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Dynamic Linkages Between Geopolitical Risk, Energy Prices and Supply Chain Disruptions: An Empirical Investigation

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ABSTRACT

This descriptive research has attempted to explore the sound relation among Crude Oil Price (COP) fluctuations, Geopolitical Risk (GPR) and Global Supply Chain Pressure (GSCP) by examining 339 monthly data pertaining to the period of January 1998 to March 2026. Distress in GSC has been gauged using the GSCP Index while geopolitical acts and threats have been assessed using the GPR index and fluctuations in global crude oil prices have been measured using COP index. Data pertaining to GPR Index was collected from the Economic Policy Uncertainty database developed by Caldara and Iacoviello while COP data was retrieved from World Bank commodity price database and GSCP Index was obtained from the Federal Reserve Bank of New York. Stationarity of the data has been established and Regression Analysis was used to expose the relationship between GPR, GSCP and COP. The study has revealed that GPR exerts positive impact on GSCP, GPR acts exerts negative impact on COP, GPR threat exerts positive impact on COP and GSCP exerts positive impact on COP. This study contributes to the growing literature on GSCP by integrating GPR and COP dimensions into macro-supply chain analysis and offers important policy implications for managing global economic vulnerabilities in an increasingly uncertain geopolitical environment.

1. Introduction.

Global supply chains (GSC) have become increasingly complex, interconnected, and vulnerable to external shocks in recent decades. Events such as trade wars, geopolitical conflicts, and pandemics have exposed structural weaknesses in global production and distribution networks. In particular, disruptions linked to geopolitical tensions and energy price volatility have significantly affected the stability and efficiency of supply chains worldwide. The Global Supply Chain Pressure Index (GSCPI) has emerged as a comprehensive measure of supply chain stress, capturing delays, transportation costs and production bottlenecks across major economies. Fluctuating crude oil prices (COP) continue to influence production costs, transportation expenses and overall economic activity, making energy markets a critical determinant of supply chain performance.

Furthermore, Geopolitical risk (GPR) has also gained prominence as a key driver of economic uncertainty. The GPR index, along with its subcomponents of geopolitical acts (GPRA) and geopolitical threats (GPRT), captures both realized events and anticipatory tensions that may disrupt economic systems. While GPRA represent actual occurrences such as conflicts and sanctions, GPRT reflect the uncertainty and expectations surrounding potential disruptions. Despite a growing body of literature on supply chain disruptions and energy price shocks, limited attention has been given to the combined impact of GPR and COP fluctuations on GSC dynamics. In particular, the differentiated effects of GPRA and GPRT on GSCP remain un-

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derexplored. Against this backdrop, the present study aims to investigate the dynamic linkages between GRP, COP and GSCP using a comprehensive time-series framework. By using monthly data relating to the period of January 1998 to March 2026, this study seeks to answer the following research questions:

- Does GPR significantly influence GSCP?
- Does GPRA and GPRT substantially influence COP?
- Does GSCP substantially influence COP?

The findings of this study are expected to contribute to the literature by providing new insights into the role of GPR in shaping GSC outcomes and by offering policy-relevant implications for absorbing GSCP.

2. Concepts Used in the Study.

Geopolitical Risk: GPR represents a form of exogenous uncertainty that affects economic decision-making at both macro and micro levels. According to uncertainty theory, heightened geopolitical tensions increase risk perceptions, leading firms to delay investment, alter sourcing strategies, and adjust inventory management practices. GPR, even in the absence of actual conflict, can disrupt expectations and planning processes, while geopolitical acts—such as wars, sanctions, and diplomatic breakdowns—can directly interrupt trade flows and logistics networks. These disruptions can propagate through global supply chains, increasing delays and costs. Crude Oil Prices: COP play a central role in global economic activity through their impact on production and transportation costs. From a cost-push perspective, increases in oil prices raise input costs for firms, particularly in manufacturing and logistics-intensive industries. This leads to higher production costs, reduced efficiency, and increased supply chain pressures. Moreover, oil price volatility introduces additional uncertainty, complicating planning and pricing decisions across supply chains. As global trade relies heavily on fuel-dependent transportation systems, fluctuations in oil prices can significantly affect the smooth functioning of supply networks. Global Supply Chain Pressure: GSC operate within highly interconnected networks characterized by interdependence and specialization. According to global value chain theory, disruptions in one part of the network can have cascading effects across multiple regions and industries. GSCP arise from various sources such as demand shocks, supply constraints, logistical bottlenecks, and external uncertainties such as GPR. The GSCP index captures these pressures by integrating multiple indicators, making it a suitable proxy for analyzing systemic disruptions. GSCPI acts like a stress thermometer for global logistics. GSCPI value may be almost zero or positive or negative. GSCP Index Value of more than 0 suggests the presence of high GSCP (disruption in supply chain) while value of almost equal to zero suggests the presence of a normal GSC situation. If the GSCP Index is negative, it suggests a situation of smooth and efficient supply chain, free from any disruption. For instance, during COVID, the GSCPI was very high suggesting large scale disruption in the GSC.

Integrated Framework: This study conceptualizes GSCP as a function of GPR while COP has been conceptualized as a function of GPRA and GPRT as well as GSCP. GPR affect GSC, both directly and indirectly. Disrupting trade routes by GPR results in disturbance to production while it also plays a pivotal role in affecting future expectations and investment decisions. COP gets affected by GSCP as any disruption in supply chain directly affects flow of oil. Further, any political threat plays a substantial role in fluctuating oil prices while GPR acts/events also never fail to cast their impact. The interaction between these factors creates a complex dynamic system in which both short-term shocks and long-term equilibrium relationships may exist. Accordingly, this study adopts a time-series econometric framework to capture these dynamics and provide a comprehensive understanding of the interplay between GPR, GSCP and COP.

3. Literature Review.

3.1. Geopolitical Risk Index (GPRI).

Caldara and Iacoviello (2022) found that GPR significantly increases macroeconomic volatility and reduces investment while Pastor and Veronesi (2013) found that in US Context, GPR shocks negatively affect stock returns. Eissa et al. (2025) exposed the influence exerted by GPR on stock markets via oil channels in the Middle East. Bouri et al. (2019) found that GPR substantially affects financial markets under crises. Abadie and Gardeazabal (2003) found that under US context, terrorism-related GPR reduces investment confidence. Bouoiyour et al. (2019) found that GPR shocks create uncertainty in market reactions. Sherlim and Ekaputra (2025) established that under Indonesian context, GPR improves volatility forecasting of assets. Asadollah et al. (2024) exposed the strong influence cast by GPR on inflation through supply shocks. Chen et al. (2021) established that GPR casts a negative impact on China's economic growth. Antonakakis et al. (2017) studied G7 countries and found that GPR shocks transmit across developed markets. Gulen and Ion (2016) found that GPR increases uncertainty and reduces trade flows. Antonakakis et al. (2022) established that GPR is a substantial predictor of oil prices while Balcilar et al. (2023) established the substantial impact exerted by GPR on renewable energy markets. Kang et al. (2023) established that GPR affected oil volatility to a greater extent than returns associated with it. Zhang et al. (2025) conducted a study on 23 countries and found that GPR spillovers dominate oil volatility globally. It can be observed from the aforesaid literature that some authors have established the influence of GPR on finance market while some have focused on the impact of GPR on the economy. Some studies have focused on the effect of GPR on the oil market also.

3.2. Crude Oil Price (COP) Index.

Kilian (2009) found that COP is largely affected by demand & speculation while Kilian and Murphy (2014) found that oil demand shocks dominate supply shocks. Sadorsky (1999) established that oil volatility is linked to financial markets. Blanchard and Gali (2007) found that increasing COP diminishes GDP growth of the OECD nations while Li et al., (2023) established that oil price volatility predicts economic cycles. Zhao et al., (2021) established that oil shocks affect exchange rates while Hamilton (1983) found that COP shocks affect US macroeconomy. Hooker (2002) found that volatile COP affects inflation while Berument et al. (2010) also established that increasing COP augments inflation in emerging economies. Bernanke (1983) established that volatile COP reduces investments while Ready (2018) also established the linkage between volatile COP and financial stress. Baumeister and Kilian (2016) found that GPRA strongly affects COP. Wang et al. (2025) established the linkage between COP and GSCP while Balcilar et al. (2018) uncovered the impact of GPR on COP. Maitra (2023) established the reactive behaviour of COP to uncertainty and pandemics.

A close scrutiny of the above-mentioned literature reveals that many studies have been conducted revealing the effect of COP volatility on economic conditions while very few studies have been conducted on linking GPR and COP.

3.3. Global Supply Chain Pressure (Gscp) Index.

Ivanov (2021) asserted that viable Supply chain reduces economic shocks. Wang (2025) established that GSCP influences investment portfolios while Baldwin and Freeman (2022) found that GSCP casts a substantial impact on employment opportunities. Benigno et al. (2022) found that GSCP increased inflation volatility in US while Asadollah et al. (2024) also highlighted that GSCP strongly augments inflation. New York Fed (2022) also established that GSCPI is a strong predictor of inflation. Guerrieri et al. (2022) found that GSCP diminishes global output drastically while OECD (2021) also established that GSCP affect industrial production. Freund et al. (2023) found that GSCP substantially affect trade costs while Attinasi et al. (2021) established that GSCP substantially enhances producer prices in Europe. Similarly, UNCTAD (2022) suggested that GSCP is reflected by shipping costs. Wang et al. (2025) exposed the strong prediction of COP volatility by GSCP. Baqaee and Farhi (2022) established the immense contribution of COVID turbulence on GSCP. Zhou et al. (2025) established the linkage between GPR and GSC while Arezki et al. (2022) established the linkage between GSCP and energy markets. A close scrutiny of the above literature affirms that much of the studies have focused on the impact of GSCP on economic conditions. Few studies have concentrated on the linkage of GSCP, COP and GPR.

3.4. Research Gap.

Considering the conduct of very few studies on establishing the linkage between GPR, GSCP and COP, this study has made an attempt to establish the linkage between GPR, GSCP and COP. Furthermore, this study shall also establish the linkage between COP and GPRA and GPRT, which has been explored very little. Geopolitical risk captures the intensity of conflict, war threats, and international tensions, which directly affect global trade routes, especially strategic chokepoints like the Strait of Hormuz. COP volatility is included because GPR primarily transmit through energy market disruptions, influencing logistics and production costs globally.

GSCP is very important as disruption in the GSC will result in volatility of COP, which will have a cascading effect on the economy. Hence, these three variables have been selected for this study and the inter-linkage between them has been explored.

4. Objectives of the Study.

1. To assess the impact of GPR on GSCP;
2. To gauge the influence of GPRA and GPRT on COP;
3. To unearth the impact of GSCP on COP.

5. Hypotheses of the Study.

1. GPR exerts substantial impact on GSCP;
2. GPRA and GPRT exerts substantial impact on COP;
3. GSCP exerts substantial impact on COP.

6. Methodology.

This descriptive research is based on secondary data. Data pertaining to GPR, GPRA and GPRT during the 339-month period of January 1998 to March 2026 have been collected and suitably fed in an Excel sheet. GSCP has been gauged using the GSCP Index while geopolitical acts and threats have been assessed using the GPR index and fluctuations in global COP have been measured using COP index. Data pertaining to GPR Index was collected from the Economic Policy Uncertainty database developed by Caldara and Iacoviello while COP data was retrieved from World Bank commodity price database and GSCP Index was obtained from the Federal Reserve Bank of New York. Stationarity of the data has been established and Regression Analysis was used to expose the relationship between GPR, GSCP and COP. MS Excel and SPSS have been used to analyse the data using the statistical techniques of Regression, Cluster and Correspondence Analysis.

7. Data Analysis.

7.1. Impact of GPR on GSC Pressure.

Influence of GPR on GSC pressure has been gauged using Regression Analysis and the outcome is displayed in table 1.

Table 1: Impact of GPR on GSC Pressure.

Variable	B	Std. Error	T	Sig.
Constant	-4.867	1.675	-2.906	0.004
GPR	0.053	0.014	3.725	0.000
R Square=0.04	F = 13.873	P = 0.000		

Source: Authors.

Table 1 suggests that the independent variable of GPR explains 0.04% variance of the dependent variable of GSC (R Square = 0.04) while the Regression model is perfectly fit at 1% significance (F = 13.873; P = 0.000).

Further, GPR exerts substantial positive impact on GSC (B = 0.053; T= 3.725; Sig. = 0.000).

The following Regression equation is derived from the above Regression Analysis:

GSC = -4.867 + 0.053*GPR.

This suggests that if GPR increases by one unit, GSC pressure will augment by 0.053 units.

7.2. Impact of GPRA and GPRT on COP.

The influence of GPRA (GPR Acts) and GPRT (GPR Threat) on COP has been gauged using Regression Analysis and the outcome is displayed in table 2.

Table 2: Impact of GPRA and GPRT on COP.

Variable	B	Std. Error	T	Sig.
Constant	59.944	4.064	14.748	0.000
GPRT	0.131	0.041	3.152	0.002
GPRA	-0.099	0.024	-4.200	0.000
R Square = 0.053	F = 9.381	P = 0.000		

Source: Authors.

Table 2 showcases that the two independent variables of GPRA and GPRT explain 5.3% variance of the dependent variable of COP (R Square = 0.053) while the Regression model is perfectly fit at 1% significance (F = 9.381; P = 0.000). Most importantly, both the independent variables of GPRA and GPRT exerts substantial impact on COP. However, GPRA exerts negative impact (B = -0.099; T = -4.200; Sig. = 0.000) while GPRT exerts positive impact (B = 0.131; T = 3.152; P = 0.002). From the Regression analysis, the following Regression equation is derived:

COP = 59.944 + 0.131*GPRT - 4.200*GPRA

It can be observed from the above equation that GPRT exerts a substantial positive impact on COP whereas GPRA exerts substantial negative impact.

7.3. Impact of GSCP on COP.

The influence of GSCP on COP has been unearthed using Regression Analysis and the outcome is displayed in table 3.

Table 3: Impact of GSCP on COP.

Variable	B	Std. Error	T	Sig.
Constant	63.298	1.601	39.548	0.000
GSC Index	6.065	1.597	3.798	0.000
R Square = 0.041	F= 14.424	P = 0.000		

Source: Authors.

Table 3 highlights that GSCP explains 0.041% variance of COP (R Square = 0.041) while the Regression Model is perfectly fit at 1% significance (F= 14.424; P = 0.000). The table further suggests that GSCP exerts substantial positive impact on COP (B= 6.065; T= 3.798; Sig. = 0.000). From the above Regression Analysis, the following Regression equation is derived.

Hence, even if GSCP increases by one unit, COP will inflate by 6.065 units suggesting the GSCP shall immensely augment global crude oil prices. Hence, stability of COP largely depends on reduced GSCP.

7.4. Months of Low, Moderate and High Level of COP, GPR and GSC.

339 months' data have been used pertaining to GSC, GPR, GPRA, GPRT and COP. An attempt has been made to assess the number of months which have witnessed low, moderate and high degree of GPR, GSC and COP. Cluster Analysis has been employed for this purpose and the outcome is depicted in table 4.

Table 4: Months of Low, Moderate and High Level of COP, GPR and GSC.

Variable	C1(Low Level)		C2(Moderate Level)		C3(High Level)	
	Mean	N	Mean	N	Mean	N
GPR	85.55	250	148.68	83	382.15	6
GSC	-0.26	307	2.64	31	251.38	1
COP	29.45	112	67.75	155	107.13	72
GPRT	84.46	232	143.78	98	303.60	9
GPRA	81.95	275	197.41	62	847.63	2

Source: Authors.

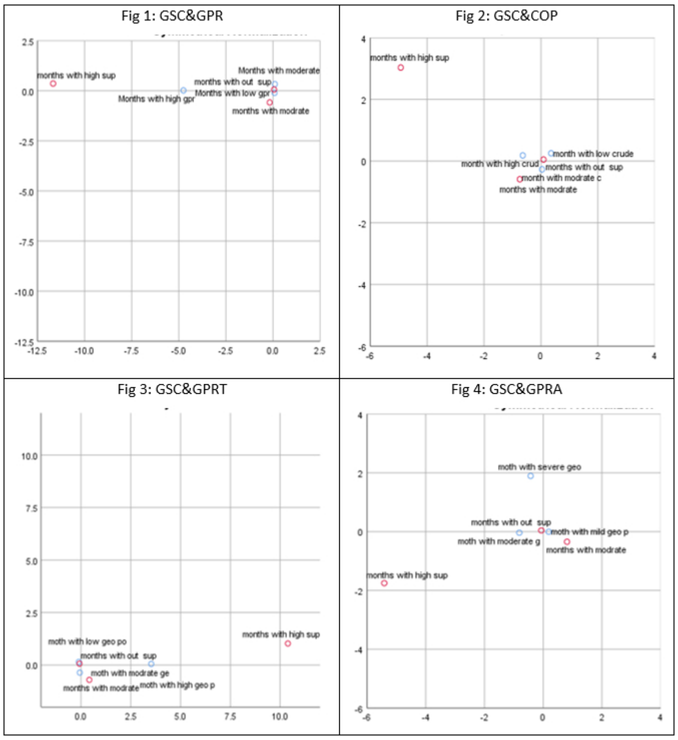
Table 4 suggests that the world has not confronted much of months in which there has been poor GPR, COP or GSC pressure. Only 6 months have witnessed high level of GPR during the 339 months under study while only a solitary month has witnessed high level of GSC. 72 months have witnessed high COP while 9 months have witnessed high level of GPRT and just a couple of months have witnessed high level of GPRA.

7.5. Association Between Months of GPR, GSC and COP Levels.

The nature of association prevalent between the months which have witnessed different levels of GPR, GSC and COP have been explored using Correspondence Analysis and the outcome have been portrayed in tables 5 and 6, engulfing figures 1-4 and 5-7 respectively.

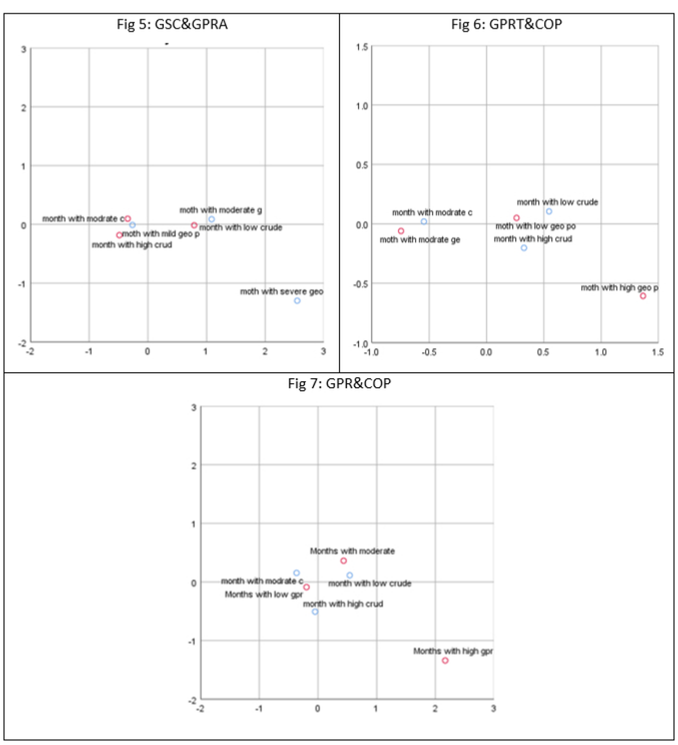
Figures 1-4 contained in table 5 clearly project that months with high GSCP align with months with high GPR and months with high GPRT while months with low GSCP align with months with low GPR, months with low COP, months with low GPRT and months with low GPRA. Finally, months with moderate GSCP aligns with months with moderate GPR, Months with moderate COP, months with moderate GPRT and months with moderate GPRA.

Table 5: Association between GSC and GPR, GPRT, GPRA, COP.



Source: Authors.

Table 6: COP, GPR, GPRA and GPRT.



Source: Authors.

Table 6 engulfing figures 5-7 suggest that months with low GSCP align well with months with low GPRA, months with low GPRT and months with low GPR while months with moderate GSCP align with months with moderate GPRA, months with moderate GPRT and months with moderate GPR.

8. Results, Discussion and Implications.

The study has exposed that GPR exerts positive impact on GSCP; GPRA exerts negative impact on COP and GPRT exerts positive impact on COP; GSCP exerts substantial positive impact on COP. Hence, all the three positive hypotheses formulated for this study has been accepted. The study has revealed that only 6 months have witnessed high level of GPR during the 339 months under study while only a solitary month has witnessed high level of GSCP. 72 months have witnessed high COP while 9 months have witnessed high level of GPRT and just a couple of months have witnessed high level of GPRA. Furthermore, months with low GSCP align well with months with low GPRA, months with low GPRT and months with low GPR while months with moderate GSCP align with months with moderate GPRA, months with moderate GPRT and months with moderate GPR. Months with high GSCP align with months with high GPR and months with high GPRT while months with low GSCP align with months with low GPR, months with low COP, months with low GPRT and months with low GPRA. Finally, months with moderate GSC pressure aligns with months with moderate GPR, Months with moderate COP, months with moderate GPRT and months with moderate GPRA.tionally, utilization of MTRVs minimizes the food waste which in turn minimizes the emissions.

8.1. *Implications of the Study.*

This study offers the following theoretical, policy and managerial implications:

Differentiated Impact of GPR Components: The study has highlighted that GPR is not homogeneous. While GPRA reduce COP, GPRT augments them. This distinction is crucial. Threats signal anticipatory uncertainty which augments speculative outlook and cautionary demand. This will push COP. However, actual events may at times, stabilise or even diminish prices. Shocks in demand, corrective policy measures or neutralising market conditions may result in stabilisation of prices. Hence, policy-makers should consider GPR as a multi-dimensional concept rather than a single aggregate index when forecasting commodity markets. GSCP as an Important Transition Channel: Result of this study stressing strong relationship between GSCP and COP suggests that GSCP magnifies cost distress among different industries. With GSCP, logistics blockages deepens which makes oil more costly. Hence, it is imperative for government and businesses to use supply chain suppleness as an energy-price balancing approach rather than as logistics issue. GPR Drives GSCP: This study has affirmed that GPR substantially augments GSCP. Political developments such as economic / trade sanctions, disputes, wars or ambiguity upset the entire manufacturing and distribution channels world-wide. Just a possible threat might activate cautionary hoarding which will aggravate the prices. This calls for smart diplomatic efforts on the part of government to maintain cooperative relationships with many other countries so that trade disruptions from one side may be offset from other friendly nations. Correspondence of Period with Low, Moderate and High GSCP, COP and GPR: Substantial association between GSCP, COP and GPR suggests that these processes move together. This implies that investors and policy-makers should utilise GPR to predict possible GSCP and inflating COP. Uncommon Occurrence of Extreme Acts/Events: Months with high GSCP and GPR suggests that occurrence of substantially disruptive events are quite sporadic but they exert utmost impact. The world is witnessing mild and modest GPR and GSCP predominantly. Extreme occurrences are very scanty. This calls for governments to adopt highly diplomatic and well-prepared risk mitigation approaches and tactics, focusing on being ready for any eventualities as such rare occurrences might disastrously hurt the economy.

8.2. Directions for Further Studies.

Future studies may Scrutinizes the impact of specific categories of GPR such as battles, sanctions or any form of political uncertainty. The important GPR of latest US-Iran war has not been covered by this study. Such significant events may be studied. This shall offer deeper understanding about different shocks which might have an important bearing on COP. More macro-economic concepts such as inflation, production and distribution prices, output, trade, interest and exchange rates may be included to expose the effect of GPR and GSCP on these economic parameters. Further research might utilise nonlinear modeling to obtain varying responses to differing conditions. Daily or weekly data may be used to gauge responses to political shocks or GSCP. Effective model may be arrived at to scientifically forecast such highly consequentially disastrous events. Sector-wise Analysis: Further studies may adopt deep investigations by exploring the impact of GPR or GSCP on specific industries such as automobiles, energy, processed food or dairy products. This shall result in the identification of sector-related susceptibility. With renewable energy gaining momentum globally, studies may be conducted whether this shift shall weaken the linkage between GPR, GSCP and fuel prices. Comparison of renewable energy and fossil fuel markets may provide good insights. Studies may involve unearthing reactions of investors to GPRT and how well-developed finance market characterised by derivatives, options and futures can mitigate the risks arising from such events.

Conclusions.

This research has provided an insightful indication about the linkage between GPR, GSCP and COP. GPR is effectively driving both supply chain and energy markets. GPRT exerts positive impact on COP suggesting the vitality of tightening ambiguous and speculative market outlook. GPR positively impacts GSCP, suggesting that political environment plays a vital role in shaping trade, business and economic policies. A strong association between GSCP and COP reiterates the importance of being aware about possible supply chain disruptions which might trigger COP, which shall result in high inflationary pressure for the economy. Similarly, the strong alignment of period with less, modest and high GPR, GSCP and COP suggests the strong linkage between these concepts. Even though occurrence of extremely vulnerable events has been quite remote, their outcome will be disastrous. This emphasizes the vitality of readiness and suppleness to any eventualities on the part of policy-makers, businessmen and investors. They should be absolutely fore-sighted and adopt risk-sensitive tactics, duly engulfing geopolitical variables while making decisions. To conclude, this research has offered good theoretical insights into the effects of geopolitical occurrences. The study has underlined the vitality of integrating policies, vigorous supply chain approaches and adoption of scientific modeling to ease the adversative effects of geopolitical adversities on international trade and energy markets.

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