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The Impact of EPU on the Relation Between International Oil Price Shocks and the Chinese Stock Market: Industry and Transnational Perspectives

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Abstract

In this study, we employ the panel smooth transition (PSTR) model to establish a nonlinear framework for examining the relationship between international oil prices and stock returns in China. We specifically investigate how economic policy uncertainty (EPU) acts as a threshold-driven moderator in this relationship. We analyze data from August 2007 to November 2023 and select the EPU index from seven representative countries to examine its cross-border effects on China's oil-stock relationship. Furthermore, we incorporate an analysis of industry heterogeneity to gain a deeper understanding of how international crude oil prices impact stocks in both upstream and downstream industries. Our findings reveal the following: (1) Under the influence of EPU, there is a significant nonlinear regime-switching effect between international oil prices and Chinese stock returns. (2) Sensitivity to U.S. EPU is the highest, but its effect on risk magnification is the weakest. In contrast, European EPU shows lower sensitivity but a more pronounced risk magnification effect. (3) Chinese EPU significantly amplifies the risk for midstream manufacturing stocks more than for downstream consumer service stocks. This variation reflects the differing abilities of industries to transfer costs along the supply chain; however, there are no substantial differences in sensitivity.

Keywords: economic policy uncertainty; international oil prices; stock returns; panel smooth transition model



Academic Editor: Periklis Gogas

Received: 11 January 2026

Revised: 9 February 2026

Accepted: 12 February 2026

Published: 20 February 2026

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1. Introduction

In recent years, the global economic landscape has undergone significant changes. The rise in protectionist trade policies, the increase in geopolitical conflicts, and the rapid transition to alternative energy sources are closely linked, leading to unprecedented levels of economic policy uncertainty. Baker et al. (2016) employed text analysis methods to quantify this uncertainty, developing the EPU index for 22 countries and regions worldwide. According to this index, the average global EPU from 2020 to 2023 was 68% higher than that from 2016 to 2019. As the largest crude oil importer and the second-largest economy in the world, China's capital market faces the dual challenges of significant fluctuations in international oil prices and uncertainties in both domestic and international policies, making the prevention of systemic risk a top priority. Against this background, practically significant questions need to be answered: Are international crude oil prices and Chinese stock returns jointly exposed to the dual shocks of domestic and international economic policy uncertainty? Does their cross-border spillover mechanism exhibit asymmetric characteristics?

Existing research frequently considers crude oil prices to be a significant factor influencing the stock market. Most studies support the notion of a “negative shock effect” of price shocks, indicating that increases in international oil prices tend to suppress stock returns (Kilian & Park, 2009; Zhu & Yuan, 2019; Z. Liu et al., 2019). Conversely, some studies indicate a positive correlation (Zhao et al., 2022), while others suggest a lack of significant causal relationships (Jin & Jin, 2008).

As research progresses, new trends are emerging. First, there is a methodological shift toward nonlinear approaches (Conrad et al., 2014). Aloui and Jammazi (2009) found significant regime-switching effects in how oil price shocks influence actual stock returns, utilizing Markov regime-switching models. This echoes the nonlinear interaction characteristics confirmed by Feng et al. (2020), further highlighting the applicability and necessity of nonlinear methods in this field of research. Second, research has expanded to focus on sector-specific stocks. Oberndorfer (2009) found that crude oil prices negatively affected stock prices in the European utilities sector while positively impacting stocks in the oil and gas industries.

Traditional studies typically treat crude oil prices and EPU as independent variables, analyzing their individual impacts on stock markets using linear models. However, given the deep interconnections within the global supply chain and the integration of financial markets, the nonlinear interactions between these risk factors have become more pronounced. Since the onset of the global financial crisis, there has been a rapid increase in EPU, resulting in reduced investments in the real economy (C. S. Zhang et al., 2023) and heightened default risks (Li et al., 2022). Simultaneously, financial markets have experienced increased stock price volatility, liquidity shortages (Dong & Liu, 2020), and a collapse in investor confidence (Xing & Wang, 2022).

As noted by Balcilar et al. (2015), it is essential to consider and test for potential nonlinear relationships when modeling complex systems in fields such as economics and finance. Neglecting to do so can lead to biased or misleading conclusions derived from linear models. In an early attempt to conduct nonlinear research, Kang and Ratti (2013) employed the structural vector autoregression (SVAR) model, confirming that EPU amplifies the direct impact of oil price shocks on stock market returns. Further investigation by Kang et al. (2017) indicated that this moderating effect is particularly significant in the oil and gas industry. The study by Batten et al. (2021) further confirms that the correlation between crude oil and stock markets exhibits significant time-variation and asymmetry, presenting typical nonlinear characteristics.

X. J. Liu et al. (2022) applied panel smooth transition models to demonstrate that an increase in economic policy uncertainty intensifies the negative consequences of oil price shocks. Additionally, some researchers have examined the varying effects of economic policy uncertainty on the relationship between crude oil and stock markets under different market conditions. For instance, Wen et al. (2019) found that, while U.S. economic policy uncertainty (USEPU) enhances the dependence of oil stocks, a strong U.S. economy can mitigate this association. Z. Liu et al. (2022) also discovered that the effect of economic policy uncertainty on the correlation of crude oil–stocks was more pronounced during periods of economic distress, particularly during the COVID-19 pandemic, than during the global financial crisis.

While there have been limited studies on the nonlinear effects of EPU on the relationship between oil prices and stock markets, a more thorough explanation is necessary. Our paper has three main features:

First, we integrate EPU into the analysis of oil–stock market correlations utilizing the nonlinear model of PSTR. This reveals its dual transmission mechanism through both real

economy channels and financial market channels. This model has significant advantages in identifying critical threshold points and quantifying the effects of regime switching.

Second, we extend the impact of economic policy uncertainty research from a single country to transnational interaction. Previous studies have explored the differences in oil–stock correlations between oil-importing and -exporting nations (Jung & Park, 2011; Bartsch & Lothian, 2019), as well as between developed and developing countries (Broadstock & Filis, 2014). Some studies have even investigated these correlations across different historical periods (Chen & Lv, 2015; Z. Liu et al., 2022). However, most existing studies focus mainly on how a country's EPU affects its own domestic oil–stock relationships, without considering the varying impacts of one nation's EPU on others. K. Q. Zhang and Li (2022) systematically analyzed the global spillover characteristics of economic policy uncertainty and its transmission mechanism to stock market volatility, providing an empirical basis for the cross-border EPU research in this paper.

Given the economic interconnectedness of nations, it is crucial to examine the characteristics of these international interactions. In this study, we select seven representative countries based on key criteria, including oil production status, level of economic development, and financial market maturity. This allows us to examine the differences in the impact of these countries' EPU fluctuations on China's oil–stock relationship.

As the world's largest crude oil importer, China's dependence on imported crude oil remains high. By identifying differences in cross-border EPU thresholds, we can understand the sensitivity of capital markets to policy changes, establish graded early warning indicators, achieve forward-looking prediction of spillover risks, help regulatory authorities accurately block the transmission of spillover risks, and safeguard energy security and financial stability.

Third, most studies analyze stock markets as a whole when investigating the impact of oil price shocks, and only a few focus on specific industry stocks (Oberndorfer, 2009; Z. Liu et al., 2022). To thoroughly examine the impact of oil price shocks on stock returns across various industries, this study performs a sector-specific analysis of 11 key industries within the oil supply chain.

Given the varying positions of industries within the supply chain and differing cost-shifting capabilities, their responses to international oil price shocks also vary. Understanding these industry-specific differences will enable the development of more precise and effective industrial policies, thereby reducing the need for frequent economic policy adjustments. This approach facilitates optimized risk hedging strategies and achieves differentiated risk management approaches across sectors.

2. Data and Methodology

In a groundbreaking development, Gonzalez et al. (2005) combined the continuous transition mechanism from the smooth transition autoregression model with the regime-partitioning framework of the panel threshold regression model. This integration resulted in the emergence of the panel smooth transition (PSTR) model. A key innovation of this model is the replacement of the traditional step function used in panel threshold regression models with a Sigmoid function. This significant enhancement mitigates the discontinuities associated with structural breakpoints in standard panel threshold regression models, making the PSTR model more representative of real-world economic systems.

Furthermore, the PSTR model enables the precise modeling of shocks to EPU, facilitating the exploration of the nonlinear impact mechanisms of international oil prices on Chinese stock market returns during periods of uncertainty. The model identifies critical threshold values for EPU and quantifies the regime-switching effects. This capability en-

ables policymakers to accurately identify crucial intervals of EPU changes, providing a theoretical basis for informed decision-making.

The PSTR model is constructed as follows:

$$Y_{it} = \mu_i + \beta_0 X_{it} + \beta_1 X_{it} g(q_{it}; \gamma, C) + u_{it} \quad (1)$$

$$g(q_{it}; \gamma, C) = \left\{ 1 + \exp \left[-\gamma \prod_{j=1}^m (q_{it} - C_j) \right] \right\}^{-1}, \gamma > 0, C_1 \ll C_2 \ll \dots \ll C_3 \quad (2)$$

This study utilizes the PSTR model, which includes two regions and a position parameter. In this model, the explanatory variable is denoted as X_{it} , the dependent variable as Y_{it} , the position parameter as C , and the transformation variable as q_{it} . The slope parameter γ takes values greater than zero, indicating how the response function changes its rate with variations in the transformation variable.

The transformation function, denoted as $g(q_{it}; \gamma, C)$, behaves differently as q_{it} changes: as q_{it} approaches infinity, the transformation function approaches 0, indicating low-region behavior; conversely, as q_{it} approaches zero, it approaches 1, signaling high-region behavior. The transformation variable ranges from zero to infinity, enabling smooth transitions between 0 and 1 for the transformation function, which allows for continuous and smooth transitions between regions.

Additionally, C serves as the inflection point for regional transitions. The regression coefficient for the linear component is denoted as β_0 , which represents the baseline marginal impact of OPU on R_{it} when EPU is far below the threshold ($T(EPU_{it}; \gamma, C) \rightarrow 0$, low-uncertainty regime). It captures the direct effect of oil price fluctuations on stock returns in a stable policy environment. The coefficient corresponding to the nonlinear component is denoted as β_1 . As the transformation function varies between 0 and 1, the corresponding regression coefficients shift between β_0 and $\beta_0 + \beta_1$.

When extending the model, it comprises three regions and two position parameters. Here, $m = 2$, with the transformation function exhibiting a V-shaped pattern: values at both ends remain similar, while intermediate values show significant differences. As the number of transformation variables q_{it} increases, the function $g(q_{it}; \gamma, C)$ first decreases and then increases, reaching a minimum at $(C_1 + C_2)/2$. When q_{it} approaches $-\infty$ or ∞ , the function takes a value of 1, indicating the model's external region state; when q_{it} equals $(C_1 + C_2)/2$, it takes a value of 0, marking the intermediate region state. The three-region panel smoothing transformation model is expressed as follows:

$$y_{it} = \mu_i + \beta_0 x_{it} + \sum_{j=1}^r \beta_j x_{it} g(q_{it}^j; \gamma, C) + u_{it} \quad (3)$$

By considering economic policy uncertainty as a variable that influences outcomes, this study analyzes the differing impacts of international crude oil prices on China's stock market at varying levels of economic policy uncertainty. The model equations are as follows:

$$R_{it} = \mu + \beta_0 OPU_{it} + \left(\beta_1^{OPU} OPU_{it} + \beta_{1s} \text{Controls} \right) T(EPU_{it}; \gamma, C) + \varepsilon_{it} \quad (4)$$

$$T(EPU_{it}; \gamma, C) = \frac{1}{1 + \exp(-\gamma \prod_{j=1}^d (EPU_{it} - C_j))}, \gamma > 0 \quad (5)$$

The dependent variable, R_{it} , indicates the monthly stock return ratio of the CSI 300 industry index for the i -th industry in period t . The ratio is calculated using the following formula: ((Closing Index of Period t – Closing Index of Period $t - 1$)/Closing Index of

Period $t - 1) \times 100\%$. β_1^{OPU} represents the additional marginal impact of OPU on R_{it} when EPU exceeds the threshold ($T(EPU_{it}; \gamma, C) \rightarrow 1$, high-uncertainty regime). It reflects the incremental effect of oil prices on stock returns driven by EPU's "risk magnification" role. $T(EPU_{it}; \gamma, C)$ acts as a "weighting factor" that shifts smoothly between 0 and 1 as EPU crosses threshold C , ensuring a continuous regime switch (a key advantage of the PSTR model). When EPU is below C , $T(EPU_{it}; \gamma, C) \rightarrow 0$, and the total impact of OPU is β_0 ; when EPU is above C , $T(EPU_{it}; \gamma, C) \rightarrow 1$, and the total impact becomes $\beta_0 + \beta_1^{OPU}$.

The CSI 300 industry index classifies the 300 largest and most liquid stocks from the Shanghai and Shenzhen stock exchanges into 11 primary sectors, providing a comprehensive representation of China's A-share market. These sectors include energy, raw materials, industry, consumer discretionary goods, consumer staples, healthcare, finance, real estate, information technology, communication services, and utilities. The number of constituent stocks in each industry is as follows: 71 in industry, 49 in finance, 43 in information technology, 31 in raw materials, 26 in healthcare, 21 in consumer discretionary goods, 17 in consumer staples, 15 in communication services, 13 in utilities, 10 in energy, and 4 in real estate. Among them, upstream resource industries include the energy and public utilities indices; midstream manufacturing industries include the industry, information technology, raw materials, and communication services indices; and downstream consumption and service industries include the medicine and health, optional consumption, and main consumption indices. Table 1 presents the basic statistical characteristics of the CSI 300 index as a whole and each industry sector.

Table 1. Basic statistics of the CSI 300 index and its sectors.

	Mean (%)	Std Dev (%)	Max (%)	Min (%)	Skewness	Kurtosis
CSI 300	0.37	8.6	43.48	−32.86	−5.11	1.49
Upstream Resource Sectors	0.34	8.56	43.48	−32.86	−2.91	1.58
Midstream Manufacturing Sectors	0.17	9.11	32.12	−29.21	6.7	1.69
Downstream Consumer Service Sectors	0.72	8.02	26.03	−26.92	−3.28	0.99

The analysis covers the period from August 2007 to November 2023. The explanatory variable, OPU_{it} , represents the price of WTI crude oil futures, which is considered the primary factor driving fluctuations in crude oil prices in the 21st century due to its financial characteristics (Z. Liu et al., 2019). The transition variable, EPU_{it} , represents EPU. Several scholars have developed their own EPU indices, with the index created by Baker et al. (2016), which utilizes a textual analysis, being the most influential and widely recognized. Huang and Luk (2020) constructed a targeted EPU measurement system for the Chinese market to address the adaptability of international EPU indices in emerging economies.

This analysis considers data availability and representativeness by including EPU indices from major oil-producing countries such as Russia (RUEPU) and Canada (CAEPU). It also includes those from emerging markets such as India (INEPU) and China (CNEPU). Furthermore, this study incorporates EPUs from developed financial markets, including the United States (USEPU), the United Kingdom (UKEPU), and Japan (JPEPU). Additionally, it takes into account European economic policy uncertainty (EUREPU) and global economic policy uncertainty (GEPU).

Additionally, considering the impact of global indices and the significant role of the U.S. dollar in crude oil transactions, the analysis also includes the MSCI World Index and the volatility of the Renminbi exchange rate as control variables.

The transition function $T(EPU, \gamma, C)$ consists of the transition variable EPU, the slope parameter γ , and the location parameter c . If EPU is significantly smaller than c , $T(EPU, \gamma,$

C) approaches 0, indicating that the effect of the independent variable on the dependent variable is simply β_0 . In contrast, if EPU is much larger than c , $T(EPU, \gamma, C)$ approaches 1, and the relationship becomes $\beta_0 + \beta_1$. As EPU increases, the impact of the independent variable transitions smoothly between β_0 and $\beta_0 + \beta_1$. Overall, the effect of international oil prices on stock returns changes within these two extreme regimes, as influenced by the level of EPU through a smooth transition mechanism.

3. Empirical Analysis

3.1. Nonlinearity and Residual Nonlinearity Tests

The construction of the PSTR (panel smooth transition regression) model assumes that there are nonlinear dynamic interrelationships among the variables involved. First, we verify the nonlinearity of the relationship between international oil prices and Chinese stock market returns by conducting nonlinear tests. This step ensures that the conditions for PSTR modeling are satisfied. Once we confirm the presence of nonlinear effects, we conduct residual nonlinearity tests to determine the optimal number of transition functions needed for the model.

This study selects three test statistics for nonlinear testing: Wald Tests, Fisher Tests, and LRT Tests. This statistic is also applicable to the remaining nonlinear tests. The null hypothesis of “nonlinear testing” is $H_0: r = 0$, meaning that there is no nonlinear transition effect between international oil price fluctuations and China’s stock market returns; otherwise, the alternative hypothesis, $H_1: r \geq 1$, is accepted, indicating that the model has at least one transition function and a nonlinear transition effect. In other words, a nonlinear dynamic relationship exists between international oil prices and China’s stock returns, meeting the conditions for using the panel smooth transition model. The formulas for the LM, LMF, and LRT statistics are as follows:

$$LM = \frac{TN(SSR_{linear} - SSR_{PSTR})}{SSR_{PSTR}} \quad (6)$$

$$LMF = \frac{\frac{SSR_{linear} - SSR_{PSTR}}{mk}}{\frac{SSR_{linear}}{TN - N - mk}} \quad (7)$$

$$LRT = -2(\log SSR_{PSTR} - \log SSR_{linear}) \quad (8)$$

If the model contains nonlinear effects, that is, if the nonlinear test rejects the null hypothesis, then a “residual nonlinear test” can be conducted to determine the number of existing transformation functions. The logical approach of the test involves performing a Taylor expansion when the slope parameter v equals 0 for the second transformation function and then examining the nonlinear constraints of the parameters, still using the three statistics LM, LMF, and LRT. In this case, the null hypothesis $H_0: r = 1$ indicates the existence of a transformation function between international oil price fluctuations and China’s stock market returns; otherwise, the alternative hypothesis $H_1: r = 2$ is accepted, indicating the presence of two transformation functions in the model. Suppose that the test continues to reject the null hypothesis. In that case, the new null hypothesis becomes $H_0: r = r + 1$, and the “residual nonlinear test” is repeated until the null hypothesis is accepted, thereby ultimately determining the number of transformation functions. At this point, $r = a$ represents the optimal number of transformation functions in the model. Subsequently, the number of transformation zones m is determined through the minimum residual sum (RSS), Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC).

The results of the nonlinearity tests regarding China’s EPU are presented in Table 2. The statistics from the LM, LMF, and LRT tests significantly reject the null hypothesis at the 1% level: $H_0: r = 0$. This suggests that there are nonlinear transition effects, indicating

that at least one transition function is present. Moreover, there is a significant nonlinear relationship between international oil prices and the Chinese stock market, influenced by China's EPU.

Table 2. Results of nonlinearity and residual nonlinearity tests.

	Nonlinearity Test		Residual Nonlinearity Test	
	Statistic	<i>p</i> -Value	Statistic	<i>p</i> -Value
Wald Tests (LM)	50.334	0.000	6.63	0.036
Fisher Tests (LMF)	57.744	0.000	3.303	0.037
LRT Tests (LRT)	51.066	0.000	0.408	0.036

In additional tests for residual nonlinearity, the LM, LMF, and LRT statistics support the acceptance of the null hypothesis at the 1% level: $H_0: r = 1$. This indicates that a single transition function is sufficient to explain all nonlinear characteristics within the model.

The models incorporating EPU from China, the U.S., the U.K., Europe, and globally passed the nonlinearity tests. However, the results from Japan, Russia, Canada, and India did not show significant nonlinear characteristics in the relationship between international oil prices and Chinese stock returns under their respective EPUs.

By referring to the previous literature, we can attempt to explain the above results from two aspects: fundamental (C. S. Zhang et al., 2023; Li et al., 2022) and financial market (Xing & Wang, 2022; Z. Liu et al., 2019). As the largest source of oil imports for China, Russia's EPU shocks can significantly impact China's crude oil supply. However, the effect of Russia's EPU on the relationship between oil and Chinese stock returns is relatively direct and pronounced. This direct influence limits the exploration of nonlinear relationships between oil and stock markets. Although Canada is a major global oil exporter and has increased its share of exports to China, India, South Korea, Japan, and other Asia-Pacific regions in recent years, its contribution to China's oil imports remains small. Consequently, the impact of Canada's EPU on China's oil-stock relationship is limited. In the case of Japan, which has a well-developed financial market, its EPU may transmit through financial channels to influence China's stock market. However, due to the low correlation in oil markets between Japan and China, no nonlinear relationship has been demonstrated between the international oil price and China's stock markets. For India, both the low correlation with oil-related issues and weak financial market connectivity further constrain the impact of its EPU on China's oil-stock relationship.

3.2. Parameter Estimation

This study employs both ordinary least squares (OLSs) and nonlinear least squares (NLSs) to estimate model parameters, following the implementation of nonlinear and residual nonlinear tests, as outlined in the research methodology by Fouquau et al. (2008). The developed model analyzes the impact of EPU shocks on international oil prices and their subsequent effects on stock returns in China.

Table 3 displays the results of the parameter estimates. The linear parameters represent the coefficients of impacts during periods of low uncertainty, while the nonlinear parameters indicate the marginal changes that occur after a threshold breach. The concept of elasticity amplification refers to the percentage increase in the marginal impact of international oil prices (OPU) on Chinese stock returns (R) when economic policy uncertainty (EPU) crosses the critical threshold C , switching from a low-uncertainty regime to a high-uncertainty regime. Mathematically, it is defined as the absolute value of the ratio of the nonlinear parameter (β_1^{OPU}) to the linear parameter (β_0) in Equations (3)–(5) multiplied by 100%: Elasticity Amplification = $\beta_0\beta_1^{OPU} \times 100\%$. This measure quantifies the economic

significance of the nonlinear regime switch, enabling cross-context comparisons of EPU's moderating strength and providing actionable insights for policy and investment decisions.

Table 3. Results of PSTR models.

	Transition Variable	Location Parameter	Linear Parameters	Nonlinear Parameters	Elasticity Amplification
PSTR Model (1)	CNEPU	156.19	−0.59	−0.45	76%
PSTR Model (2)	USEPU	124.7	−0.60	−0.23	38%
PSTR Model (3)	UKEPU	176.74	−0.54	−0.27	50%
PSTR Model (4)	EUREPU	193.7	−0.64	−0.25	39%
PSTR Model (5)	GEPU	117.64	−0.56	−0.32	57%

The fundamental idea is that, once EPU exceeds a certain threshold, the market's sensitivity to oil price shocks significantly heightens due to changes in the economic policy environment, thereby quantifying this nonlinear jump effect.

The results from Model 1 estimate the location parameter at $C = 156.19$, indicating a significant change in the relationship between crude oil prices and the stock market in China at an EPU index level of 156.19. The sample's distribution characteristics show that this threshold is notably lower than the median value of 263.6 yet slightly higher than the lower quartile value of 131.45. This suggests that the threshold is positioned within the left-skewed interval of the sample distribution. It indicates that structural breakpoints in the relationship between crude oil prices and the stock market are more likely to occur at moderately low levels of EPU.

The model identifies two distinct regimes through a threshold analysis. When EPU is below the threshold ($CNEPU < 156.19$), international oil prices have a negative impact on Chinese stock returns, with a coefficient of -0.59 . This means that, for every unit increase in oil prices, stock returns decrease by 0.59 units. This effect is likely due to a relatively stable economic policy environment, where investors are more concerned about the adverse effects of rising oil prices on corporate costs, thereby putting pressure on the Chinese stock market. When EPU exceeds the threshold ($CNEPU > 156.19$), the negative impact of international oil prices on Chinese stock returns intensifies, with the impact coefficient decreasing to -1.04 , representing an elasticity amplification of 76%. This indicates that the same volatility in oil prices has an approximately 76% greater effect on the stock market. EPU acts as a “risk magnifier” in the financial market contagion process, amplifying the negative relationship between the two markets.

In contrast, the United States has the lowest threshold for EPU ($C = 124.7$), indicating that the relationship between crude oil prices and the stock market is more susceptible to U.S. EPU. This sensitivity may arise from the international status of the U.S. dollar and the highly developed financial markets in the United States, which experience strong policy spillover effects. However, the United States exhibits the weakest elasticity amplification, with the effects of oil price shocks magnified by only 38%.

European EPU has the highest threshold ($C = 193.7$), suggesting that the European market has a better capacity to adapt to policy changes. This may be due to the complementary economic structures between China and Europe. Key trade areas between the two regions include manufacturing and green technologies, particularly in automotive and renewable energy sectors, where significant complementarity exists. Capital flows between China and Europe tend to focus more on physical investments rather than short-term financial capital. This deep economic complementarity enhances cooperation between China and Europe, outweighing competitive dynamics and mitigating the impact of policy changes.

The robustness test is detailed below.

Brent crude oil and West Texas Intermediate (WTI) crude oil are the two most important benchmark prices in the international crude oil market, and they are the most frequently traded crude oil futures by investors. Both benchmarks effectively reflect the factors influencing crude oil prices. This study uses Brent crude oil futures prices as a proxy for international oil prices to examine the robustness of the research conclusions. Additionally, it incorporates China's economic policy uncertainty, U.S. economic policy uncertainty, and global economic policy uncertainty as transformation variables to enhance the reliability of the analysis. The results of the model parameter estimation are shown below. The findings indicate that, when economic policy uncertainty exceeds a certain threshold, the negative impact of oil price shocks on China's stock market returns intensifies. This supports the empirical findings presented earlier, reinforcing the robustness of the research conclusions, as shown in Table 4.

Table 4. Robustness test results.

Conversion Variable	Positional Parameter	Linear Parameter	Nonlinear Parameter
CNEPU	156.12	−0.48	−0.38
USEPU	124.63	−0.51	−0.60
GEPU	176.63	−0.19	−0.27

3.3. Industry Analysis

To further investigate the differing impacts of global oil prices on stock returns across various Chinese industries, this study employs the CSRC industry chain index classification method. Specifically, upstream resource industries include the energy and utilities indices; midstream manufacturing industries include the industrial, information technology, basic materials, and telecommunication services indices; and downstream consumer and service industries include the healthcare, consumer discretionary, and consumer staples indices. By using EPU as a transitional variable, this study examines how international oil prices affect stock returns in these specific industries differently.

The nonlinear test results presented in Table 5 indicate that the upstream resource industries accepted the null hypothesis $H_0: r = 0$. This demonstrates that the impact of international crude oil prices on the stock returns of these industries is linear, with no significant thresholds. Several factors may contribute to this observation.

Table 5. Results of nonlinearity and residual nonlinearity tests on sector portfolios.

	Nonlinearity Test			Residual Nonlinearity Test		
	LM	LMF	LRT	LM	LMF	LRT
Upstream Resource Sectors	0.157	0.156	0.157	-	-	-
Midstream Manufacturing Sectors	5.432 *	5.435 *	5.451 **	3.555	3.539	3.563
Downstream Consumer Service Sectors	4.269 *	4.271 *	4.284 *	2.079	2.066	2.083 *

Note: *, ** indicates statistical significance at the 10%, 5% level respectively.

To examine the heterogeneous responses of the oil–stock nexus at the industry level, this section prioritizes Chinese economic policy uncertainty (CNEPU) as the threshold variable, which is consistent with the core model setting in Section 3.2. The table below reports the results of the nonlinearity and residual nonlinearity tests for upstream, midstream, and downstream sectors.

Firstly, the cost structure of upstream resource industries, which primarily rely on oil as a direct material, creates a high demand for crude oil. As a result, the effect of

international oil prices is most pronounced in these industries: when oil prices rise, costs increase directly, leading to reduced profits. Consequently, stock price reactions occur immediately, without delays or sudden shifts.

Secondly, upstream companies often have a unique pricing mechanism that links their product prices to benchmark oil prices through long-term sales contracts. This allows fluctuations in international oil prices to be transmitted almost proportionally, which reduces any nonlinear effects.

The midstream manufacturing, downstream consumption, and service industries reject the null hypothesis $H_0: r = 0$. This finding suggests that, influenced by EPU, the relationship between international oil prices and stock returns in both the midstream and downstream sectors displays nonlinear characteristics.

A notable commonality between these two sectors is that EPU serves as a risk-amplifying factor, significantly intensifying the negative correlation between them. Several mechanisms may account for this phenomenon.

Firstly, supply shocks emerge through the real economy channel, resulting in decreased consumption. In an environment of heightened policy uncertainty, businesses struggle to forecast future costs associated with taxes, environmental regulations, and other policy-related expenses. When coupled with fluctuations in international oil prices, this creates a dual shock related to “policy and cost”. At the same time, consumers’ increased precautionary savings and reduced willingness to spend lead to fluctuations in orders for midstream and downstream industries, ultimately affecting the stock market.

Secondly, financial frictions in the markets become evident. As EPU escalates, banks tighten the availability of credit for midstream and downstream industries (Toh & Zhang, 2022). Consequently, companies are compelled to seek funding at higher interest rates or scale back production, which undermines their capacity to manage oil price shocks.

Additionally, when responding to shocks from EPU, there are notable industry-specific differences between the midstream manufacturing and downstream consumer service sectors. The midstream manufacturing sector experiences a greater increase in elasticity, with values reaching 82%, while the downstream consumer service sector shows an increase of 62%, as indicated in Table 6. This suggests that the impact of EPU on oil price shock risks is more significant in the midstream manufacturing sector than in the downstream consumer service sector. This difference may stem from the midstream manufacturing sector’s position in the supply chain. Faced with high EPU, it must navigate the dual pressures of rising costs for upstream raw materials and pricing pressures from downstream clients. In contrast, the downstream consumer service sector is more influenced by demand-side factors, resulting in lower demand elasticity and the ability to manage cost shocks through mechanisms such as cost pass-through.

Table 6. Results for parameter estimation tests on sector portfolios.

	Location Parameter	Linear Parameter	Nonlinear Parameter	Elasticity Amplification
Midstream Manufacturing Sectors	156.21	−0.63	−0.52	82%
Downstream Consumer Service Sectors	156.07	−0.7	−0.44	62%

4. Discussion

These findings serve as essential guidelines for policymakers. For countries that are sensitive to policy thresholds, it is advisable to enhance cross-border monitoring of EPU and safeguard against “threshold breaches” that could result in cross-market resonance. In

nations where the risk magnification effect is pronounced, it is important to improve risk warning systems and effectively manage investor expectations.

Monitoring priorities should differ based on the current EPU stage. During periods of low EPU, the focus should be on observing the transmission of cost in energy-intensive industries and considering the supply-side impacts of international oil prices on the real economy. Conversely, during periods of high EPU, governments should concentrate on market and liquidity risks in stock markets; prioritize stabilizing financial market sentiment to prevent overreactions; and, if necessary, provide proactive policy guidance. This can be achieved by enhancing the alignment of fiscal, monetary, and financial policies through counter-cyclical adjustments to mitigate external shocks and reduce the uncertainties affecting the capital market.

Regarding industrial policy, targeted support for midstream sectors is crucial. When EPU exceeds certain thresholds, measures such as tax incentives, loans for manufacturing, or special subsidies can help mitigate the cost impacts of oil price volatility. For downstream sectors, it is important to manage expectations using strategies such as car purchase subsidies, though these should be avoided during high-EPU periods. Additionally, strengthening price monitoring in the service industry is essential to prevent cost pass-through from leading to inflation spirals.

In response to market liquidity shocks that heighten financial market volatility and risk premiums, which, in turn, can exacerbate the risk of oil price shocks, it is essential to implement policies that encourage institutional investors to focus on long-term investments. This can be achieved by increasing the allocation of social security funds and sovereign wealth funds in A-shares through tax incentives. Such measures would mitigate the impact of short-term speculative capital on economic policy uncertainties.

To address the risk of cross-border economic policy uncertainty, it is essential to mitigate its spillover effects through a mechanism for transnational cooperation and policy coordination.

Author Contributions: Conceptualization, Y.G.; methodology, X.H.; software, X.H.; validation, Y.G.; formal analysis, X.H.; investigation, X.H.; resources, X.H.; data curation, X.H.; writing—original draft, X.H.; writing—review & editing, Y.G.; visualization, Y.G.; supervision, Y.G.; project administration, Y.G.; funding acquisition, Y.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The original contributions presented in this study are included in the article. Further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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