**Task 1 Interim Report — Brent Oil Price Change Point Analysis**

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 **Project:** Brent Oil Price Analysis — Bayesian Change Point Detection  
 **Client:** Birhan Energies

**1. Introduction and Business Context**

This project aims to analyze how significant geopolitical and economic events affect Brent oil prices. Given the oil market’s volatility, identifying structural changes in price behavior is critical for investors, policymakers, and energy companies to manage risks and optimize decisions. The core objective of Task 1 is to establish a data analysis workflow and apply a Bayesian change point model to detect meaningful shifts in Brent oil prices.

**2. Data Description and Preparation**

Two datasets were used:

* **Brent Oil Prices:** Daily closing prices from January 1, 2019, to December 31, 2021, totaling 1,096 records. Prices were synthetically generated to simulate three distinct market regimes with varying mean price levels.
* **Key Events:** Five major events relevant to the oil market during this period, including trade tensions, pandemic impacts, OPEC decisions, and geopolitical conflicts.

Both datasets were loaded and cleaned using Python’s pandas library, ensuring date formats were parsed correctly for time series analysis.

**3. Exploratory Data Analysis (EDA)**

Initial visualization of Brent prices over time revealed distinct periods of price behavior, reflecting the synthetic regime changes:

* A stable period around $60/barrel in 2019.
* A rise to approximately $70/barrel in 2020.
* A decline to around $50/barrel in 2021.

Rolling mean plots (30-day window) confirmed these trends and indicated potential structural breaks warranting further analysis.

**4. Methodology: Bayesian Change Point Model**

A Bayesian change point detection model was implemented using PyMC3 to estimate when significant shifts in the mean price occurred. The key modeling assumptions include:

* Price observations are normally distributed with piecewise constant means separated by unknown change points.
* One change point was initially modeled to simplify interpretation.
* Priors were set for change point location (discrete uniform) and mean prices before and after the change.

The model sampled posterior distributions of the change point and mean price parameters using Markov Chain Monte Carlo (MCMC) methods with 2,000 iterations after tuning.

**5. Results and Interpretation**

* The model estimated a change point approximately in early 2020, aligning with the onset of the COVID-19 pandemic and associated market disruptions.
* Visualizations showed the estimated change point clearly demarcating a shift in price regimes.
* Cross-referencing with the event dataset identified a key event (Global pandemic impacts demand on 2020-02-15) within 30 days of the detected change point, suggesting plausible correlation.

**6. Limitations and Assumptions**

* Only a single change point was modeled, which may oversimplify the complex dynamics of oil price fluctuations.
* The analysis assumes normality and piecewise constant means, which may not fully capture volatility or gradual transitions.
* Statistical correlation does not imply causation; detected change points should be interpreted cautiously in light of external events.

**7. Areas for Improvement and Next Steps**

* Expand the model to detect multiple change points to better capture the complexity of price dynamics over the entire period.
* Incorporate volatility change point detection to understand shifts in price variance, not only mean.
* Enrich exploratory data analysis with additional visualizations such as autocorrelation plots, stationarity tests (ADF), and volatility clustering.
* Develop an interactive dashboard to allow stakeholders to explore findings dynamically.
* Enhance the report with deeper insights linking detected change points to a wider range of geopolitical and economic events.

**8. Communication Plan**

Results will be communicated via:

* A comprehensive written report with visualizations and interpretation.
* An interactive dashboard (Streamlit or Plotly Dash) for intuitive exploration.
* Presentation to stakeholders highlighting actionable insights.