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Time-Varying Impacts of Financial Stress on Energy-Related Uncertainty

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ABSTRACT

In literature, studies address the relationship between financial and energy markets. In this context, there are a lot of works which examine the impact of financial markets on energy markets. However, there are not any research undertaken to explore the effect of financial stress index (FSI) on energy-related uncertainty index (EUI). Therefore, this work assesses this relation in the case of US with time-varying parameter vector autoregression (TVP-VAR) model, using monthly data from Quarter 1 1996 to Quarter 3 2022 in the United States (US). The findings reveal that time-varying impacts of FSI on EUI is positive and significant, validating theoretical linkage.

Keywords: Financial Stress Index, Energy-Related Uncertainty Index, Time-Varying Parameter Vector Autoregression
JEL Classifications: G1, Q4, C15, E32

1. INTRODUCTION

The interconnection between financial markets and energy markets has become an increasingly vital area of study, particularly in the wake of global economic and geopolitical shocks that influence both sectors (Demirtas et al., 2025; Nguyen et al., 2024; Özkan et al., 2024). A robust understanding of how financial conditions affect energy markets is essential not only for investors and policymakers but also for forecasting and managing economic risk (Liu and Wang, 2024). While previous research has extensively explored the influence of financial markets on energy prices, returns, and volatility (Dong and Huang, 2024; Lyu et al., 2025), there remains a critical gap in the literature regarding the relationship between financial stress and energy-related uncertainty. As financial stress often intensifies during periods of economic turmoil, understanding its impact on uncertainty in energy markets becomes crucial for both market participants and regulators (Luqman and Li, 2024).

Financial stress is typically characterized by heightened volatility in financial markets, reduced liquidity, and increased risk premia (IMF, 2024). It is often triggered by events such as banking crises, stock market crashes, or policy uncertainty (World Bank, 2025). The FSI serves as a composite measure to track these tensions in financial systems and has been used in empirical literature as a leading indicator of systemic risk (NguyenHuu and Örsal, 2024; Wang et al., 2024). On the other hand, energy-related uncertainty, as captured by indices such as the EUI, reflects the unpredictability surrounding energy production, consumption, regulation, and policy (Dang et al., 2023). It encompasses factors such as volatile oil prices, geopolitical risks, and environmental policy changes, all of which can be amplified during times of financial instability.

Although energy markets are inherently volatile and affected by a wide array of global factors, they are also highly sensitive to the broader financial environment (Liu et al., 2021; Gong et al., 2024). During times of financial stress, firms may delay energy-related investments, consumers may alter their consumption patterns, and policymakers may adjust regulations—all contributing to increased uncertainty in the energy sector (Reboredo and Uddin, 2016; Salisu et al., 2024). Yet, while numerous studies have explored the impact of oil price shocks on financial markets (Demirer et al., 2020; Anand et al., 2023), or vice versa (Barrales-Ruiz and Mohammed, 2021), the specific link between financial stress and energy uncertainty has received little empirical attention.

This paper aims to address this gap by investigating how financial stress affects energy-related uncertainty over time. More importantly, it moves beyond static models and employs a time-varying parameter vector autoregression (TVP-VAR) model to capture the dynamic and potentially nonlinear nature of this relationship. The TVP-VAR framework is particularly suitable for this analysis as it allows model parameters to evolve over time, thereby reflecting the changing influence of financial stress across different economic regimes (Kasal, 2022). Such an approach is crucial given that the effects of financial stress are unlikely to be constant and may vary across periods of recession, recovery, or market boom.

Using monthly data from the first quarter of 1996 to the third quarter of 2022 for the United States, this study provides novel empirical insights into how the relationship between FSI and EUI has evolved. The results reveal a positive and statistically significant time-varying impact of financial stress on energy-related uncertainty. This finding confirms the theoretical expectation that increased financial market instability leads to heightened uncertainty in energy markets. Moreover, the strength and direction of the relationship appear to vary over time, becoming more pronounced during episodes such as the 2008 global financial crisis and the COVID-19 pandemic.

In summary, this research contributes to the growing literature on financial-energy market interlinkages by introducing an overlooked yet critical dimension—the dynamic impact of financial stress on energy-related uncertainty. It not only enriches the theoretical understanding of these markets but also has practical implications for risk management, investment strategy, and energy policy. By uncovering this relationship, the study encourages the integration of financial stress indicators into models used for forecasting and decision-making in the energy domain.

2. LITERATURE REVIEW

2.1. Impact of Financial Stress on Energy-Related Uncertainty

In literature, the effect of financial variables on energy variables are investigated enough that the impact of financial stress on energy-related uncertainty can be theoretically linked. However, the composites of both indices play a key role since the relationship between financial stress and energy-related uncertainty is justified through them. The FSI comprises five groups of indicators: Credit conditions, equity market valuation, funding availability, demand for safe assets, and market volatility (OFR, 2025). The EUI is a composite index consisting of various energy variables with text-based approach (Dang et al., 2023). The composites of EUI include energy-related key words, including "oil price," "natural gas price," clean energy," "green energy" and "energy price volatility." The effect of FSI on EUI can be theoretically justified with three ways: (a) the effect of FSI on the composites of EUI; (b) The effect of composites of FSI on EUI; and (c) the effect of composites of FSI on the composites of EUI.

In literature, there are sufficient amounts of studies examining the effect of financial stress on the composites of energy-related uncertainty. More specifically, Reboredo and Uddin (2016) investigate how financial stress influences the price movements of U.S. energy commodity futures, including crude oil, heating oil, and natural gas. Their analysis identifies significant Granger causality effects of financial stress, particularly within the intermediate and upper quantiles of commodity returns. In a related study, Liu and Wang (2024) explore the interrelationship between coal prices, financial technology (fintech), financial stress, and green energy stocks using a quantile regression approach. Their findings indicate that the financial stress index (FSI) consistently exerts a negative impact on clean energy stock performance across the entire distribution, from lower to upper quantiles. Similarly, Dong and Huang (2024) examine the dynamic linkages between oil price volatility, fintech, financial stress, and clean energy stocks on a global scale. Their results suggest that declines in financial stress tend to have a positive effect on clean energy stock performance. Finally, Lyu et al. (2025) analyze how risks originating in the oil market contribute to financial uncertainty shocks. Their study concludes that increases in financial uncertainty lead to higher systemic risk, with spillover effects from the oil market extending into equity markets. Chen et al. (2023) examine the impact of financial stress on the volatility of commodity prices, including energy volatility. They find that an increase in financial stress leads to a persistent increase in energy volatility.

Another stream of the literature examines the influence of financial variables on various aspects of the energy sector. For instance, Mengfeng et al. (2024) investigate how financial sector development impacts fossil fuel consumption, renewable energy use, and overall energy consumption. Lee and Fang (2025) focus on the role of climate finance in enhancing energy security, finding that climate finance exerts a significantly positive effect on the energy security of recipient countries. Similarly, Ma et al. (2024) conduct an empirical study on the relationship between green finance and the growth of the non-hydro renewable energy sector, concluding that green finance has been a key driver of its expansion. In a related analysis, Wang et al. (2025) explore how environmentally friendly financial instruments contribute to improving energy efficiency.

Moreover, Behera et al. (2024) assess the joint impact of green finance and fiscal decentralization on renewable energy adoption, showing that both factors significantly encourage the use of renewable sources. Sultanuzzaman et al. (2024) examine the asymmetric effects of green finance and business cycle fluctuations on energy development, revealing that green finance plays a crucial role in supporting sustainable energy growth. Finally, Tao et al. (2024) analyze how financial inclusion can help reduce energy poverty, with their findings confirming that access to inclusive financial services is a significant factor in mitigating energy deprivation.

The literature review shows that theoretical roots exist between financial stress and energy-related uncertainty. The indices and their composites are related to each other. It can be clearly seen that financial stress impacts on energy-related uncertainty and the effect are postulated to be negative.

2.2. Impact of Financial Stress on Consumer Price Index (Inflation)

Acharya et al. (2024) demonstrate that "zombie credit"—subsidized loans to nonviable firms—has a deflationary effect. By keeping these businesses viable, zombie loans generate surplus aggregate supply, exerting downward pressure on prices. Granular European data on inflation, companies, and banks support this method. Kumar and Dash (2020) used a large dataset of 439 variables to study the time-varying impacts of monetary policy on aggregate, sectoral, and disaggregate inflation in India between 1997 and 2017. Researchers find that a contractionary monetary policy is more successful at managing aggregate inflation over time. This increase in policy effectiveness can be attributable to improved transmission via credit and asset price channels. Factors influencing inflation in Jordan from 2000 to 2017 using quarterly data on inflation, money supply, interest rates, credit, oil prices, and production gaps were analysed by Adayleh (2018). The fully modified ordinary least square (FMOLS) technique was used. The study found that money supply, credit, and oil price factors had a positive impact on Jordanian inflation, whereas interest rates and output gap have a negative impact. Altunöz (2024) examined the impact of credit use on inflation volatility in the context of commercial and consumer loans in Turkey from 2005 to 2020 using ARCH, GARCH, and E-GARCH models. The increased use of consumer loans in Turkey resulted in consumer inflation. Furthermore, the usage rate of commercial loans lowers the volatility of inflation rates. Structural vector autoregression (SVAR) model was utilized by Gebesoglu and Varlik (2019) to analyze how credit shocks affect Turkey's macroeconomic performance from 2005 to 2018. Results revealed that positive loan shocks in Turkey boost output but can lead to inflation. Ünüvar and Yeldan (2023) recorded the risks connected with climate change for the Central Bank of the Republic of Turkey (CBRT) in light of its primary mandate of price stability, as well as to give data to support green policies. According to authors, adopting a green monetary strategy has the potential to help the CBRT achieve its goal of price stability. The short-term relationship between stock returns and inflation in the United States market is examined by Chiang and Chen (2023). Results suggest that the aggregate market data suggest that stock returns are inversely connected to inflation. Moreover, most sectoral stock returns are inversely connected to inflation. The only industry that regularly shows a positive relationship between stock returns and inflation is the energy sector.

2.3. Impact of Financial Stress on Gross Domestic Product (Economic Development)

A substantial body of literature explores the impact of financial development, financial stress, and credit dynamics on macroeconomic indicators such as economic growth, inflation, energy development, and systemic risk. For instance, Korkmaz (2015) analyzes panel data from 2006 to 2012 to investigate the influence of domestic credit generated by the banking sector on inflation and economic growth in ten European countries. The findings indicate that while credit creation had no discernible effect on inflation, it significantly contributed to economic growth. In a similar vein, Nguyen Hoang Vinh and Dinh (2021) assess the role of credit and other macroeconomic variables—such as money supply, inflation, and foreign direct investment—on Vietnam's economic development from 2004Q1 to 2019Q4. Using a VECM model, they find that credit expansion accounts for 45.23% of economic growth, while Bayesian estimates suggest a 39.30% probability that credit development positively influences economic prosperity.

Hubrich and Tetlow (2015) investigate the macroeconomic consequences of financial stress using a Markov-switching VAR (MS-VAR) model and a real-time financial stress index (FSI) developed by the Federal Reserve. Their analysis reveals that stress measures align closely with historical economic patterns and that periods of elevated stress significantly harm economic performance, often rendering traditional monetary policy ineffective. Similarly, Alessandri and Mumtaz (2019) apply a nonlinear VAR model to examine the relationship between credit markets and economic uncertainty. They find that during financial downturns, uncertainty exerts deflationary pressure and reduces output, with the Great Recession showing a 1% decline in manufacturing capacity due to uncertainty shocks.

In the Sub-Saharan African context, Bandura (2020) examines the effect of inflation on the finance-growth relationship across 23 countries using data averaged over 5-year periods from 1982 to 2016. Results indicate that when inflation exceeds 31%, the impact of financial development on economic growth turns negative. However, when financial development is measured as private credit by deposit banks and other financial institutions, an inflation threshold of 13% is identified—above which financial development continues to positively impact growth.

Ferrer et al. (2018) utilize cross-wavelet analysis in the time-frequency domain to study the relationship between U.S. financial stress indices and economic activity. Their results show that the impact of financial stress varies over time and across horizons, with the most significant negative effects occurring after the 2007 subprime mortgage crisis—particularly over 1-4 year periods. Similarly, Aboura and Roye (2017) develop a real-time FSI for France using a dynamic factor model applied to 17 financial indicators and analyze it through a Markov-switching Bayesian VAR model. Their findings show that high financial stress periods substantially dampen economic activity, while low-stress periods have minimal effects, highlighting the FSI's usefulness in tracking financial sector stability.

Apostolakis and Papadopoulos (2015) explore the relationship between financial stress, growth, and inflation, concluding that even favorable financial stress events can temporarily suppress output and price levels. Stona et al. (2018) assess the relationship between Brazil's FSI and real economic activity, inflation, and monetary policy between 2000 and 2015 using a Markov-switching VAR model. Their results warn that standard policy measures—such as expansionary monetary policy—may backfire during times of high stress.

In the context of green finance and financial technology, Yang et al. (2021) apply a two-step system GMM panel regression to evaluate the effects of green banking and fintech on economic growth across 30 Chinese provinces from 2007 to 2019. They find that green financing supports economic expansion by improving environmental quality, productivity, and economic structure. Bu et al. (2023) use a threshold regression model to examine how fintech influences the real economy. Their results show a U-shaped relationship, where early-stage fintech development may initially slow growth, but continued advancement yields a strong positive impact—following the law of diminishing marginal returns.

In a country-specific study, Belinga et al. (2016) analyze the causal relationship between bank loans and economic growth in Cameroon from 1969 to 2013 using a VECM framework. Their findings reveal a unidirectional causal link from domestic credit and bank deposits to GDP per capita. Similarly, Cecchetti and Kharroubi (2019) study 20 countries over 25 years and find that excessive credit growth correlates with lower productivity growth per worker. Finally, Majeed and Iftikhar (2020) investigate the effect of bank lending on Pakistan's economic development across various sectors from 1982 to 2017. Their aggregate findings suggest that private sector lending has a positive but limited impact on overall economic growth.

3. DATA AND METHODOLOGY

3.1. Data

3.1.1. Definition of the variables

This research employs the US data in monthly frequency spanning from Quarter 1 1996 to Quarter 3 2022. The vector of endogenous variables Y_t is defined as:

$$Y_t^{'} = \left[FSI_t\ EUI_t\ CPI_t\ GDP_t \right] \quad (1)$$

The core variable of the model is the FSI, denoted by FSI_t. This index is calculated by Office of Financial Research (OFR, 2025). The index of energy-related uncertainty (EUI_t), developed by Dang et al. (2023), is another important variable in the model. This index is constructed with text-based approach using energy-related key words. This data is available in Economic Policy Uncertainty (2025). As a measure of inflation, consumer price index, denoted as (CPI_t), measured in growth rate, is utilized, and it is obtained from OECD (2025). Finally, as a proxy for economic development, gross domestic product (GDP_t), measured in billion dollars, is employed, and it is downloaded from OECD (2025). Natural log transformation is applied to all variables except for CPI as this variable is already given in growth rate and contains negative values over the estimation period. Descriptive statistics of the variables in their levels are presented in Table 1 and Figure 1.

Before the estimation of the VAR, unit root tests, including the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) tests and Break test of ADF test statistics tests, are implemented to determine integration levels of the variables. The results, presented in Table 2, indicate that the FSI and GDP have a unit root, as evidenced by the non-significant test statistics obtained from all tests including break test, but become stationary after the first difference is applied. However, the remaining variables, i.e. EUI and CPI are found to be stationary at their levels. ADF break test reveals significant structural breaks in the time series data of the examined variables. FSI has a significant break in the first quarter of 2011. During the early months of 2011, the political standoff between the White House and the U.S. Congress over raising the debt ceiling had a significant impact on U.S. government credit default swaps (CDSs) and elevated the funding costs for American banks (CEPR, 2021). EUI has a significant structural break in the third quarter of 2002. This might be linked with the fact of oil prices increase in US (EIA, 2002). CPI has a structural break in the fourth quarter of 2008, reflecting the effects of the global financial crisis. Finally, GDP has a unit root with a significant break in the second quarter of 2020, adhered to the economic recession resulting from the COVID-19 pandemic. The breaks identified in the ADF unit root test underlines the need for the nonlinear time series modelling to capture the dynamics among the variables.

Based on the results of unit root test the variables FSI and GDP are used in their first difference form, whereas EUI and CPI are employed at levels in the VAR model.

Table 1: Descriptive statistics (in levels)

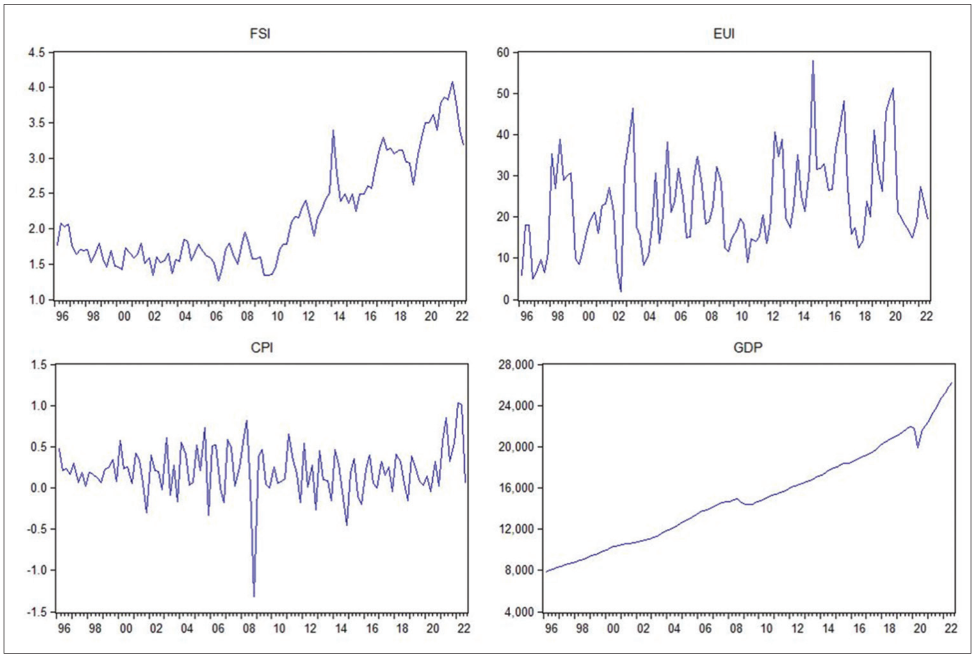
Variable	FSI	EUI	CPI	GDP
Mean	2.167	23.235	0.206	15178.16
Median	1.794	21.130	0.204	14.715
Maximum	4.080	57.806	1.029	26272.01
Minimum	1.264	1.974	−1.319	7868.468
Std. Dev.	0.733	11.109	0.310	4661.592
T	107	107	107	107

Table 2: Unit root tests

Variable	ADF			
	FSI	EUI	CPI	GDP
Level	−1.374	−6.000***	−10.081***	−0.398
First difference	−11.967***	-	-	−10.918***
Variable	**Phillips and Perron**			
	FSI	EUI	CPI	GDP
Level	−1.153	−5.674***	−10.080***	−0.398
First difference	−11.988***	-	-	−10.896***
Variable	**ADF test statistics**			
	FSI	EUI	CPI	GDP
Level	−4.051	−7.623***	−11.730***	−3.128
Breaking date	2011Q1	2002Q3	2008Q4	2020Q2
First difference	−12.513***	-	-	−21.682***
Breaking date	2014Q1	-	-	2020Q2

(***) Significant at the 1%

Figure 1: The plots of financial stress index, energy-related uncertainty index, consumer price index and gross domestic product at levels



3.1.2. Cholesky ordering

The ordering of the variables is critical in the identification of shocks in Cholesky ordering. Based on the paper's main objective, the FSI is ranked first affecting on other variables, EUI, CPI and GDP in the system. Moreover, due to Cholesky ordering, EUI impacts on CPI (Usman et al., 2024) and GDP (Li et al., 2024), while CPI impact on GDP (Jui et al., 2024) in the VAR system. The theoretical background for the impacts of FSI on EUI, CPI and GDP is provided in literature review section. Moreover, reverse impacts should be considered among the studies variables. More precisely, the impact of energy-related uncertainty (Shahbaz et al., 2024), inflation (Apostolakis and Giannellis, 2024) and gross domestic product (Giannellis and Tzanaki, 2025) on financial stress must exist for the application of TVP-VAR model.

3.2. Methodology

This paper employs the TVP-VAR methodology devised by Primiceri (2005) to analyze the impact of financial stress on the energy-related uncertainty, consumer price index and gross domestic product in US. In contrast with the linear VAR, the TVP-VAR model is designed to track the evolution of the dynamics among the variables in accordance with the varying economic conditions. Hence the model might be represented as follows (Casas and Fernandez-Casal, 2019: 17):

$$Y_t = A_{0,t} + A_{1,t}Y_{t-1} + ... + A_{p,t}Y_{t-p} + U_t,\ t = 1,2...,T, \quad (2)$$

Where Y_t is the previously defined endogenous variables' vector, $A_{i,t}$ (i = 0, 1., p) represents time-varying coefficient matrices, and U_t is the innovation vector with a time-varying covariance matrix Σ_t. Contrary to the TVP-VAR model based on the Bayesian methodology, the time-varying coefficients in $A_{i,t}$ are modelled as a smooth function of time ($\tau = t/T$) (Robinson, 1989). The estimation of coefficients is based on nonparametric kernel regression, where the parameters are estimated locally at each time point. This is undertaken with the estimation of weighted regressions, where the weights are determined by a kernel Epanechnikov function and a bandwidth parameter. The bandwidth parameter used to adjust the degree of smoothness of the time-varying parameters, is determined with cross-validation to balance bias and variance (Li & Racine, 2007).

The use of nonparametric polynomial kernel regression in the estimation offers significant advantages. First, this estimator is able to produce entirely data-driven estimates, in contrast with the Bayesian methodologies such as those proposed by Primiceri (2005) and Cogley and Sargent (2005), as there is no need to specify the prior distribution of the coefficients. Furthermore, in contrast with the Bayesian approach, which typically assumes that the time-varying parameters follow a random walk process, this technique does not make priori assumptions about the coefficients' law of motion, enabling it to adapt flexibly to complex or unknown data-generating processes (Fan, 2018; Robinson, 1989). Finally, as a type of local linear estimator concentrating on a small portion of data at each point in time, it is able to capture the abrupt changes in the relationship among variables, providing more efficient analysis of structural changes, including economic crises or policy interventions (Chen et al., 2017).

To obtain time-varying impulse responses the TVP-VAR model described in Equation (2) can be transformed into World representation as follows (Casas and Fernandez-Casal, 2019: 18):

$$\bar{Y}_t = \sum_{j=0}^{\infty} \Phi_{j,t} U_{t-j} \quad (3)$$

Such that $|Y_t - \bar{Y}_t| \rightarrow 0$. Matrix $\Phi_{0,t} = I_N$ and matrix $\Phi_{h,t} = \sum_{j=0}^{h} \Phi_{h-j} A_{j,t}$ for horizons h=1,2,…h. as for the constant model $\Phi_{h,t}$ represent the time-varying coefficient matrices of the impulse response functions. It can be interpreted as the expected response of $Y_{i,t+s}$ to and exogenous shock of $Y_{j,t}$ ceteris paribus lags of Y_t when the innovations are orthogonal.

The orthogonal time-varying responses can be obtained from the Cholesky decomposition of the time-varying variance covariance matrix Σ_t. This decomposition a lower triangular matrix P_t such that $\Sigma_t = P_t P_t^{\top}$. Finally using the orthogonalized innovations, the time-varying impulse response functions at horizon are computed as follows:

$$\Psi_{h,t} = \Phi_{h,t} P_t \quad (4)$$

The time-varying responses quantify the response of the endogenous variables to a one-unit shock in the orthogonalized innovations hence it allows for the identification of the interactions among the variables in a time-varying framework.

4. EMPIRICAL RESULTS

This section presents the results of the TVP-VAR analysis to analyze the impact of financial stress. Before proceeding to TVP-VAR, the linear VAR model is estimated to examine the reaction of energy-related uncertainty, consumer price index and gross domestic product to the positive financial stress shocks in a linear framework.

Figure 2 illustrates the linear accumulated responses of the EUI, consumer price index (CPI) and gross domestic product (GDP) to the one standard deviation shocks in the FSI. The positive shocks to the FSI have no a significant impact on all EUI. The reactions of consumer price index and gross domestic product are statistically significant in the earlier periods.

After the linear VAR, The TVP-VAR model is estimated to assess the effects of financial stress, as previously evidenced by break unit root test, and stability test of the estimated linear VAR model (Figure 3)[1]. Recent studies indicate that linear models inadequately capture the relationship between uncertainties and stock and commodity markets, especially during periods of increased uncertainty (Helmi et al., 2023; Bouteska et al., 2023).

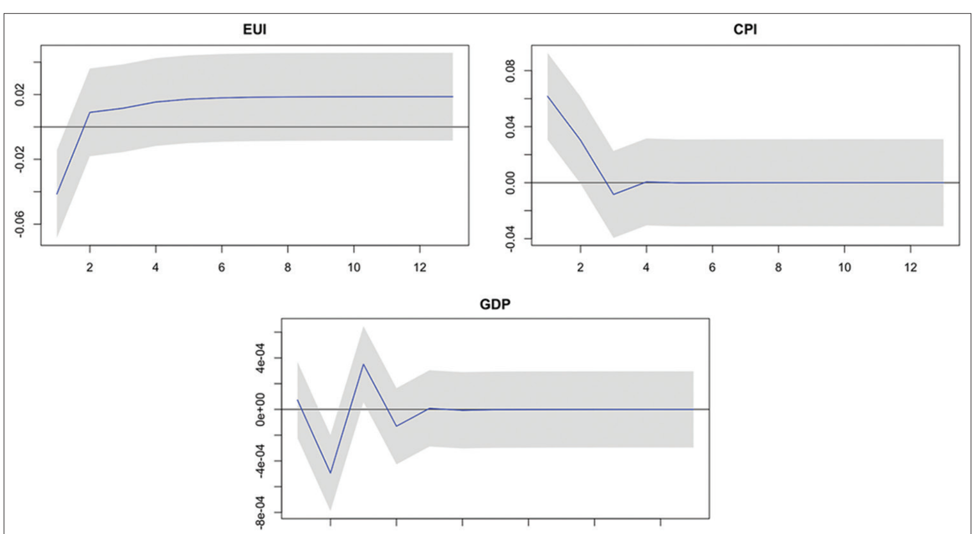
After estimating the model with the nonparametric kernel function described above, time-varying impulse responses are computed using Eq. (4). The responses of energy-related uncertainty, consumer price index and gross domestic product are reported from Figures 4-6. The figures include time series plot of the accumulated time-varying impulse-responses at the horizons $h = 1,3,6$, quarters. The responses are illustrated along with their 90% confidence bands to evaluate their significance throughout the analysis period.

The results indicate that the response of variables to FSI shocks is not time-invariant and is significantly influenced by energy-related uncertainty, consumer price index and gross domestic product.

The time-varying responses of energy-related uncertainty to financial stress are presented in Figure 4. The time-varying responses demonstrate significant fluctuations. It should be noted that all the responses are positive, validating theoretical background. More specifically, the positive and significant impacts of FSI on EUI can be observed in 1996-1997 when high interest rates caused less investment, including in the energy sector. Thus, energy-related uncertainties increased in US (IAEA, 1996; Federal Reserve Board, 1997). Furthermore, in the period of 2003, the positive and significant responses of FSI to EUI shocks can be linked with war in Iraq. More specifically, global energy demand increased as a result of decline in energy supply by Iraq. Consequently, the financial market in US also suffered from the consequences of high energy prices, and further interrelated effect between financial stress and energy-related uncertainty occurred (Federal Reserve Board, 2003). The positive response of the shocks in FSI in 2013 is associated with the reason that financial trading volumes for natural gas fell on the Intercontinental Exchange, thereby leading to energy-related uncertainty (FERC, 2014).

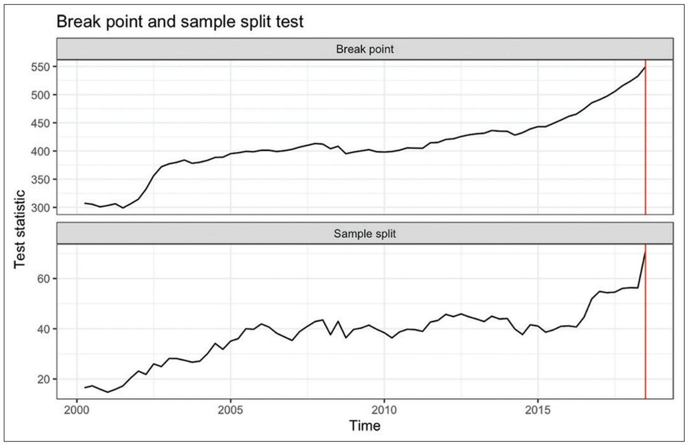
1 tvReg package of R developed by Casas and Fernandez-Casal (2019) is used in the TVP-VAR estimation.

Figure 2: Accumulated linear responses of energy-related uncertainty index, consumer price index and gross domestic product to financial stress index



Lastly, from 2016 to 2018 the positive impact of FSI on EUI occurred. In 2016, Federal financial interventions and subsidies in energy markets decreased, and as a result, energy imports rose 6% from 2015 to 2016, causing energy issues (EIA, 2017; EIA, 2018). The positive impact of FSI on EUI in 2017 can be linked with the increase of state tax on gasoline by 4.5% compared to 2016 (EIA, 2018). In 2018, strong and healthy financial system caused energy markets fall (IEEFA, 2019). More specifically, stock returns in energy markets declined, and thus further investment on energy markets decreased, leading to uncertainties of energy.

Figure 3: Stability test of linear vector autoregression



The time-varying responses of consumer price index to financial stress are displayed in Figure 5. Significant variations in the responses have been observed, with notable positive and negative impacts occurring during the important events. The responses are positive during the global financial crisis occurred in 2007-2008. Admittedly, a decline in credit availability and a rise in commodity prices led to high inflation in US during the financial crisis. Moreover, the negative impacts are observed during the start of Russo-Ukraine War in the period 2022. US benefited exporting

Figure 4: Responses of energy-related uncertainty index to financial stress shocks at different time horizons

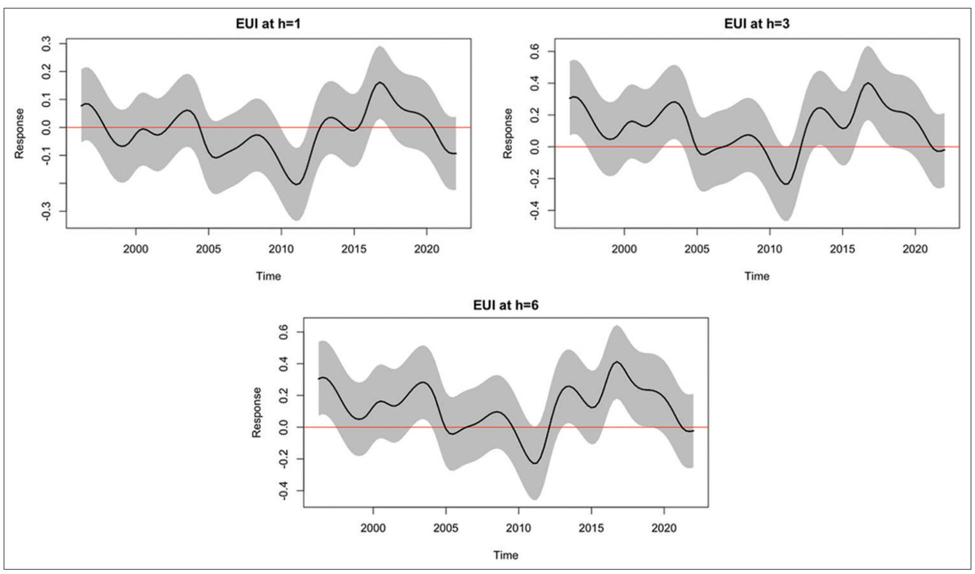


Figure 5: Responses of consumer price index to financial stress shocks at different time horizons

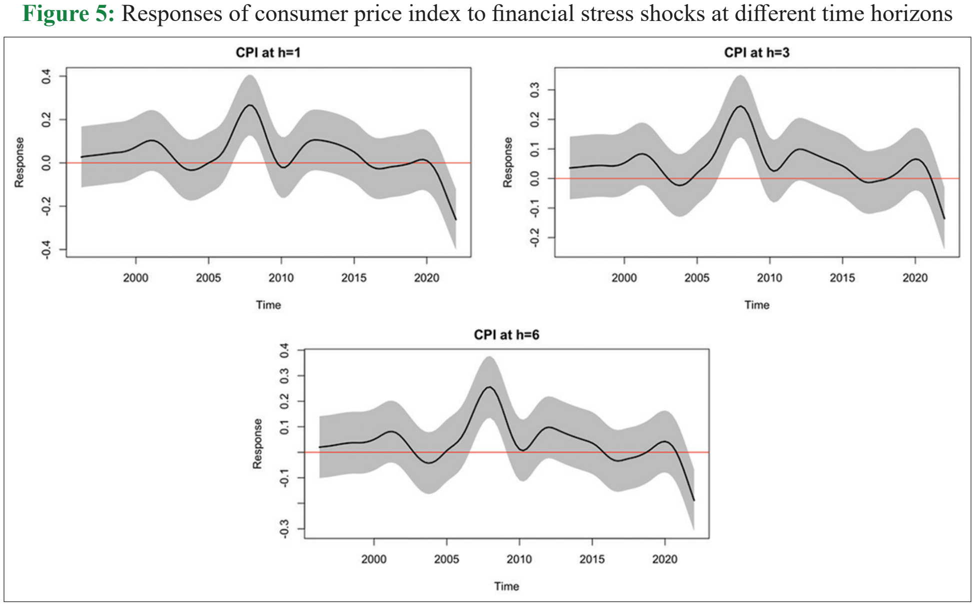
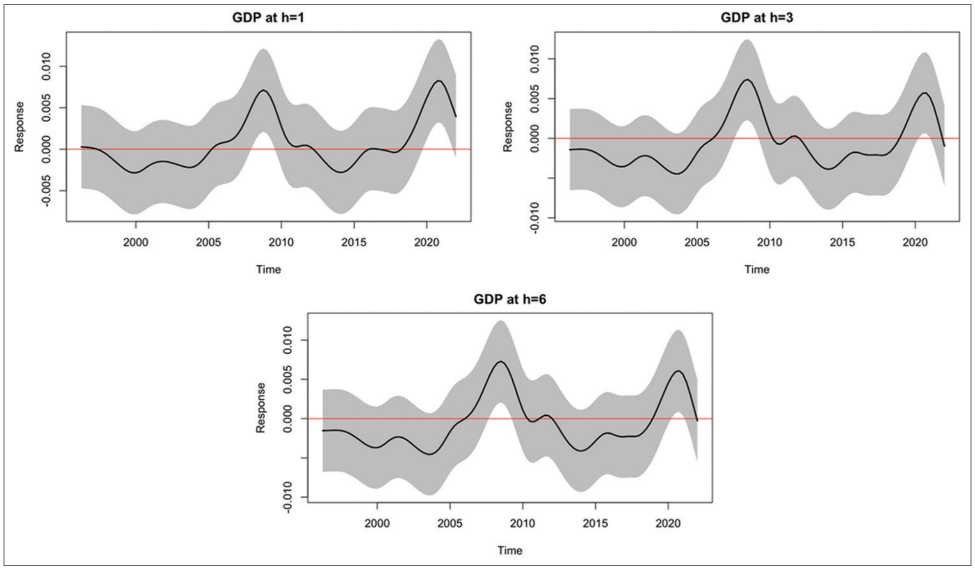


Figure 6: Responses of gross domestic product to financial stress shocks at different time horizons



energy resources because of sanctions and restriction on Russian energy resources in the global market. Therefore, turbulence in financial markets could not diminish energy markets' effectiveness and profitability.

The time-varying responses of gross domestic product to financial stress are illustrated in Figure 6. Interestingly, the effect is significant and positive during the global crisis such as financial crisis occurred in 2007-2008, and the COVID-19 pandemic in 2020 and 2021. This positive response can be associated with the rising inflation and government debt during such global events. More precisely, during the recession, government borrows and inflation rises which causes a rise in economic activity, even though it might be artificial.

5. CONCLUSION

The study for the first time explored the time-varying impact of financial stress on energy-related uncertainty in the case of the US, applying the data spanning from the first quarter of 1996 to the third quarter of 2022. As an econometric approach, time-varying vector autoregression (TVP-VAR) model is employed. Overall, the findings reveal that time-varying effect of financial stress on energy-related uncertainty is positive and significant. This outcome validates the theoretical linkage supported by the literature review. This result shows that an increase in financial stress leads to a surge in energy-related uncertainty. More specifically, during times of financial stress, stock prices increase. Due to a rise in stock prices, energy investments face vulnerability. This is associated with an increase of energy stocks. Since energy stock prices come across high prices, further investment in the energy sector declines. The disbalance of energy sector creates problems, and energy supply will be distorted, losing ability of meeting energy demand. Consequently, energy-related uncertainty increases, affected by financial stress.

Admittedly, financial stress is one of the determinants of energy-related uncertainty. More precisely, the development of energy markets relies on the development of the financial sector, especially investment. As a result of a healthy financial system, energy transition might be fostered, whereas energy transition is slow down because of lack of financial resources. Therefore, policymakers must consider the role of financial stress when implementing policy decisions related to coping with energy-related uncertainty.

Moreover, it is evident that financial resources are important to renewable energy transition. The main problem associated with renewable energy development is lack of money to pay for the installment of renewable energy equipment. Especially, the households are not always willing to pay the costs related to the technology of renewable energy mining such as solar panels, wind turbines and etc. Therefore, financial support is needed in the renewable energy sector. More specifically, renewable energy plays a pivotal role in coping with energy-related uncertainty. Financial support towards renewable energy development leads to speeding up the transition, thus mitigating uncertainties related to energy. Policymakers should take into account the nexus between financial stress and energy-related uncertainty through renewable energy.

The study is not free from the drawbacks. More precisely, it would be interesting to examine the time-varying impact of financial stress on energy-related uncertainty at different quantiles of energy-related uncertainty by employing time-varying quantile connectedness approach. However, this suggestion can be considered in future works.

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