Examining the Threshold Effects of Financial Stress on the Behavior of Oil and Stock Markets in Selected OPEC Member Countries

Arash Shakouri [1], Gholamreza Abbasi [2,*], Kambiz Peykarjou [3] and Azadeh Mehrabian [4]

[1] Department of Economics, CT.C., Islamic Azad University, Tehran, Iran;
[2] Department of Economics, CT.C., Islamic Azad University, Tehran, Iran;
[3] Department of Economics, SR.C., Islamic Azad University, Tehran, Iran;
[4] Department of Economics, CT.C., Islamic Azad University, Tehran, Iran;

* Correspondence: qol.abasi@iauctb.ac.ir

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Abstract: The objective of this article is to examine the threshold effects of financial stress on the behavior of the oil and stock markets. For this purpose, the Panel Smooth Transition Regression (PSTR) model was employed based on annual data from selected OPEC member countries during the period 2005–2023. According to the results of the first model, which relates to the stock market where the transition variable is the financial stress index, the stock return function and the effect of the financial stress index on stock returns are modeled. Given the confirmation of the nonlinear model, the analysis then turns to the nonlinear results. Based on the estimation of the nonlinear part of the model, the coefficient of the financial stress index (FSI) variable equals -0.23, indicating the negative effect of financial stress on stock returns in the selected countries. Considering the corresponding probability of this coefficient, which equals 0.0053 and is less than 0.05, this effect is statistically significant at the 95% confidence level. In the second model, which focuses on the oil market and again uses the financial stress index as the transition variable, the oil market function and the effect of the financial stress index on the oil market in the selected countries are modeled. Given the confirmation of the nonlinear model, the analysis again proceeds to the nonlinear results. According to the estimation results, the coefficient of the financial stress index variable equals 0.17, indicating the direct effect of this variable on the oil market (oil prices) in the selected countries. Considering the corresponding probability of this coefficient, which equals 0.0126 and is less than 0.05, this effect is statistically significant at the 95% confidence level. It should be noted that a large part of the increase in financial stress in the economies of the selected OPEC member countries (through channels such as political tensions, government financial pressures, currency tensions, and ultimately monetary tensions) stems from the failure to achieve endogenous growth and economic sustainability. Therefore, the ultimate path toward long-term improvement emphasizes economic growth, and creating the conditions for economic growth is largely dependent on controlling economic instability. Thus, one of the fundamental requirements for enhancing production levels and achieving endogenous economic growth is paying attention to political relations and striving to reduce political tensions.

Keywords: Financial stress, oil market, stock market, panel smooth transition regression (PSTR) model.

1. Introduction

The dynamics between financial stress, oil price fluctuations, and stock market behavior have been central to financial and economic research over the past two decades. Globalization of markets and heightened uncertainty in policy, geopolitics, and macroeconomic fundamentals have created interdependent shocks that influence energy markets and financial systems simultaneously. In this context, the volatility of oil prices and the associated risks in capital markets have emerged as pivotal factors shaping investment strategies, growth trajectories, and policy responses worldwide [1]. For oil-exporting and importing economies alike, the dual forces of financial instability and energy price shocks carry profound implications for both short-run fluctuations and long-term sustainability of growth [2].

Scholars have long recognized that the intricate relationships between oil prices, financial stress, and equity markets are not linear. Rather, they exhibit asymmetric and threshold effects, where the magnitude of shocks and the level of stress interact to amplify or dampen outcomes [3]. These nonlinearities are especially significant in emerging and oil-dependent economies, where fiscal reliance on petroleum revenues and exposure to external financial shocks are more pronounced [4]. In such contexts, policy uncertainty and exchange rate instability exacerbate stock market volatility, undermining investor confidence and increasing systemic risk [5].

The conceptualization of financial stress as an index capturing multiple dimensions—governmental, monetary, and foreign exchange pressures—has enabled scholars to systematically examine its impact on economic and market outcomes [6]. Such indices, when applied to the study of OPEC member states and other resource-dependent economies, shed light on the transmission channels through which financial instability permeates oil markets and equity returns. At the same time, global crises, such as the COVID-19 pandemic, have intensified these linkages, revealing the sensitivity of capital markets to both real-sector shocks and policy-driven uncertainty [7].

A critical strand of literature emphasizes the mediating role of uncertainty in shaping investor sentiment and risk perception. Empirical evidence shows that monetary policy uncertainty and macroeconomic shocks influence stock performance in advanced markets such as the United States, and by extension, affect global investor behavior [8]. Parallel to this, national-level studies in Iran highlight the disruptive influence of economic policy uncertainty on crash risk in equity markets, indicating that fragile institutional environments exacerbate vulnerability [9, 10]. These findings highlight the dual role of domestic institutions and global markets in shaping resilience against financial stress.

The interaction between oil price uncertainty and financial markets is another extensively studied dimension. Evidence from global data suggests that oil shocks not only affect GDP growth but also contribute to wider cyclical fluctuations, with oil importers and exporters exhibiting divergent responses [11, 12]. Corporate-level analyses further reveal that oil price volatility influences leverage decisions and investment strategies, underscoring the transmission of energy shocks into firm-level financial behavior [13]. Moreover, nonlinear frameworks have been employed to illustrate how risk aversion, investor sentiment, and monetary policy shocks collectively shape stock returns, reaffirming the necessity of models that capture dynamic interactions [14].

Building on these insights, studies have incorporated the dimension of financial stress spillovers across borders. For example, Eurozone data demonstrate how macro-uncertainty generates contagion effects in financial markets, amplifying systemic vulnerabilities [15]. Similarly, in emerging markets, the interconnectedness between financial stress, government debt, and real-sector performance has been highlighted, pointing to the importance of fiscal soundness in moderating crisis transmission [16, 17]. Furthermore, research in hospitality and service industries indicates that economic policy uncertainty constrains corporate investment, suggesting that sector-specific dynamics also condition the effect of macro shocks [18].

The broader body of work on oil price shocks has consistently confirmed their role in generating uncertainty and financial stress. In China, oil price shocks combined with policy uncertainty have been shown to impede industrial economic growth [19], while in Iran, similar dynamics affect stock markets through regime-switching mechanisms [20]. Studies in Pakistan and Sub-Saharan Africa also confirm that political and macroeconomic uncertainty significantly affects investment behavior and performance volatility [21, 22]. These findings reinforce the argument that the relationship between oil prices, uncertainty, and financial stress is not geographically constrained but rather global in scope.

From a methodological standpoint, the development of financial stress indices in different contexts has contributed to advancing empirical research. Early work in Iran constructed an index to measure financial stress and analyzed its impact on economic growth, establishing a foundation for subsequent studies [23, 24]. Later studies extended these methods to France and other economies, highlighting how financial stress interacts with macroeconomic cycles and policy interventions [25]. More recent work has applied principal component analysis and other econometric tools to refine measurement, capturing both cyclical and structural dimensions of financial instability [26]. These methodological advancements allow for nuanced insights into how stress operates differently across economies and time horizons.

In addition to traditional econometric approaches, contemporary research incorporates machine learning and big data analytics to forecast oil price dynamics under conditions of uncertainty. For instance, cryptocurrencies have been utilized as predictive tools for oil price movements, especially during the COVID-19 pandemic, underscoring the integration of digital finance with traditional energy markets [27]. Similarly, high-frequency analyses of investor sentiment during the pandemic period provided new evidence on the sensitivity of oil and stock markets to short-term shocks [28]. The geopolitical dimension has also received renewed attention, with geopolitical oil price risks found to generate significant economic fluctuations across advanced economies [29].

The specific case of Middle Eastern economies, particularly Iraq and Iran, highlights the compounded effects of oil dependence, financial stress, and weak institutional resilience. Research on Iraq demonstrates the asymmetric impact of oil prices and international financial markets on growth, reflecting the heightened vulnerability of resource-dependent economies to global shocks [30]. Similarly, evidence from Iran shows that exchange rate volatility has asymmetric effects on stock returns, intensifying the fragility of capital markets under uncertainty [4]. Together, these cases illustrate the challenges of achieving sustainable economic growth in the face of persistent financial and political instability.

The existing literature thus converges on the recognition that oil prices, financial stress, and stock market behavior are intricately linked, with outcomes mediated by policy uncertainty, institutional contexts, and investor sentiment. Nonlinearities, asymmetries, and threshold effects are consistent themes, demonstrating that linear models often underestimate the complexity of these interactions [1, 5]. As global energy markets undergo transitions driven by geopolitics, technological innovation, and climate policy, the importance of understanding these dynamics becomes even more pressing. For policymakers, the findings suggest that stability in financial markets requires careful management of both domestic institutions and exposure to global shocks. For investors, they highlight the necessity of integrating energy price volatility and financial stress indicators into risk management frameworks [3, 8].

This article builds upon these strands of literature by empirically investigating the threshold effects of financial stress on the behavior of oil and stock markets in selected OPEC member countries. By adopting the Panel Smooth Transition Regression (PSTR) model, the study captures the nonlinear transmission mechanisms through which financial stress influences oil prices and equity returns.

2. Methodology

In this article, following the studies of Alavi-Tabar et al. (2021), Fallahpour et al. (2019), Fasanya et al. (2021), Floros et al. (2021), and Wang (2021), in examining the threshold effect of the financial stress index on the behavior of the oil market and the stock market in OPEC member countries, the regression model of the research is presented in two models as follows:

Model One:

$SR(i,t) = a + \beta 1\ FSI(i,t) + \beta 2\ GDP(i,t) + \beta 3\ ICT(i,t) + \beta 4\ RL(i,t) + \beta 5\ PS(i,t) + (\theta 1\ FSI(i,t) + \theta 2\ GDP(i,t) + \theta 3\ ICT(i,t) + \theta 4\ RL(i,t) + \theta 5\ PS(i,t))\ F(St, \gamma, c) + ut$

Model Two:

$OP(i,t) = a + \beta 1\ FSI(i,t) + \beta 2\ GDP(i,t) + \beta 3\ ICT(i,t) + \beta 4\ RL(i,t) + \beta 5\ PS(i,t) + (\theta 1\ FSI(i,t) + \theta 2\ GDP(i,t) + \theta 3\ ICT(i,t) + \theta 4\ RL(i,t) + \theta 5\ PS(i,t))\ F(St, \gamma, c) + ut$

Dependent Variables:

SR – Stock Returns: In this study, stock returns are considered instead of stock prices. Stock returns are constructed by taking the difference between the log of current and past stock prices, calculated as follows:

$sr(t) = \ln(pt / p(t-1))$

In equation (1), sr(t) represents the calculated stock return, ln refers to the natural logarithm, pt denotes the stock price at time t, and p(t-1) represents the previous immediate stock price.

OP – Oil Market Behavior: In this study, the OPEC oil price variable is used to represent oil market behavior.

Explanatory Variables:

FSI – Financial Stress Index: The financial stress index is constructed from three components: government, monetary, and foreign exchange sectors. After measuring financial stress in these sectors, the aggregate financial stress index for the entire economy is calculated. A crucial issue in aggregation is the application of an appropriate weighting method. Given the literature and the conditions of Iran's economy, it appears that these sectors do not have equal weights in creating stress in the Iranian economy, and therefore a weighted method must be employed.

In various studies, including Stoney et al. (2018), Aboura and van Roye (2017), and Semmler and Chen (2018), regression of cyclical components has generally been used. In this method, the cyclical component of each variable involved in constructing the composite index is regressed on the cyclical component of a reference variable (such as output growth), which the composite index is intended to explain. Then, the obtained correlation coefficient is used as the weighting criterion for the composite index of financial stress according to equation (3):

$Wk = (rk^2) / (\Sigma \text{ from } k=1 \text{ to } n \text{ of } rk^2)$ (3)

Accordingly, in this study, to obtain the overall financial stress index, after calculating the stress indices in the different sectors, the cyclical components of the variables in each sector are regressed on the cyclical component of output growth. The resulting correlation coefficient, based on equation (3), serves as the basis for calculating different weights in the overall economic stress index.

Table 1. Financial Stress Index

Variable	Variable Definition	Operational Definition
Financial Stress Index (Government Sector)	GEXP – Government Size	Ratio of total government expenditures to gross national product
	TAXINC – Total Government Tax Revenues	Ratio of total government tax revenues to gross national product
	CU/M1 – Currency to Money Supply	Ratio of total currency in circulation to M1

Monetary Stress	SHD/LOD – Ratio of Short-term to Long-term Deposits	Ratio of short-term deposits to long-term deposits
	M1/M2 – Money to Liquidity	Ratio of money supply to liquidity
	Depo – Deposit Balance Ratio	Ratio of total deposits to gross national product
	Pdebt – Ratio of Non-government Debt	Ratio of non-government debt to banks relative to gross national product
	RInt – Real Interest Rate	Nominal interest rate minus inflation rate
Exchange Rate Stress	RER – Real Exchange Rate	RER = ER * Pout / Pin, where ER = nominal exchange rate, Pout = foreign price index, and Pin = domestic price index

Finally, by applying the Principal Component Analysis (PCA) method, the financial stress index is calculated and used in the model.

ICT – Information and Communication Technology: This index is published by the International Telecommunication Union (ITU) of the United Nations, based on internationally agreed indicators in the ICT field. It is a valuable tool for benchmarking the most important measures of the information society. The ICT Development Index (IDI) provides a standard that governments, ICT operators, development agencies, researchers, and other actors can use to measure the digital divide and compare ICT performance across countries. The IDI is constructed based on eleven ICT indicators, grouped into three sub-categories: access, use, and skills.

ICT measurement = Imported ICT goods (as % of total imports) + Exported ICT goods (as % of total exports).

RL – Rule of Law: In the ranking of countries based on the control of corruption index, the percentile rank between 0 and 100 is used. The closer a country's rank is to 100, the better its rule of law indicator. (Source: Transparency International).

PS – Political Stability: In the ranking of countries based on the control of corruption index, the percentile rank between 0 and 100 is used. The closer a country's rank is to 100, the better its political stability indicator. (Source: Transparency International).

GDP – Gross Domestic Product: GDP at basic prices of the year 2010.

3. Findings and Results

In this section, before conducting the panel cointegration test to determine the long-run relationship between the main study indices, the Levin, Lin, and Chu (LLC) unit root test is performed.

Table 2. Results of the Unit Root Test for Variables

Abbreviation	Selected Countries
Variable	LLC W-stat
FSI	-7.05763
GDP	-2.26506
ICT	-3.58325
OP	-2.98642
PS	-3.14347
RL	-5.89128
SR	-2.39457

The results of the table and the examination of the calculated statistics and their probabilities show that all the research variables are stationary at level.

Most economic theories express the long-run relationship between variables in level form. To ensure the existence of a long-run relationship among the variables in the model, it is necessary that the variables be stationary, or otherwise, if non-stationary, they must have the same order of integration. Thus, to detect a long-run relationship among the variables, their stationarity or cointegration must be examined using various tests. Accordingly, if the residuals from the estimated regressions are I(0) or stationary, we can ensure the existence of a long-run relationship among the variables. In this study, to confirm the existence of a long-run equilibrium relationship, Kao's panel cointegration test is used.

Table 3. Results of Kao Cointegration Test for Stock Return Model

Test	Test Statistic	Probability
ADF	-2.807461	0.0025

Table 4. Results of Kao Cointegration Test for Oil Market Model

Test	Test Statistic	Probability
ADF	-4.822915	0.0000

As shown in the tables above, with the implementation of the panel cointegration test among the estimated variables, the existence of a relationship among the variables in the estimated regression for the selected countries is confirmed in both regression models. The hypotheses of the cointegration test are defined as follows:

H0: No cointegration

H1: Cointegration among variables exists

Given that the significance level is below 0.05, the null hypothesis of no cointegration is rejected, and the variables are cointegrated in the long run, indicating a long-term relationship among them.

To determine the optimal model type for panel data, various tests are used. The most common one is the homogeneity test, which determines whether the panel data model is superior to the pooled data model. If the linear panel regression is as follows:

$Yit = \alpha i + \beta 1\ X1it + \beta 2\ X2it + \dots + \beta k\ Zkit + eit$

where Yit is the dependent variable for unit i in period t, and Xjit is the explanatory variable j for unit i in period t. The cross-sectional differences are shown in αi, which is assumed constant over time. If the null hypothesis states that αi is constant for all countries, the OLS method provides efficient and consistent estimates of α and β. However, if the assumption is that differences exist across sections, the Panel Data method is used for estimation. For testing, the hypotheses H0 and H1 are as follows:

H0: Intercepts are identical across all cross-sections

H1: At least one cross-section has a different intercept

To determine whether separate intercepts exist for each cross-section, the F statistic is used as follows:

$F0 = ((RRSS – URSS) / (N – 1)) / (URSS / (NT – N – K)) \sim F(N-1, N(T-1)-K)$

In the equation above, UR denotes the unrestricted model, R denotes the restricted model with a constant term for all groups, K is the number of explanatory variables in the model, n is the number of cross-sections, and t denotes the time period. If the calculated F exceeds the critical F value from the table with degrees of freedom N-1 and N(T-1)-K, the null hypothesis is rejected, and separate intercepts must be included in the estimation. Another important question arises: whether the intercept differences act uniformly or whether different functions better capture the heterogeneity across units (Ashrafzadeh & Mehregan, 2010, p. 103). The results of the homogeneity test are presented in the following table.

Table 5. Results of Model Selection Test – Homogeneity Test for Stock Return Model

Test	F-test Statistic	Probability
Homogeneity Test (Stock Return Model)	5.548517	0.0002

Table 6. Results of Model Selection Test – Homogeneity Test for Oil Market Model

Test	F-test Statistic	Probability
Homogeneity Test (Oil Market Model)	3.362892	0.0024

Given that the probability values are less than 0.05, the null hypothesis of the pooled data model is rejected, and the research model is selected as a panel data model.

To examine whether there is a linear or nonlinear relationship among the variables in the model, it must be determined whether m (the number of regime parameters) equals one. It should be noted that in the following tests, the null hypothesis is that the model is linear, and the alternative hypothesis is that the model is either a logistic PSTR (m=1) or an exponential PSTR (m=2). The results of the diagnostic test in Table 7 show that the null hypothesis of linearity is rejected; therefore, a nonlinear relationship exists between financial stress and stock returns in the selected countries, and consequently, the PSTR method must be used to estimate the model parameters.

Table 7. Results of Linearity Hypothesis Test (BBC Test)

Selected Countries	Null Hypothesis	F Statistic	Significance Level
Wald Test	3.785	0.000	
Fisher Test	2.638	0.001	
LRT Test	2.957	0.012	

As evident in Table 7, the null hypothesis of linearity between the variables is rejected; therefore, the possibility of a linear relationship among variables is denied. It is also noteworthy that the proposed PSTR model with the transition variable selected is chosen as the optimal model for estimation in the selected countries. Following González et al. (2005) and Colletaz & Hurlin (2006), the null hypothesis of a PSTR model with one transition function versus the alternative of at least two transition functions is tested, and the results are presented in Table 8. The results show that the null hypothesis of sufficiency with one transition function is not rejected in both cases of one and two thresholds. Thus, one transition function is sufficient to specify the effect of the financial stress index on stock returns in the selected countries.

Table 8. Test of Nonlinear Relationship in Residuals

Case of Two Thresholds (m=2)	Case of One Threshold (m=1)
LR = 1.297 (p=0.802)	LR = 1.432 (p=0.654)
LMf = 1.362 (p=0.751)	LMf = 1.471 (p=0.630)
LMw = 1.425 (p=0.675)	LMw = 1.352 (p=0.743)

H0: r=1, H1: r=2

With the confirmation of the nonlinear relationship among variables and the sufficiency of one transition function to specify nonlinear behavior, the optimal choice between one or two thresholds must be determined. For this purpose, the PSTR model corresponding to each case is estimated, and based on the criteria of the sum of squared residuals, Schwarz, and Akaike, the PSTR model with one threshold is identified as the optimal model. Hence, a PSTR model with one transition function and one threshold is selected to examine the nonlinear behavior among the study variables.

Using a PSTR model in which the transition variable is the financial stress index, the stock return function and the effect of the financial stress index on stock returns are modeled. Given the confirmation of the nonlinear model, the analysis then turns to the nonlinear results. Based on the estimation of the nonlinear part of the model, the coefficient of the financial stress index (FSI) variable equals -0.23, indicating the negative effect of financial stress on stock returns in the selected countries. Considering the corresponding probability of this coefficient, which equals 0.0053 and is less than 0.05, this effect is statistically significant at the 95% confidence level.

Table 9. Estimation of the Model Using the PSTR Framework (Stock Return Model for the Selected Countries)

Estimation of the Linear Component of the Model

Variable	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	0.329059	0.136048	2.418698	0.0234
FSI	-0.158886	0.075984	-2.091051	0.0419
ICT	0.582868	0.239013	2.438644	0.0149
GDP	0.096233	0.026454	3.637702	0.0003
RL	0.496421	0.175702	2.825358	0.0069
PS	0.212527	0.090308	2.353357	0.0356

Estimation of the Nonlinear Component of the Model

Variable	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	0.016839	0.006021	2.796881	0.0049
FSI	-0.235516	0.085117	-2.762255	0.0053
ICT	0.016559	0.007091	2.335214	0.0355
GDP	0.089278	0.027937	3.195642	0.0015
RL	0.197885	0.085146	2.324058	0.0201
PS	0.022717	0.010298	2.205968	0.0274
Threshold (c)	0.210178	0.013521	15.54456	0.0000
Slope parameter (γ)	0.735776	0.215697	3.411155	0.0007

Adjusted coefficient of determination (R2) = 0.85.

The comparison of coefficients across the two regimes is based on the transition variable and its values, and the value of the transition variable can determine the transition function and hence the prevailing regime. In the above estimation, the transition variable is the financial stress index, for which the estimated threshold value for the selected countries equals 0.21. Based on the distance of the financial stress index from this threshold value, the model follows two distinct limiting regimes. Comparing the model's coefficients across the two regimes shows that once the financial stress index crosses the threshold (0.21) (transition from the linear to the nonlinear segment), the response of stock returns to changes in this variable intensifies; thus, as the financial stress index rises further, stock returns react more strongly to it and decline more.

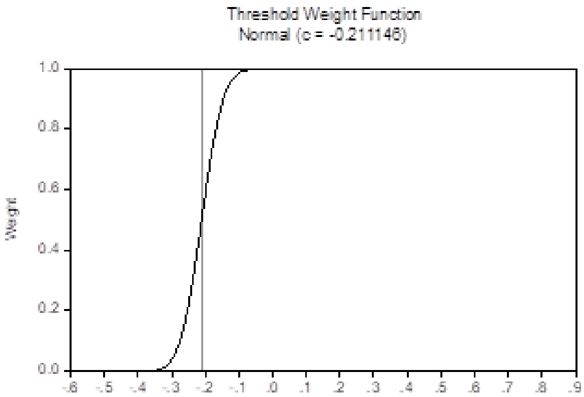

Figure 1: Relationship Between the Transition Function and the Transition Variable

In the present study, the Durbin–Watson test is used to examine autocorrelation.

Table 10. Results of the Autocorrelation Test

	F-statistic	Prob	Durbin–Watson
Selected countries	1.235	0.69	2.236

As shown in the table above, the Durbin–Watson autocorrelation test results indicate that there is no correlation among the disturbance terms; therefore, the third classical standard assumption regarding the absence of autocorrelation among the error terms is not violated. Hence, the estimators possess the required properties (minimum variance and efficiency).

Another classical standard assumption is homoskedasticity; in the present study, the Breusch–Pagan–Godfrey test is used.

Table 11. Results of the Heteroskedasticity Test

	F-statistic	Prob	Breusch–Pagan–Godfrey
Selected countries	1.298	0.556	1.327

As observed in the table, the test results indicate the absence of heteroskedasticity.

Another suitable metric for evaluating the quality of the estimated model is to examine changes in coefficients between the two regimes. If the estimated model is appropriate, the coefficients are expected to remain constant and unchanged with regime shifts.

Table 12. Results of the Smooth Transition Parameter Stability Test

Null hypothesis	F-statistic	Prob
b1 = b2 = b3 = b4 = 0	0.745	0.754
b1 = b2 = b3 = 0	0.798	0.712
b1 = b2 = 0	0.821	0.695
b1 = 0	0.836	0.674

As is evident from the table, the test of coefficient stability between the two regimes shows that the coefficients do not change due to regime shifts.

To examine whether a linear or nonlinear relationship exists among the model variables, it must be determined whether m (the number of regime parameters) equals one. It should be noted that in the following tests, the null hypothesis is that the model is linear, and the alternative hypothesis is a logistic PSTR model (m = 1) or an exponential PSTR model (m = 2). The diagnostic test results in Table 13 indicate that the null hypothesis of linearity is rejected; therefore, a nonlinear relationship between the effects of the financial stress index and the oil market exists in the countries under study, and accordingly the PSTR method must be used to estimate the model parameters.

Table 13. Results of the Linearity Hypothesis Test (BBC Test)

Null hypothesis	F-statistic	Significance level
Wald test	5.236	0.000
Fisher test	4.598	0.000
LRT test	4.789	0.000

As is also evident from the test results reported in Table 13, the null hypothesis of linearity among the variables is rejected; therefore, the possibility of a linear relationship among the variables is ruled out. It is also noteworthy that the proposed PSTR model, with the selected transition variable, is chosen as the optimal model for estimation in the selected countries. For this purpose, following González et al. (2005) and Colletaz and Hurlin (2006), the null hypothesis of a PSTR specification with one transition function versus the alternative of a PSTR specification with at least two transition functions is tested, and the results are presented in Table 13. The results indicate that the null hypothesis of sufficiency of a single transition function is not rejected in both cases of one and two thresholds. Therefore, a single transition function can adequately specify the nonlinear behavior between the financial stress index and the oil market in the selected countries.

Table 14. Test of Nonlinear Relationship in Residuals

Case of Two Thresholds (M=2)	Case of One Threshold (M=1)
LR = 1.425 (p = 0.489)	LR = 1.236 (p = 0.542)
LMf = 1.239 (p = 0.532)	LMf = 1.116 (p = 0.612)
LMw = 1.258 (p = 0.521)	LMw = 1.012 (p = 0.687)

H0: r = 1, H1: r = 2

With the confirmation of the nonlinear relationship among variables and the sufficiency of a single transition function to capture nonlinear behavior, the next step is to select the optimal case between a transition function with one or two thresholds. For this purpose, the PSTR model corresponding to each case is estimated, and among them, based on the criteria of residual sum of squares, Schwarz, and Akaike, the PSTR model with one threshold is identified as optimal. Therefore, a PSTR model with one transition function and one threshold is selected to examine the nonlinear behavior among the study variables.

By using a PSTR model in which the transition variable is the financial stress index, the oil market function and the effect of the financial stress index on the oil market in the selected countries are modeled. Given the confirmation of the nonlinear model, the analysis then turns to the nonlinear results. According to the estimation results of the nonlinear part, the coefficient of the financial stress index equals 0.17, which indicates the direct effect of this variable on the oil market (oil prices) in the selected countries. Considering the corresponding probability of this coefficient, which equals 0.0126 and is less than 0.05, this effect is statistically significant at the 95% confidence level.

Table 15. Estimation of the Model Using the PSTR Framework (Oil Market Model)

Estimation of the Linear Component of the Model

Variable	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	0.521556	0.300193	1.737401	0.0823
FSI	0.091832	0.078581	1.168618	0.2445
ICT	0.023861	0.039414	0.605379	0.5459
GDP	0.289564	0.208206	1.390754	0.1664
RL	-0.237879	0.061631	-3.859691	0.0001
PS	-0.139694	0.048299	-2.892296	0.0038

Estimation of the Nonlinear Component of the Model

Variable	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	0.454951	0.260162	1.748721	0.0937
FSI	0.177326	0.070478	2.516070	0.0126
ICT	0.533757	0.307849	1.733825	0.0829
GDP	0.092199	0.056633	1.628006	0.1057
RL	-0.071610	0.029185	-2.453674	0.0147
PS	-0.035862	0.014372	-2.495362	0.0129
Threshold (c)	0.964102	0.158623	6.077495	0.0000
Slope parameter (γ)	6.675325	2.934622	2.274678	0.0284

Adjusted coefficient of determination (R2) = 0.79.

The comparison of coefficients across the two regimes is based on the transition variable and its values, and the value of the transition variable can determine the transition function and hence the prevailing regime. In the above estimation, the transition variable is the financial stress index, for which the estimated threshold value for the selected countries equals 0.964102. Based on the distance of the financial stress index from this threshold value, the model follows two distinct limiting regimes. Comparing the model's coefficients across the two regimes shows that once financial stress crosses the threshold (0.964102) (transition from the linear to the nonlinear segment), the response of the oil market to changes in this variable intensifies. Thus, energy policymakers have attempted, through more appropriate reactions, to control oil prices as the core of the oil market and prevent further increases.

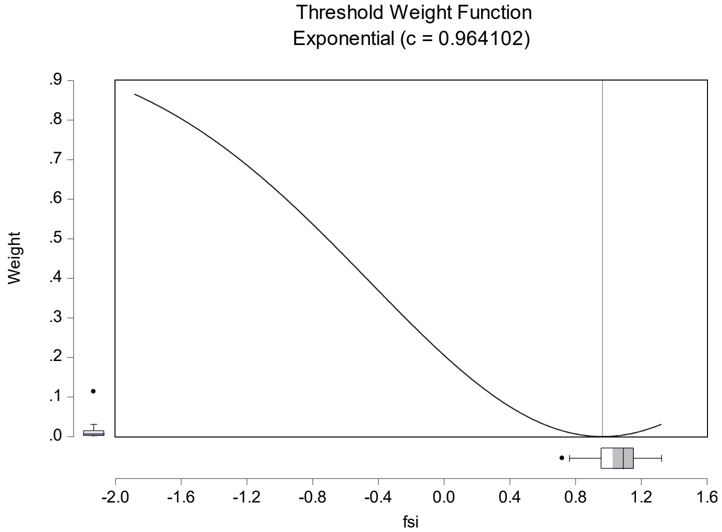

Figure 2: Relationship Between the Transition Function and the Transition Variable (Financial Stress Index)

In the present study, the Durbin–Watson test is used to examine autocorrelation.

Table 16. Results of the Autocorrelation Test

F-statistic	Prob	Durbin–Watson
1.458	0.48	2.398

As shown in the table above, the Durbin–Watson autocorrelation test results indicate that there is no correlation among the disturbance terms. Therefore, the third classical standard assumption regarding the absence of autocorrelation among the error terms is not violated. Hence, the estimators possess the required properties (minimum variance and efficiency). Another classical standard assumption is homoskedasticity; in the present study, the Breusch–Pagan–Godfrey test is used.

Table 17. Results of the Heteroskedasticity Test

F-statistic	Prob	Breusch–Pagan–Godfrey
0.698	0.812	1.139

As observed in the table, the test results indicate the absence of heteroskedasticity.

Another suitable metric for evaluating the quality of the estimated model is to examine changes in coefficients between the two regimes. If the estimated model is appropriate, the coefficients are expected to remain constant and unchanged with regime shifts.

Table 18. Results of the Smooth Transition Parameter Stability Test

Null hypothesis	F-statistic	Prob
b1 = b2 = b3 = b4 = 0	1.236	0.653
b1 = b2 = b3 = 0	1.326	0.574
b1 = b2 = 0	1.348	0.512
b1 = 0	1.487	0.456

As is evident from the table, the test of coefficient stability between the two regimes shows that the coefficients do not change due to regime shifts.

4. Discussion and Conclusion

The findings of this study highlight the threshold effects of financial stress on the behavior of oil and stock markets in selected OPEC member countries. Using a nonlinear framework, the results demonstrated that financial stress exerts a statistically significant negative impact on stock returns once it surpasses a certain threshold, whereas its influence on oil prices manifests as a direct positive relationship under nonlinear conditions. This dual effect reflects the asymmetric nature of stress transmission across different markets. For the stock market, higher levels of financial stress erode investor confidence, leading to sharp declines in returns. Conversely, in oil markets, financial stress amplifies upward price dynamics, likely due to geopolitical risks, currency depreciation, and speculative pressures. These outcomes underscore the necessity of understanding financial stress not as a linear driver but as a threshold variable whose effects intensify when economic and political pressures accumulate beyond critical levels [1].

The negative relationship between financial stress and stock returns in OPEC countries is consistent with findings in other contexts. Previous research on China has shown that oil price uncertainty increases stock price crash risk, revealing how stress-related variables contribute to heightened downside risks [2]. Similarly, studies on OPEC economies affirm that policy uncertainty exacerbates equity volatility, underscoring the fragile nature of capital markets under high stress [3]. The current results extend these insights by illustrating that the impact is nonlinear and significantly stronger beyond a threshold, thereby aligning with evidence from Iran that exchange rate volatility and asymmetry amplify stock market instability [4]. Such findings emphasize the importance of adopting modeling approaches that capture nonlinear dynamics, as linear models risk underestimating systemic vulnerabilities.

Another key contribution of this research lies in demonstrating that financial stress exerts upward pressure on oil prices. This aligns with studies showing that policy uncertainty and oil shocks interact to shape commodity price trajectories. For instance, nonlinear models confirm that oil price volatility interacts with policy uncertainty to affect returns in complex ways [5]. Likewise, the broader literature on financial stress indicates that stress can fuel speculative activity in commodity markets, contributing to sharp price swings and reinforcing procyclical dynamics [6]. By documenting the threshold effect of stress on oil markets, the present study highlights how energy markets serve as both transmitters and amplifiers of global instability, consistent with evidence that oil price shocks during crises such as COVID-19 significantly influenced financial systems [7].

The role of investor sentiment and uncertainty in shaping these dynamics cannot be understated. In the United States, research has shown that monetary policy uncertainty and investor sentiment jointly condition stock market performance [8]. Comparable findings in Iran demonstrate that economic policy uncertainty contributes directly to stock price crash risks [9, 10]. The results from OPEC countries corroborate these patterns, suggesting that investor sentiment deteriorates rapidly under high financial stress, particularly in contexts where political institutions are weaker. The asymmetric responses observed in this study are consistent with the literature on nonlinear effects, where risk aversion, sentiment, and monetary shocks magnify volatility in times of crisis [14].

Oil-importing and exporting countries react differently to financial stress, and this research confirms the specific vulnerabilities of oil-exporting OPEC states. Previous studies reveal that global oil importers and exporters face divergent responses to policy uncertainty, with exporters experiencing more pronounced impacts [11]. Likewise, in Korea, asymmetric effects of financial conditions on GDP growth have been identified, illustrating how stress dynamics can differ based on economic structures [12]. The results of the present study align with this stream of research by showing that for oil-exporting economies, financial stress increases oil price sensitivity, likely reflecting the dual role of petroleum as both a fiscal resource and a speculative commodity.

At the corporate level, these findings have implications for investment and leverage strategies. Evidence from China suggests that oil price uncertainty influences corporate leverage decisions, highlighting the link between macro shocks and firm-level financial choices [13]. Moreover, research on the hospitality sector in the United States shows that uncertainty constrains corporate investment [18]. The observed decline in stock returns under high stress levels in OPEC countries reinforces the notion that firms reduce or delay investment decisions in times of heightened instability. This is particularly salient in emerging markets, where capital markets are less resilient, and the capacity for risk absorption is limited [17].

Cross-country studies further emphasize the contagion and spillover effects of financial stress. In the Eurozone, research has demonstrated that macro-uncertainty transmits financial stress across borders [15]. Similarly, in France, stress dynamics have been shown to shape broader economic cycles [25]. The OPEC-focused findings of this study align with these observations by illustrating how domestic financial stress not only constrains local equity markets but also interacts with global energy dynamics, thereby amplifying volatility. This resonates with studies in China and Iran, where oil price shocks and uncertainty jointly impede growth and destabilize financial systems [19, 20].

The role of political and macroeconomic uncertainty is also confirmed in the results. In Pakistan, political and economic uncertainty has been found to negatively affect investment behavior [21]. In Sub-Saharan Africa, adverse macroeconomic conditions drive performance volatility [22]. For OPEC countries, where political tensions are frequent, financial stress interacts with governance weaknesses to magnify instability. This finding echoes earlier Iranian studies on financial stress indices, which identified the critical role of stress in shaping growth [23, 24]. The construction and application of financial stress indices in this study, therefore, follow an established methodological tradition while extending it to a multi-country OPEC setting.

Recent methodological advances also support the significance of nonlinear modeling for understanding oil and stock markets. Nonparametric and nonlinear models have been employed to capture complex interactions between oil prices, policy uncertainty, and growth, especially in China and global samples [26]. More recent approaches employ advanced econometrics and principal component analysis to refine stress indices [16]. The results of the present study, obtained through a Panel Smooth Transition Regression (PSTR) model, reinforce these methodological innovations by demonstrating that threshold-based analysis provides a more accurate understanding of stress impacts compared to linear models.

In addition to econometric methods, contemporary studies explore alternative predictors and mechanisms. The use of cryptocurrencies to forecast oil prices, particularly during the COVID-19 period, highlights the integration of digital finance with traditional commodities [27]. Likewise, sentiment-based approaches during the pandemic confirmed the role of investor psychology in shaping oil and stock dynamics [28]. At the same time, geopolitical risks remain a central driver of oil price fluctuations, with research demonstrating their profound impact on global economic cycles [29]. In Iraq, oil prices and international financial markets have asymmetric effects on growth, reaffirming the vulnerability of resource-dependent economies [30]. Nonlinear models further reveal that oil price shocks exert significant effects on macroeconomic dynamics when nonlinearity is accounted for [31]. The findings of this study complement these results by illustrating that financial stress is a central transmission channel for both geopolitical and policy-related shocks.

Taken together, the results confirm the complex interplay between financial stress, oil price dynamics, and stock market behavior. The evidence underscores the importance of considering asymmetries, nonlinearities, and thresholds in understanding market responses to stress. These dynamics are not unique to OPEC but are consistent with global trends observed across developed and emerging economies. By focusing on selected OPEC members, this study enriches the literature by offering insights into economies where dependence on oil revenues amplifies the dual effects of financial stress on equity and energy markets.

Despite the contributions of this study, several limitations must be acknowledged. First, the analysis focused on selected OPEC member countries, which, while representative of oil-exporting economies, may not fully capture the heterogeneity across all resource-dependent states. Second, the construction of the financial stress index, although comprehensive, is constrained by the availability and quality of data in emerging markets. Third, while the PSTR model effectively captures nonlinearities, it does not account for potential endogeneity between oil prices and financial stress, which may bias the estimates. Finally, the study period did not include the most recent post-pandemic recovery years in full, which could provide additional insights into long-term adjustment dynamics.

Future research could extend this study by incorporating a broader set of countries, including oil-importing states, to allow for comparative analysis across economic structures. In addition, future work could integrate high-frequency data to better capture short-term dynamics and volatility spillovers. Employing advanced econometric techniques, such as structural VARs or machine learning-based forecasting, could further improve accuracy and account for endogeneity issues. Moreover, exploring sectoral effects within OPEC economies, such as the impact of stress on manufacturing, services, and fiscal sustainability, would enrich understanding of transmission channels. Finally, future studies could integrate climate policy and energy transition variables, which are increasingly important for oil-dependent economies.

For policymakers in OPEC member countries, the findings highlight the importance of monitoring financial stress indices as early warning signals of instability in both stock and oil markets. Efforts to reduce political and policy uncertainty can mitigate the amplification effects observed under high stress conditions. For investors, the results underscore the necessity of incorporating stress indicators into portfolio management strategies, particularly in resource-dependent economies. For energy policymakers, the findings suggest that stabilizing oil markets under stress requires proactive intervention and diversification strategies to reduce vulnerability to financial and political shocks.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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