

FUELLING THE FUTURE:

ARAMCO'S OIL PRICES FORECASTING INITIATIVE

GROUP 6

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ABOUT SAUDI ARAMCO

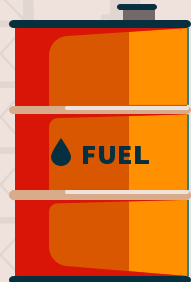


SEARCH FOR CRUDE OIL

REFINES CRUDE OIL INTO GASOLINE

BUYS AND SELLS PETROLEUM FROM OTHER BUSINESSES

2-3 MILLION BARRELS



OPPORTUNITY STATEMENT

Oil giant Saudi Aramco posts 38% drop in second-quarter profit as lower prices bite

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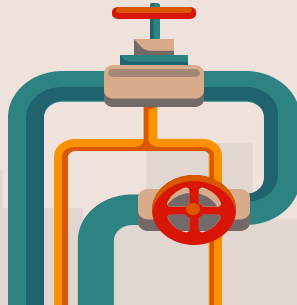


Dan Murphy
@DAN_MURPHY

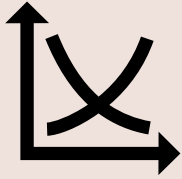


Natasha Turak
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SHARE



KEY BUSINESS QUESTIONS



Demand and Supply



Market Dynamics



Risk Management

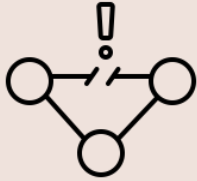


01

DATA CLEANING AND PREPROCESSING

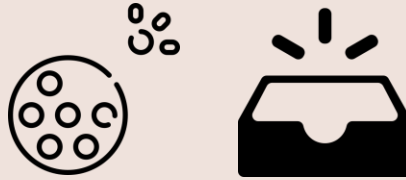


DATA CLEANING AND PREPROCESSING



Redundant Variables

Removing GSCI variable



Outliers and Empty Values

Replacing empty values and outliers
with variable's monthly mean



Duplicates

Removing duplicates for
DATE variable



02

EXPLORATORY DATA ANALYSIS



EXPLORATORY DATA ANALYSIS

1. SUMMARY STATISTICS

2. UNIVARIATE ANALYSIS

3. BIVARIATE ANALYSIS



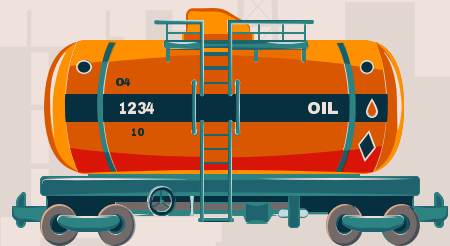
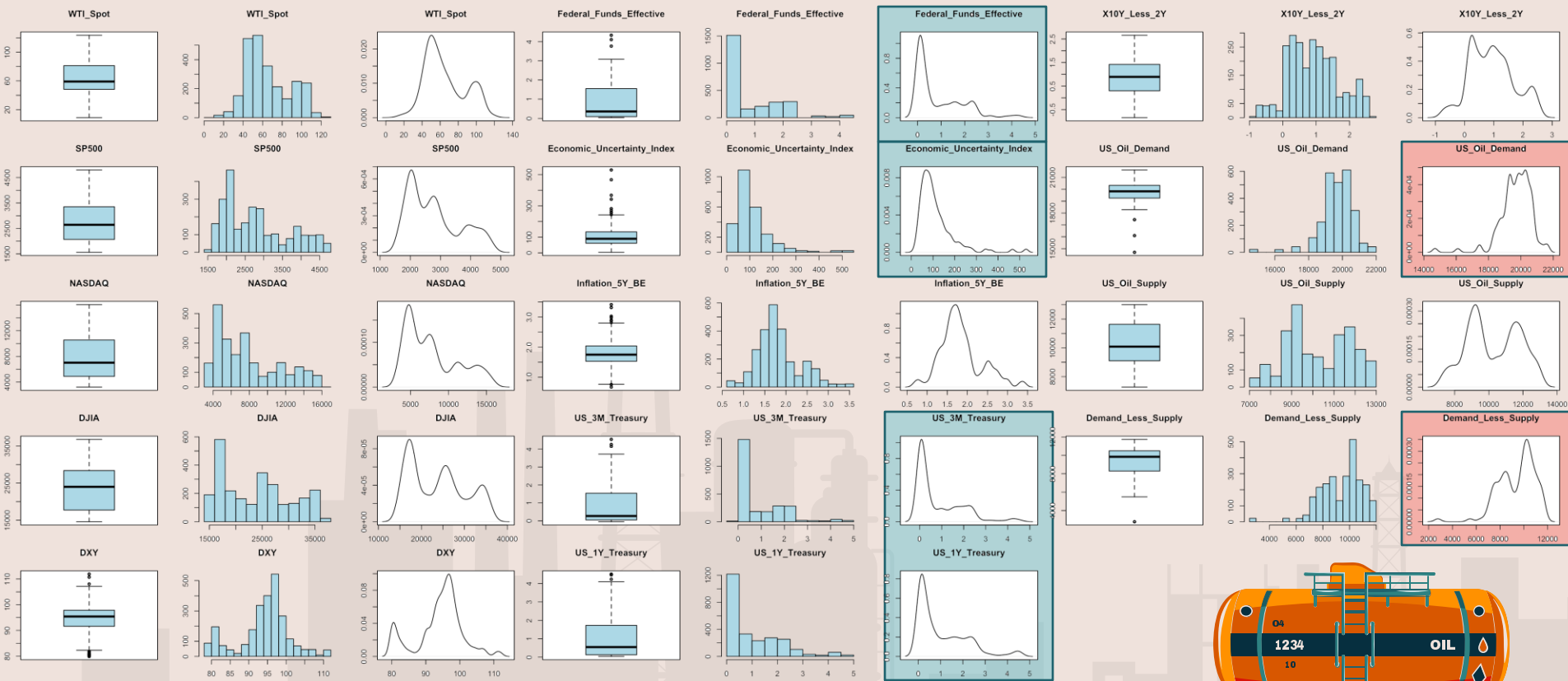
1. SUMMARY STATISTICS

Isaac

VARIABLE	DATA TYPE	DESCRIPTION
Date	Character	Date
WTI_Spot	Numeric	Closing Price of WTI Crude Oil Spot
GSCI	Numeric	Closing Price of GSCI Commodities Index
SP500	Numeric	Closing Price of S&P500
DJIA	Numeric	Closing Price of DJIA
NASDAQ	Numeric	Closing Price of NASDAQ
DXY	Numeric	Closing price of DXY. This is an index that measures the relative strength of the USD versus a basket of other relevant currencies
Federal_Funds_Effective	Numeric	Effective Federal Funds Rate
Economic_Uncertainty_Index	Numeric	Metric for Economic Policy Uncertainty
Inflation_5Y_BE	Numeric	5-Year Break even inflation rate
US_3M_Treasury	Numeric	Closing price of US 3-month treasury
US_1Y_Treasury	Numeric	Closing price of US 1-year treasury
10Y_Less_2Y	Numeric	US 10-year treasury rate minus US 2-year treasury rate
US_Oil_Demand	Numeric	Monthly US Oil Demand for the observation month
US_Oil_Supply	Numeric	Monthly US Oil Supply for the observation month
Demand_Less_Supply	Numeric	Monthly US Oil Demand minus Monthly US Oil Supply for the observation month

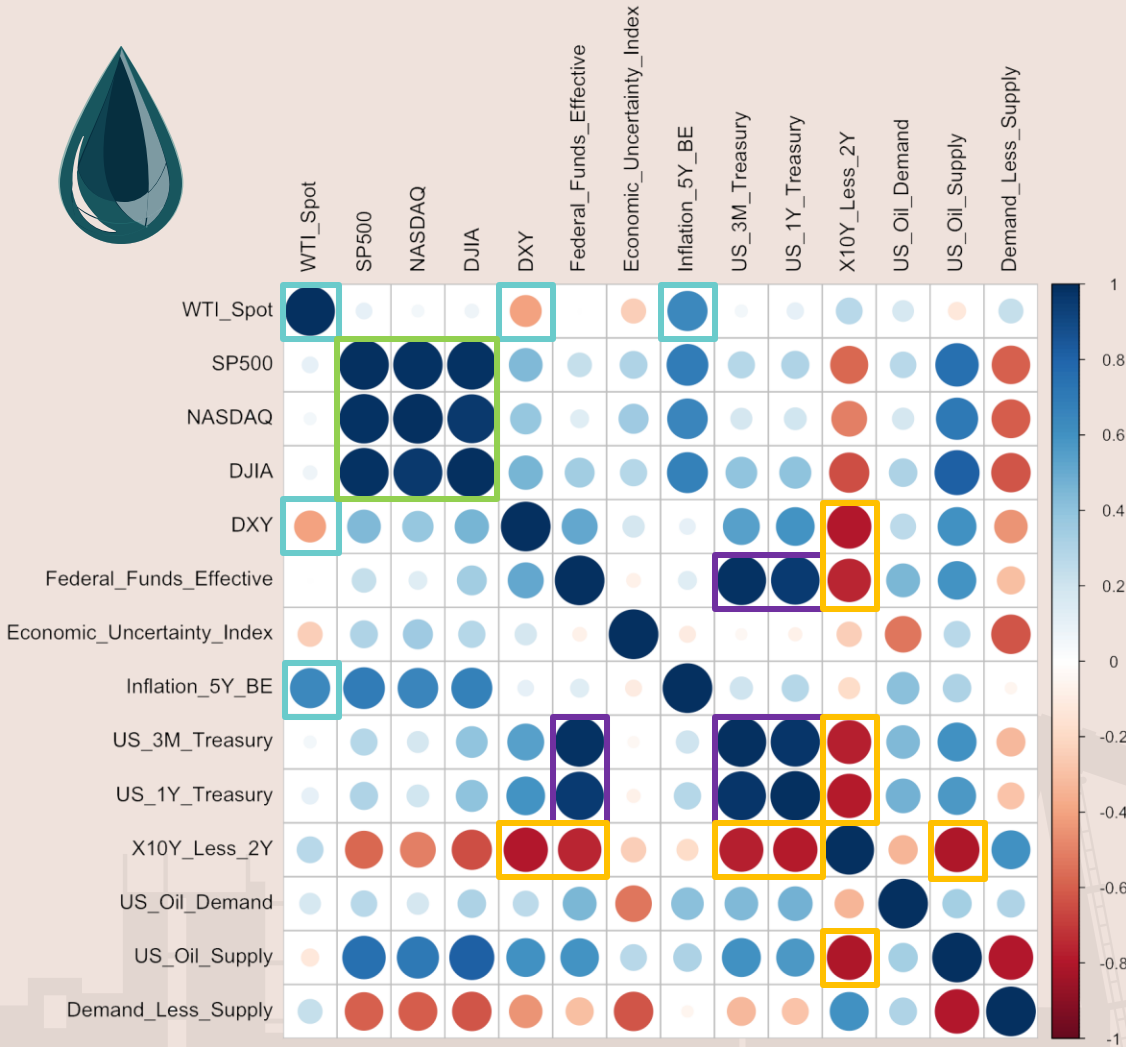
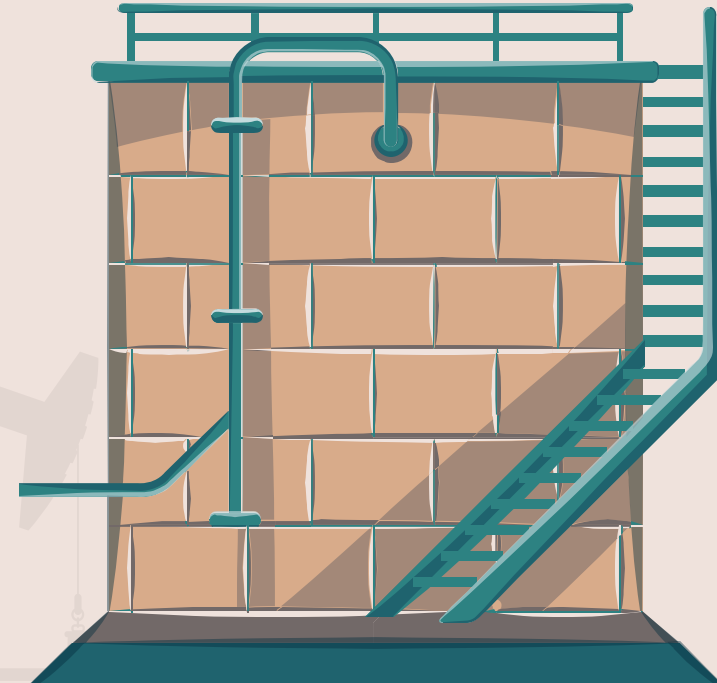


2. UNIVARIATE ANALYSIS



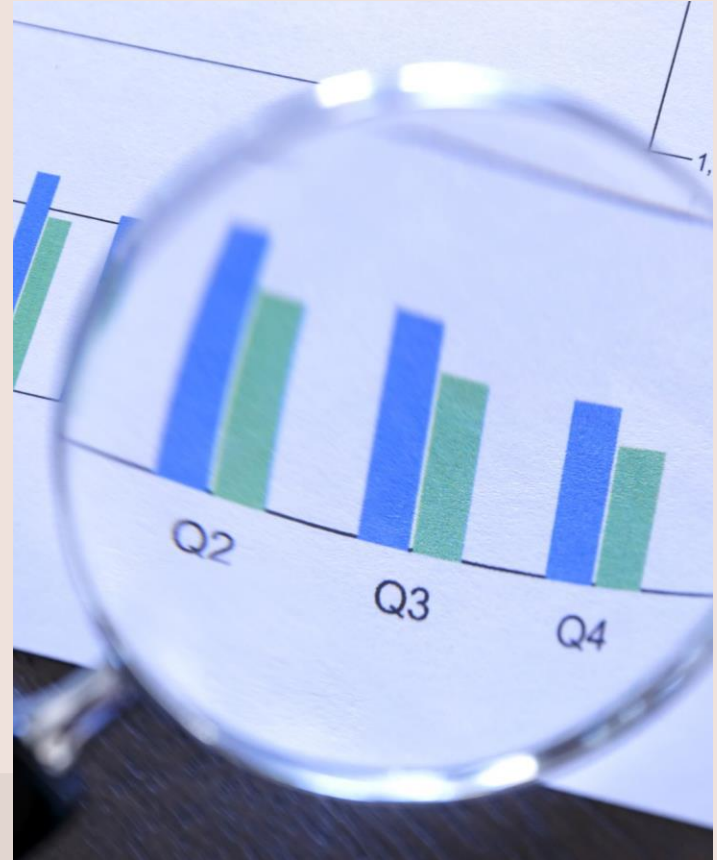


BIVARIATE ANALYSIS

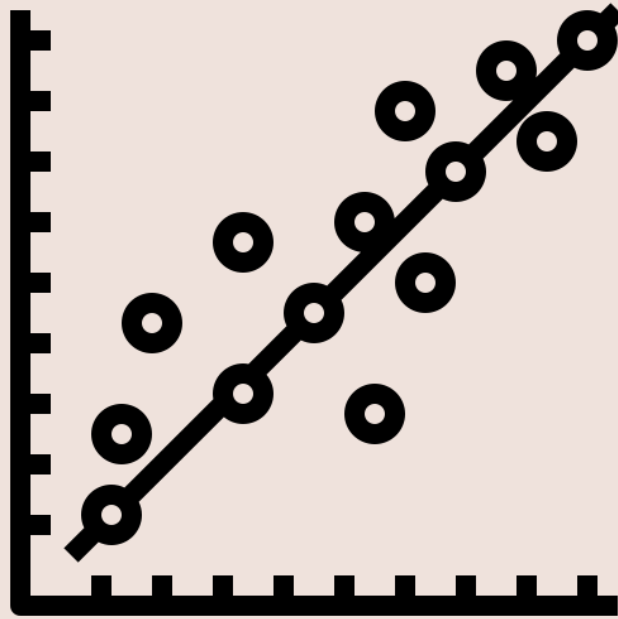


3

MODELING AND PERFORMANCE EVALUATION



LINEAR REGRESSION MODEL



OPTIMIZATION OF LINEAR MODEL VIA AIC MINIMISATION

Step: AIC=7409.71

WTI_Spot ~ SP500 + NASDAQ + DJIA + DXY + Federal_Funds_Effective +
Economic_Uncertainty_Index + Inflation_5Y_BE + US_3M_Treasury +
US_1Y_Treasury + X10Y_Less_2Y + US_Oil_Demand + US_Oil_Supply

	Df	Sum of Sq	RSS	AIC
<none>			110548	7409.7
- US_1Y_Treasury	1	973	111521	7423.4
- US_3M_Treasury	1	1221	111769	7427.4
- Federal_Funds_Effective	1	1303	111851	7428.7
- US_Oil_Demand	1	2048	112596	7440.6
- Economic_Uncertainty_Index	1	4401	114949	7477.6
- X10Y_Less_2Y	1	8569	119117	7541.4
- US_Oil_Supply	1	19257	129805	7695.3
- NASDAQ	1	26783	137332	7796.3
- DJIA	1	32399	142947	7868.0
- Inflation_5Y_BE	1	47444	157992	8047.3
- SP500	1	53500	164048	8114.6
- DXY	1	75439	185987	8339.4

AKAIKE INFORMATION CRITERION
(AIC)

12 VARIABLES

RESULT

```
Call:
lm(formula = WTI_Spot ~ SP500 + NASDAQ + DJIA + DXY + Federal_Funds_Effective +
    Economic_Uncertainty_Index + Inflation_5Y_BE + US_3M_Treasury +
    US_1Y_Treasury + X10Y_Less_2Y + US_Oil_Demand + US_Oil_Supply,
    data = training_data[, -1])
```

Residuals:

	Min	1Q	Median	3Q	Max
	-23.896	-4.948	-0.505	3.905	29.021

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	1.643e+02	8.408e+00	19.542	< 2e-16 ***
SP500	1.009e-01	3.439e-03	29.334	< 2e-16 ***
NASDAQ	-1.334e-02	6.429e-04	-20.755	< 2e-16 ***
DJIA	-7.794e-03	3.414e-04	-22.827	< 2e-16 ***
DXY	-2.026e+00	5.817e-02	-34.833	< 2e-16 ***
Federal_Funds_Effective	-7.955e+00	1.738e+00	-4.578	5.03e-06 ***
Economic_Uncertainty_Index	3.072e-02	3.651e-03	8.413	< 2e-16 ***
Inflation_5Y_BE	3.051e+01	1.105e+00	27.624	< 2e-16 ***
US_3M_Treasury	1.129e+01	2.547e+00	4.432	9.91e-06 ***
US_1Y_Treasury	6.410e+00	1.620e+00	3.956	7.92e-05 ***
X10Y_Less_2Y	1.036e+01	8.822e-01	11.740	< 2e-16 ***
US_Oil_Demand	-1.829e-03	3.188e-04	-5.739	1.12e-08 ***
US_Oil_Supply	5.566e-03	3.163e-04	17.599	< 2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.885 on 1778 degrees of freedom

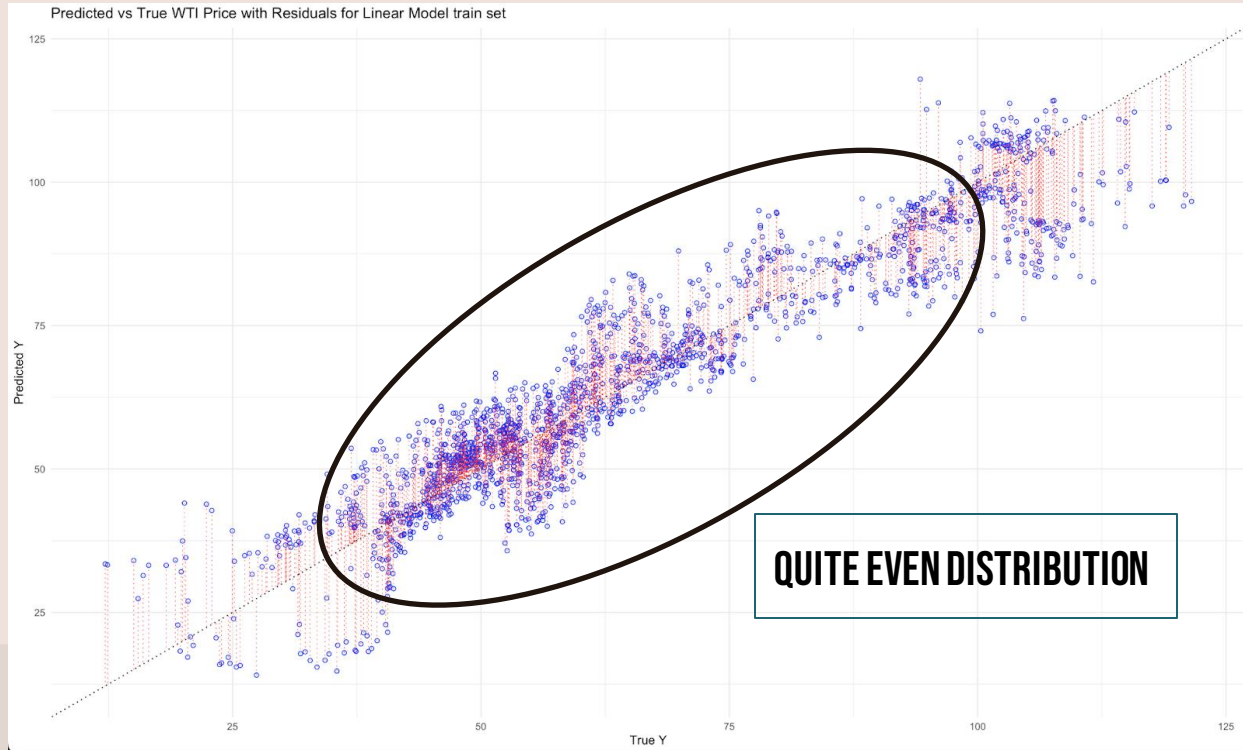
Multiple R-squared: 0.878, Adjusted R-squared: 0.8772

F-statistic: 1066 on 12 and 1778 DF, p-value: < 2.2e-16

0.8772

0.000000000000000022

VISUAL ANALYSIS

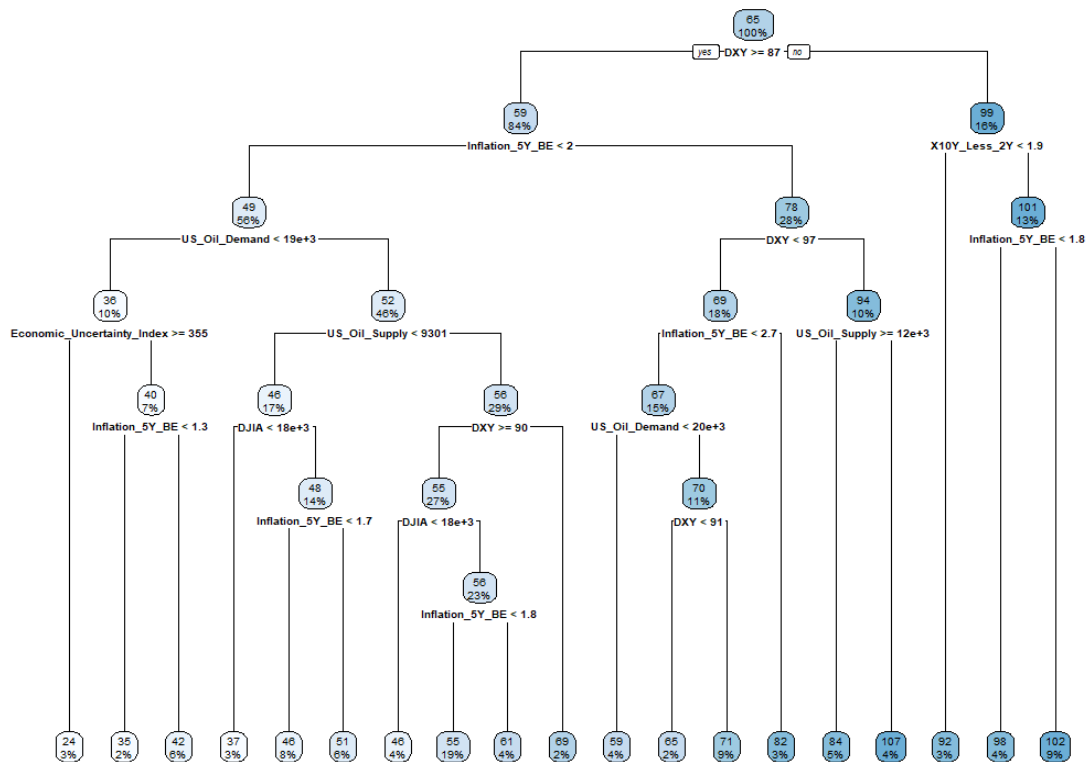


PREDICTED VS ACTUAL VALUES



**PREDICTED
FOLLOWS TRUE
CAREFULLY**

CLASSIFICATION AND REGRESSION TREE

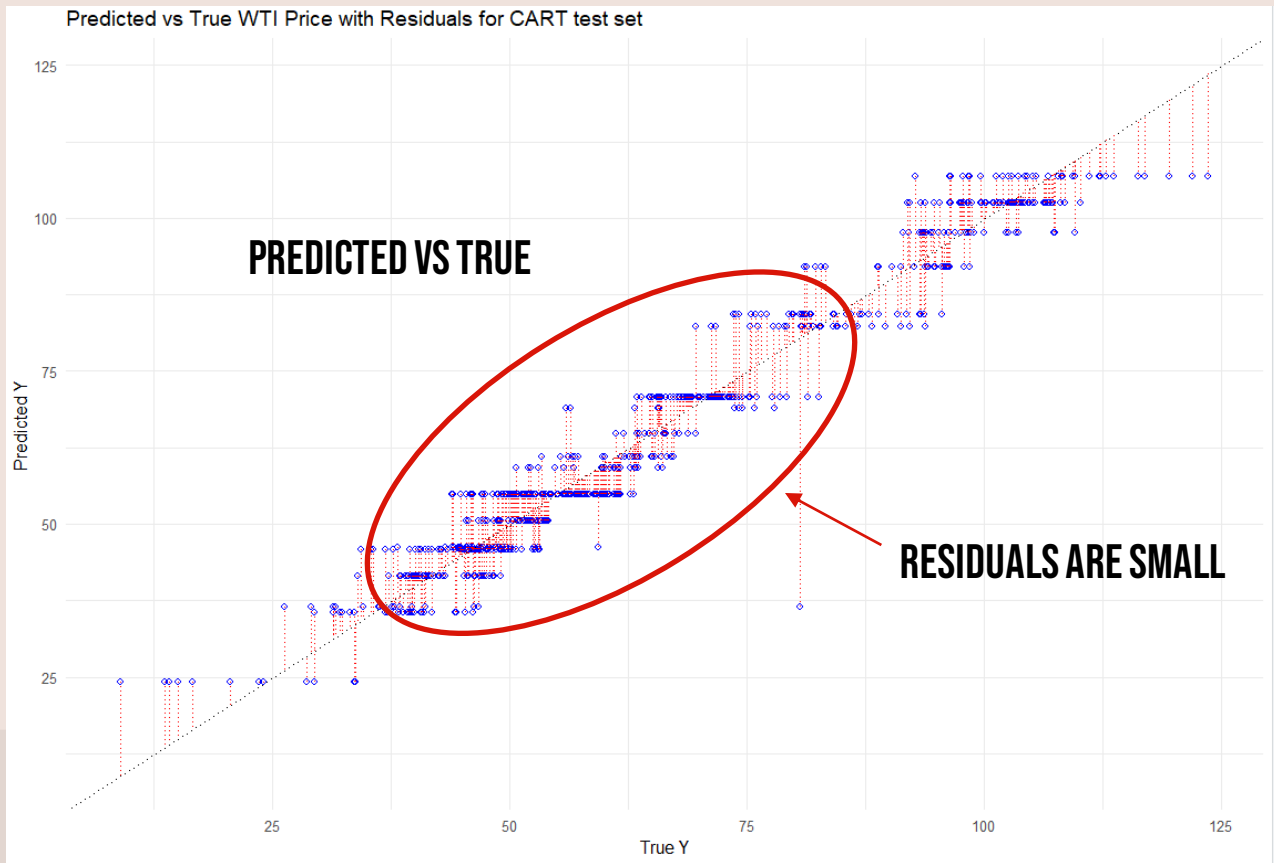


10-FOLD CROSS

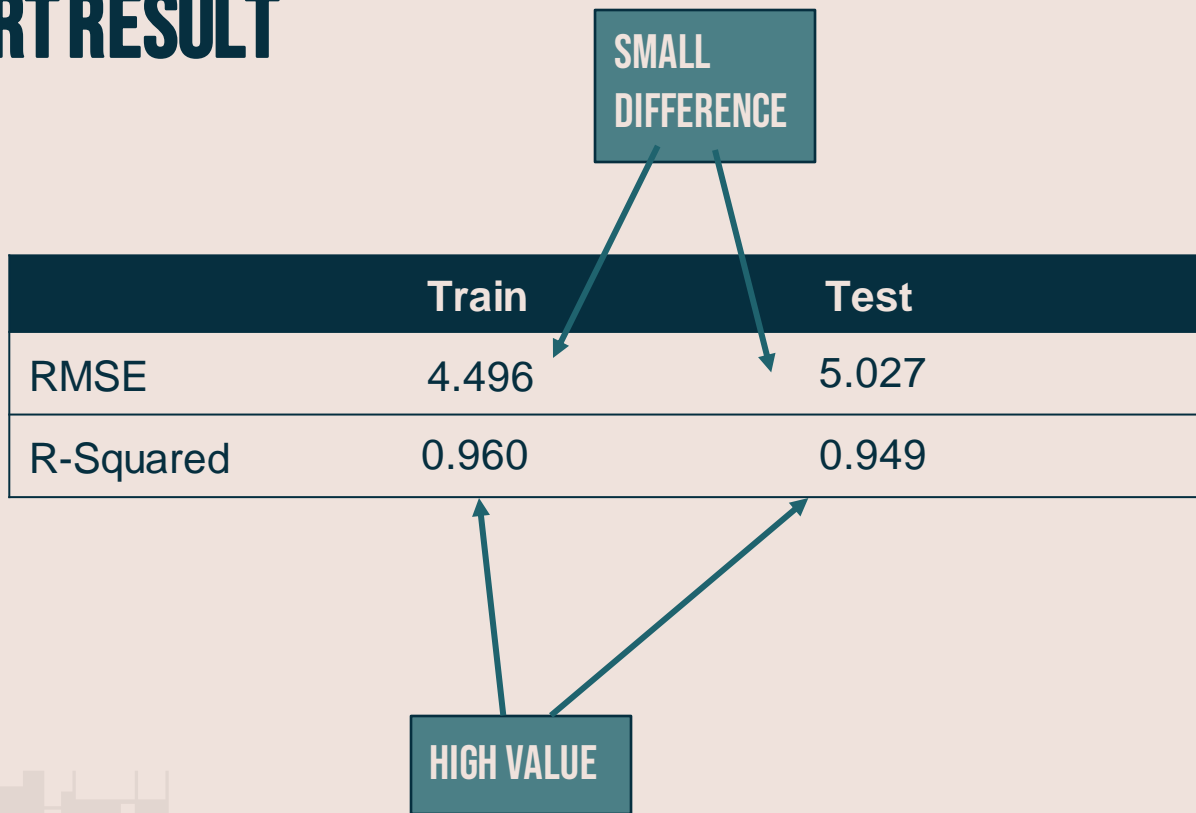
MINIMUM SPLIT = 100

19 TERMINAL NODES

PERFORMANCE OF THE CART

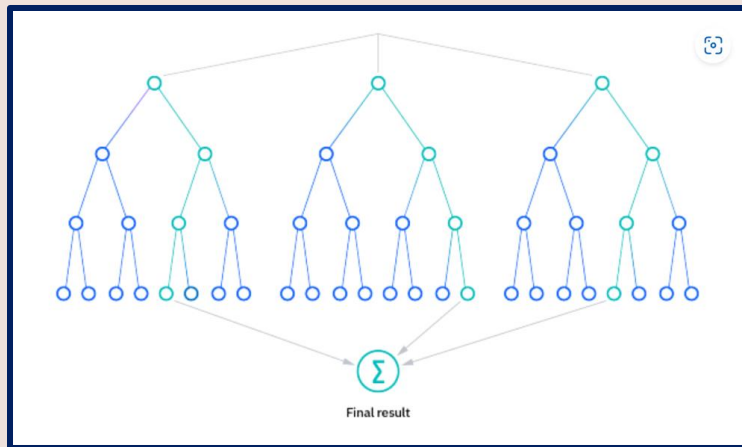


CART RESULT



	Train	Test
RMSE	4.496	5.027
R-Squared	0.960	0.949

RANDOM FOREST



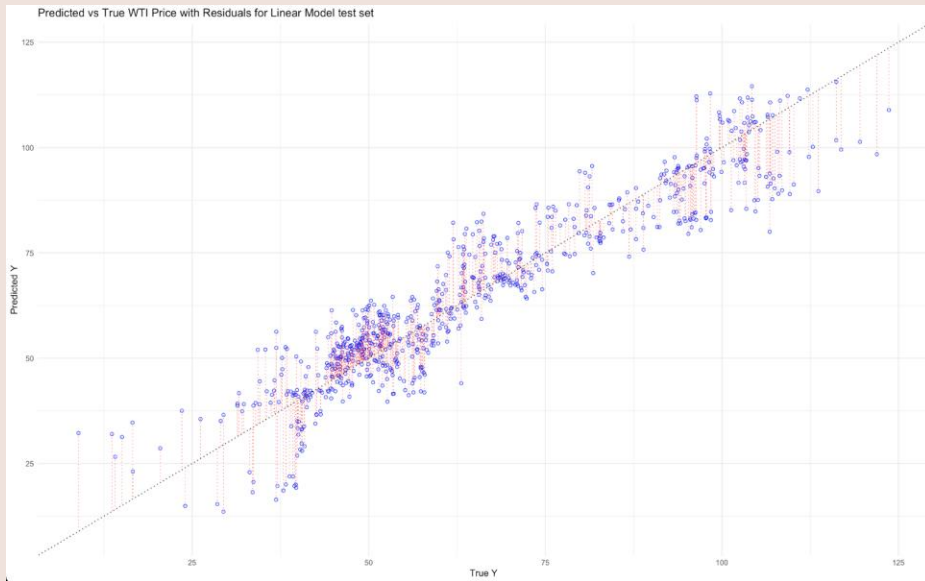
FEATURE SELECTION (FEATURES)

BAGGING (DATA)



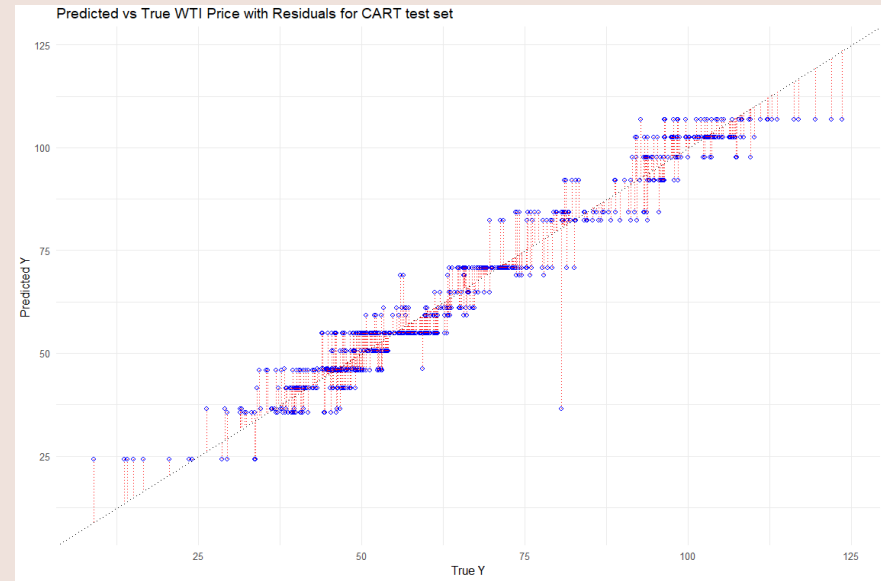
VISUAL COMPARISON OF SCATTER PLOTS

LINEAR REGRESSION



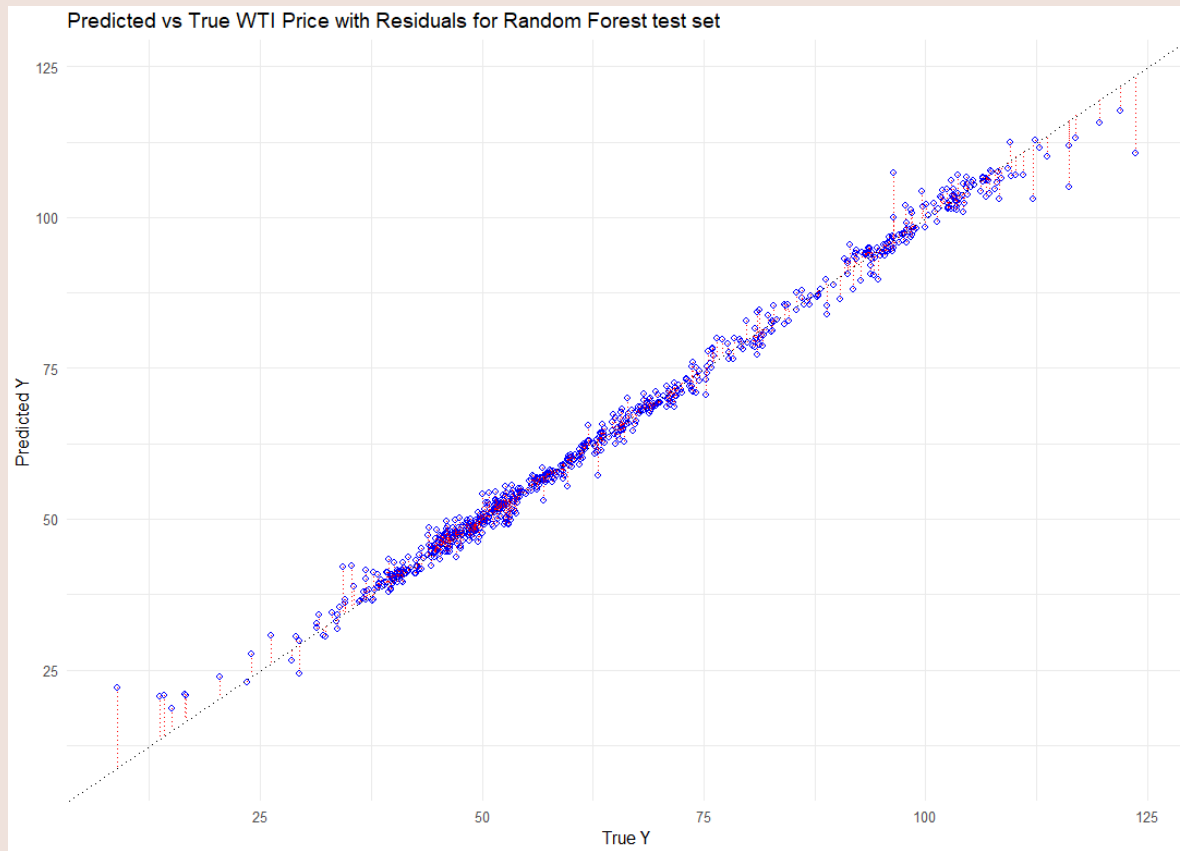
Predicted vs True WTI Price with Residuals for Linear Model test set

CART



Predicted vs True WTI Price with Residuals for CART test set

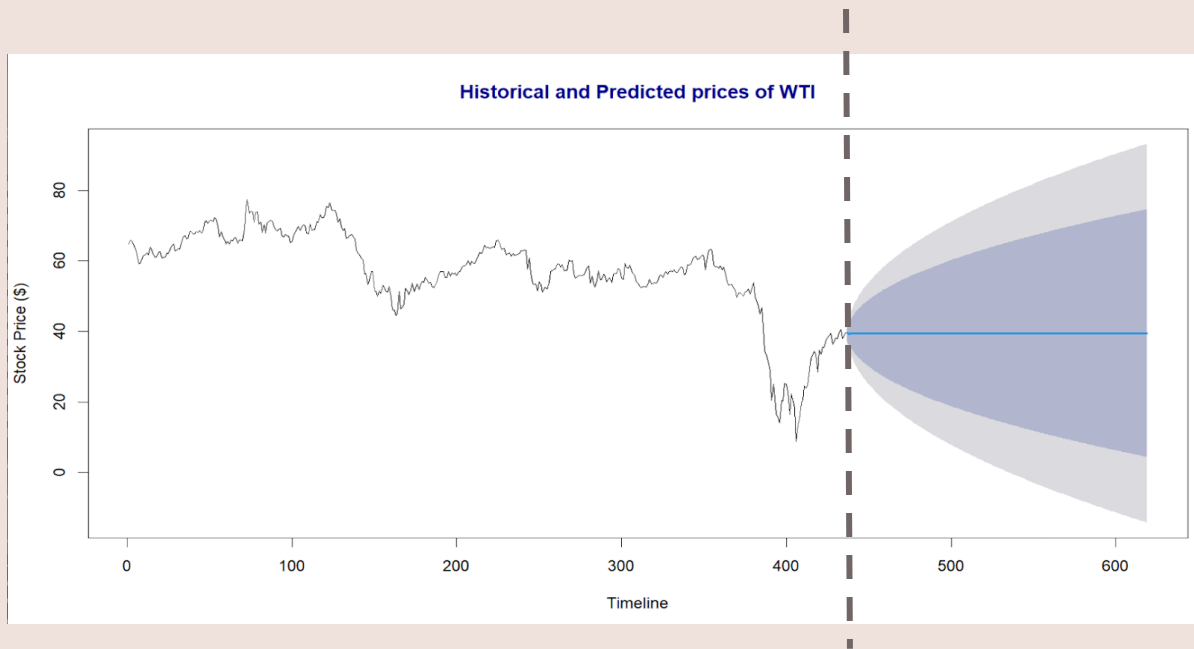
RANDOM FOREST SCATTER PLOT



Predicted vs True WTI Price with Residuals for Random Forest test set

ARIMA MODEL

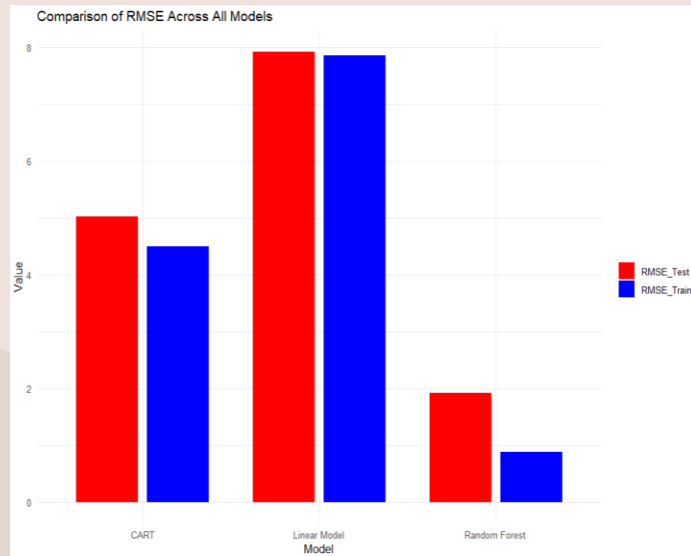
- Time-Series Forecasting
- Takes average of difference of past values to forecast the future value



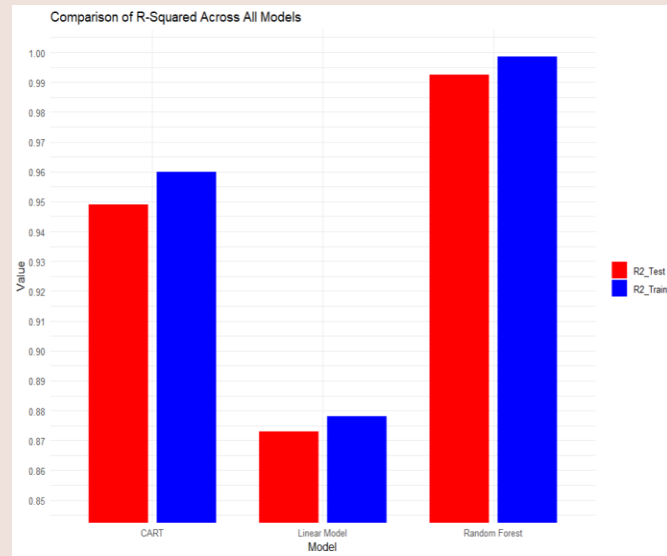
```
> RMSE_upper;RMSE_mean;RMSE_lower  
[1] 22.21789  
[1] 3.059781  
[1] 24.95654
```


CONCLUSION

RANDOM FOREST HAS HIGHEST PREDICTION ACCURACY & BEST FIT



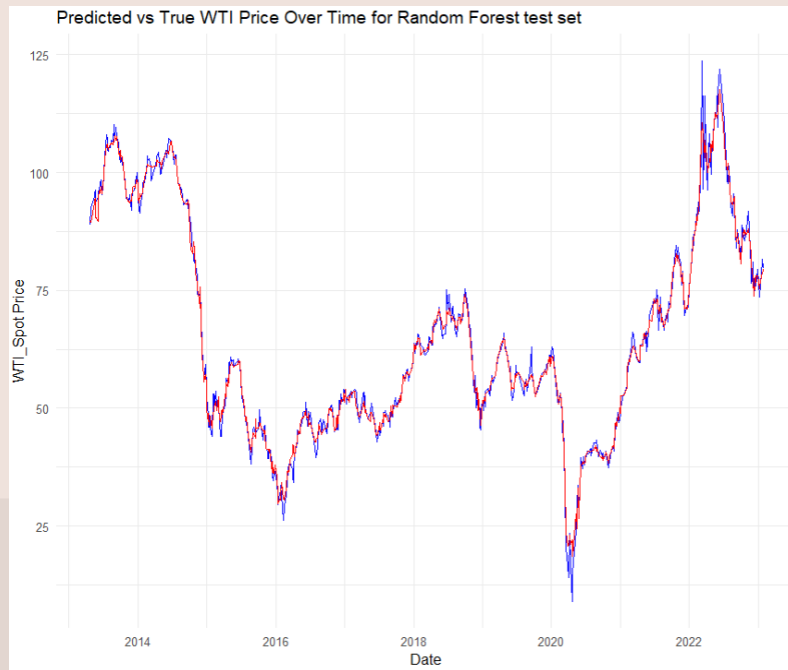
Comparison of RMSE Across All Models



Comparison of R-Squared Across All Models

CONCLUSION

RANDOM FOREST HAS HIGHEST PREDICTION ACCURACY & BEST FIT



*With a near perfect alignment of predicted and true values,
Random Forest is clearly our best model*

4

BUSINESS INSIGHTS AND SOLUTIONS



PREDICTIVE RISK-HEDGING INVESTMENT IN FINANCIAL INSTRUMENTS



DATA-DRIVEN DECISION-MAKING

Aramco can harness the power and guidance of our model to make well-informed decisions



LEVERAGING ON FINANCIAL INSTRUMENTS

With data-driven insights from our model, Aramco can take advantage of various financial instruments like futures contracts, price swaps and put/call options



REVOLUTIONISE INVESTMENT PLANS

Accurate predictions made by our model will enable Aramco to gain remarkably huge returns on investment while mitigating financial risks, thereby securing its financial well-being



Jace Aung Kaung Kaung



EMPLOYING FUTURES CONTRACTS & PRICE SWAPS



UTILISE LUCRATIVE FUTURES CONTRACTS

Futures contract is a standardised financial agreement that allows Aramco to sell oil at a predetermined price in future



LOCK IN HIGHER FIXED PRICES

When our model predicts a decline in oil prices, Aramco should lock in higher fixed prices. It will have upper hand as our model's forecasts prove to be accurate. It is more likely that market price < fixed price, so it will still receive its higher expected revenue and benefit more than counterparty



SECURE PROFITABLE PRICE SWAPS

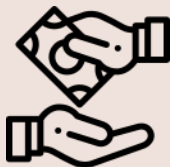
Price swap is an agreement in which if the actual market price exceeds the fixed price, Aramco will make payment to counterparty, but if it falls below that, Aramco will receive compensation from the counterparty



ATTAIN REVENUE STABILITY

By securing prices in advance, Aramco can mitigate the risk of revenue erosion caused by falling market rates. Hence, this strategy provides revenue stability even in the midst of declining market prices.

SUPERIOR TAILORED OPTIONS TRADING STRATEGY



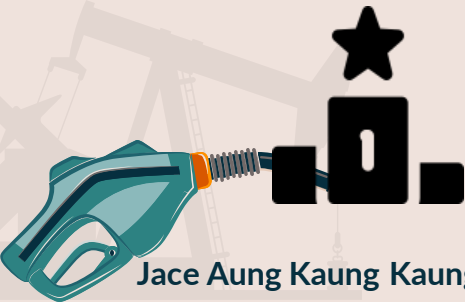
PUT OPTION

Purchasing put options will grant Aramco the right to sell oil at a predetermined price, also known as the strike price within the stipulated time frame



CALL OPTION

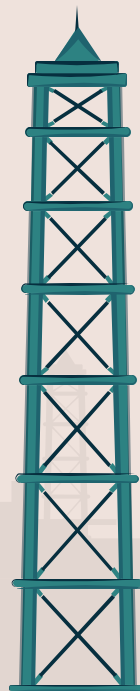
Within the stipulated time frame, selling call options will give Aramco's customers the right to buy a specified amount of oil at the strike price and in exchange, Aramco will receive premium payment from customer as compensation.



COMPETITIVE EDGE

Unbeknownst to its customers and competitors, our model's ability to anticipate future oil prices empowers Aramco to make informed decisions about when and which options to buy and sell. By leveraging on our model's valuable insights and accurate predictions, it can capitalise on price movements by thinking multiple steps ahead of its economic stakeholders, thereby gaining an edge over them

Jace Aung Kaung Kaung



EXTENSIVE CAPITALISATION OF OPTIONS TRADING



Our model signals a potential price decline



Aramco can acquire put options at optimal spot prices with advantageous strike prices that guarantees a profitable sale



If market price < the strike price, which is likely as accurately predicted by our model, Aramco can exercise put option to sell oil at higher strike price



This enables Aramco to obtain enormous profits even in a pessimistic market where its competitors will be struggling



Our model predicts stable or dropping prices



Aramco can consider selling attractive call options that lure customers with strike prices similar to current market prices



They will probably never get a good chance to exercise their call options since prices are unlikely to increase based on our model's reliable forecast



Essentially Aramco will be able to generate premium income at virtually no cost



PROACTIVE DIVERSIFICATION



Aramco can conduct comprehensive market research to uncover hidden business opportunities with explosive growth potential



Aramco can collaborate with influential partners worldwide to get invaluable insights, networks, and resources, ensuring that its market expansion is swift and secure



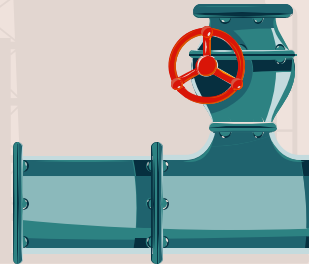
**OUR MODEL PREDICTS
STABLE PRICES**



Aramco can expand to adjacent markets like petrochemicals/refining for revenue diversification, leveraging on its hard-earned expertise



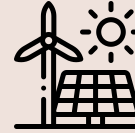
Aramco can invest in research and development to boost efficiency and technological advancements, driving innovation and productivity



PROACTIVE DIVERSIFICATION



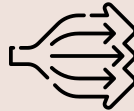
Aramco can strategically acquire or partner with established renewable energy giants, thereby catapulting it into the sector's limelight



Aramco can develop its own projects, such as solar and wind farms



**OUR MODEL PREDICTS
VOLATILE PRICES**



Renewable energy development projects will give Aramco multiple alternative revenue streams that can sustain it through oil market volatility



Exploring renewable energy sector can reduce Aramco's reliance on oil

