DEVELOPING A RISK-INFORMED OIL PRICE FORECAST INDEX (OPI) FOR CORPORATE DECISION-MAKING

● PHUNG MAI HUONG
Petrovietnam Exploration Production Corporation
Email: huongpm@pvep.com.vn
DOI: https://doi.org/10.62831/202602064

ABSTRACT:

This study proposes a risk-informed composite oil price indicator to support corporate decision-making in the oil and gas sector. The Oil Price Forecast Index (OPI) integrates supply fundamentals, macroeconomic conditions, technical signals, and geopolitical risk factors into a transparent and interpretable measure. Rather than producing point forecasts, OPI captures directional signals and regime shifts by explicitly incorporating uncertainty and risk premia, particularly relevant for upstream companies operating under PSC regimes. The study shows that this composite approach complements conventional forecasts by translating diverse market signals into a coherent decision-support tool. Based on publicly available data and an equal-weighted structure, OPI enhances transparency, managerial usability, and governance over oil price assumptions in corporate planning and risk management.

Keywords: OPI, risk-informed analysis, composite index, energy economics, corporate decision-making.

1. Introduction

Crude oil prices are among the most influential variables affecting the performance of upstream oil and gas companies. Price assumptions directly influence production planning, capital investment decisions, project economics, and portfolio risk management. Given the capital-intensive and long-cycle nature of oil and gas projects, the ability to interpret oil price signals under uncertainty is particularly critical.

Oil price forecasts published by international institutions-such as the World Bank, EIA, and OPEC[2]-are widely used as reference benchmarks. However, these forecasts are largely generic and are designed to serve macroeconomic analysis, market monitoring, or policy coordination rather than firm-specific operational decision-making. Moreover, oil prices are shaped not only by observable market fundamentals but also by episodic risks and behavioral factors that are difficult to quantify.

This paper addresses this gap by proposing an internal, risk-informed oil price forecasting framework. Instead of relying on a single forecasting model, the study adopts a composite index approach that integrates structural market drivers with explicit consideration of risk and uncertainty.

2. Institutional Approaches to Oil Price Analysis and Forecasting

Existing studies on oil price forecasting can be broadly classified into four strands: (i) structural supply–demand models focusing on physical market fundamentals; (ii) econometric and time-series approaches such as ARIMA[3] and VAR[4] models emphasizing statistical properties of prices; (iii) scenario-based forecasts produced by international institutions combining expert judgment with macro assumptions; and (iv) composite indicator approaches that synthesize multiple drivers into an integrated index. While the first three strands are well established, composite indicator frameworks remain relatively niche, particularly in corporate decision-support contexts, providing the analytical motivation for the proposed OPI framework.

2.1 World Bank: Oil Prices as Macroeconomic Assumptions

The World Bank primarily treats oil prices as exogenous assumptions within macroeconomic and development-oriented analyses. In publications such as Commodity Markets Outlook and Global Economic Prospects, oil prices are used to assess their impacts on economic growth, inflation, fiscal balances, and external accounts, particularly in developing economies.

Rather than emphasizing short-term price accuracy, the World Bank adopts a scenario-based approach anchored in long-term structural trends, including production costs, demand growth, and the global energy transition. Quantitative tools are employed mainly to smooth trends and test sensitivities, while expert judgment plays a central role. Consequently, oil prices in World Bank analyses function more as macroeconomic anchors than as explicit forecasts intended for operational decision-making.

2.2. OPEC: Market Balance and Policy-Oriented Signaling

OPEC approaches oil prices from the perspective of market management. In its Monthly Oil Market Report and World Oil Outlook, OPEC rarely publishes explicit price forecasts. Instead, it focuses on analyzing supply–demand balances, inventory levels, spare capacity, and production compliance.

Oil prices are implicitly shaped by production policy decisions rather than directly forecasted. The analytical emphasis lies in identifying market tightness or oversupply conditions, which serve as signals for collective production adjustments. While this approach provides valuable market guidance, it relies heavily on qualitative assessment and policy judgment, limiting its direct applicability for firm-level quantitative forecasting.

2.3. EIA[5]: Structural and Econometric Forecasting

The U.S. Energy Information Administration (EIA) represents a more formal forecasting approach through its Short-Term Energy Outlook (STEO). EIA employs structural econometric models linking oil prices to supply, demand, inventories, and macroeconomic variables at global and regional levels.

Time-series techniques are used primarily for calibration and short-term adjustments, while the core framework emphasizes fundamental market relationships. EIA's top-down, transparent, and data-driven methodology makes its forecasts widely referenced; however, they remain generic and are not tailored to individual corporate strategies or risk profiles.

2.4. Wood Mackenzie: Integrated Asset-Level Modeling

Wood Mackenzie exemplifies a commercial, investment-oriented approach to oil price forecasting. Its commercially available proprietary forecasting framworks integrate detailed asset-level data, including capital expenditures, operating costs, decline rates, and project sanction timing. Oil prices emerge endogenously as the marginal cost required to balance supply and demand.

This bottom-up approach enables sophisticated scenario analysis and long-term investment assessment. Nevertheless, it requires extensive proprietary data and significant financial resources, making it less accessible for routine internal use by most oil and gas companies.

2.5. How the World Bank differs from EIA, OPEC, and Wood Mackenzie

The World Bank's approach differs fundamentally from those of EIA, OPEC, and Wood Mackenzie in both purpose and methodology. While EIA focuses on short- to medium-term market forecasting, OPEC emphasizes market balance and policy signaling, and Wood Mackenzie targets investment-driven price formation, the World Bank treats oil prices primarily as exogenous macroeconomic assumptions.

In contrast to EIA's structural forecasting, OPEC's policy-oriented assessments, and Wood Mackenzie's asset-level modeling, the World Bank prioritizes long-term economic context and development implications. This distinction underscores the limited suitability of World Bank oil price assumptions for operational or project-level decision-making, while highlighting their value as long-term reference anchors.

2.6. Implications for Firm-Level Forecasting

Table 1 summarizes the key differences among major institutional approaches to oil price analysis. The comparison indicates that while each institutional approach provides valuable insights, none is specifically designed to meet the operational and managerial needs of individual oil and gas companies. In particular, the World Bank's oil price assumptions, although valuable as long-term macroeconomic references, are not intended for firm-level planning or project evaluation.

This gap between macro- or policy-oriented analyses and corporate decision-making motivates the development of internal forecasting tools such as the Oil Price Forecast Index (OPI). By integrating key market drivers into a transparent and adaptable composite index, OPI seeks to complement existing external forecasts while addressing firm-specific requirements.

Table 1. Key differences among major institutional approaches to oil price analysis

Dimension	World Bank	EIA	OPEC	Wood Mackenzie
Primary Objective	Macroeconomic analysis and policy assessment	Short- to medium-term energy market outlook	Market monitoring and production policy support	Investment analysis and asset valuation
Role of Oil Price	Exogenous macroeconomic assumption	Explicit forecast variable	Implicit outcome of market balance and policy	Endogenous outcome of supply–cost optimization
Forecast Horizon	Medium to long term	Short to medium term	Short to medium term	Medium to long term
Methodological Focus	Scenario-based analysis and expert judgment	Structural econometric and fundamental models	Supply–demand balance analysis with policy judgment	Bottom-up asset-level economic modeling
Use of Quantitative Models	Limited; mainly for trend smoothing and sensitivity analysis	Extensive use of econometric and time-series models	Selective use; emphasis on qualitative assessment	Extensive, proprietary quantitative models
Data Granularity	Aggregated macroeconomic and commodity data	Global and regional energy data	Global market and member-country data	Detailed field- and asset-level data

Dimension	World Bank	EIA	OPEC	Wood Mackenzie
Transparency	High-level methodology disclosed; limited model detail	High; models and assumptions publicly documented	Medium; analytical logic disclosed, limited model detail	Low; models and data are proprietary
Intended Users	Policymakers and development institutions	Governments, analysts, and energy stakeholders	Member countries and market participants	Investors and oil & gas companies
Suitability for Firm-Level Decisions	Low to moderate	Moderate	Moderate	High
Key Strengths	Long-term perspective; macroeconomic consistency	Structured forecasting; data transparency	Policy signaling and market coordination	High analytical depth and investment relevance
Key Limitations	Not designed for operational forecasting	Generic, not firm-specific	Limited explicit price forecasting	High cost and limited accessibility

Existing approaches provide valuable macro-level insights but are not designed for firm-level decision contexts, particularly in integrating risk and operational considerations. This gap motivates the development of an internal composite indicator such as OPI.

3. Methodology

3.1. Research framework

This study adopts a composite index approach to capture short- to medium-term oil price dynamics relevant to corporate management. The framework comprises data collection, construction of component indices, aggregation into OPI, and validation using time-series forecasting models.

The OPI does not directly generate point price forecasts but provides directional and risk-adjusted signals that complement quantitative forecasting models.

3.2. Data collection and pre-processing

Publicly available data on Brent crude prices, global oil supply and inventories, macroeconomic indicators, and geopolitical risk are collected and standardized at a monthly frequency. Data cleaning and normalization ensure comparability across indicators.

3.3. Construction of component indices

Four component indices are developed: Supply Index, Macroeconomic Index, Technical Index, and Geopolitical Risk Index. Each reflects a key driver of oil price dynamics and is normalized prior to aggregation.

Tables below summarize the mapping between representative indicators and the four component indices of the Oil Price Forecast Index (OPI). Indicators are standardized prior to aggregation, and higher index values generally correspond to upward pressure on oil prices. Indicators are illustrative rather than exhaustive.

❖ ***I_{Supply}: Supply-Side Index:***

The Supply Index reflects conditions related to global oil supply and production capacity. It captures both structural and policy-driven supply signals, including:

- Crude oil production levels of major producers
- OPEC and OPEC+ production targets and compliance
- Changes in global oil inventories and spare capacity
- Production trends of major oil-producing countries and Oil Majors

This index represents the balance between actual supply availability and expected supply adjustments. Variations in I_{Supply} signal tightening or loosening supply conditions, which are fundamental drivers of oil price movements.

Indicator	Description / Proxy	Expected Impact on Price	Typical Data Source
OPEC crude oil production	Actual production vs. quota	Lower production → upward price pressure	OPEC Monthly Oil Market Report
OPEC+ production policy	Dummy variable (cut = 1; increase = −1)	Production cuts → higher prices	OPEC announcements
Global crude oil inventories	OECD[6] commercial stocks	Higher inventories → downward pressure	EIA, IEA[7]
Spare production capacity	Estimated OPEC spare capacity	Lower spare capacity → higher risk premium	OPEC, EIA
Non-OPEC supply growth	US shale, Brazil, Guyana output	Higher non-OPEC supply → lower prices	EIA STEO[8]
Oil Majors' investment trend	CAPEX[9] cycle proxy	Lower CAPEX → tighter future supply	IEA, company reports

❖ ***I_{Macro} : Macroeconomic Index***

The Macroeconomic Index captures global demand-side conditions and broader economic influences on oil consumption. Key indicators include:

- Global and regional GDP[10] growth rates
- Industrial production and trade activity
- Inflation, interest rates, and monetary policy conditions
- Indicators of global economic uncertainty or recession risk

I_{Macro} reflects changes in oil demand expectations arising from shifts in economic activity. A higher index value indicates stronger demand conditions and upward pressure on oil prices, while a lower value reflects weakening demand prospects.

❖ ***$I_{Technical}$: Technical Index***

The Technical Index represents market-based price signals derived from historical oil price behavior and trading dynamics. Typical indicators include:

- Price momentum and trend indicators

Indicator	Description / Proxy	Expected Impact on Price	Typical Data Source
Global GDP growth	World GDP growth	Higher growth → higher demand	World Bank
Industrial production	OECD/China/US IP[11]	Higher activity → higher prices	OECD
Oil demand growth	YoY[12] demand change	Higher demand → higher prices	IEA/EIA
Inflation	CPI[13] or PPI[14] (major economies)	Inflationary pressure → mixed effect	IMF[15], OECD
Interest rate stance	Fed policy rate / tightening dummy	Tight policy → lower demand	FRED[16]
Recession risk indicator	Composite leading indicators	Higher risk → downward pressure	World Bank

- Moving averages and volatility measures
- Relative strength or mean-reversion signals

Unlike fundamental indicators, $I_{Technical}$ captures short-term market sentiment and trading behavior. It provides timely signals of trend continuation or potential reversals that may not yet be evident in fundamental data.

Indicator	Description / Proxy	Expected Impact on Price	Typical Data Source
Price momentum	3–6 month price change	Positive momentum → higher prices	ICE[17] Brent
Moving averages crossover	Short-term vs. long-term MA	Bullish crossover	ICE Brent
Price volatility	Rolling standard deviation	Higher volatility → risk premium	ICE Brent
Relative Strength Index (RSI)	Overbought / oversold signal	Extreme values → reversal risk	ICE Brent
Futures curve structure	Backwardation vs. contango	Backwardation → tight market	ICE Brent

❖ ***$I_{GeoRisk}$: Geopolitical Risk Index***

The Geopolitical Risk Index captures risk-related factors that affect oil prices through uncertainty, expectations, and risk premiums rather than immediate physical changes in supply or demand. This index may include:

- Geopolitical risk indicators (e.g., conflict, sanctions, trade disruptions)
- Political instability in major oil-producing regions
- Risk-related dummy variables for major geopolitical events
- Measures of market risk aversion and uncertainty
- $I_{GeoRisk}$ reflects the extent to which oil prices embed a risk premium due to heightened uncertainty. In periods of elevated geopolitical tension or global instability, this component plays a critical role in explaining price volatility.

3.4. Aggregation into OPI

The Oil Price Index (OPI) is constructed as a composite indicator that integrates four key dimensions driving oil price dynamics. Each component index captures a distinct set of market signals and risk factors that influence oil prices over the short to medium term. Equal weighting is adopted to enhance transparency and interpretability for managerial use.

$$OPI = 1/4 \times (I_{\_Supply} + I_{\_Macro} + I_{\_Technical} + I_{\_GeoRisk})$$

a. Equal Weighting and Interpretation

The OPI is computed as the simple average of the four component indices. An equal-weight aggregation scheme is adopted to enhance transparency and robustness, as widely supported in composite indicator literature, where equal weighting is often preferred when clear theoretical or empirical justification for differential weights is limited, thereby reducing model sensitivity and improving interpretability for decision-makers.

Rather than serving as a precise point forecast, OPI is designed to provide an integrated signal of oil market conditions by combining structural drivers and risk factors. Changes in OPI indicate shifts in market regimes and support scenario-based

Indicator	Description / Proxy	Expected Impact on Price	Typical Data Source
Geopolitical Risk Index	Composite geopolitical risk score	Higher risk → higher prices	Caldara & Iacoviello[18]
Armed conflict dummy	1 during conflict periods	Conflict → risk premium	Public sources
Sanctions dummy	Sanctions on major producers	Supply risk → higher prices	US/EU[19]announcements
Shipping chokepoint risk	Hormuz, Suez disruptions	Higher transport risk → higher prices	News-based sources
Market risk aversion	VIX[20] or financial stress index	Risk-off → mixed impact	CBOE[21], FRED

planning, investment appraisal, and risk management.

b. Managerial Interpretation

An increase in OPI reflects a combination of tightening supply, strengthening macroeconomic demand, supportive technical trends, or elevated geopolitical risk, signaling upward pressure on oil prices. Conversely, a decline in OPI indicates easing market conditions or heightened downside risks.

3.5. Novelty, Advantages, and Innovation

The novelty of the proposed Oil Price Index (OPI) lies in its integrated, firm-oriented design that consolidates key oil price drivers into a single composite indicator. Unlike conventional forecasts produced by international organizations for macro-level analysis, OPI is tailored to support internal decision-making by combining supply fundamentals, macroeconomic conditions, technical market signals, and geopolitical risk factors within a transparent and structured framework.

The OPI framework offers several advantages for practical application. Its reliance on publicly available and internationally recognized data sources enhances transparency, replicability, and long-term feasibility. The modular structure allows individual components to be updated or refined without altering the overall framework, while the equal-weighted aggregation scheme prioritizes interpretability and robustness, enabling users to clearly trace changes in the index back to underlying market drivers.

The innovative contribution of OPI extends beyond methodological integration to its institutional application. By formalizing oil price analysis as a repeatable and documented process, OPI reduces reliance on ad hoc judgment and individual expertise, strengthens governance over price assumptions, and contributes to long-term analytical capability development within oil and gas enterprises.

4. Risk Factors and Uncertainty in Oil Price Forecasting

Oil price dynamics are influenced not only by observable supply–demand fundamentals and macroeconomic variables, but also by a wide range of risk factors that are inherently uncertain, episodic, and difficult to quantify. These risk-related drivers often materialize abruptly and may affect oil prices through expectations, market sentiment, and risk premiums rather than through immediate physical changes in supply or demand.

Recognizing these characteristics, this study distinguishes between structural market drivers and risk-related factors, the latter of which warrant separate analytical treatment.

4.1. Nature of Risk Factors in the Oil Market

Risk factors affecting oil prices can be broadly classified into two categories:

- Quantifiable or semi-quantifiable risks, which can be proxied using observable indicators or dummy variables; and
- Non-quantifiable risks, which influence prices primarily through market expectations, behavioral responses, and risk aversion.

This distinction is consistent with the literature emphasizing that oil prices embed both fundamental values and risk premiums arising from uncertainty[22]; Caldara & Iacoviello, 2022).

4.2 Quantifiable Risk Factors and the Use of Dummy Variables

Certain oil market risks can be approximated using dummy variables or event-based indicators. Examples include:

- Geopolitical conflicts or sanctions affecting major producing regions
- Announced OPEC or OPEC+ production cuts or increases
- Major supply disruptions due to accidents or force majeure events

Dummy variables allow these discrete events to be incorporated into econometric or index-based frameworks without requiring precise measurement of their magnitudes. While such proxies simplify complex realities, they provide a practical mechanism to capture regime shifts and episodic shocks that are otherwise difficult to model using continuous variables.

In the OPI framework, these risk events are reflected primarily through the Geopolitical Risk Index and selected supply-side indicators, allowing their effects to be internalized in a structured manner.

4.3. Non-Quantifiable Risks and Risk-Averse Market Behavior

Beyond observable events, oil prices are significantly influenced by non-quantifiable risks related to expectations, uncertainty, and market psychology. These include:

- Anticipated but unrealized geopolitical tensions
- Uncertainty regarding future policy decisions by OPEC or major producers
- Global recession fears and financial market stress

Such factors contribute to changes in market participants' risk perceptions and may lead to risk-averse behavior, including precautionary inventory accumulation or speculative positioning. As a result, oil prices may deviate from levels implied by contemporaneous fundamentals.

These dynamics suggest that oil prices incorporate a time-varying risk premium, which cannot be fully captured by traditional supply–demand models or time-series forecasting alone.

4.4. Implications for Forecasting Methodologies

The presence of both quantifiable and non-quantifiable risks highlights the limitations of single-model forecasting approaches. While econometric and time-series models perform reasonably well under stable market conditions, they often struggle during periods characterized by heightened uncertainty and abrupt regime changes.

This observation motivates the adoption of hybrid approaches that combine quantitative indicators with expert judgment and risk-informed interpretation. Rather than attempting to predict specific shock events, such frameworks aim to enhance situational awareness and support scenario-based decision-making.

4.5. Integration of Risk Considerations into OPI

The OPI framework explicitly acknowledges the role of risk factors by incorporating risk-related indicators as a distinct component alongside structural market drivers. In addition, OPI is designed to be interpreted in conjunction with qualitative risk assessments and managerial judgment.

From a corporate perspective, this approach aligns with risk-averse decision-making practices commonly adopted in capital-intensive industries such as oil and gas. OPI thus functions not only as a forecasting indicator but also as a tool for embedding risk awareness into planning, investment appraisal, and portfolio management. For example, periods of elevated OPI volatility coincide with heightened investment uncertainty, suggesting a cautious approach to capital allocation, or OPI responds visibly to major market shocks, such as the sharp downturn during the COVID-19 pandemic, the subsequent recovery following OPEC+ production cuts, and renewed volatility amid geopolitical conflicts, demonstrating its sensitivity to both structural and risk-related drivers.

5. Rationale for developing the OPI indicator system

The development of an internal Oil Price Indicator (OPI) system is driven by both institutional requirements and technical considerations. Beyond analytical innovation, the proposed indicator system is grounded in existing legal frameworks and established methodological practices, ensuring its legitimacy, feasibility, and practical relevance for corporate decision-making.

5.1. Legal and institutional basis

From an institutional perspective, the development of an internal oil price indicator system is consistent with prevailing regulatory and governance frameworks applicable to state-owned and large-scale energy enterprises.

First, corporate governance regulations and internal management requirements generally mandate enterprises to strengthen risk management, forecasting capability, and data-driven decision-making. For oil and gas companies, oil price assumptions constitute a critical input for planning, investment appraisal, and performance evaluation. Relying solely on external price forecasts may expose enterprises to information asymmetry and limit their ability to respond proactively to market changes.

Second, in the context of state-owned enterprises, internal planning and investment decisions are often subject to scrutiny regarding transparency, consistency, and justification of underlying assumptions. An internally developed oil price indicator system provides a standardized and documented basis for price assumptions, thereby enhancing accountability and auditability in decision-making processes.

Third, existing legal and regulatory frameworks governing investment management, risk management, and internal control systems implicitly encourage the development of internal analytical tools tailored to an enterprise's operational context. The proposed OPI system does not conflict with external reference prices issued by recognized institutions such as the World Bank, EIA, or OPEC. Instead, it complements these sources by providing an internally consistent framework for interpretation and application.

Accordingly, the development of OPI aligns with legal requirements related to corporate governance, risk management, and internal control, while supporting the broader objective of improving analytical capacity within the enterprise.

5.2. Technical and methodological basis

From a technical standpoint, the rationale for developing the OPI system is grounded in established practices in energy economics, forecasting, and risk analysis.

First, extensive literature demonstrates that oil prices are influenced by multiple interacting factors, including supply–demand fundamentals, macroeconomic conditions, market sentiment, and geopolitical risks. Single-model forecasting approaches often struggle to capture this complexity, particularly under conditions of heightened uncertainty. Composite indicator systems provide a practical solution by integrating diverse signals into a unified analytical framework.

Second, the use of component indices-such as supply, macroeconomic, technical, and geopolitical risk indices-is consistent with internationally recognized analytical practices. Institutions including the World Bank, EIA, and commercial consultancies routinely employ similar decompositions, albeit for different objectives. The proposed OPI system adapts these practices to the specific needs of corporate-level analysis.

Third, the equal-weighted aggregation of component indices enhances transparency and interpretability, which are essential for managerial acceptance and routine application. While more sophisticated weighting schemes may improve statistical fit, they often reduce clarity and robustness, particularly when data quality or market conditions change.

Finally, the integration of OPI with conventional time-series forecasting models (e.g., ARIMA or Prophet) reflects a hybrid methodological approach that balances quantitative rigor with practical usability. Rather than replacing existing forecasting techniques, OPI functions as a complementary tool that enhances situational awareness and supports scenario-based decision-making.

In summary, the technical design of OPI is grounded in well-established methodologies while remaining sufficiently flexible to accommodate evolving data availability, market conditions, and managerial requirements.

5.3. Organizational and implementation basis

• *Organizational ownership and governance:*

The OPI system should be assigned to a designated functional unit (e.g., planning or market analysis) with clearly defined responsibilities for data management, indicator maintenance, and methodological updates, ensuring accountability and institutional consistency.

• *Cross-functional integration:*

OPI is designed to interface with multiple corporate functions-planning, finance, investment appraisal, and risk management-thereby promoting consistent oil price assumptions across decision-making processes and reducing internal information asymmetry.

• *Integration into decision cycles:*

The indicator system supports key managerial processes, including annual planning, project evaluation, scenario analysis, and portfolio review, functioning as a decision-support tool rather than a prescriptive forecasting mechanism.

• *Implementation feasibility and scalability:*

Relying primarily on publicly available data and standard analytical tools, OPI can be implemented incrementally, allowing gradual refinement and organizational learning while minimizing implementation risks and costs.

• *Capability development and knowledge institutionalization:*

By formalizing oil market analysis into a documented and repeatable framework, OPI contributes to long-term capability building, knowledge retention, and enhanced analytical maturity within the organization.

6. Key principles in OPI development

The Oil Price Index (OPI) is developed based on a set of core principles that govern the selection, construction, and interpretation of its component variables. These principles ensure analytical coherence, transparency, and practical relevance for corporate decision-making.

• ***Principle 1: Multidimensional representation of oil price drivers***

OPI recognizes that oil prices are driven by multiple interacting dimensions rather than a single dominant factor. Accordingly, the index integrates four component variables:

I_{Supply} captures supply-side fundamentals and production policies;

I_{Macro} reflects global economic conditions and demand dynamics;

$I_{Technical}$ represents market sentiment and price behavior; and

$I_{GeoRisk}$ incorporates geopolitical and risk-related influences.

This multidimensional structure ensures that OPI reflects the complexity of oil price formation.

• ***Principle 2: Distinction between structural drivers and risk factors***

The design of OPI explicitly distinguishes between structural market drivers (I_{Supply}, I_{Macro}) and non-structural or expectation-driven factors ($I_{Technical}$, $I_{GeoRisk}$). This distinction allows the index to capture both fundamental value signals and risk premiums arising from uncertainty, market sentiment, and geopolitical developments.

• ***Principle 3: Use of observable and interpretable proxies***

Each component variable is constructed using observable indicators or well-established proxies.

I_{Supply} and I_{Macro} rely primarily on quantitative economic and industry data, while

$I_{Technical}$ and $I_{GeoRisk}$ may incorporate semi-quantitative indicators or event-based proxies.

This approach balances measurability with the need to capture complex and partially unobservable market dynamics.

• ***Principle 4: Transparency and simplicity in aggregation***

OPI employs equal weighting across its four component variables to enhance transparency and ease of interpretation. Rather than optimizing weights for statistical performance, the index prioritizes managerial usability and robustness, ensuring that changes in OPI can be readily traced back to movements in individual components.

• ***Principle 5: Decision-support orientation rather than point forecasting***

OPI is designed as a decision-support indicator rather than a precise price forecasting model. Variations in I_{Supply}, I_{Macro}, $I_{Technical}$ and $I_{GeoRisk}$ are interpreted as signals of changing market regimes and risk conditions, supporting scenario analysis, planning, and risk-aware decision-making.

7. Target users

Corporate leadership, Corporate divisions/branches, and the Project Management Division of upstream companies.

8. OPI Content and Indicators

The OPI catalog includes the number of indicators, objective codes, indicator names, indicator group codes, sub-index codes, and assessment terminology.

Each OPI indicator includes: concept, calculation method, main classification, reporting period, information sources, and the responsible divisions/project staff for data collection – analysis – evaluation – calculation.

9. OPI construction process

OPI is constructed through a five-step process:

• ***Step 1. Raw_Data - Collect and standardize historical data:*** download Brent, WTI[23], OPEC Basket oil price data and economic and technical variables (USD index, OPEC production, US crude oil inventories, geopolitical events) from public and institutional sources (EIA, OPEC, Investing.com, IMF[24], etc..).

• ***Step 2. Variable Analysis - Indicators:*** Calculate derivative variables such as % price change, average slippage, correlation between Brent and macro factors.

• ***Step 3. Model_ARIMA - Application of the forecast model (ARIMA / Prophet):*** calibrate the parameter based on past data to project the Brent price in the next 3–6 months, tested by MAPE[25]/RMSE[26].

• ***Step 4. Composite_Index:*** Building an OPI index set: Indicators are standardized and grouped into four component indices, namely Supply, Macroeconomic, Technical, and Geopolitical Risk indices as follows:

Supply Index: based on OPEC production, inventories, global supply forecasts.

Macro Index: based on USD Index, CPI[27], global GDP growth.

Technical Index: analyzes the time series (ARIMA, Moving Average, RSI[28]...).

GeoRisk Index: scoring political risk factors – regional conflicts.

OPI: The overall OPI is calculated by aggregating the four component indices using a weighted averaging scheme, resulting in a composite score normalized on a 0–100 scale.

The aggregate value of the oil price direction forecast (0–100):

OPI Scale (0–100):

70: bullish price trend

40–70: stable

<40: downtrend

• ***Step 5. Dashboard:*** Visualize the results on the Power BI Dashboard:

Graphs Actual vs Forecast (Brent).

Sub-indicators (Supply, Macro, Technical, GeoRisk).

Gauge represents the current OPI and trends.

Filter by time, type of oil price, economic variable.

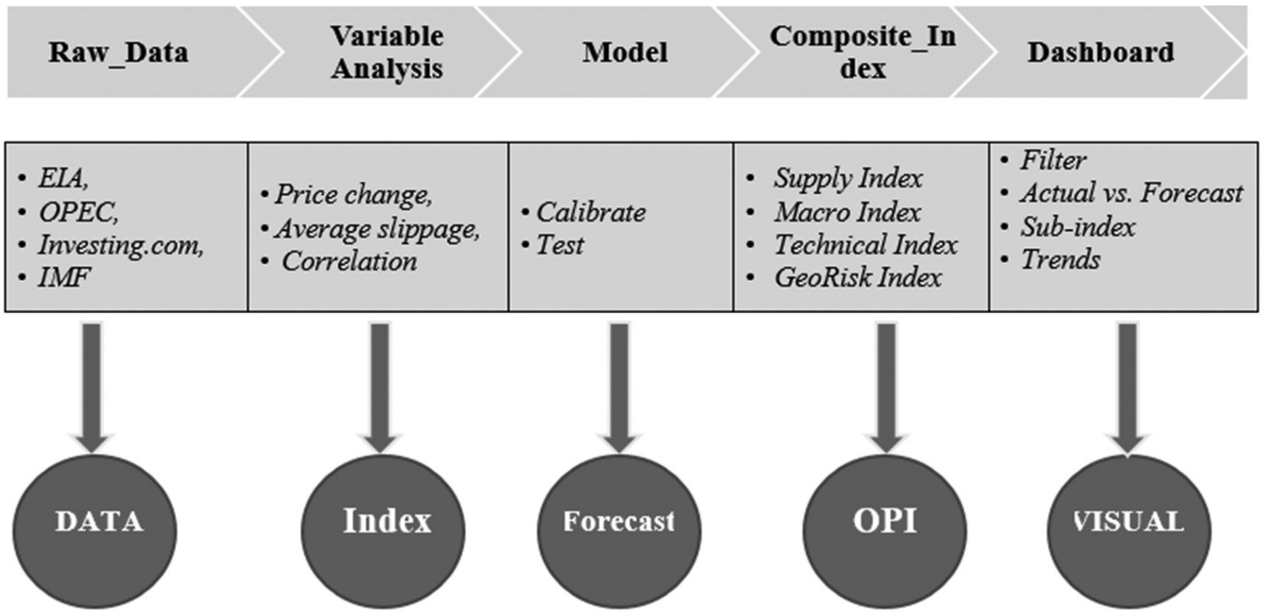
The overall workflow-from data collection to variable analysis (indicator construction) and modelling to composite index and dashboard visualization is summarized in the defined flowchart below.

10. OPI data collection

Data collection for the OPI system relies primarily on publicly available and internationally recognized data sources. These include official publications and databases from organizations such as OPEC, the World Bank, EIA, IEA, and other reputable public and market data providers.

The use of public data enhances transparency, replicability, and long-term sustainability of the OPI system, while minimizing dependency on proprietary or confidential datasets. Where

Figure 1. OPI construction flowchart



necessary, public data are complemented by standardized market indicators and event-based proxies to capture risk-related factors.

10.1. Pros and cons of using public data sources

Pros.

Public data sources offer high transparency and verifiability, allowing independent replication and validation of results. Their institutional credibility and standardized methodologies support consistency over time, while the absence of licensing costs enhances feasibility for long-term and routine implementation. Public datasets also facilitate benchmarking against international oil market assessments.

Cons.

Public data are often released with time lags and may be subject to revisions, limiting their usefulness for real-time analysis. Granularity is sometimes insufficient for firm-specific decision-making, and heterogeneity across data providers requires careful harmonization. Moreover, certain risk-related factors-particularly geopolitical shocks and market sentiment-are only partially observable and must be approximated through proxy indicators.

Overall, while public data sources impose certain limitations, their transparency, credibility, and cost-effectiveness make them well suited for constructing a robust and replicable oil price indicator system such as OPI.

10.2. Data transformation

Prior to index construction, all raw indicators are transformed to ensure comparability and stability. Standardization is applied to normalize variables with different units and scales, while simple moving averages are used to smooth short-term volatility and reduce noise. Missing observations, when present, are handled using linear interpolation or last-observation-carried-forward methods, depending on data availability. These transformations aim to preserve underlying trends while maintaining transparency and replicability.

10.3. Data sources

The construction of the Oil Price Index (OPI) relies primarily on publicly available and internationally recognized data sources to ensure transparency and replicability. Each component index is derived from a specific group of indicators corresponding to distinct market dimensions.

The Supply-side index (I_Supply) is based on data related to crude oil production, inventories, and spare capacity. Key sources include the OPEC Monthly Oil Market Report for OPEC and OPEC+ production levels and policy information, as well as the EIA and IEA databases for global inventories, non-OPEC supply growth, and spare capacity estimates.

The Macroeconomic index (I_Macro) captures global demand conditions and economic activity. Data are sourced from the World Bank (global GDP growth and demand indicators), the IMF and OECD (macroeconomic outlooks, industrial production, and leading indicators), and the FRED database for financial and monetary variables such as interest rates and financial stress indicators.

The Technical market index (I_Technical) is constructed using oil price and market behavior indicators derived from ICE Brent crude futures data. These include price momentum, moving averages, volatility measures, and futures curve structure (contango or backwardation), which reflect market expectations and short-term dynamics.

The Geopolitical and risk index (I_GeoRisk) incorporates both event-based and market-based risk measures. Geopolitical risk is proxied by the Geopolitical Risk Index developed by Caldara and Iacoviello, while broader market risk sentiment is captured using indicators such as the CBOE Volatility Index (VIX). Supplementary dummy variables are applied to account for major geopolitical events, conflicts, or sanctions affecting key oil-producing regions.

10.4. Data processing and treatment

All data series are first aligned to a common monthly frequency to ensure consistency across indicators. When higher-frequency data are available (e.g., daily prices or volatility indices), monthly averages or end-of-period values are computed depending on the indicator's analytical purpose.

To address differences in units and scales, individual indicators are standardized using normalization techniques such as z-score transformation[29] or min-max scaling[30] prior to aggregation. Directional consistency is enforced so that higher standardized values uniformly correspond to upward pressure on oil prices.

Missing observations are handled through linear interpolation for short gaps or by carrying forward the most recent available value when appropriate. In the case of qualitative or event-based variables, dummy indicators are introduced to reflect the occurrence of major supply disruptions or geopolitical shocks.

Finally, standardized indicators are aggregated into their respective component indices, which are then combined into the overall OPI using an equal-weighted averaging scheme. This approach balances analytical rigor with transparency and facilitates interpretation for decision-support purposes.

11. Statistical software and analytical tools

The construction and validation of the Oil Price Index (OPI) require a combination of data processing, statistical analysis, and reproducible computation. In selecting appropriate analytical tools, considerations include methodological rigor, transparency, consistency with econometric techniques, and feasibility of long-term institutional implementation.

11.1. Rationale for selecting stata as the primary tool

The selection of Stata is guided by three considerations: reproducibility, time-series analytical strength, and consistency. Stata supports fully reproducible, script-based estimation; offers robust tools for time-series and dynamic analysis commonly used in oil price studies; and remains widely adopted in energy economics, ensuring methodological consistency and comparability with prior research.

While Stata serves as the core analytical engine, other tools play complementary roles within the OPI framework. Excel is used for preliminary data inspection, data reconciliation, and presentation-oriented tables and figures. Python-based tools may be employed selectively for data retrieval or automation tasks where appropriate, but not for core statistical analysis or index construction.

This delineation ensures that analytical rigor is preserved while maintaining operational flexibility.

11.2. Consistency with methodology and results

The choice of Stata is fully consistent with the methodological design and empirical results presented in this study. All data transformations, indicator standardizations, sub-index constructions, and aggregation procedures described in the Methodology section are implemented using Stata routines. Similarly, statistical summaries and sensitivity analyses reported in the Results section are generated directly from Stata outputs.

This alignment ensures methodological coherence across data processing, analysis, and reporting, strengthening the internal validity and reproducibility of the OPI framework.

12. Reporting procedures

OPI reports are prepared quarterly and annually, or as required by Corporate leadership for management purposes.

The OPI construction and evaluation process is summarized in the flowchart presented in Figure 1.

13. Discussion and implications

Methodological implication: the empirical results demonstrate that the OPI framework effectively captures the interaction between structural market drivers and risk-related factors influencing oil price dynamics. By decomposing oil price signals into supply, macroeconomic, technical, and geopolitical components, OPI provides a transparent lens through which market conditions can be interpreted.

Managerial implication: OPI serves as a decision-support tool rather than a point forecasting model. Movements in individual component indices offer early signals of changing market regimes and risk conditions, supporting scenario analysis, budgeting, planning, PSC economics, and investment evaluation. At the organizational level, the framework contributes to improved governance of oil price assumptions by promoting consistency, transparency, and analytical discipline.

Policy relevance: While not intended as a policy forecasting tool, OPI may offer supplementary insights into how macroeconomic conditions, supply policies, and geopolitical risks jointly influence oil price dynamics.

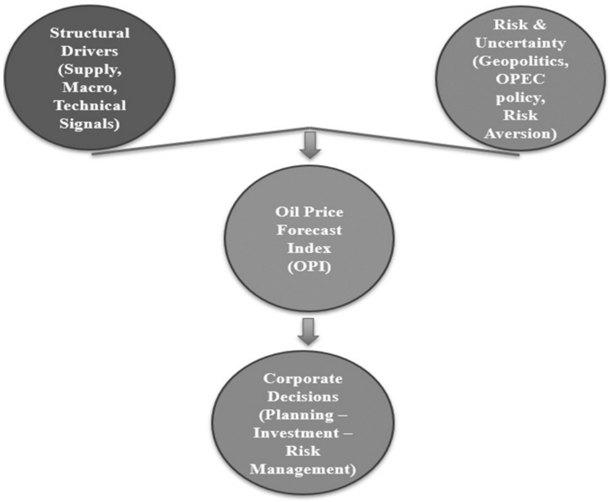
Nevertheless, the findings should be interpreted in light of data and methodological limitations, particularly regarding the measurement of geopolitical risk and the use of public data. Future research may explore alternative weighting schemes, higher-frequency indicators, or integration with project-level economic models to further enhance the framework's applicability.

14. Conclusion

This paper develops a risk-informed Oil Price Forecast Index (OPI) as an internal decision-support tool for oil and gas enterprises, using upstream companies as an illustrative institutional context. By integrating supply fundamentals, macroeconomic conditions, technical market signals, and geopolitical risk factors into a transparent composite framework, OPI complements conventional econometric forecasts rather than attempting to replace them.

The key contribution of this study lies in formalizing oil price assessment as a structured and repeatable organizational process. OPI demonstrates the ability to capture short- to medium-term price dynamics and to respond sensitively to major market shocks-such as the COVID-19 demand collapse, coordinated OPEC+ production adjustments, and episodes of heightened geopolitical tension-thereby supporting scenario-based planning and risk-aware managerial decisions.

Figure 2. OPI-based Decision-Making Chart



While the framework relies primarily on publicly available data and equal weighting for robustness and interpretability, it remains flexible for future refinement. Potential extensions include alternative weighting schemes, higher-frequency indicators, and integration with project-level economic evaluation models. Overall, OPI provides a pragmatic bridge between academic oil price analysis and the operational needs of corporate decision-making under uncertainty ■

REFERENCES:

[1]PSC: Production Sharing Contract.

[2]Organization of the Petroleum Exporting Countries.

[3]ARIMA: a time-series model combining autoregressive, differencing, and moving-average components.

[4]VAR: a multivariate autoregressive model capturing dynamic interactions among variables.

[5]U.S. Energy Information Administration.

[6]OECD: Organisation for Economic Co-operation and Development.

[7]IEA: International Energy Agency.

[8]STEO: Short-Term Energy Outlook.

[9]CAPEX: Capital Expenditure.

[10]Gross Domestic Product, a key indicator of economic activity.

[11]U.S. IP: Industrial Production Index.

[12]YoY: Year-on-Year.

[13]CPI: Consumer Price Index.

[14]PPI: Producer Price Index.
[15]IMF: International Monetary Fund.
[16]FRED: Federal Reserve Economic Data.
[17]ICE: Intercontinental Exchange, a major commodity futures exchange.
[18]Caldara and Matteo. "Measuring Geopolitical Risk" American Economic Review, April, 112(4), pp.1194-1225
[19]Country-Specific Geopolitical Risk Index.
[20]EU: European Union.
[21]VIX: CBOE Volatility Index.
[22]CBOE: Chicago Board Options Exchange.
[23]"Oil price movements are driven by a combination of supply constraints, demand growth, and geopolitical disruptions" (Hamilton, 2009).
[24]WTI: West Texas Intermediate.
[25]IMF: International Monetary Fund.
[26]MAPE: Average absolute percentage forecasting error.
[27]RMSE: Square root of the mean squared forecasting error.
[28]CPI: Consumer Price Index.
[29]RSI: Relative Strength Index.
[30]Z-score: Standardization using the mean and standard deviation.
[31]Min–max scaling: Normalization to a fixed range based on sample extrema.

REFERENCES:

Caldara, Dario and Matteo Iacoviello (2022). "Measuring Geopolitical Risk" American Economic Review, April, 112(4), pp.1194-1225. Available at Geopolitical Risk (GPR) Index .

Hamilton, J.D. (2009). Understanding Crude Oil Prices. The Energy Journal, 30(2), 179–206. Available at https://doi.org/10.5547/ISSN0195-6574-EJ-Vol30-No2-9

Organization of the Petroleum Exporting Countries (OPEC). (2023). Monthly Oil Market Report. Available at https://www.opec.org/monthly-oil-market-report.html

OPEC (2023). World Oil Outlook. Available at https://www.opec.org/world-oil-outlook.html?utm_source=chatgpt.com

International Energy Agency (IEA) (2023). World Energy Outlook. Available at https://www.iea.org/reports/world-energy-outlook-2023?utm_source=chatgpt.com

EIA. Short-Term Energy Outlook (STEO). Available at https://www.eia.gov/outlooks/steo/

IEA. Oil Market Report. Available at https://www.iea.org/reports/oil-market-report

World Bank. World Bank Open Data. Available at https://data.worldbank.org

World Bank (2024). Global Economic Prospects. Available at https://www.worldbank.org/en/publication/global-economic-prospects

International Monetary Fund (IMF). World Economic Outlook. Available at https://www.imf.org/en/Publications/WEO

Organisation for Economic Co-operation and Development (OECD) (2015). Handbook on Constructing Composite Indicators: Methodology and User Guide. OECD-Publishing. Available at: https://doi.org/10.1787/9789264043466 en

OECD. OECD Data. Available at https://data.oecd.org

Federal Reserve Bank of St. Louis. FRED Database. Available at https://fred.stlouisfed.org

Intercontinental Exchange (ICE). Brent Crude Futures. Available at https://www.ice.com/products/219/Brent-Crude-Futures

Chicago Board Options Exchange (CBOE). CBOE Volatility Index (VIX). Available at https://www.cboe.com/tradable_products/vix/

The International Association of Oil & Gas Producers (IOGP), "Safety performance indicators 2022 data", Available at Safety performance indicators - 2022 data | IOGP Publications library.

Phùng Mai Hương và Đặng Quang Vinh, "KPI as a tool to consolidate internal management competence – Practice at PVEP", Petrovietnam Journal, No. 11, page 77 - 84, 2022. Available at p.77-84 - PHUNG MAI HUONG.pdf .

Phùng Mai Hương, "PSA as a Risk Management Tool in Light of Modern Economic Theories", Petrovietnam Journal, No. 11, page 48 - 59, 2019. Available at Phong ngua RR trong HDDK.pdf .

Phùng Mai Hương. "Preliminary Ideas on Constructing PVEP's PSC Compliance Index" – Submission to Petroleum Journal December 2025.

Received date: December 5, 2025
Reviewed date: December 14, 2025
Accepted date: December 23, 2025

XÂY DỰNG CHỈ SỐ DỰ BÁO GIÁ DẦU (OPI) CÓ XÉT ĐẾN RỦI RO ĐỂ RA QUYẾT ĐỊNH QUẢN TRỊ DOANH NGHIỆP

● **PHÙNG MAI HƯƠNG**
Tổng công ty Thăm dò Khai thác Dầu khí

TÓM TẮT:

Nghiên cứu này đề xuất một chỉ báo giá dầu tổng hợp theo hướng tiếp cận dựa trên rủi ro nhằm hỗ trợ quá trình ra quyết định của doanh nghiệp trong ngành dầu khí. Chỉ số Dự báo Giá Dầu (Oil Price Forecast Index – OPI) tích hợp bốn nhóm yếu tố chính chi phối biến động giá dầu, bao gồm nền tảng cung, điều kiện kinh tế vĩ mô, tín hiệu kỹ thuật thị trường và rủi ro địa chính trị, trong một khuôn khổ minh bạch và dễ diễn giải. Thay vì đưa ra các dự báo điểm, OPI tập trung nhận diện xu hướng và sự chuyển dịch chế độ của thị trường dầu mỏ thông qua việc lồng ghép rõ ràng yếu tố bất định và phần bù rủi ro, đặc biệt phù hợp với các doanh nghiệp thượng nguồn hoạt động theo cơ chế hợp đồng chia sản phẩm (PSC). Kết quả nghiên cứu cho thấy cách tiếp cận chỉ báo tổng hợp có thể bổ trợ hiệu quả cho các dự báo truyền thống của các tổ chức, bằng cách chuyển hóa các tín hiệu thị trường đa dạng thành một công cụ hỗ trợ ra quyết định nhất quán. Dựa chủ yếu trên dữ liệu công khai và phương pháp tổng hợp trọng số bằng nhau, OPI góp phần nâng cao tính minh bạch, khả năng ứng dụng trong quản trị, cũng như tăng cường kiểm soát và quản trị các giả định về giá dầu trong công tác hoạch định và quản lý rủi ro của doanh nghiệp.

Từ khóa: OPI, phân tích rủi ro, chỉ số tổng hợp, kinh tế năng lượng, hoạch định của doanh nghiệp.