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Oil price regimes under geopolitical crises: implications for logistics cost management and supply chain planning

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Abstract: This paper examines how geopolitical crises and macroeconomic conditions shape oil price behaviour and discusses the implications of these dynamics for logistics costs and supply chain planning. Using annual data for 1990-2022 and a Markov regime-switching framework, the study identifies distinct regimes in oil price, oil production, oil consumption, oil reserves, GDP, and inflation. The results indicate that oil-market dynamics are state-dependent rather than stable over time, with high-stress regimes associated with higher oil prices, higher inflation, and relatively persistent transition probabilities. The contribution of the paper is not to claim a direct causal measurement of logistics performance, but to provide a structured interpretation of oil-market regimes as different fuel-cost environments that may affect fuel surcharge design, contract adjustment, routing decisions, procurement planning, and supply-chain resilience. Because the analysis relies on 33 annual observations and does not include direct logistics indicators such as freight rates or bunker surcharges, the findings should be interpreted as exploratory and conceptually grounded rather than definitive. Even so, the results suggest that regime-aware monitoring may help logistics managers respond more effectively to geopolitical and macroeconomic instability.

1 Introduction

Economists, policymakers, and researchers have long studied oil price dynamics because oil prices affect inflation, trade balances, monetary conditions, and financial risk [1-3]. In transport and logistics, however, their relevance is even more immediate: changes in diesel and bunker fuel costs influence freight rates, fuel surcharge mechanisms, warehousing budgets, procurement decisions, route selection, and the resilience of supply-chain networks [4-8]. Recent geopolitical crises, including sanctions-related trade frictions and corridor disruptions, have reinforced the need to understand oil-price behaviour not only as a macroeconomic issue but also as a source of logistics cost exposure [3,9-11].

The literature offers strong evidence on oil-price shocks, geopolitical risk, and regime-dependent market behaviour [2,3,12-14]. It also provides valuable insights into transport-cost formation, surcharge practices, and logistics resilience [4-8,15-19]. Yet these two strands are rarely connected in a single analytical framework. In particular, relatively few studies interpret oil-market regimes as distinct fuel-cost environments with implications for logistics decision-making under uncertainty.

Against this background, this paper addresses the following research question: how do geopolitical and macroeconomic disturbances shape oil-market regimes, and what logistics-relevant implications can be derived from those regimes? The study makes three contributions. First, it applies a Markov regime-switching framework to identify stable, transitional, and stress states in oil-price and related macroeconomic variables. Second, it develops a conceptually explicit link between regime shifts and logistics cost exposure, especially through fuel surcharge management, contract adjustment, procurement planning, routing, and resilience. Third, it offers a cautious managerial interpretation of the findings while clearly recognizing that the empirical model does not directly measure logistics performance.

The remainder of the manuscript is organized as follows. Section 2 reviews the theoretical and empirical literature and clarifies the logistics mechanism through which oil-price regimes may matter for cost management. Section 3 presents the data, the econometric approach, and the methodological limits of the design. Section 4 reports the empirical results. Section 5 discusses the theoretical and managerial implications, and Section 6 concludes.

2 Literature review

2.1 Theoretical framework

Oil occupies a central position in energy security and the international political economy, which means that geopolitical shocks can be transmitted rapidly into oil prices [1]. Such price movements have direct implications for

Oil price regimes under geopolitical crises: implications for logistics cost management and supply chain planning

Nada El Moussaouia, Brahim Idelhakkarb

freight markets because fuel is a major component of transport operating costs and is often passed through via surcharges and contractual indexation [4,7,8]. A central insight from the oil literature is that price dynamics depend not only on the size of a shock, but also on its source and on the broader macroeconomic environment in which it occurs [2]. From a logistics perspective, this distinction matters because supply disruptions, sanctions, and corridor insecurity may generate abrupt fuel-cost pressure and operational uncertainty, whereas demand-driven oil-price movements may be more closely aligned with freight cycles and inventory adjustments. The broader supply-chain literature further suggests that volatile input-cost environments call for resilience-oriented responses, including flexibility in sourcing, contract design, routing, and contingency planning [15-19]. Taken together, these arguments indicate that oil-price shocks should not be viewed solely as an energy-market phenomenon; they should also be understood as a source of logistics cost pressure and operational risk.

2.2 Empirical framework

Recent empirical studies show that geopolitical shocks can alter oil prices and related markets through time-varying and multivariate transmission mechanisms. Evidence from TVP-VAR and spillover models indicates that crisis episodes can strengthen connectedness among oil, gold, inflation, and financial markets [3,20-22]. Regime-switching approaches are therefore especially relevant because they allow oil-market behaviour to vary across latent states rather than assuming a single average process [12-14]. Markov-switching models have been used to identify distinct oil-market regimes and to show that the same economic factors may produce different effects depending on prevailing market conditions [12,13]. These findings motivate the present study's empirical strategy. At the same time, they also reveal a gap: the regime literature typically focuses on price dynamics and volatility, whereas the logistics literature concentrates on transport costs, operational adjustment, and resilience. The present paper brings these strands together by using regime-based oil-market evidence as the basis for a cautious logistics-oriented interpretation.

2.3 Linking oil-price regimes to logistics cost exposure

The analytical link proposed in this study is straightforward. Geopolitical crises may disturb oil supply, market expectations, and inflationary conditions; these shocks may in turn shift the oil market from a relatively stable regime to a transitional or stress regime. For logistics actors, such shifts can be interpreted as changes in the fuel-cost environment rather than as abstract macroeconomic episodes. A stable regime is associated with greater budget predictability, routine surcharge practices, and more conventional planning. A stress regime, by contrast, is more likely to intensify fuel surcharges, contract renegotiation, rerouting, procurement adaptation, and broader resilience measures [4-8,15-19]. The contribution of the paper is therefore conceptual and interpretive, but it is not loose or purely rhetorical: it is grounded in identifiable cost channels through which oil-price regimes may matter for logistics management.

3 Research methodology

3.1 Data and variables

The empirical analysis is based on annual data covering the period 1990–2022, yielding 33 observations for each series. The model includes six variables: oil price (OIL_PRICE), oil production (PROD_OIL), oil consumption (OIL_CONSUM), oil reserves (OIL_RESERVE), gross domestic product (GDP), and inflation (INFLATION). GDP is measured by GDP (current US\$) from the World Bank's World Development Indicators (indicator code: NY.GDP.MKTP.CD), while inflation is measured by the World Bank indicator Inflation, consumer prices (annual %) (indicator code: FP.CPI.TOTL.ZG). Oil price data were obtained from the World Bank Commodities Price Data, annual historical series. The oil production, oil consumption, and oil reserves series were compiled from annual financial and energy-statistics databases and harmonized with the World Bank macroeconomic indicators in order to construct a balanced dataset. The use of annual data is consistent with the purpose of the study because the analysis focuses on medium- and long-run regime changes rather than short-term market fluctuations. The selected variables capture both oil-market fundamentals and the broader macroeconomic environment within which geopolitical shocks may influence cost conditions. From a logistics perspective, this selection is relevant because oil prices directly affect fuel expenditures, while production, consumption, reserves, GDP, and inflation provide information on supply conditions, demand pressures, and the wider cost environment. Nevertheless, because the sample is limited to 33 annual observations, the empirical results should be interpreted with appropriate caution.

3.2 Stationarity and pre-testing

Before estimating the regime-switching models, the time-series properties of the variables are examined using two standard unit-root tests: the Augmented Dickey-Fuller (ADF) test [23] and the Phillips-Perron (PP) test [24]. Testing for stationarity is a necessary preliminary step in time-series analysis because non-stationary variables may generate spurious regression results and misleading inference. The null hypothesis of both tests is that the series contains a unit root. The results reported in Table 2 show that most variables are non-stationary in levels, as their p-values generally exceed the

5% significance threshold. After first differencing, however, all series become stationary under both the ADF and PP tests. This result supports the econometric strategy adopted in the paper and justifies the use of differenced data where necessary. Given the relatively small sample size, the use of both tests also helps strengthen the pre-estimation diagnosis. From a substantive standpoint, this step is important because the objective of the analysis is to identify genuine regime changes in oil-market behaviour rather than patterns driven by common trends in the raw data. Ensuring stationarity therefore improves the reliability of the estimated regimes and supports their interpretation in relation to oil-price dynamics and logistics cost exposure.

3.3 Markov regime-switching model

To identify distinct states of oil-market behaviour, the paper estimates a three-regime Markov regime-switching model [25]. The model is specified as (1):

$$y_t = \mu_{s_t} + \varepsilon_t \quad (1)$$

where y_t is the observed variable, S_t denotes the latent regime at time t , μ_{S_t} is the regime-specific mean, and ε_t is the error term (2).

$$\varepsilon_t \sim N(0, \sigma_{s_t}^2) \quad (2)$$

and the regime variable S_t evolves according to a first-order Markov process (3).

$$s_t \in \{0, 1, 2\} \quad (3)$$

The transition probabilities are defined as $p_{ij} = \Pr(S_t = j \mid S_{t-1} = i)$, for $i, j \in \{0, 1, 2\}$, with each row of the transition matrix summing to one (4).

$$p_{ij} = P(s_t = j \mid s_{t-1} = i), i, j \in \{0, 1, 2\} \quad (4)$$

Accordingly, the transition probability matrix summarizes the likelihood of remaining in, or switching across, the stable, intermediate, and stress regimes (5).

$$P = \begin{pmatrix} p_{00} & p_{01} & p_{02} \\ p_{10} & p_{11} & p_{12} \\ p_{20} & p_{21} & p_{22} \end{pmatrix}, \text{ with } \sum_{j=0}^2 p_{ij} = 1 \text{ for each } i \quad (5)$$

In this framework, the conditional mean μ_{s_t} and the conditional variance $\sigma_{s_t}^2$ vary across regimes, which allows the model to capture different states of oil-market behaviour. This specification is appropriate for the present study because oil prices and related macroeconomic variables may evolve differently during stable periods, transition phases, and stress episodes associated with geopolitical or economic shocks. The regime-dependent structure therefore makes it possible to identify changes not only in the level of the series, but also in its volatility.

From a logistics-oriented perspective, the regimes may be interpreted as different fuel-cost environments. Regime 0 may represent a relatively stable state, Regime 1 an intermediate or transitional state, and Regime 2 a high-stress state characterized by greater volatility and uncertainty. These distinctions are relevant for transport and logistics management because shifts across fuel-cost regimes may influence fuel surcharge design, contract adjustment, routing decisions, procurement planning, and broader resilience strategies. The estimated transition probabilities further show how likely the system is to remain in a given regime or to switch to another regime over time.

3.4 Methodological positioning and sample-size

This methodological design is intentionally exploratory. Annual data are used because the objective is to capture medium- and long-run shifts in the oil-cost environment rather than short-term operational fluctuations. At the same time, the sample contains only 33 observations, which limits parameter richness and requires parsimonious modelling. For this reason, the three-regime specification is retained primarily because it provides an interpretable stable–transitional–stress structure while keeping the analysis tractable; the results should therefore be read as indicative regime patterns rather than as precise structural estimates [12–14, 18, 25]. This positioning is also important because the model does not include direct logistics indicators such as freight rates, bunker surcharges, or service-level measures. The article therefore makes a conceptually grounded inference about logistics cost exposure, not a direct causal estimate of logistics performance.

4 Results

4.1 Basic statistics

Table 1 reports descriptive statistics for the six variables included in the analysis. From a logistics perspective, the dispersion of OIL_PRICE and INFLATION is particularly important because variability in energy prices and the general price level directly affects transport costs, fuel surcharge adjustments, budgeting accuracy, and supply-chain planning. OIL_PRICE exhibits substantial dispersion and positive skewness, which suggests that high-price episodes are not isolated events in the sample. Such episodes are especially relevant for freight and distribution activities because they may trigger sudden increases in fuel-related operating costs [4,5,7]. Inflation also shows positive skewness, indicating that periods of broader cost pressure may coincide with energy-market stress and thus amplify logistics cost exposure.

Table 1 Descriptive statistics for six economic variables

Variable	Mean	Median	Std. Dev.	Skewness	Kurtosis	Observations
OIL_CONSUM	45861.88	46887.75	5082.618	-0.184919	1.829407	33
OIL_PRICE	321.9748	275.0792	203.8960	0.548196	1.992631	33
OIL_RESERVE	1.95×10^{11}	1.89×10^{11}	3.50×10^{10}	-0.158996	1.531556	33
GDP	5.52×10^{13}	5.19×10^{13}	2.47×10^{13}	0.244190	1.616887	33
PROD_OIL	3567994	3676515	312188.0	-0.333216	1.852910	33
INFLATION	4.645874	3.725327	2.517255	0.763562	2.315091	33

The patterns in Table 1 provide an initial indication that oil-market and macroeconomic conditions do not evolve in a smooth and stable manner. Instead, the descriptive evidence points to asymmetry and variability that may justify the use of a non-linear framework. For logistics management, this is important because decisions on pricing, routing, procurement, and contract adjustment are often more sensitive to stress episodes than to average market conditions. Figure 1 presents the historical evolution of the variables over the sample period. The visual evidence suggests that the series are characterized by changing levels and periods of stronger fluctuation rather than by a single stable path. This observation is consistent with the idea that oil-market dynamics may shift across different states associated with geopolitical disturbances and macroeconomic change.

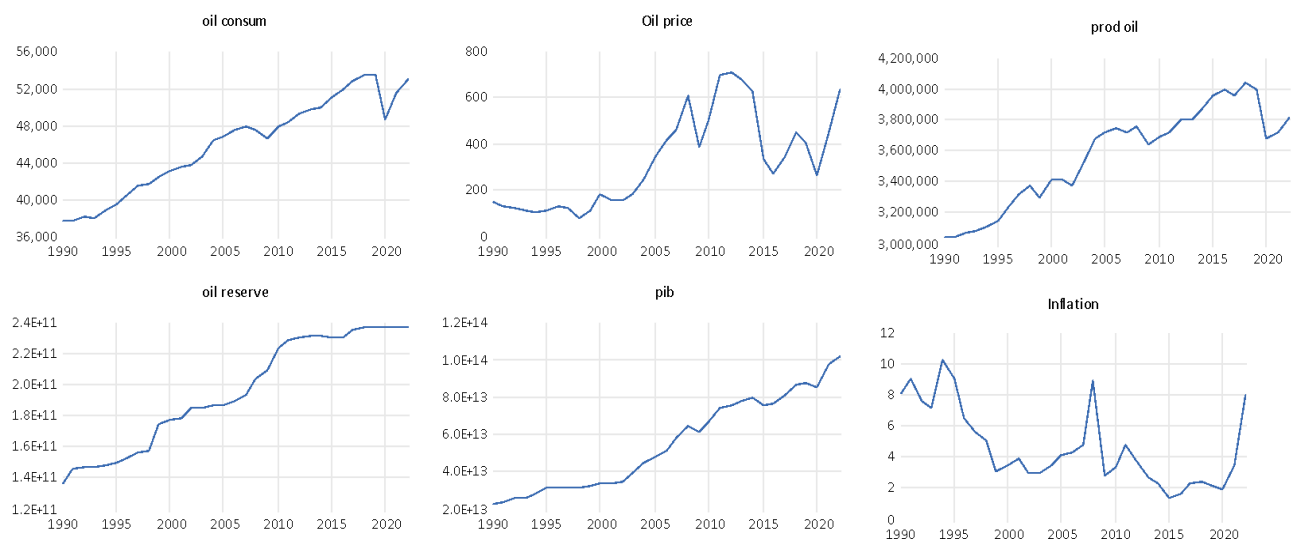


Figure 1 Graphical presentation of historical variable trends

Before estimating the regime-switching models, the stationarity properties of the variables are examined using the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. Table 2 shows that most variables are non-stationary in levels, as the corresponding p-values generally exceed the 5% threshold. After first differencing, however, all series become stationary under both tests. This result supports the econometric strategy adopted in the paper and reduces the risk of spurious inference [23,24]. In substantive terms, this pre-estimation step is necessary to ensure that the identified regimes reflect genuine changes in market conditions rather than common trends in the raw data.

Table 2 Variable stationarity test

Variable	Test	Test Statistic	p-value	Variable	Test	Test Statistic	p-value
INFLATION	ADF	-2.272	0.181	INFLATION (1st Diff)	ADF	-4.785	0.0001
	PP	-2.068	0.564		PP	-6.155	0.000

Oil price regimes under geopolitical crises: implications for logistics cost management and supply chain planning

Nada El Moussaouia, Brahim Idelhakkarb

OIL_PRICE	ADF	-1.191	0.678	OIL_PRICE (1st Diff)	ADF	-5.667	0.000
	PP	-3.798	0.017		PP	-6.176	0.000
PROD_OIL	ADF	-1.520	0.524	PROD_OIL (1st Diff)	ADF	-5.174	0.000
	PP	-1.574	0.803		PP	-7.269	0.000
OIL_CONSUM	ADF	-2.495	0.117	OIL_CONSUM (1st Diff)	ADF	-5.485	0.000
	PP	-2.932	0.152		PP	-6.518	0.000
OIL_RESERVE	ADF	-0.890	0.791	OIL_RESERVE (1st Diff)	ADF	-6.219	0.000
	PP	-1.360	0.872		PP	-7.284	0.000
GDP	ADF	-1.689	0.437	GDP (1st Diff)	ADF	-3.536	0.007
	PP	-2.211	0.484		PP	-5.253	0.000

From a logistics standpoint, the stationarity results matter because the objective is not merely to describe long-run upward trends in oil and macroeconomic variables, but to identify meaningful shifts in cost environments. This distinction is important when interpreting the empirical results for fuel-cost management, contract flexibility, and supply-chain resilience.

4.2 Estimation of a Markov model of regime change

The Markov regime-switching results are summarized in Tables 3 to 10 and Figures 2 to 7. For analytical clarity, the estimated states are interpreted as three broad environments: a relatively stable regime, an intermediate regime, and a higher-stress regime. This classification does not imply that logistics outcomes are directly observed in the model. Rather, it offers a structured basis for interpreting how changes in oil-market and macroeconomic conditions may reshape the fuel-cost environment faced by transport and supply-chain actors [4-8].

Table 3 reports the estimated regime-specific coefficients. A notable pattern is that the highest values for several variables are concentrated in Regime 2. In particular, oil prices, oil consumption, oil reserves, GDP, and inflation all reach their highest conditional means in this regime.

This concentration strengthens the interpretation of Regime 2 as the state most likely to generate stronger cost pressure, budgeting uncertainty, and contract-adjustment needs for logistics operators. By contrast, Regime 0 is more consistent with a comparatively predictable fuel-cost environment, while Regime 1 can be interpreted as an intermediate state in which adjustment pressures begin to rise without yet reaching full stress conditions [5,6,8].

Table 3 The estimated coefficients for each of the variables

Variable	Regime 0	Regime 1	Regime 2	Sigma
Oil Prices	381.275	182.532	655.160	58.1353
Oil Production	3.71903×10^6	3.23133×10^6	3.91583×10^6	116199
Oil Consumption	47232.9	40351.1	51551.3	1816.43
Oil Reserves	2.14922×10^{11}	1.65675×10^{11}	2.33102×10^{11}	1.44210×10^{10}
GDP	6.74311×10^{13}	3.27790×10^{13}	8.62950×10^{13}	7.84673×10^{12}
Inflation	5.69985	3.10859	8.46956	0.922246

The transition probabilities for oil consumption are presented in Table 4, while Figure 2 illustrates the corresponding regime probabilities over time. The high diagonal probabilities indicate that once the system enters a given state, it tends to remain there rather than switching immediately. This persistence is analytically important because persistent cost environments are more likely to affect logistics planning than short-lived shocks. If consumption-related conditions remain in a stress regime, firms may need to adjust fuel policies, purchasing decisions, and service planning over a longer horizon rather than through temporary responses only.

Table 4 Transition probabilities oil cons

Regime (t+1)\Reg (t)	Reg 0,t	Reg 1,t	Reg 2,t
Regime 0,t+1	0.90617	0.074682	0.00000
Regime 1,t+1	0.00000	0.92532	0.00000
Regime 2,t+1	0.093829	0.00000	1.0000

Oil price regimes under geopolitical crises: implications for logistics cost management and supply chain planning

Nada El Moussaouia, Brahim Idelhakkarb

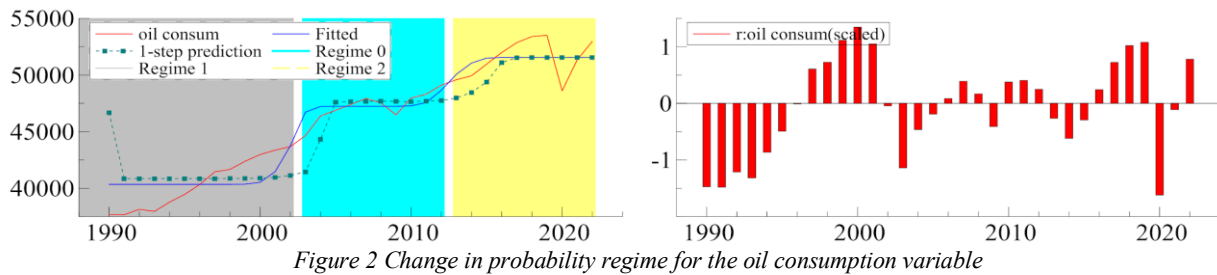


Figure 2 Change in probability regime for the oil consumption variable

Figure 2 also suggests that the model captures broad movements in the oil consumption series, although some residual deviations remain. These deviations may reflect shocks, policy changes, or structural factors not fully captured by the specification. In logistics terms, changes in oil consumption may signal wider shifts in economic demand conditions and therefore in future transport activity and cost pressure.

Oil price results are of central importance for the paper's logistics interpretation. Figure 3 and Table 5 show that oil-price behaviour is also characterized by distinct regimes and meaningful transition probabilities. The persistence of the higher-stress regime is particularly relevant because it implies that oil-price pressure may last long enough to affect freight pricing, fuel surcharge mechanisms, and budgeting decisions. The non-uniform transition pattern also suggests that oil markets do not move smoothly between states, which reinforces the case for regime-based monitoring rather than reliance on unconditional averages.

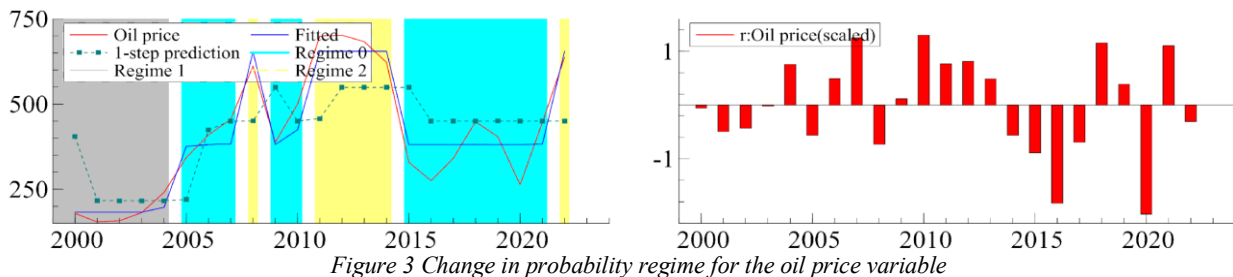


Figure 3 Change in probability regime for the oil price variable

Table 5 Transition probabilities oil price

Regime (t+1)\Reg (t)	Reg 0,t	Reg 1,t	Reg 2,t
Regime 0,t+1	0.74771	0.16791	0.38695
Regime 1,t+1	0.00000	0.83209	0.00000
Regime 2,t+1	0.25229	0.00000	0.61305

From a managerial perspective, the oil-price results indicate that the most difficult periods are likely to be those in which higher prices are accompanied by larger forecasting errors and sudden market revaluations. These are precisely the conditions under which transport operators may require more responsive surcharge formulas, shorter repricing intervals, and more flexible contractual arrangements [4,7].

The production results reported in Figure 4 and Table 6 point to a similar state-dependent pattern. Oil production is relevant because it captures one dimension of supply-side pressure in the oil market. Shifts in production regimes may reinforce or reduce oil-price stress and therefore influence the cost environment faced by logistics operators. The relatively high diagonal probabilities again suggest that some states are persistent rather than transitory, which is important for medium-term planning.

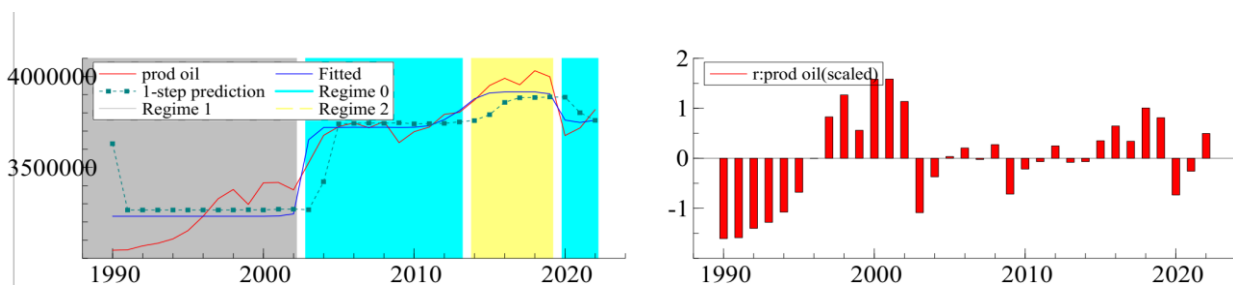


Figure 4 Change in probability regime for the oil production variable

Oil price regimes under geopolitical crises: implications for logistics cost management and supply chain planning

Nada El Moussaouia, Brahim Idelhakkarb

Table 6 Transition Probabilities oil production

Regime (t+1)\Reg (t)	Reg 0,t	Reg 1,t	Reg 2,t
Regime 0,t+1	0.90393	0.070871	0.13842
Regime 1,t+1	0.00000	0.92913	0.00000
Regime 2,t+1	0.096070	0.00000	0.86158

The oil reserve results, shown in Figure 5 and Table 7, provide additional evidence of persistence across states. In practical terms, this means that reserve-related conditions may support durable market expectations rather than purely temporary reactions. For logistics and supply-chain management, the persistence of reserve-related stress is relevant because prolonged cost pressure may affect procurement policies, network configuration, and the balance between contractual stability and operational flexibility.

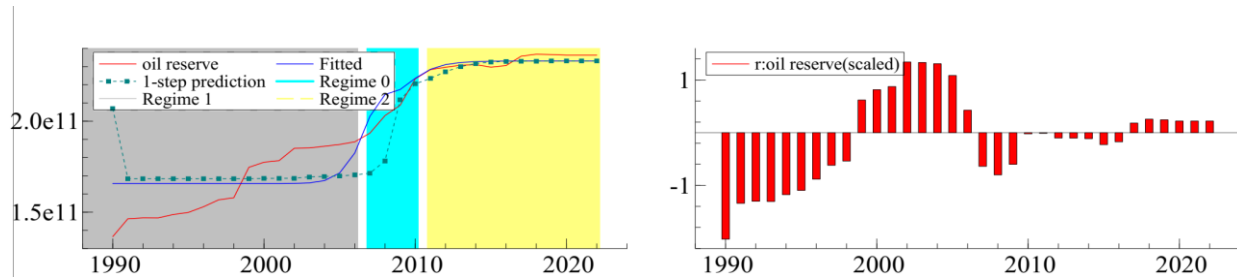


Figure 5 Change in probability regime for the oil reserve variable

Table 7 Transition probabilities oil reserve

Regime (t+1)\Reg (t)	Reg 0,t	Reg 1,t	Reg 2,t
Regime 0,t+1	0.75291	0.056314	0.00000
Regime 1,t+1	0.00000	0.94369	0.00000
Regime 2,t+1	0.24709	0.00000	1.0000

GDP regime behaviour, presented in Figure 6 and Table 8, adds macroeconomic context to the interpretation of oil-market dynamics. GDP is important because freight demand and oil demand are both closely related to overall economic activity. Regime changes in GDP may therefore amplify or dampen the pass-through from oil prices to logistics costs. In other words, the same oil-price shock may have different implications depending on whether it occurs in a stronger or weaker macroeconomic environment.

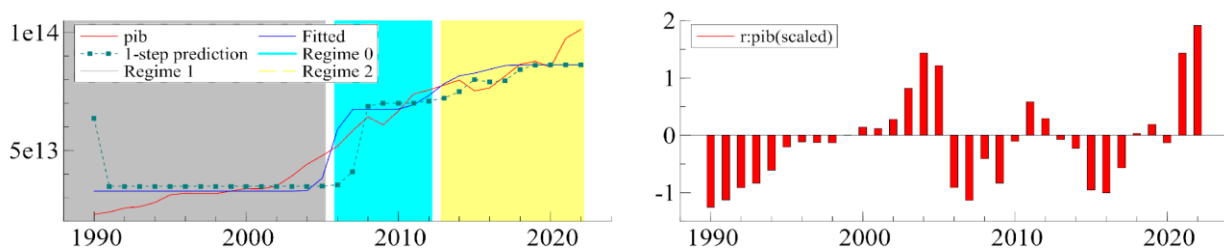


Figure 6 Change in probability regime for the GDP variable

Table 8 Transition probabilities GDP

Regime (t+1)\Reg (t)	Reg 0,t	Reg 1,t	Reg 2,t
Regime 0,t+1	0.86633	0.058547	0.00000
Regime 1,t+1	0.00000	0.94145	0.00000
Regime 2,t+1	0.13367	0.00000	1.0000

Inflation results, reported in Figure 7 and Table 9, are especially relevant. When oil-price regimes coincide with inflationary regimes, logistics firms may face simultaneous increases in fuel costs and broader operating costs, including maintenance, financing, warehousing, and labour. The persistence of inflation regimes therefore strengthens the interpretation of the results as different logistics cost environments rather than as isolated oil-market events.

Oil price regimes under geopolitical crises: implications for logistics cost management and supply chain planning

Nada El Moussaouia, Brahim Idelhakkarb

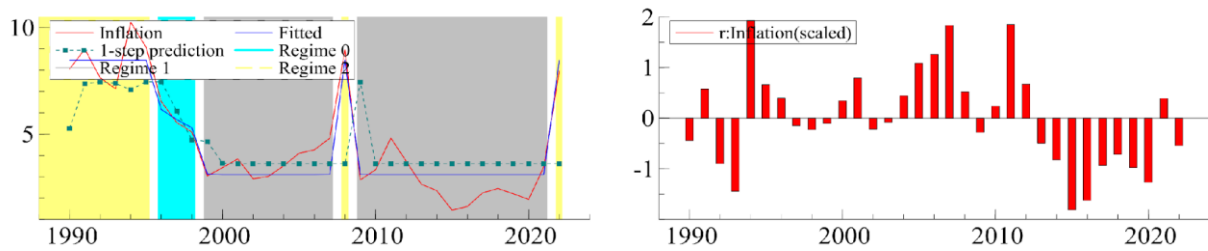


Figure 7 Change in probability regime for the inflation variable

Table 9 Transition probabilities inflation

Regime (t+1)\Reg (t)	Reg 0,t	Reg 1,t	Reg 2,t
Regime 0,t+1	0.62730	0.00000	0.12437
Regime 1,t+1	0.37270	0.90510	0.12389
Regime 2,t+1	0.00000	0.094904	0.75174

Finally, Table 10 summarizes the model-fit and diagnostic statistics for the six variables. The LR tests strongly reject linearity for all series, which supports the use of a non-linear regime-switching framework. This is an important result because it indicates that a single-regime benchmark would not adequately capture the dynamics observed in the sample. For logistics decision-making, the implication is that strategies based only on average conditions may underestimate cost pressure in stress periods and overestimate stability in calmer phases.

Table 10 The model Fit and statistics for each variable

Variable	Log-Likelihood	AIC	SC	Mean	Standard Error	Linearity LR-test Chi ² (P-value)
Oil Prices	-139.131	12.707	13.052	411.837	180.185	24.910 (0.0001*)
Oil Production	-438.010	26.970	27.287	3.567×10^6	312188	51.603 (0.0000**)
Oil Consumption	-299.589	18.520	18.792	45861.9	5082.62	56.672 (0.0000**)
Oil Reserves	-822.084	50.186	50.459	1.94918×10^{11}	3.50277×10^{10}	50.905 (0.0000**)
GDP (pib)	-1031.492	62.878	63.150	5.51804×10^{13}	2.46943×10^{13}	64.930 (0.0000**)
Inflation	-58.544	4.032	4.395	4.64667	2.5175	36.481 (0.0000**)

Overall, the results suggest that oil-market and macroeconomic variables evolve through distinct and persistent regimes rather than along one stable trajectory. The analytical value of these findings lies not only in detecting non-linearity, but also in distinguishing cost environments with different managerial implications. The combination of higher oil prices, stronger inflationary pressure, and persistent transition probabilities in Regime 2 is especially important because it points to a setting in which logistics managers may need shorter repricing cycles, more explicit fuel clauses, and stronger contingency planning.

4.3 Discussion

The empirical findings support the view that oil-price dynamics are non-linear and state-dependent rather than constant over time. This interpretation is consistent with the regime-switching literature initiated by Hamilton [25] and with later work showing that oil markets respond differently across low- and high-stress conditions [2,12-14]. What the present study adds is a clearer logistics-oriented reading of these regimes. Instead of treating regime shifts as purely econometric states, the paper interprets them as differentiated fuel-cost environments with implications for transport planning, contract design, and supply-chain resilience [4-8,15-19].

A first substantive implication concerns the meaning of the high-stress regime. Across several variables, Regime 2 combines higher oil prices with less favourable macroeconomic conditions, particularly higher inflation. This matters for logistics management because firms may then face a double pressure: fuel expenses increase, while broader operating costs—such as financing, warehousing, maintenance, and insurance—may also rise. In such a context, regime persistence becomes crucial. A short-lived price spike can often be managed through routine surcharge adjustment, but a persistent stress regime may require deeper changes in procurement strategy, route selection, network flexibility, and customer pricing.

A second implication concerns managerial preparedness. The results suggest that logistics risk management should be more explicitly regime aware. In relatively stable regimes, standard planning routines may be sufficient. In transitional and stress regimes, however, firms may need more frequent fuel surcharge revisions, shorter repricing cycles, closer cost monitoring, scenario-based budgeting, and stronger resilience mechanisms [15-17,19]. Interpreted in this way, regime

probabilities can serve as warning signals when they are read alongside geopolitical developments and macroeconomic indicators.

The study's contribution nevertheless remains bounded. The model does not include direct logistics outcomes such as freight rates, bunker surcharges, carrier margins, or corridor-level disruption measures. The dataset is also limited to 33 annual observations. These features do not invalidate the analysis, but they do mean that the findings should be interpreted as exploratory, conceptually informative, and suitable for theory-building rather than as definitive causal evidence. Future research could extend the dataset, use higher-frequency observations, and incorporate direct logistics indicators to test the proposed mechanism more explicitly [10,11].

5 Conclusion

This study examined oil-price behaviour through a Markov regime-switching framework and interpreted the estimated regimes from a logistics and supply-chain perspective. The results indicate that oil-market dynamics are not stable over time, but evolve across distinct regimes characterized by different levels, volatility patterns, and persistence. In particular, the evidence suggests that higher-stress regimes are associated with higher oil prices, stronger inflationary pressure, and transition patterns that may endure over time. These findings support the use of non-linear modelling when analysing oil-price behaviour under geopolitical uncertainty [2,12-14,25-30].

The main contribution of the paper is to connect this regime-based evidence to logistics cost management in a more explicit and disciplined way. Rather than claiming direct causal proof on logistics performance, the study argues that oil-market regimes can be interpreted as different fuel-cost environments that matter for surcharge design, contract adjustment, procurement planning, routing decisions, and supply-chain resilience [4-8,15-19]. This framing clarifies the paper's scientific contribution relative to the existing literature and responds to the need for a more analytically integrated discussion of logistics.

The conclusions should, however, be read with caution. The analysis relies on 33 annual observations and does not directly include freight rates, bunker costs, service levels, or corridor disruptions. The findings are therefore exploratory and conceptually grounded rather than definitive. Future research could strengthen this contribution by combining regime-based oil-market analysis with direct logistics indicators and higher-frequency data, and by examining whether regime probabilities can operate as early-warning signals for supply-chain decision-making under geopolitical stress.

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Oil price regimes under geopolitical crises: implications for logistics cost management and supply chain planning

Nada El Moussaouia, Brahim Idelhakkarb

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