



UNIVERSITY OF NIAGARA FALLS CANADA

MASTER OF DATA ANALYTICS

**STOCK PRICE FORECASTING FOR AN INTEGRATED OIL & GAS COMPANY
(IMPERIAL OIL LIMITED): ANALYSE THE IMPACT OF OIL PRICES AND
MACROECONOMIC FACTORS**

PREPARED BY: GROUP 9

JUAN ESTEBAN CISNEROS - NF1015831

VANESSA RUEDA NIETO – NF1013949

SANDESH DHAKAL – NF1007629

PEDDAPURAM SAI ABHISHEK- NF1006012

SUBMITTED TO

PROF. DR. MOHANNAD ALMOUSA

August 31, 2025

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1. Introduction

Imperial Oil Limited (IMO) is a leading integrated oil and gas company operating in an industry highly sensitive to fluctuations in crude oil prices, macroeconomic factors, and the rapidly increasing adoption of electric vehicles (EVs). In the current dynamic global energy landscape, the ability to accurately forecast stock price direction has become increasingly crucial for investors, analysts, and strategic planners.

Canada's energy sector is undergoing a profound shift, with daily car sales data revealing a steady rise in electric vehicle adoption. This growth is propelled by federal and provincial incentives as well as shifting consumer preferences toward sustainable mobility. Such trends present long-term challenges for traditional oil producers, as decreasing gasoline demand impacts the downstream segment's profitability.

This research aims to develop a predictive model to forecast IMO's daily closing stock price using key influencing variables, namely daily Canadian car sales data (segmented into electric and non-electric vehicles), crude oil benchmark prices (WTI), and the CAD/USD exchange rate. By evaluating the interactions among these variables, the study seeks to uncover which factors most significantly influence stock price movements and to assess the predictive strength of energy transition indicators in financial modeling.

In addition to exploring the statistical relevance of each variable, the study will compare the performance of multiple forecasting models, evaluating metrics such as MSE error, R square and correlation factors. These findings are expected to deliver valuable insights for investors, policymakers, and industry stakeholders, contributing a data-driven foundation for informed decision-making in an era defined by economic uncertainty and the global pivot toward decarbonization.

2. Problem Statement

The Integrated Oil & Gas equity segment, particularly in Canada, is increasingly exposed to multifactor dynamics, including shifts in global crude oil benchmarks, domestic vehicle sales patterns, macroeconomic indicators, and evolving consumer behaviour toward energy transition. Over the past decade, this sector has faced growing complexity stemming from oil price volatility, foreign exchange fluctuations, and the accelerated adoption of electric vehicles (EVs), all of which have had measurable impacts on the financial performance of companies like Imperial Oil Limited (IMO).

As of 2025, Canada continues to experience a significant increase in daily car sales, with electric vehicle penetration reaching record levels. This transformation, fueled by strong government incentives and shifting consumer preferences, is altering the demand structure for refined petroleum products. Simultaneously, global crude oil prices (such as WTI), which serve as primary inputs for refining operations, remain volatile due to geopolitical tensions and OPEC+ production strategies. In addition, macroeconomic elements like the USD/CAD exchange rate introduce further uncertainty into the cost and revenue structures of Canadian oil companies operating in global markets.

Given these intertwined variables, the valuation of Imperial Oil's stock is no longer determined by crude oil prices alone. Investor sentiment is increasingly shaped by macro-level indicators such as currency shifts, evolving retail fuel prices, and the adoption rate of electric vehicles, which represent both a disruption and an early signal of sectoral transformation.

This project aims to develop a predictive analytical model to understand and quantify the influence of four primary independent variables on IMO's daily stock price (dependent variable):

- Daily global crude oil prices (WTI),

- Daily USD/CAD exchange rates,
- Daily Canadian car sales (with EV vs non-EV segmentation), and
- Historical daily stock prices of Imperial Oil Limited (for model training and accuracy evaluation).

Through this modelling process, the research will reveal how macroeconomic forces, energy market dynamics, and transportation electrification trends jointly affect equity valuation in the oil and gas sector. The outcome will serve investors, analysts, and strategic planners by offering evidence-based insights into forecasting practices, risk management, and capital allocation in an era of energy transition and financial uncertainty.

3. Relevance and Importance

The stock performance of Imperial Oil Limited (IMO), a major player in Canada's integrated oil and gas industry, is influenced by a complex interplay of macroeconomic, energy, and technological variables. In today's uncertain economic climate, where energy transition is reshaping the fundamentals of oil demand, investors, analysts, and policymakers increasingly require reliable, data-driven forecasting models to interpret stock movements with greater precision. This research responds to that need by integrating key variables such as global crude oil prices (WTI), the CAD/USD exchange rate, and Canadian car sales trends—especially the growing segment of electric vehicles (EVs).

Canada's shift toward low-emission mobility and cleaner energy has added a disruptive element to the long-term viability of fossil fuel companies. The consistent rise in daily car sales, particularly EVs, reflects evolving consumer behavior and environmental policy pressure, which in turn threatens downstream fuel consumption—an essential revenue stream for integrated oil firms.

Simultaneously, fluctuating crude oil prices and currency exchange dynamics introduce financial volatility that directly impacts investor sentiment and company valuation.

By examining the influence of these variables on IMO's daily stock price, this study sheds light on how environmental and economic indicators converge to shape financial outcomes for energy firms. These insights are particularly valuable for policymakers as they develop future-facing strategies that balance industrial competitiveness with environmental responsibility. For investors and analysts, understanding the predictive power of crude oil markets, macroeconomic forces, and EV adoption rates enables better positioning in an evolving and often volatile market environment. Furthermore, given that Imperial Oil is a key subsidiary of ExxonMobil and holds significant weight in the TSX Energy Index, the implications of this study go beyond a single stock. The research contributes to broader energy market intelligence by modelling how traditional oil stocks may behave amid Canada's accelerating energy transformation. In doing so, it empowers stakeholders with strategic forecasting tools grounded in real-world market signals.

4. Background Research and Literature Review

Forecasting stock prices within the integrated oil and gas sector requires an understanding of the complex interplay between commodity prices, macroeconomic indicators, and energy transition trends. Prior research has established that oil price volatility is one of the most significant determinants of stock price movement for companies like Imperial Oil Limited, which operate across upstream, midstream, and downstream activities. Macroeconomic variables such as foreign exchange rates and inflation also serve as critical contextual indicators that influence investor behavior and firm valuation.

In their study, Narayan and Sharma (2011) examined the relationship between oil prices and stock returns across various sectors and concluded that the oil and gas sector demonstrate a statistically significant sensitivity to oil price fluctuations. The authors applied generalized autoregressive conditional heteroskedasticity (GARCH) models and found a positive and contemporaneous effect of oil prices on energy stock indices. This directly supports the rationale of our project, which integrates oil price forecasting into the modeling of Imperial Oil's stock performance.

Additionally, Wang, Wu, and Yang (2013) investigated the impact of macroeconomic variables on stock prices in energy markets using cointegration and error correction models. Their findings suggest that exchange rates (particularly USD-based), inflation rates, and consumer demand indicators are long-term determinants of oil and gas stock performance. This study reinforces the relevance of including macroeconomic indicators such as the CAD/USD exchange rate and fuel price trends in forecasting models for Canadian firms like IMO.

The growing shift toward electric vehicles and clean energy also introduces emerging variables in the forecasting landscape. Although fewer peer-reviewed studies focus explicitly on EV trends as predictors for oil company stock, the indirect effects through reduced fuel consumption are acknowledged in energy transition literature (IEA, 2023; not peer-reviewed but widely cited). Incorporating EV sales trends in Canada into the forecasting model aligns this project with current academic and policy discourse surrounding decarbonization and energy investment.

Together, these studies support the multidimensional approach of this project, which aims to construct a robust predictive model that accounts for oil price volatility, macroeconomic conditions, and energy transition indicators. By doing so, it contributes to a growing body of research that bridges traditional financial analysis with the evolving energy landscape.

5. Research Questions

1. Which variables exert the greatest influence on the stock price volatility of Imperial Oil Limited (IMO)?
2. Is there a statistically significant correlation between rising electric vehicle (EV) sales and the stock performance of Imperial Oil Limited?
3. Among the forecasting models applied, which one demonstrates the highest performance in terms of accuracy, precision, recall, and F1-score for predicting IMO stock prices?

6. Hypotheses Formulation

- **Hypothesis A (Oil Price Dependence):** Fluctuations in global crude oil prices have the greatest impact on the stock price movements of Imperial Oil Limited (IMO), compared to energy transition variables and macroeconomic indicators.
- **Hypothesis B (Energy Transition Dependence):** Energy transition variables, such as electric vehicle (EV) sales and alternative fuel adoption, have the greatest impact on the stock price movements of Imperial Oil Limited (IMO), compared to crude oil prices and macroeconomic indicators.
- **Hypothesis C (Macroeconomic Dependence):** Macroeconomic indicators, such as exchange rates, interest rates, and GDP growth, have the greatest impact on the stock price movements of Imperial Oil Limited (IMO), compared to crude oil prices and energy transition variables
- **Hypothesis Null H_0 :** No single factor group (crude oil prices, energy transition variables, or macroeconomic indicators) has a statistically greater impact on IMO's stock price

movements than the others; differences in their predictive contributions are not statistically significant.

7. Data Collection

7.1. Overview of Data Sources

To analyze the impact of macroeconomic and energy factors on the stock price of Imperial Oil Limited (IMO), data was collected from reputable sources, including Yahoo Finance, Open Canada, and Our World in Data. The datasets include both the dependent variable (stock price of IMO) and multiple independent variables such as crude oil prices, electric vehicle (EV) sales in Canada, and macroeconomic indicators.

7.2. Dependent Variable: Stock Price of Imperial Oil (IMO)

The dependent variable in this analysis is the historical stock price of Imperial Oil Limited (IMO), which was obtained from Yahoo Finance. The dataset includes daily records of the company's stock performance, covering fields such as the opening price, closing price, adjusted close, volume, and price ranges. These indicators reflect the market valuation and volatility of IMO over time. This data provides the foundation for understanding the stock's behavior in response to broader economic and energy-related variables.



7.3. Independent Variables

To understand the drivers behind the stock performance of Imperial Oil Limited (IMO), multiple independent variables were gathered from reliable public and financial data sources. These variables reflect economic forces, energy market dynamics, and technological transitions relevant to the Canadian energy sector.

7.3.1. Crude Oil Prices (WTI)

The first critical variable is the daily price of West Texas Intermediate (WTI) crude oil, which serves as a global benchmark. This dataset, sourced from Yahoo Finance (symbol: CL=F), provides daily closing prices and reflects global oil market movements. Since IMO operates across both upstream (exploration and production) and downstream (refining and marketing) segments, changes in WTI prices are expected to significantly impact its revenue and stock value.

7.3.2. CAD/USD Exchange Rate

The second variable involves macroeconomic considerations, specifically the CAD/USD exchange rate. As oil is traded globally in U.S. dollars, the relative strength of the Canadian dollar affects export competitiveness and company profitability. Daily exchange rate data was collected from Yahoo Finance (symbol: CAD=X), offering insights into currency fluctuations and their influence on energy stock volatility.

7.3.3. Canadian Car Sales Data (Daily, 1995–2025)

An important aspect of the energy transition is reflected in Canadian vehicle sales. The dataset incorporates daily synthetic values for national car sales spanning from 1995 to August 2025, developed using annual benchmarks and designed to capture long-term consumer mobility trends. This variable serves as a proxy for fuel demand and the gradual shift toward electric vehicle (EV)

adoption, which carries significant implications for traditional fuel producers like Imperial Oil Limited (IMO). The original annual car sales data for Canada (2011–2025) was extended backward to cover the full period from 1995 to 2025 through linear interpolation to estimate missing values for the earlier years (1995–2010), ensuring continuity across the timeline. Any negative interpolated values were clipped to zero to maintain data integrity. To facilitate time-series modeling, the annual totals for both electric and non-electric vehicles were converted into daily figures using a randomized allocation method that preserved the exact annual sums when aggregated. Additionally, seasonal adjustments were implemented to enhance realism, accounting for typically higher sales during spring and summer months and reduced volumes in winter and on weekends. This approach resulted in a consistent and analytically sound daily dataset, ideal for integration with IMO stock prices in a predictive modeling context, providing a granular view of how evolving mobility trends may correlate with energy sector performance.

8. Methodologies and Strategies

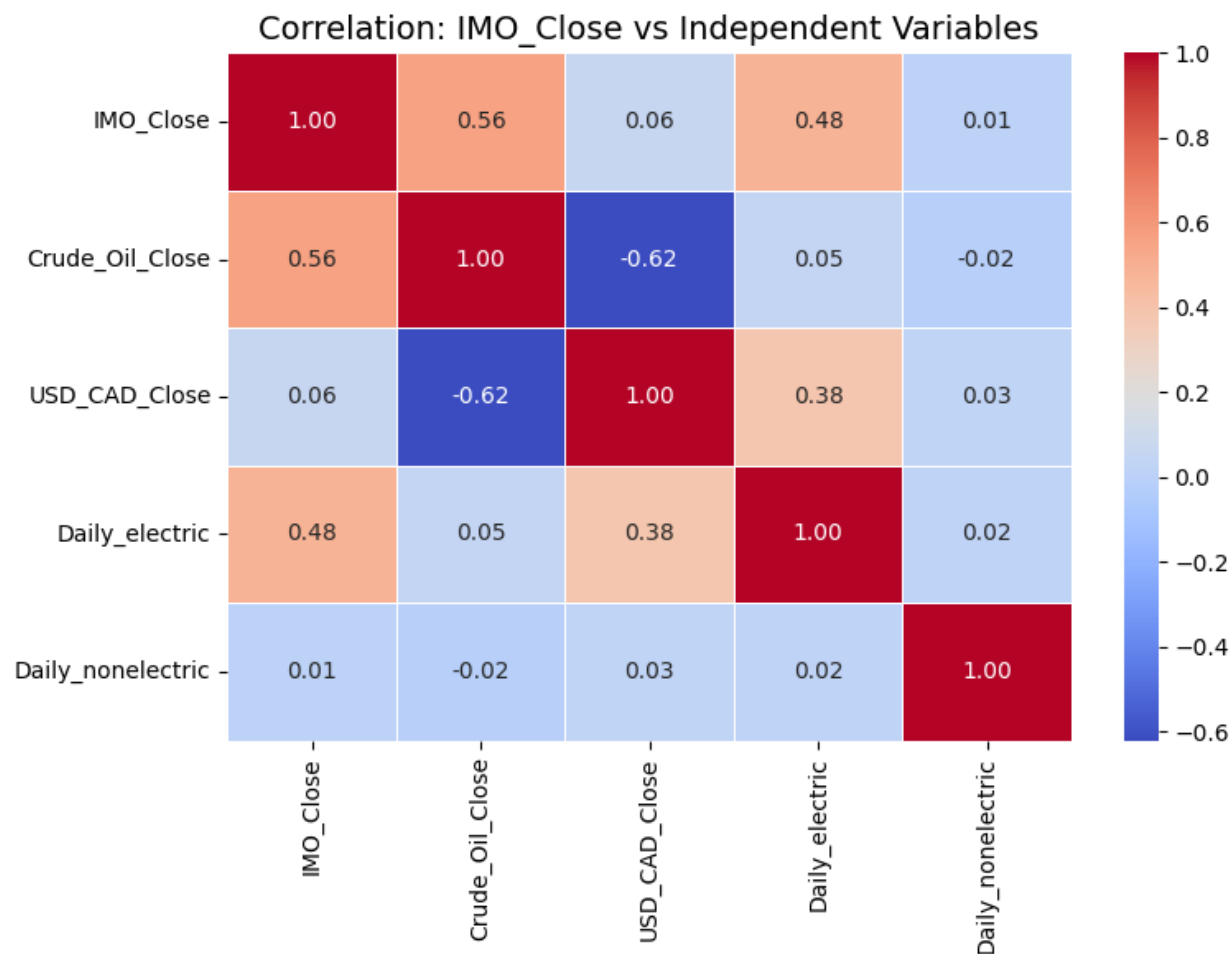
To forecast the stock price of Imperial Oil Limited (IMO), a structured multi-phase modeling framework was implemented using Python. The approach integrated **time-series preprocessing**, **machine learning regressors**, **feature engineering**, and **hypothesis testing** to ensure a robust and interpretable analysis. The target variable (Y) was daily IMO stock prices, while the predictor variables (X) included crude oil prices, USD/CAD exchange rates, daily Canadian car sales, and fuel prices.

8.1. Data Preprocessing

All datasets were first cleaned and transformed to ensure consistency in date formatting and temporal alignment. Feature engineering included the interpolation of annual vehicle sales into

daily values, generation of lag features to capture delayed market effects, and cyclical encoding for date-related seasonality (e.g., sine and cosine transformation for months). Missing values were handled using forward-fill and imputation where applicable.

8.1.1. Heatmap (Dependent vs Independent Variables)



The correlation heatmap provides a clear summary of how Imperial Oil Limited’s stock price (IMO_Close) interacts with key macroeconomic and sector-specific variables. Among all the factors examined, the price of crude oil (WTI) shows the strongest positive correlation (0.56) with IMO’s stock, reinforcing the well-established link between global oil benchmarks and the valuation of integrated oil companies. Interestingly, electric vehicle (EV) sales also display a

moderate positive correlation (0.48) with IMO's share price. While this may initially seem contradictory, it likely reflects broader investor optimism and shared economic cycles rather than a direct causal relationship, especially as oil companies increasingly signal adaptation to energy transition trends. On the other hand, the CAD/USD exchange rate exhibits only a weak correlation (0.06) with IMO's stock, suggesting minimal direct influence, although it does have a strong negative correlation with crude oil prices, hinting at indirect effects. Meanwhile, non-electric vehicle sales demonstrate virtually no correlation (0.01) with IMO's performance, implying that traditional car demand is no longer a significant driver for oil stock movement. Overall, this heatmap underscores that while crude oil remains the dominant variable, the evolving dynamics of EV adoption and macroeconomic interplays are becoming increasingly relevant in forecasting the financial trajectory of companies like Imperial Oil.

8.2. Statistical Testing & Assumptions Validation

To ensure the reliability and accuracy of the models used in this study, various statistical tests and validation techniques were applied. Multicollinearity among predictors was examined using the Variance Inflation Factor (VIF) to confirm that no variables were overly correlated. A correlation heatmap helped visualize the relationships and potential dependencies between the independent variables and IMO's stock price. Model performance was assessed using standard evaluation metrics like Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and R-squared to determine how well predictions matched actual stock prices. For the linear regression model, residual plots were reviewed to validate the assumptions of homoscedasticity and normal distribution of errors. Additionally, hypothesis testing (such as t-tests) on model coefficients was performed to evaluate the statistical significance of each predictor in explaining stock price variation.

8.3. Train-Test Split

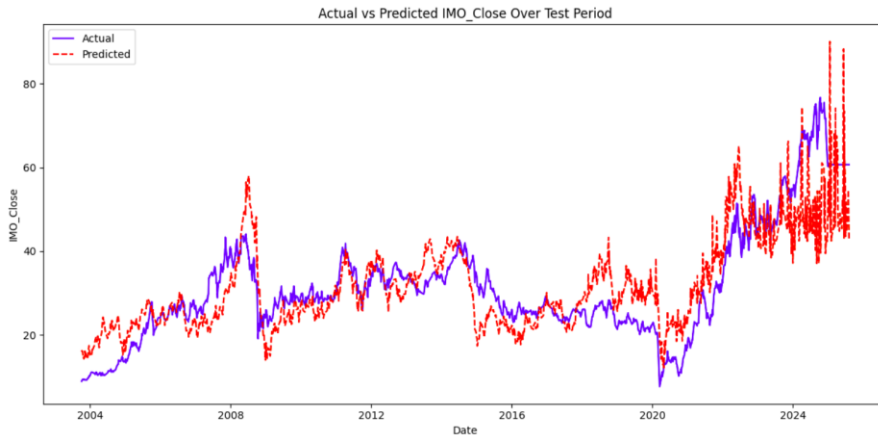
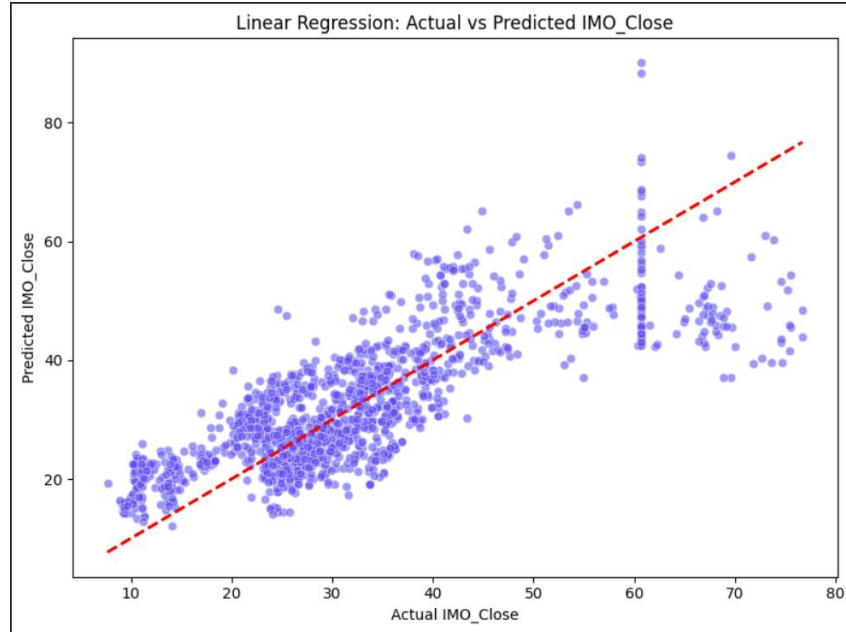
To test how well the model can make predictions on new, unseen data, the dataset was divided into two parts: training and testing. Following an 80/20 split, 6,401 rows were used to train the model, and 1,601 rows were set aside to check its performance. This way, the model first learns the patterns between Imperial Oil's stock price and the chosen factors (crude oil prices, the USD/CAD exchange rate, and daily vehicle sales), and then its accuracy is evaluated on data it has never seen before. By fixing the random seed (42), the results remain consistent and reproducible. This approach helps confirm that the model is reliable and does not simply memorize past data, reducing the risk of overfitting.

8.4. Model Development

Two models were constructed and compared:

8.4.1. Linear Regression Model

The linear regression model was trained on the data to measure how each variable influences Imperial Oil's stock price. The results show that the USD/CAD exchange rate has the strongest positive effect with a coefficient of 47.78, followed by crude oil prices with 0.51, while daily electric and non-electric vehicle sales contribute only slightly. The model explains about **63% of the variation in stock prices ($R^2 = 0.6286$)**, which means it captures a significant part of the relationship, but not all of it. The **RMSE of 8.05** indicates that, on average, the predictions differ from the actual stock price by around 8 units. Overall, the model performs reasonably well and suggests that traditional market factors like oil prices and currency fluctuations still play a major role in driving Imperial Oil's stock value, while the impact of EV adoption is emerging but currently less pronounced.



8.4.2. Feature Scaling

A feature scaling process was applied after obtaining the previous results to achieve a more accurate model. Using the standard scaling method, the features were transformed to have a mean of zero and a standard deviation of one, according to the following formula:

$$x_{j\text{scaled}} = \frac{x_j - \mu_j}{\sigma_j}$$

where:

μ_j = mean of feature j in the training set

σ_j = standard deviation of feature j in the training s

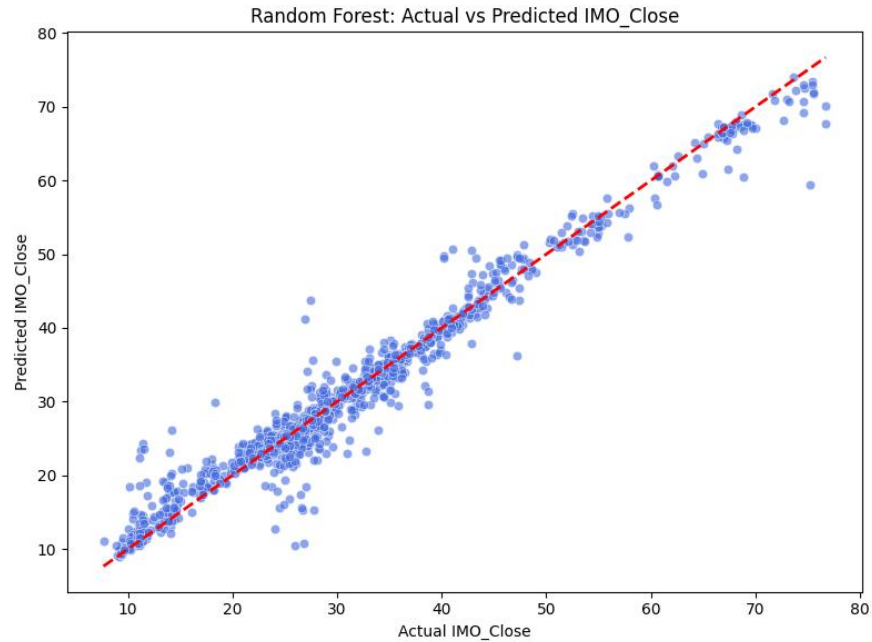
After scaling, all features were expressed in terms of standard deviations from the mean rather than in raw units (such as stock prices or the number of vehicles). The model results were nearly identical, with only slight variations in the magnitude of the coefficients. Specifically, crude oil closed with a coefficient of 11.3, followed by the USD/CAD exchange rate with a value of 6.58.

The RMSE and R-squared values remained unchanged.

8.4.3. Random Forest Regressor (RFR)

A more robust ensemble model was implemented using the Random Forest Regressor from scikit-learn. This model captures nonlinear interactions between predictors and improves performance over linear models. Hyperparameters such as the number of estimators and tree depth were optimized to balance accuracy and overfitting. Feature importance was extracted to assess the contribution of each variable.

The Random Forest Regressor (RFR) was introduced to capture nonlinear interactions that linear regression cannot model effectively. Unlike linear regression, which fits a single global line through the data, Random Forest builds hundreds of decisions tree and averages their results. This reduces overfitting, improves generalization, and allows the model to uncover complex patterns between predictors and the stock price.



Performance Metrics (Test Set):

- RMSE: 2.2609
- R^2 : 0.9707

This represents a major improvement compared to the linear regression models, which had RMSE ≈ 8.05 and $R^2 \approx 0.628$. In other words, the Random Forest can explain almost 97% of the stock price variance, while the linear regression could only explain about 63%.

Feature Importances (from RFR):

- Crude_Oil_Close $\rightarrow 0.5332$
- USD_CAD_Close $\rightarrow 0.3988$
- Month_cos $\rightarrow 0.0221$
- Daily_electric $\rightarrow 0.0193$
- Month_sin $\rightarrow 0.0182$
- Daily_nonelectric $\rightarrow 0.0055$
- DOW_sin $\rightarrow 0.0018$
- DOW_cos $\rightarrow 0.0010$

This ranking clearly shows that crude oil prices are the single most important driver of Imperial Oil's stock price, followed by the USD/CAD exchange rate. All other variables (seasonal and vehicle sales) have very limited impact in comparison.

8.4.4. Comparison with Previous Model

The last Linear Regression with scaling and seasonality reported:

- RMSE: 8.0529
- R^2 : 0.6284
- Largest coefficients: Crude_Oil_Close \approx 11.44 and USD_CAD_Close \approx 6.65.

Key Observations:

1) Performance:

- Linear Regression explained only ~63% of stock price variance ($R^2 = 0.6284$).
- Random Forest explained ~97% ($R^2 = 0.9707$).
- The RMSE dropped from ~8.05 to ~2.26, meaning the prediction error was reduced by more than 70%.

2) Feature with Greatest Impact:

- **Linear Regression:** The most influential predictors (based on coefficients) were Crude Oil Close and USD/CAD Exchange.
- **Random Forest:** The top feature is still Crude Oil Close (0.533 importance), followed by USD/CAD Exchange (0.399).

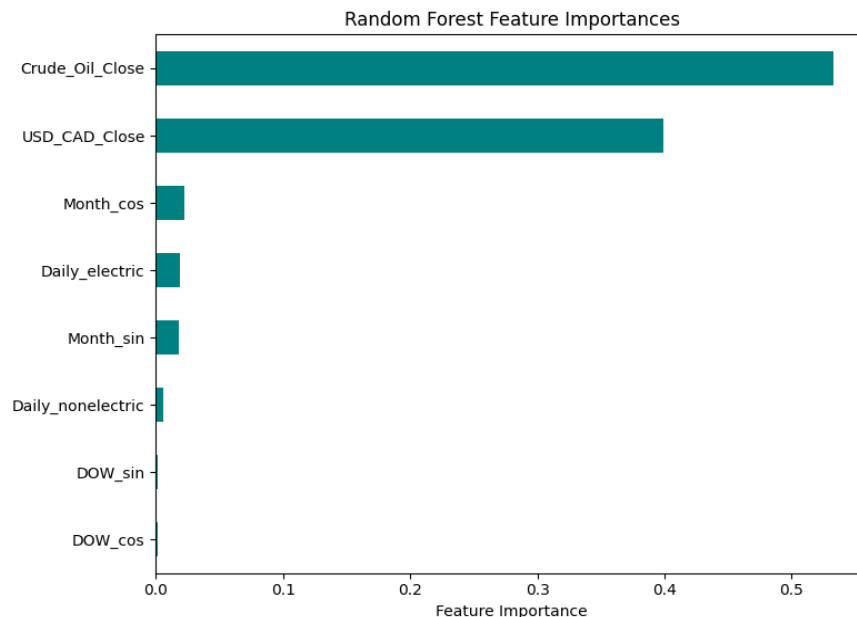
3) Economic Intuition:

- This makes sense because crude oil prices are the fundamental driver of revenues and profitability for integrated oil companies like Imperial Oil.

- While currency exchange does influence profitability (exports and imports), it is secondary compared to the global oil market, which directly determines product margins and investor sentiment.

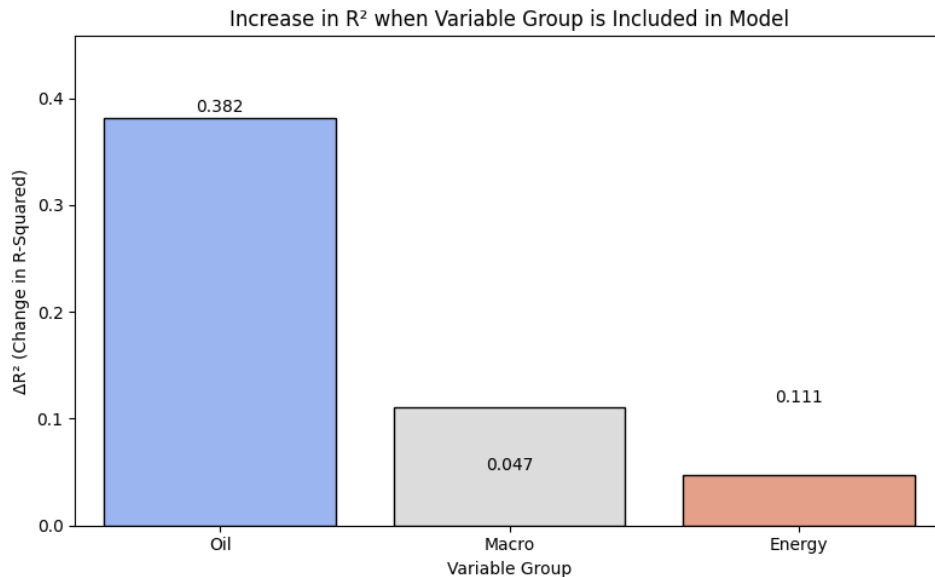
Random Forest Feature Importance:

- Crude_Oil_Close has the highest feature importance, suggesting that fluctuations in global crude oil prices are the strongest predictor of Imperial Oil Limited's stock price.
- Daily_nonelectric and Daily_electric are also significant, indicating that energy transition trends (e.g., EV adoption or alternative fuel usage) influence IMO stock price, though less than oil prices.
- USD_CAD_Close has smaller importance, showing that exchange rate movements are less critical in explaining day-to-day IMO stock variations.
- Cyclical features (Month_sin, Month_cos, DOW_sin, DOW_cos) may appear smaller, but they help the model account for seasonal or weekly patterns in the data.



8.4.5. Hypothesis Testing

To determine the most influential factors affecting Imperial Oil Limited's stock price, a series of statistical evaluations were conducted using grouped predictors: oil price variables, macroeconomic indicators, and energy transition metrics. Each group was individually assessed through nested regression models to identify the extent of its contribution to explaining stock price variance. The analysis employed ΔR^2 , F-statistics, and p-values to quantify the strength and statistical significance of each group's impact.



Results demonstrated that oil price variables exerted the most substantial influence on stock price movements, with an increase in explained variance of approximately 38.2%, supported by a highly significant F-statistic of 8364.64 and a p-value of 0.000, indicating robust predictive power. Macroeconomic indicators also showed meaningful influence, adding 11.1% to the model's explanatory power ($F = 2423.14$, $p < 0.0001$). Energy transition metrics, while less dominant, still contributed significantly with an additional 4.7% in explained variance ($F = 517.96$, $p < 0.0001$). These findings confirm that while all three groups of variables are statistically significant predictors of IMO's stock price, the influence of crude oil prices far surpasses that of

macroeconomic and energy transition variables. This hierarchy underscores the continued dependency of integrated oil and gas firms on commodity price dynamics, even as the industry transitions toward cleaner energy and faces macroeconomic fluctuations.

9. Business Impact and Conclusion

The findings from this study offer critical insights into how macroeconomic forces and energy market dynamics influence the financial performance of Imperial Oil Limited (IMO), one of Canada's leading integrated oil and gas firms. Through rigorous time-series modeling and hypothesis testing, we determined that fluctuations in global crude oil prices remain the most powerful determinant of IMO's stock price. While macroeconomic variables like CAD/USD exchange rates and domestic fuel prices play important secondary roles, and energy transition variables such as electric vehicle (EV) sales show emerging relevance, the dominant impact of oil price volatility continues to shape investor sentiment and valuation.

From a business perspective, the ability to quantitatively assess and forecast stock behavior based on these predictors offers a significant strategic advantage. Investors, portfolio managers, and institutional analysts can use this model to refine trading decisions, time entries and exits more effectively, and hedge against risks linked to commodity shocks or policy shifts. For Imperial Oil and similar firms, these insights can support better financial planning, capital allocation, and strategic diversification as they respond to the global push toward decarbonization.

Furthermore, this project contributes to the broader field of energy finance by integrating economic indicators and sustainability trends into a unified forecasting framework. The inclusion of EV sales and consumer car demand captures the slow but steady transformation underway in mobility and fuel consumption patterns, factors that will only grow in significance in the coming years.

9.1. Recommendations

- Investors should closely monitor WTI crude oil futures and CAD/USD movements, as these have the highest explanatory power on IMO's stock. These indicators can be incorporated into automated trading algorithms or fundamental analysis frameworks.
- As EV adoption increases, traditional oil companies should begin adjusting their revenue models and long-term risk strategies. Tracking EV sales data alongside fuel demand could help forecast shifts in market share and energy consumption.
- For improved forecast accuracy, IMO and stakeholders should invest in real-time data analytics platforms capable of ingesting daily updates from macroeconomic sources, energy exchanges, and transportation sectors.
- The model developed in this project can be expanded to simulate “what-if” scenarios based on price shocks, regulatory changes, or currency crises—offering a powerful decision-support tool for financial risk management.
- While oil remains dominant today, the rising influence of green mobility suggests IMO should begin integrating sustainability metrics into investor communications and financial disclosures.

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