Forecasting Auto Loan Originations: A Data-Driven Approach for the Bank

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Outlines

1. Introduction
2. Data Processing
3. Exploratory Data Analysis
4. Feature Engineering
5. Model Selection and Training
6. Model Comparison
7. Recommendations

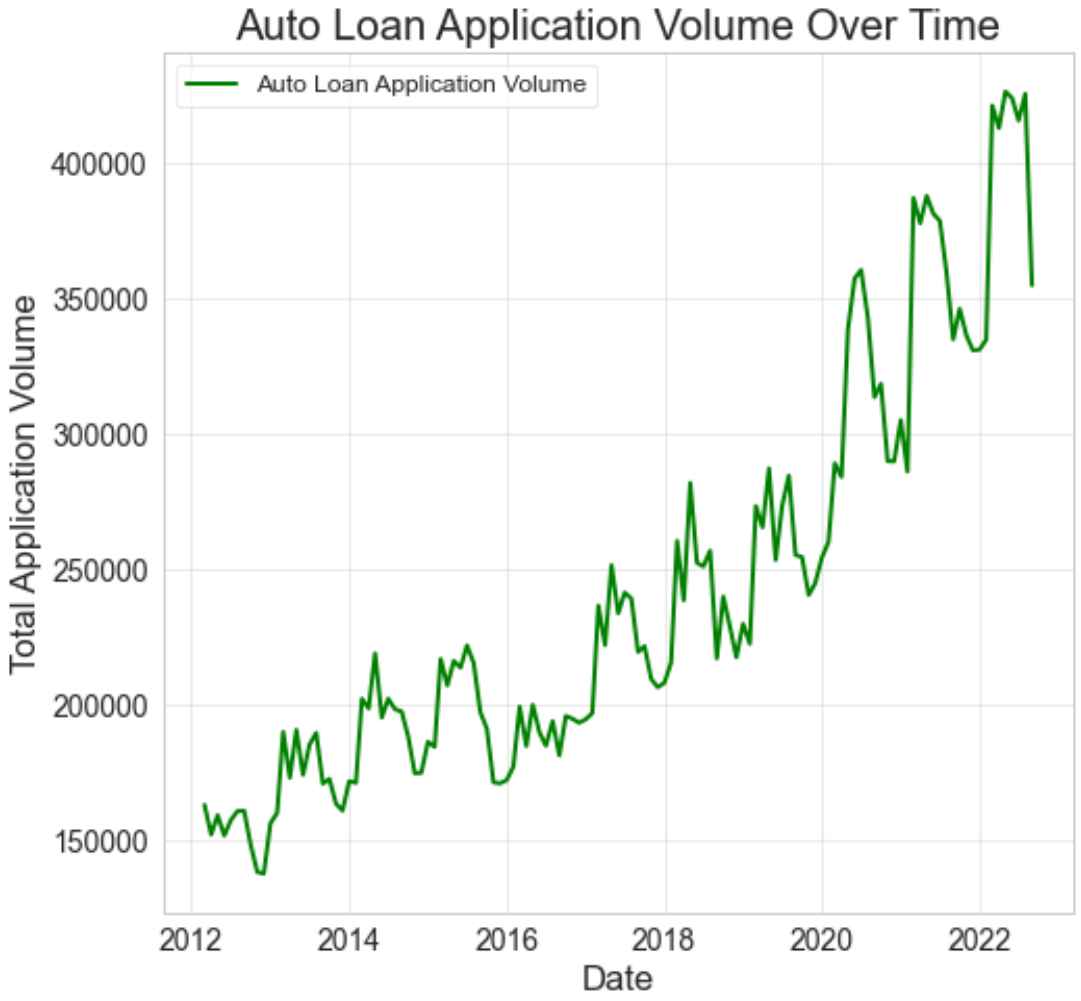
Introduction

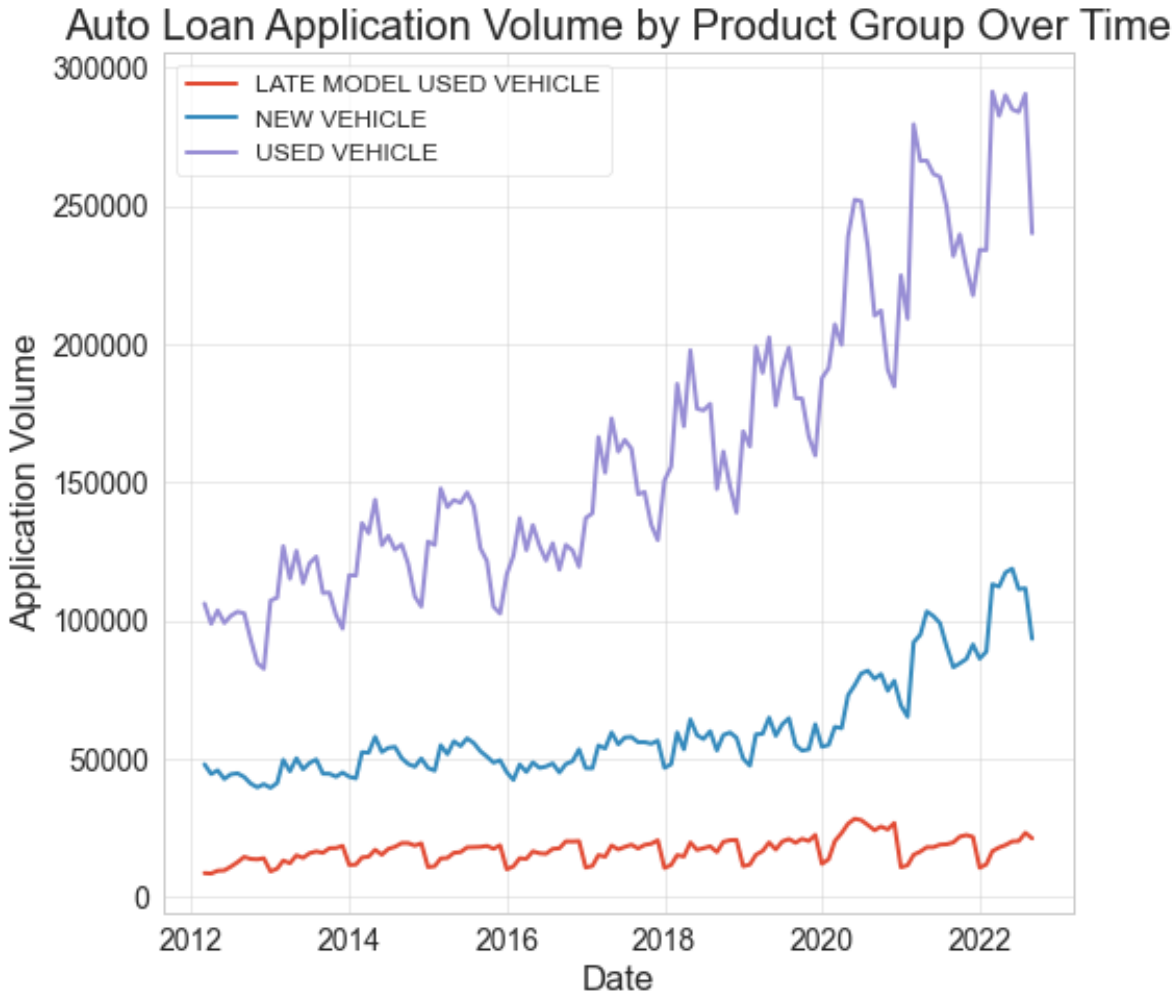
- *Bank's Offer*: Provides auto loans to its diverse client
- *Business Need*: Anticipating loan demands is crucial due to fluctuating market dynamics and evolving customer behaviors.
- *Role of Analytics*: The analytics team leverages data to forecast trends, ensuring preparedness.
- Challenges:
  - Diverse Factors: Impacted by both internal metrics and external elements.
  - Data Integration: Essential to merge varied data sources for insights.
  - Dynamic Market: Economic shifts and changing preferences complicate forecasting.

Data Processing

- The dataset to predict auto loan originations contains:
  - Total membership
  - Application volume (Group of product, pre-approve, risk tier, term code, discount and total application volume)
  - Competitor rates
  - Macroeconomic indicators
- Data processing: Merged data resulted in:
  - 12 missing values in "Pre-approve“, and 220 in "Total membership"
  - Missing values were imputed using the mean.
  - Outliers detected using the Interquartile Range and replaced with the median.
  - Drop 1,127 duplicated observations
  - Label encoding and one-hot encoding applied for categorical variables.
- Dataset Size: 32,344 observations spanning 10 years.

Data Overview





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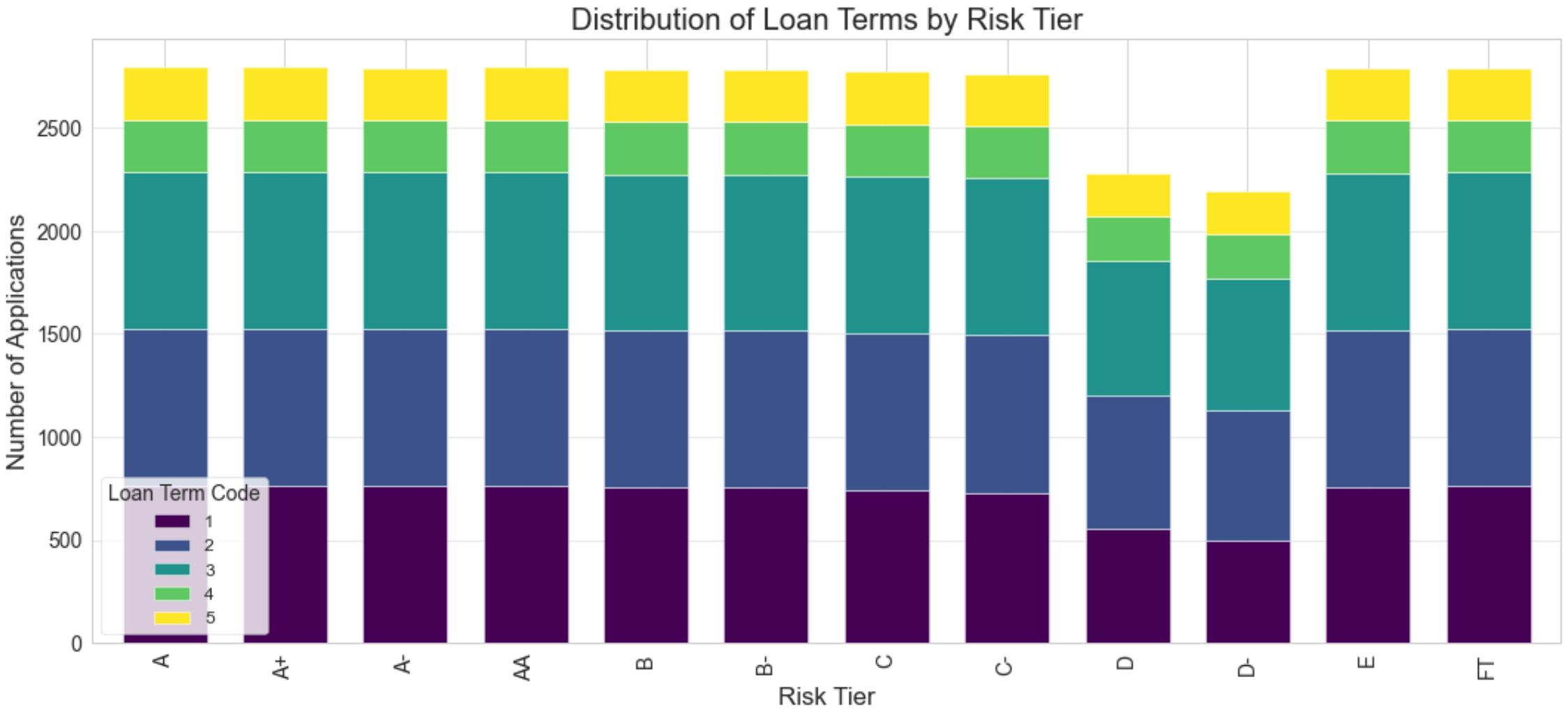

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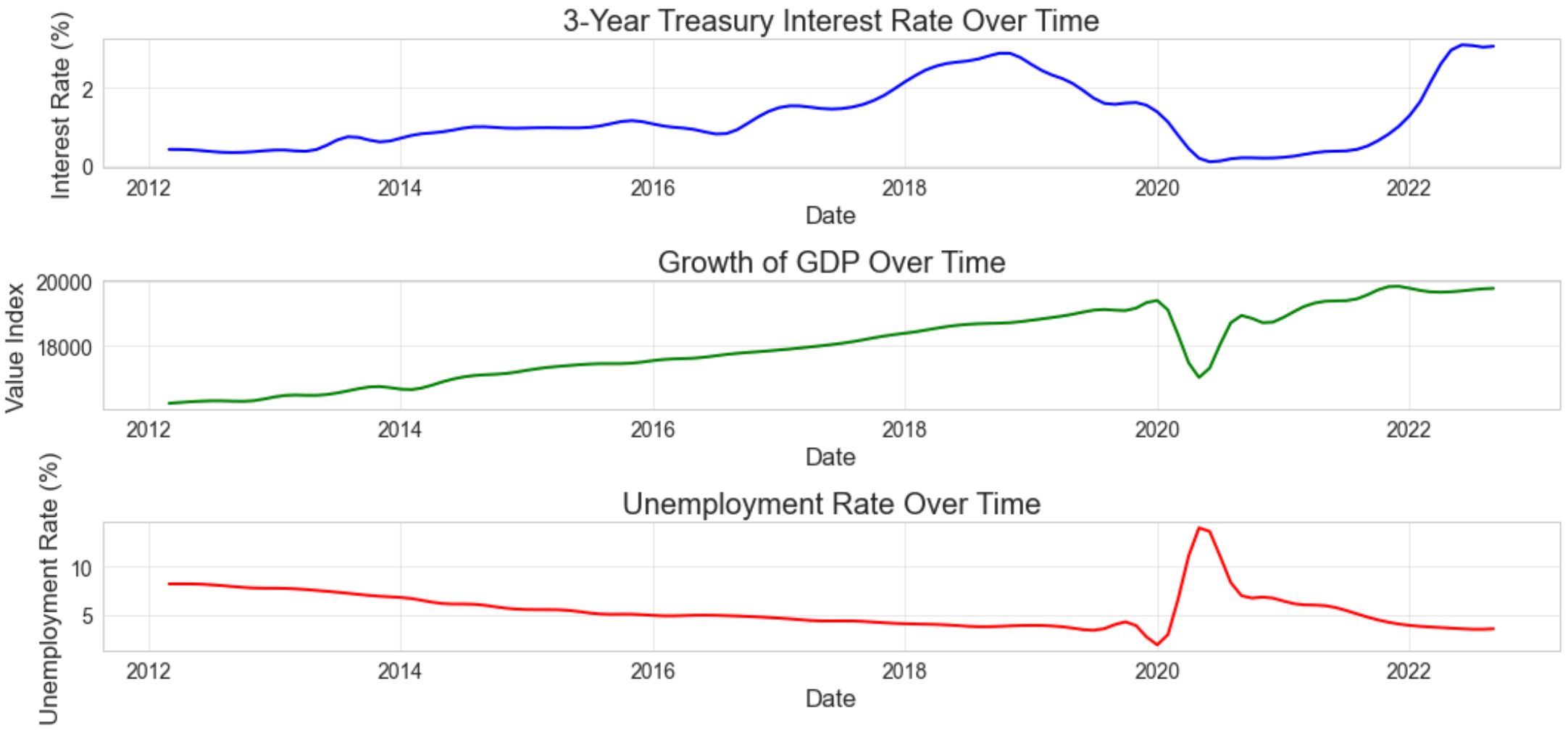
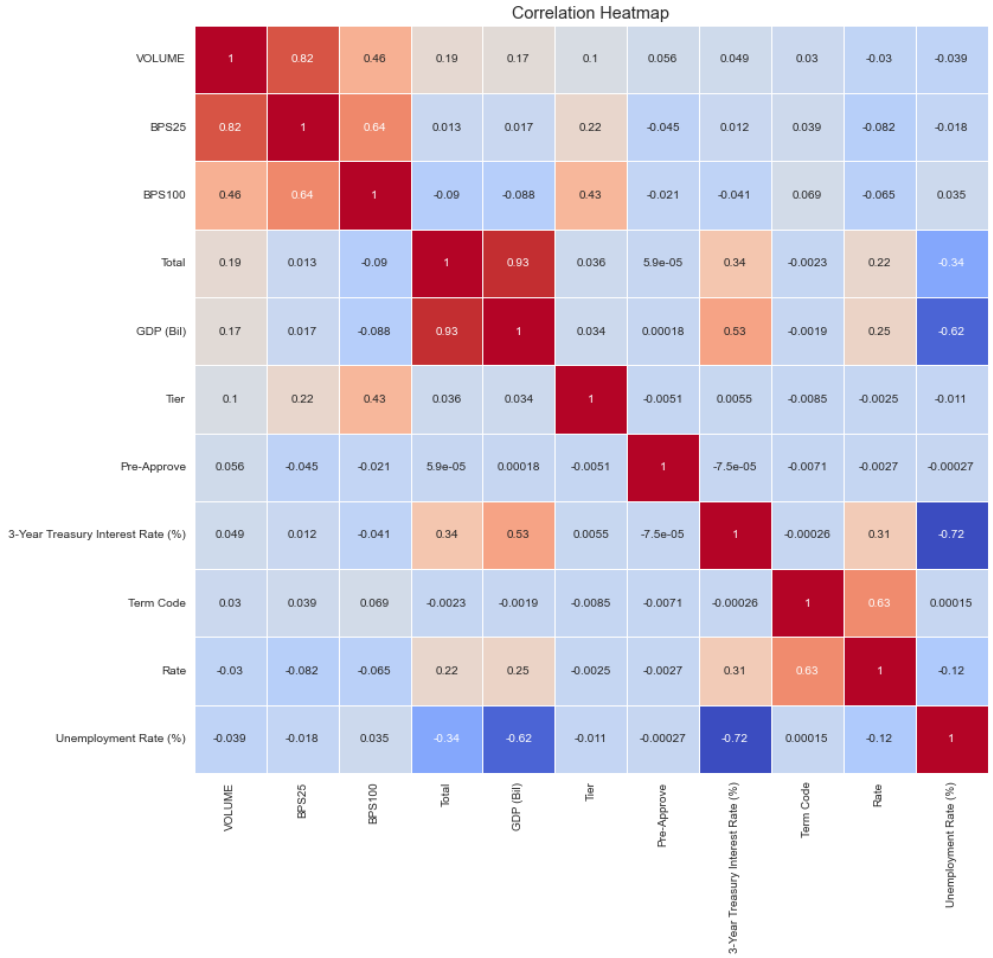


Feature engineering



	coef	std err	t	P>|t|
const	-409.7928	88.872	-4.611	0.000
PREAPPROVE	94.9068	3.203	29.630	0.000
TIER	-5.5179	0.559	-9.880	0.000
BPS25	15.9242	0.126	126.084	0.000
BPS100	24.5023	1.263	19.399	0.000
TERM_CODE	46.5765	2.015	23.118	0.000
Total	0.0023	0.000	18.894	0.000
Rate	-8575.5901	340.849	-25.160	0.000
3-Year Treasury Interest Rate (%)	47.8462	3.475	13.767	0.000
GDP (Bil)	0.0116	0.005	2.136	0.033
Unemployment Rate (%)	34.4323	2.244	15.345	0.000
PRODUCT_GROUP_NEW VEHICLE	36.9167	4.205	8.779	0.000
PRODUCT_GROUP_USED VEHICLE	311.9972	5.556	56.155	0.000

Adjusted R-squared: 0.68

Model Selection and Training

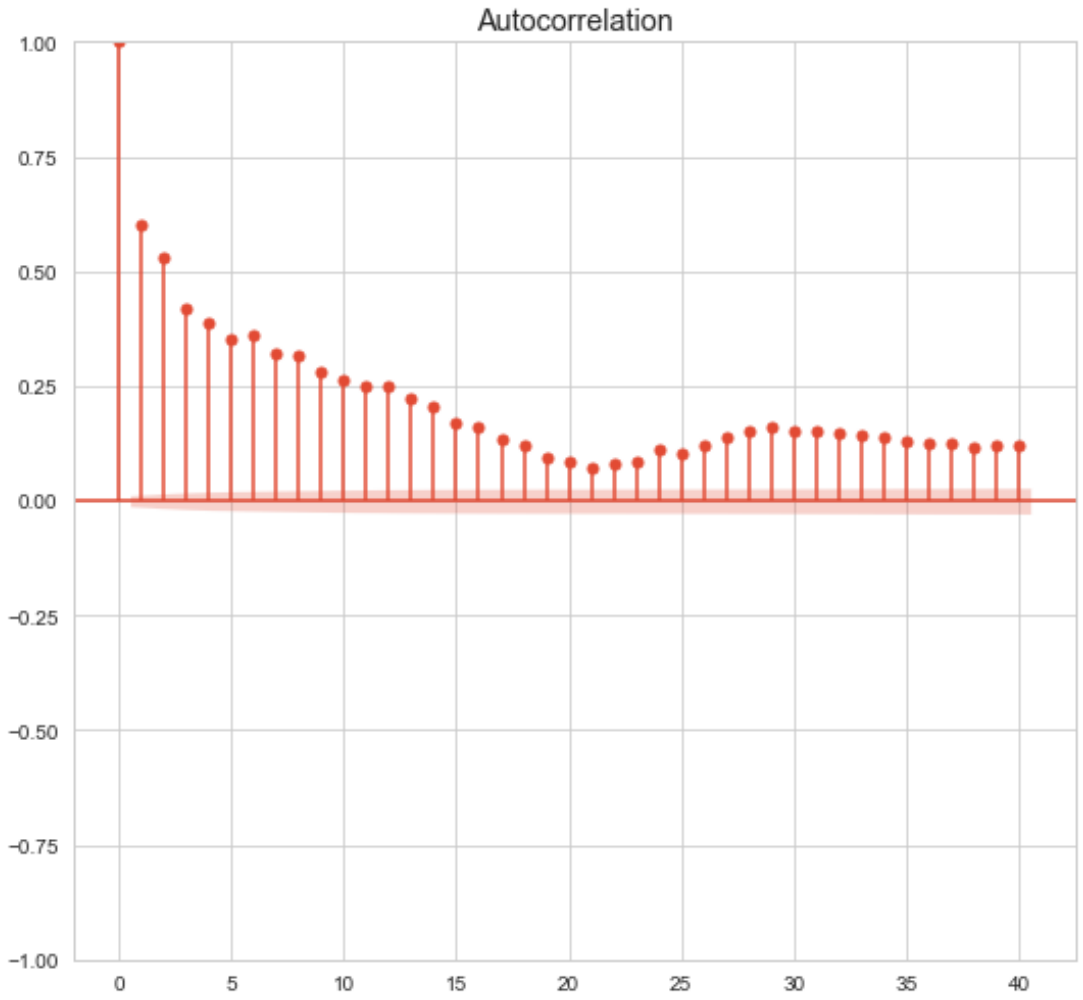
- Train-test split: set aside 20% as test data, 80% training data
- Apply for the most popular models
  - Linear regression model
  - Time-series model (ARIMA)
  - Decision tree
  - Random Forest
- Decision made:
  - Based on the result of Mean absolute error (MAE), Mean squared error (MSE) and Adjusted-R squared.

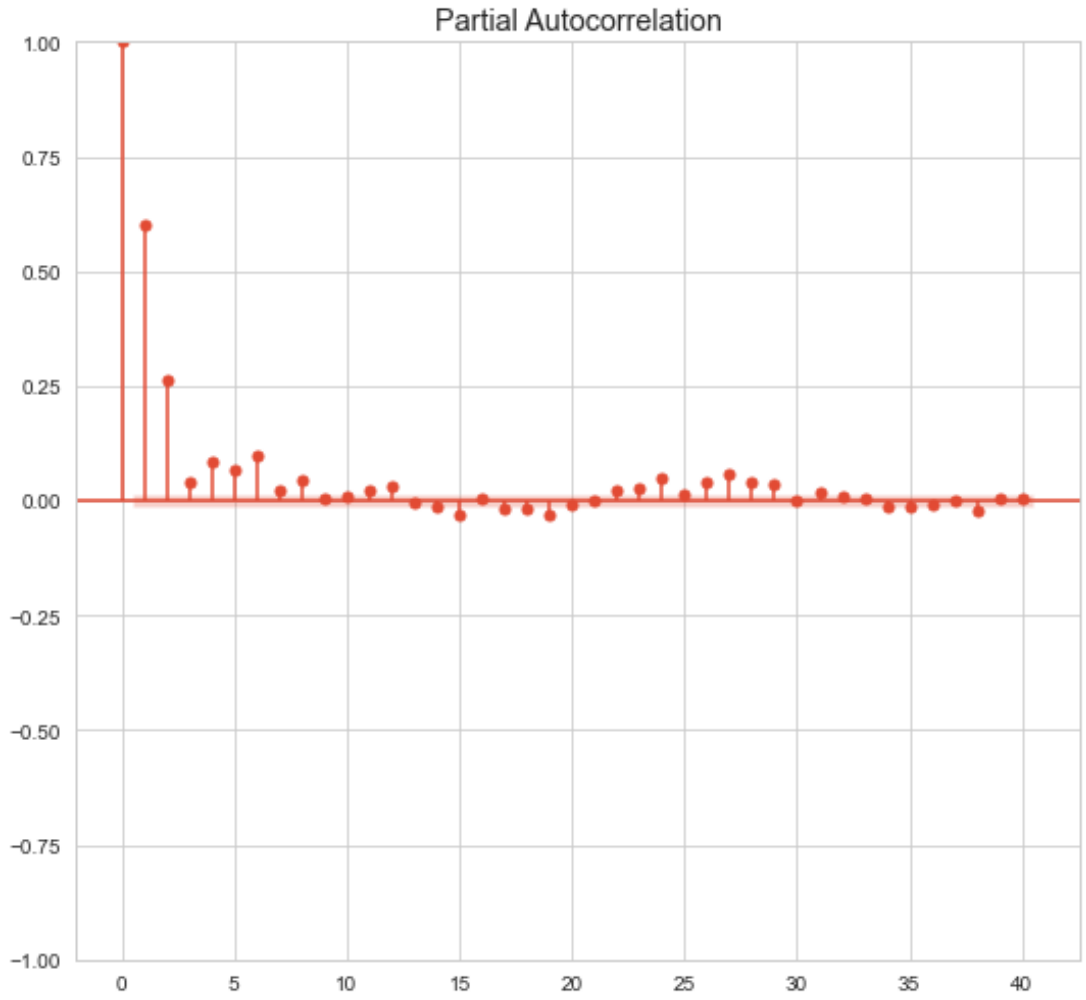
Linear Regression Model

- Mean Absolute Error (MAE): 2.39×10^{-12}
- Mean Squared Error (MSE): 8.4×10^{-23}
- R^2 : 1.0
- Conclusion: Perfect fit => overfitting?
  - Inspect the coefficients to find the significant impact of lags of Volume => Drop lags
  - Solution: Drop lags => MAE: 202.9, MSE:83352.6, R^2:0.68

ARIMA Model

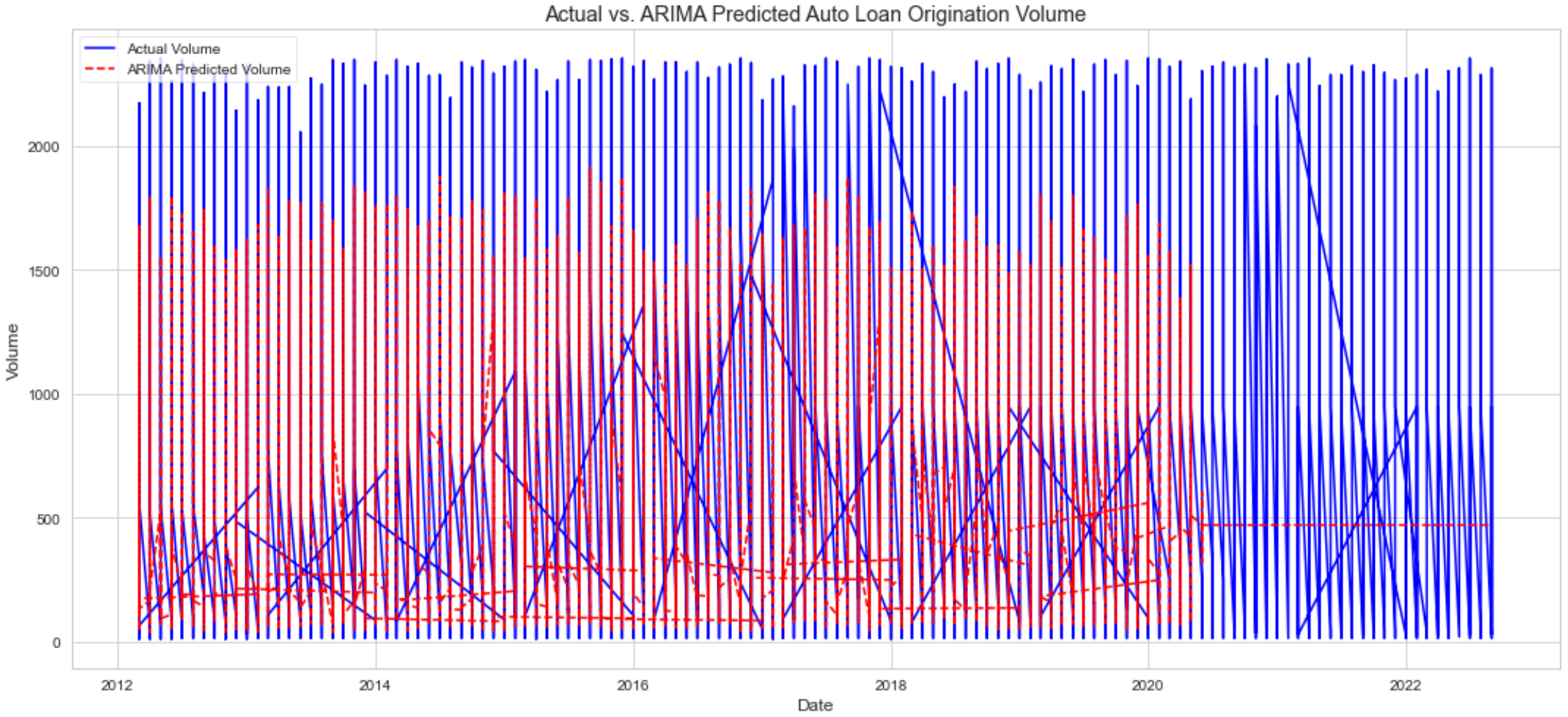
(p,d,q)=(2,1,2)





ARIMA Model

MAE:436
MSE: 299167
R^2 :-0.11



Machine Learning Model

- **Decision Tree Regressor:**
  - Mean Absolute Error (MAE): 131.814
  - Mean Squared Error (MSE): 55742.38
  - R^2 : 0.79

- **Random Forest Regressor:**
  - Mean Absolute Error (MAE): 107.90
  - Mean Squared Error (MSE): 38876.17
  - R^2 : 0.85

Model Comparison

Model	MAE	MSE	R^2
Linear regression model	202.9	83352.6	0.68
ARIMA	436	299167	-0.11
Decision Tree	131.814	55742.38	0.79
Random Forest	107.90	38876.17	0.85

Model Robustness

- Stress-testing:
  - Purpose: To evaluate the model's stability and reliability under extreme or unusual conditions.
  - Outcome for Linear Regression: A 5% decrease in R-squared when introduced with outliers.
- Sensitivity analysis:
  - Purpose: To assess the influence of changes in independent variables on a specific dependent variable.
  - Result for Linear Regression: By omitting lag features, the R-squared value decreased by 32%.

Recommendation

- Collect more historical data on auto loan originations
- Evaluate the events and factors that influence auto loans
- Try different models and techniques to make the result more accurate
  - Use k-fold cross section techniques
  - Linear regression model: use Ridge regression or Lasso regression to avoid overfitting
  - Time-series model: consider different methods, or drop the insignificant lag features, add the significant interaction features
  - Random Forest/Decision Tree: Find the best hyperparameter tuning