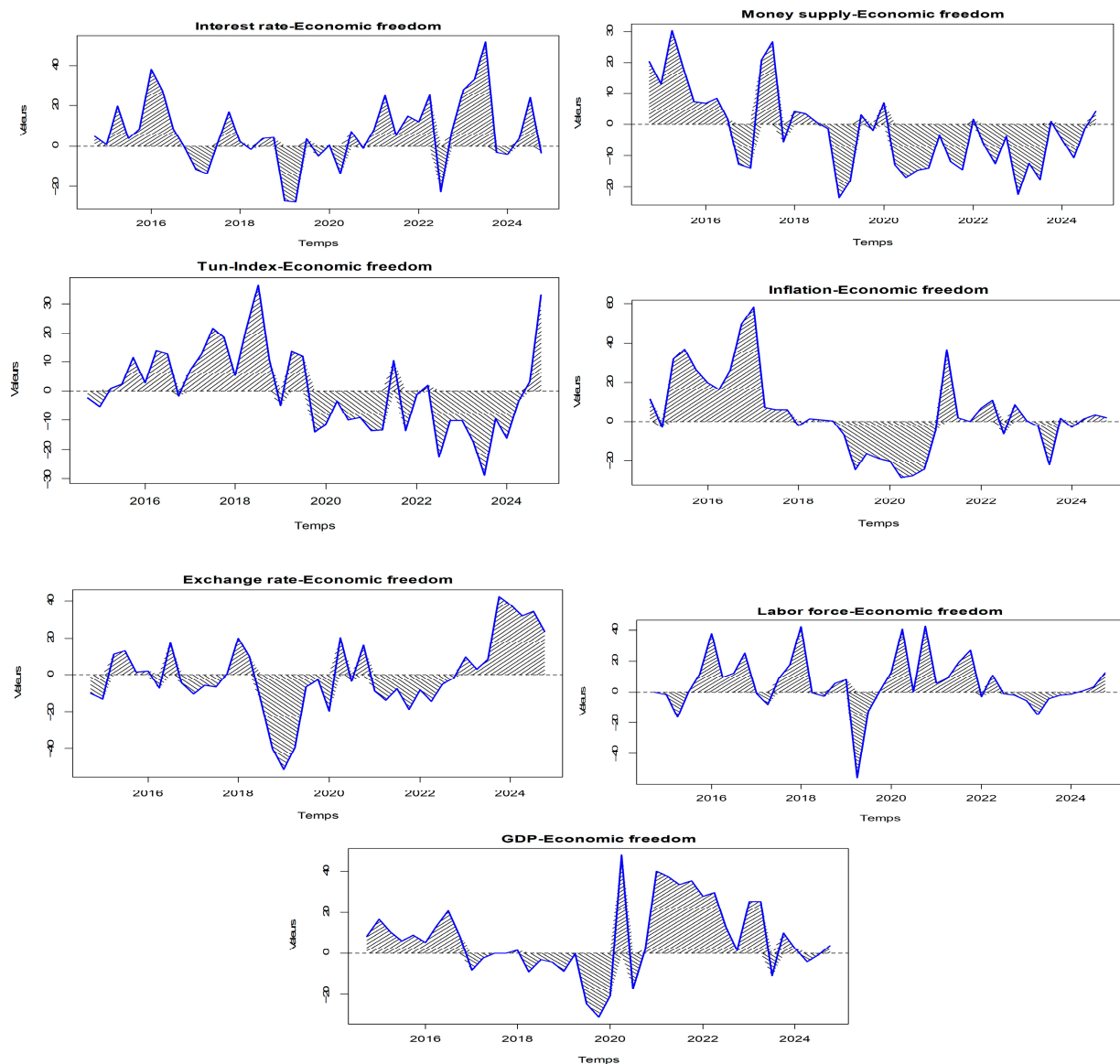


Figure 9. The net pairwise connectedness between economic freedom and each of the real-financial aggregates in the higher regime.

Evidence that economic freedom in Tunisia behaves as a receiver of externalities during downturns and as a transmitter during expansions provides several important policy insights. First, the finding that institutions tend to absorb shocks during crises highlights the need to strengthen the resilience of the components of economic freedom. Safeguarding property rights, judicial independence, and regulatory quality can help prevent macroeconomic shocks such as the 2015 tourism collapse or the 2020 COVID-19 recession from permanently undermining institutional quality. Second, the proactive role of economic freedom during expansions underscores the importance of adopting macroprudential safeguards. In periods of growth, such as 2017, 2019, and the partial recovery of 2021–2022, institutional improvements facilitated the expansion of real and financial flows. However, without adequate regulation, these dynamic risks amplify volatility through credit booms, inflationary pressures, or speculative bubbles in equity markets. Finally, the results suggest that economic freedom should be integrated into broader development strategies. Since the labor force and GDP consistently shape the institutional environment, complementary reforms in education, labor markets, and innovation systems are essential to ensure that improvements in economic freedom translate into inclusive and sustainable growth.

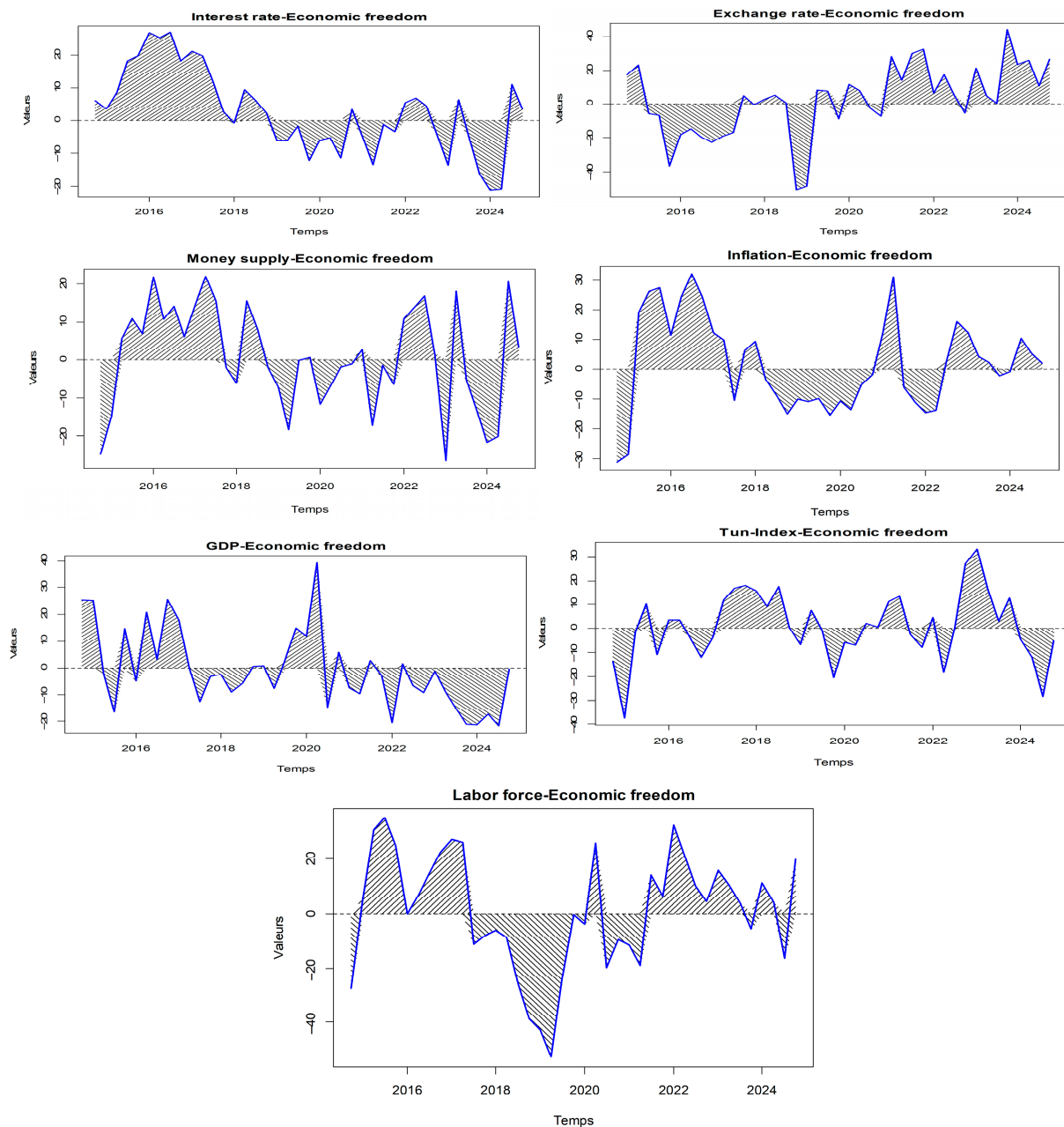


Figure 10. The net pairwise connectedness between economic freedom and each of the real-financial aggregates in the lower regime.

3.4. Robustness Test

To assess the robustness of the obtained results (see Table 4), several complementary analyses were conducted. Given the relatively limited size of the quarterly sample (59 observations) and the rolling-window framework adopted in this study, the lag order of the QVAR model was fixed at one. Indeed, introducing a second lag substantially increases the number of parameters to be estimated within each rolling window and generates numerical instability issues as well as singular matrices, making QVAR estimation infeasible in some windows. Similarly, the forecast error variance decomposition horizon was set to two quarters ($n\text{-forecast} = 2$ quarters). This choice is consistent with the objective of the study, which mainly focuses on short- and medium-term spillover dynamics, while avoiding excessive cumulative effects that may arise from longer forecast horizons in a small-sample context. The robustness analysis consisted of varying only the rolling-window size around the baseline specification by considering windows of 18, 19, 20, 21, 22, 23, 24,

and 25 quarters. The results reveal a strong stability of the Total Connectedness Index (TCI) across the different market regimes (see Table 4). More specifically, under the bearish regime, connectedness levels remain high and relatively stable, ranging between 69.04% and 70.05%. Under the bullish regime, TCI values also remain close, fluctuating between 65.10% and 66.97%. In contrast, under the normal regime, connectedness levels appear more moderate, with values ranging from 41.11% to 51.89%, confirming that periods of financial stress or expansion are associated with intensified shock transmission across the variables of the system. The results concerning the role of economic freedom also appear robust across the different rolling-window sizes and reveal clearly procyclical behavior. Under the bullish regime, economic freedom consistently appears as a major net receiver of spillovers, with net spillovers ranging between -14.07 and -9.89 , reflecting a strong sensitivity to shocks originating from the other macroeconomic and financial aggregates during expansionary periods. By contrast, under the bearish regime, economic freedom retains its status as a net receiver of spillovers, although with a substantially lower intensity, as net spillovers fluctuate between -6.70 and -4.5 . This difference suggests that the integration of economic freedom into macro-financial dynamics intensifies mainly during periods of economic and financial expansion, whereas it becomes more limited during stress episodes. Finally, under the normal regime, economic freedom appears relatively neutral, neither significantly receiving nor transmitting spillovers.

Table 4. Robustness results.

n-Forecast	Lag	Size-Window.	TCI 0.05	Net Spillovers	TCI 0.95	Net Spillovers	TCI 0.50	Net Spillovers
2 quarters	1	18	69.04	-4.5	66.97	-10.62	50.45	-1.61
2 quarters	1	19	69.2	-5.81	66.31	-13.60	50.15	-0.33
2 quarters	1	20	69.65	-5.13	64.74	-11.59	49.49	-2.06
2 quarters	1	21	69.73	-6.56	64.48	-12.80	47.23	0.95
2 quarters	1	22	69.43	-6.70	63.64	-14.07	47.55	1.92
2 quarters	1	23	69.36	-5.51	64.65	-9.59	48.69	1.12
2 quarters	1	24	70.05	-6.46	65.1	-13.04	48.75	-0.67
2 quarters	1	25	69.96	-4.9	65.93	-9.89	48.11	1.77

Note: TCI 0.05, TCI 0.50, and TCI 0.95 denote the static total connectedness indices at the 5th, 50th, and 95th quantiles, respectively. “Net Spillovers” measures the net transmission of shocks associated with economic freedom across different economic regimes, where negative values indicate that economic freedom is a net receiver of spillovers and positive values indicate that it is a net transmitter.

Overall, these robustness analyses confirm not only the stability of the connectedness indices in the different economic regimes, but also the existence of a procyclical and regime-dependent role of economic freedom in Tunisia.

4. Conclusions

This paper examined the dynamic connectedness between economic freedom and real-financial aggregates in Tunisia over the period 2010–2024 using a quantile-based connectedness framework.

The findings reveal that the role of economic freedom is strongly regime-dependent. During economic downturns, particularly during the 2015–2016 tourism crisis, the 2018 inflationary episode, and the COVID-19 recession, economic freedom mainly acts as a receiver of macro-financial shocks. By contrast, during expansionary periods such as 2017, 2019, and the post-pandemic recovery phase, it becomes a net transmitter of spillovers. Under

more stable conditions, the relationship between institutional and macro-financial variables appears more balanced and moderate. These results suggest that institutional quality in emerging economies such as Tunisia is highly sensitive to business-cycle fluctuations and cannot be considered a neutral stabilizing factor.

From a policy perspective, the findings underline the importance of strengthening institutional resilience, improving monetary and regulatory credibility, and implementing countercyclical policies capable of limiting the amplification of macro-financial shocks during crisis periods. The results also highlight the need to reinforce coordination between monetary, fiscal, and structural reforms to reduce systemic vulnerability and enhance economic stability.

More broadly, this study contributes to the connectedness literature by showing that the interaction between economic freedom and macro-financial aggregates is nonlinear, asymmetric, and state-dependent. It further demonstrates the relevance of quantile-based connectedness approaches for understanding the evolving role of institutions in emerging and crisis-prone economies.

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Notes

- ¹ These previous studies rely on panel data models, typically employing the Generalized Method of Moments (GMM) and conventional panel estimation techniques that account for individual effects (Arellano & Bond, 1991; Blundell & Bond, 1998). However, their analytical frameworks remain limited to examining unidirectional relationships among macroeconomic variables and economic freedom. The investigation of bidirectional externalities between real-financial aggregates and economic freedom capturing the dynamic spillover effects across these domains lies beyond the scope of their analyses (Barguelli et al., 2018).
- ² Acemoglu et al. (2003) examine the broader role of institutions in their study of the relationship between macroeconomic policy and economic volatility.
- ³ Kim et al. (2009) apply a panel VAR to examine the real economic interdependence among nine Asian economies and major industrialized countries, while the IMF (2007) uses VAR models to assess the transmission of U.S. shocks to more than 130 economies. More recently, Wang et al. (2023) introduce a distributional VAR framework that captures time-varying dependencies between macroeconomic and financial aggregates in the United States. These approaches provide valuable insights but rely on the assumption of stable and linear relationships, an assumption that often breaks down during episodes of economic shocks or financial crises.
- ⁴ The econometric approach uses essentially the GMM method applied to time series and panel data.
- ⁵ Given the small size of our sample and the short- to medium-term objective of our study, we reduced the QVAR lag to 1 and the forecast error variance decomposition horizon to 2 quarters.
- ⁶ Diebold and Yilmaz (2012, 2014) provide seminal evidence that systemic connectedness among financial and macroeconomic variables rises sharply during episodes of turmoil. Similarly, Bouri et al. (2021) and X. Chen et al. (2022) show that connectedness

- dynamics become significantly amplified in extreme quantiles, highlighting the heightened transmission of shocks under bullish and bearish regimes. N. Kyriazis et al. (2024b) further confirm that both real and financial markets exhibit stronger interdependencies during periods of elevated uncertainty and stress, in line with macro-financial spillover theories.
- 7 Frenkel (1976) and Dornbusch (1976) argued that monetary expansions exert depreciation pressures through higher inflation expectations and exchange rate overshooting. Bahmani-Oskooee and Malixi (1992) supports this view, showing that money supply shocks significantly affect exchange rates in developing economies. Alesina and Summers (1993); Acemoglu et al. (2003) and Lawson and Murphy (2020) show that higher levels of economic freedom, reflected in sound monetary institutions, stronger property rights, and regulatory quality, have been shown to mitigate exchange rate volatility.
 - 8 Carlsson and Lundström (2002) emphasize that the growth effects of economic freedom in developing economies are often conditional on structural and institutional maturity. Also consistent with our insights, Hayet and Naceur (2021) provide evidence that although FDI inflows respond positively to improvements in Tunisia's economic freedom, the transmission of macroeconomic shocks through these channels remains limited. This pattern reflects persistent structural constraints, weak institutional maturity, and limited policy leverage compared to advanced economies.
 - 9 Gwartney et al. (2023) argue that higher levels of economic freedom support better capital allocation and lower risk premium, thus fostering more resilient markets. Similarly, Shah et al. (2024) demonstrate that property rights and financial freedom dimensions mitigate stock market volatility in emerging economies.
 - 10 Lipset (1959) and de Haan and Sturm (2000) highlight the positive association between higher income levels and stronger institutional frameworks. Acemoglu et al. (2005) show that economic development strengthens the demand and enforcement of inclusive institutions. The labor market channel echoes the work of Botero et al. (2004), Feldmann (2009), and Heckelman and Stroup (2005a), who demonstrate how labor market regulations shape broader economic freedom. The monetary and financial dimension, captured by interest rate sensitivity, is closely related to the "sound money" and "financial freedom" components of the Index of World Economic Freedom (Gwartney et al., 2023) and is consistent with the literature on financial liberalization (McKinnon, 1973; Shaw, 1973).
 - 11 Labor force expansion, financial market conditions, and interest rate dynamics are well-established drivers of output growth (Solow, 1956; Mankiw et al., 1992; Fama, 1990; Schwert, 1990; King & Levine, 1993; Bernanke & Gertler, 1995; Mishkin, 1996). In contrast, the effect of economic freedom on GDP appears more indirect and long-term, operating through improvements in institutions and market efficiency (Graeff & Mehlkop, 2003; Feldmann, 2017; Nyström, 2008). This explains why, in our results, economic freedom transmits weaker spillovers to GDP relative to labor, stock markets, and interest rates.
 - 12 Empirical evidence further supports this interconnectedness, as Diebold and Yilmaz (2012, 2014) demonstrate that GDP often acts as a net receiver of shocks originating in both real and financial markets, while Antonakakis and Gabauer (2017) find strong spillover effects from equity markets to GDP in open economies.
 - 13 The net pairwise directional connectedness illustrates the net externality transmission on the bilateral level. The Net Pairwise Dynamic Connectedness, noted $NPDCi, j, t$ represents the difference in exchanged externalities between the variable i and the variable j at time t .
 - 14 To substantiate the dominance of externalities received by economic freedom, one only needs to examine the pairwise connectivities, with particular attention to the positive and negative hatched areas. The analysis reveals that the positively hatched surfaces consistently outweigh the negative ones—especially in the cases of money supply–economic freedom, inflation–economic freedom, and labor force–economic freedom. In other words, the externalities transmitted by real and financial aggregates globally exceed those generated by economic freedom.
 - 15 The crisis years include 2015–2016, marked by terrorist attacks (Bardo and Sousse) that led to a collapse in tourism, very weak growth, and high unemployment; 2018, characterized by widespread protests against rising living costs and inflation, which further deteriorated the social and economic climate; and 2020, when the COVID-19 pandemic triggered a historic recession (−8.8% of GDP), soaring unemployment, and mounting public debt. During these phases, economic freedom behaved reactively: it primarily absorbed shocks from GDP, inflation, and employment, while transmitting relatively little to financial markets or monetary aggregates.

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