UMBC

Financial Data Analysis of Insurance Sector

Course: Financial Data Science
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Introduction

Objective and Scope:The project aimed to analyze the financial performance of five insurance companies, using the S&P 500 Index as a market benchmark, over five years from 2019 to 2024. The analysis spans pre-pandemic, pandemic, and post-pandemic market conditions.

Data Collection and Preparation:Stock price data for the insurance companies and the S&P 500 Index were collected, followed by data cleaning to ensure accuracy and completeness for analysis.

Exploratory Data Analysis (EDA):EDA techniques, including time series plots of stock prices, were used to visualize performance trends over the specified period.

Statistical Analysis for In-depth Insights:Statistical measures like mean, standard deviation, Z-score, and confidence intervals were determined.

Main Financial Concepts:Financial concepts such as return, risk, covariance, correlation, and risk-return ratios were evaluated.

Capital Asset Pricing Model (CAPM) Analysis:Used CAPM to evaluate expected returns based on systematic risk, gaining insights into each company's market performance relative to overall market movements. Performance metrics calculators such as Sharpe and Treynor ratios were calculated.

Application of Modern Portfolio Theory (MPT):MPT principles guided the exploration of optimal investment strategies and portfolio construction, enhancing investment decision-making.

Time Series Analysis:The time series analysis focused on evaluating and forecasting insurance stock prices using methods like decomposition, stationarity testing, ARIMA, and Monte Carlo simulations to understand patterns and predict future trends

Motivation:

Resilience and Strategic Insights: To evaluate the financial performance and resilience of key insurance companies (AIG, MET, PRU, ALL, and TRV) by analyzing their stock price behavior and financial metrics over a five-year period (2019-2024), including pre-pandemic, pandemic, and post-pandemic phases.

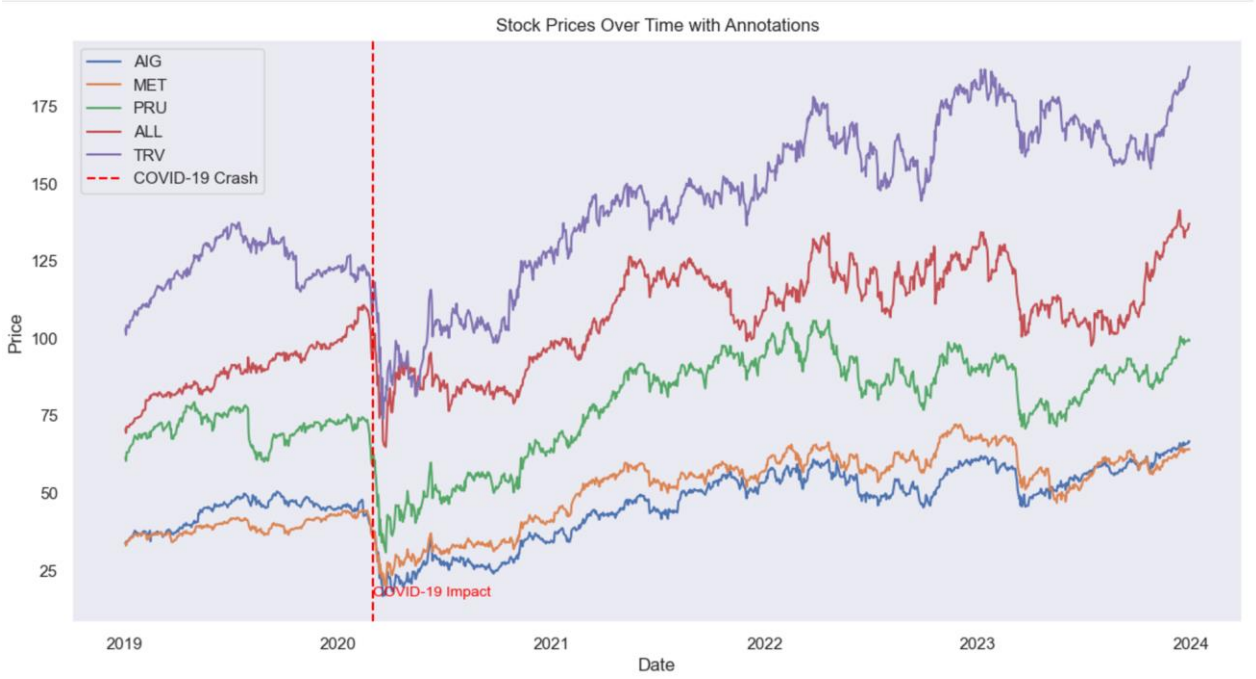
Understanding Market Risk and Returns: To investigate how these companies navigate market dynamics using risk-return metrics such as Sharpe Ratios, Treynor Ratios, and Z-scores, highlighting differences in risk exposure and return potential.

Application of Financial Models: To integrate advanced financial models like CAPM, ARIMA, Monte Carlo Simulations, and Modern Portfolio Theory to evaluate systematic risk, forecast future performance, and construct optimal investment portfolios.

Enhancing Investment Decision-Making: To provide actionable insights for portfolio allocation and risk management, offering lessons on strategic adaptability in volatile market conditions and enhancing informed decision-making.

Contribution to Financial Understanding: To bridge the gap between academic financial concepts and their practical application, helping stakeholders understand how these companies adapt to global economic disruptions.

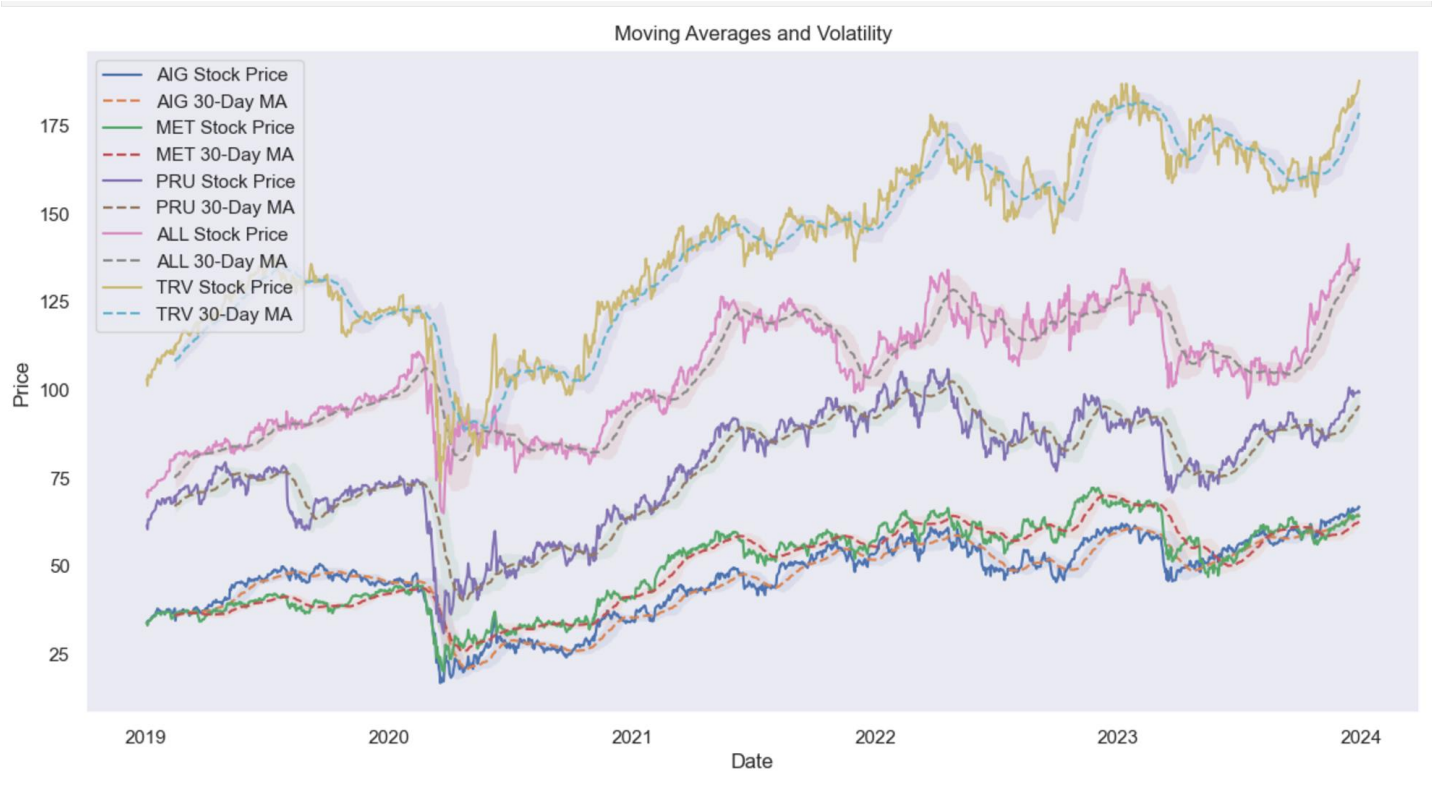
Stock Analysis



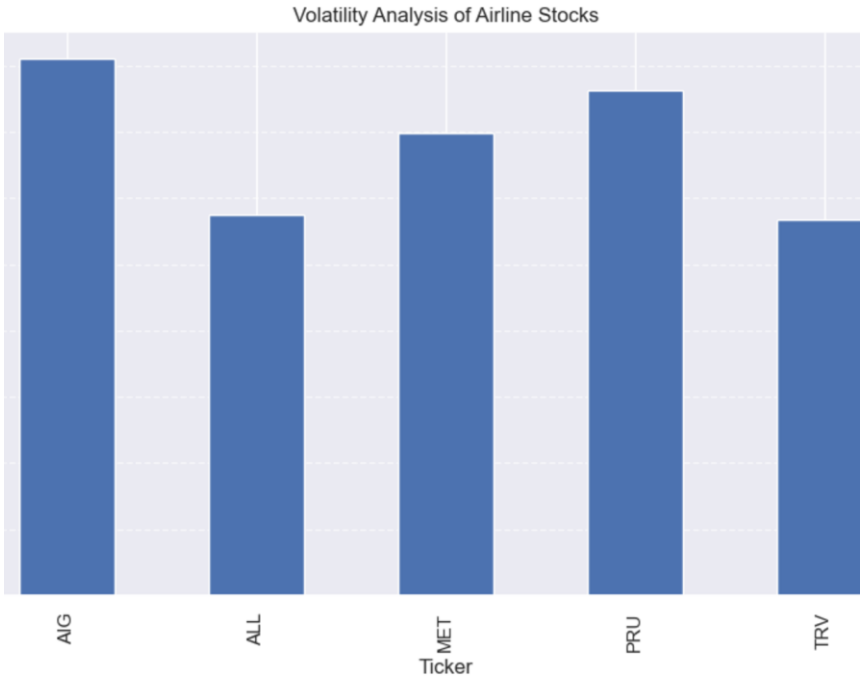
Stock Data Summary:

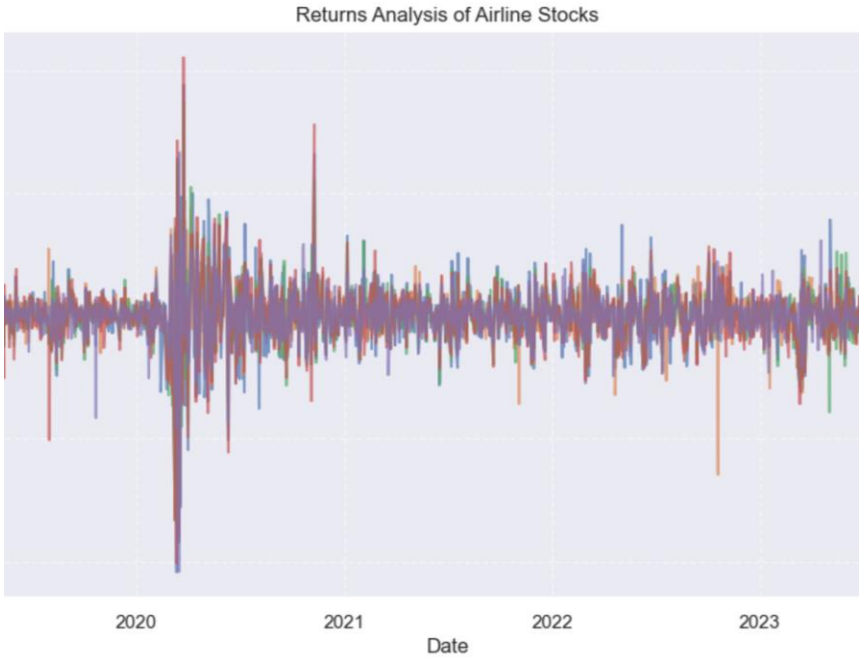
Ticker	AIG	ALL	MET	PRU	TRV
count	1258.000000	1258.000000	1258.000000	1258.000000	1258.000000
mean	46.395299	104.744321	49.758135	77.814258	141.480792
std	10.928041	16.288956	12.003382	15.416472	25.389396
min	16.710825	64.940834	19.971468	30.819284	73.875793
25%	38.912795	90.250259	39.045776	68.732088	122.194801
50%	47.970390	105.734695	53.428793	78.793816	144.194618
75%	54.952633	118.973305	59.486722	90.134632	163.125618
max	66.815887	141.402298	72.154030	105.916809	187.869827

Moving Averages and Volatility:



Volatility and Returns:





Correlation and Covariance Matrix

Covariance matrix:

Ticker	AIG	ALL	MET	PRU	TRV
AIG	0.164312	0.072667	0.116441	0.128292	0.080377
ALL	0.072667	0.082675	0.064033	0.070474	0.053700
MET	0.116441	0.064033	0.121885	0.122996	0.065576
PRU	0.128292	0.070474	0.122996	0.145239	0.072469
TRV	0.080377	0.053700	0.065576	0.072469	0.080687

Correlation matrix:

Ticker	AIG	ALL	MET	PRU	TRV
AIG	1.000000	0.623471	0.822806	0.830470	0.698062
ALL	0.623471	1.000000	0.637883	0.643130	0.657478
MET	0.822806	0.637883	1.000000	0.924430	0.661249
PRU	0.830470	0.643130	0.924430	1.000000	0.669434
TRV	0.698062	0.657478	0.661249	0.669434	1.000000

Correlation Matrix:

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Lowest Correlation: AIG (('AIG', 'ALL'))
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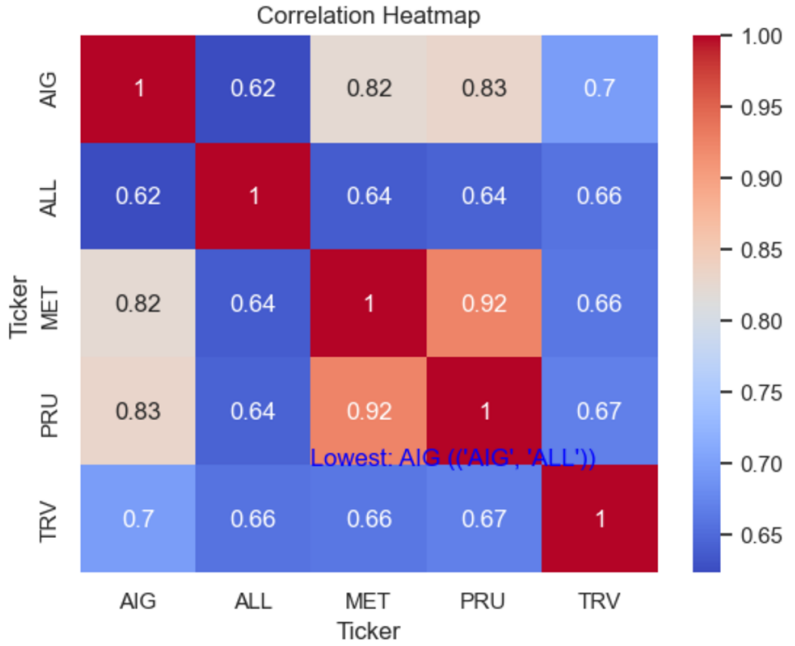
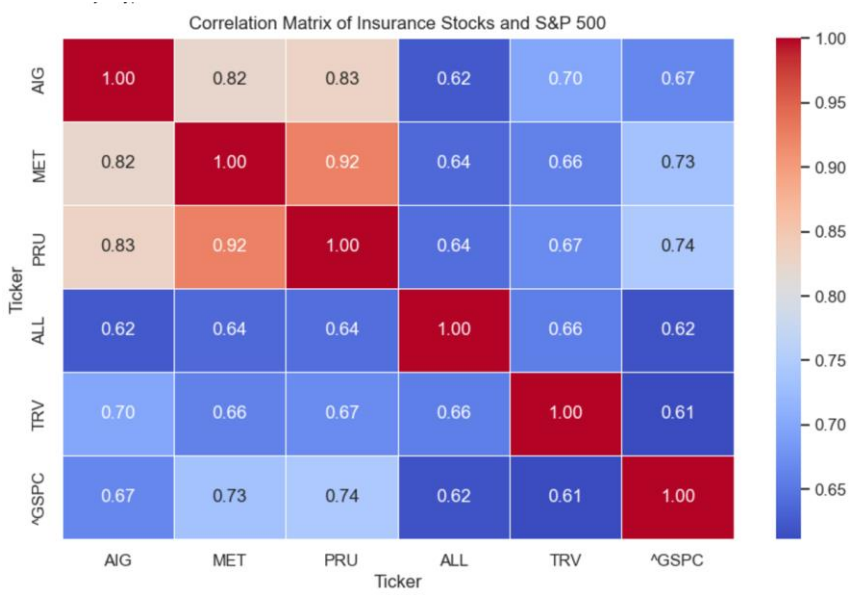
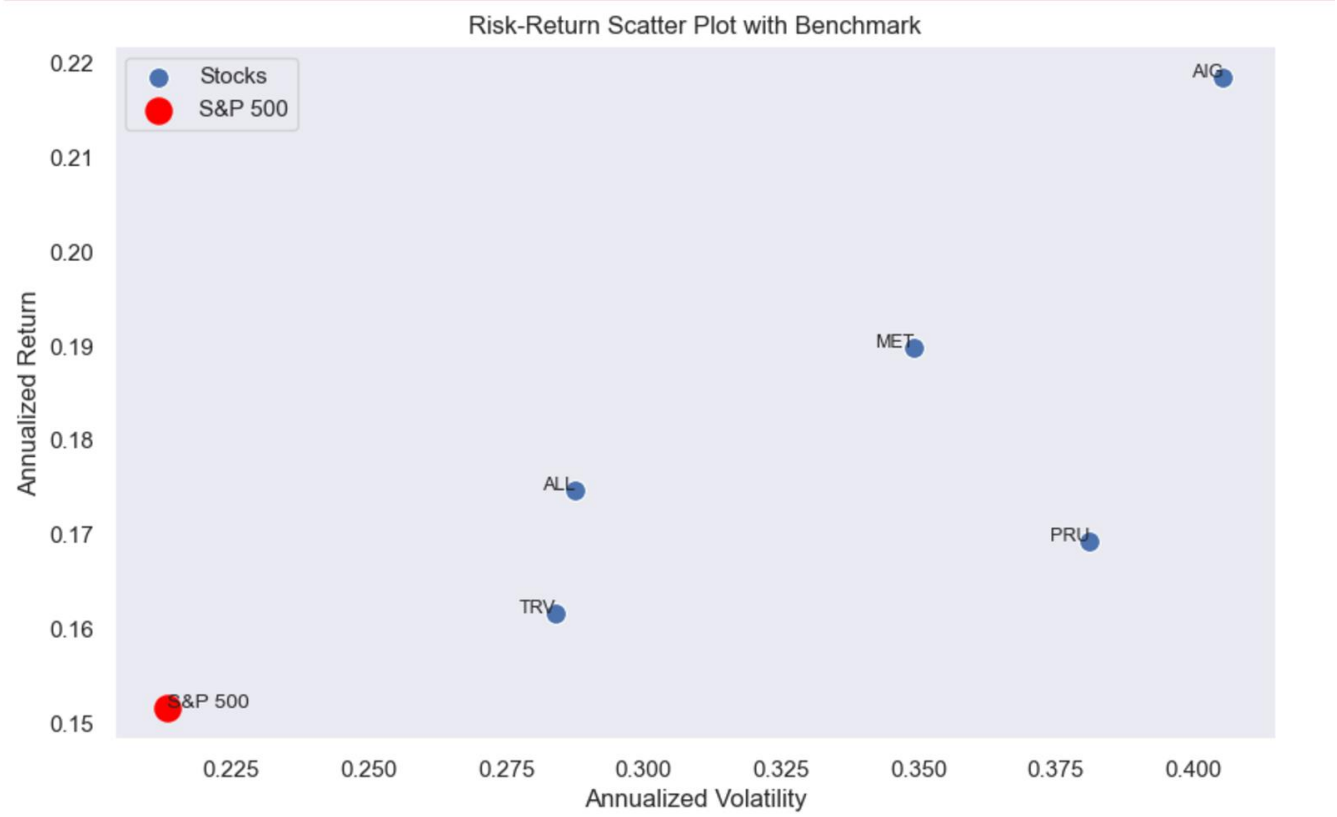
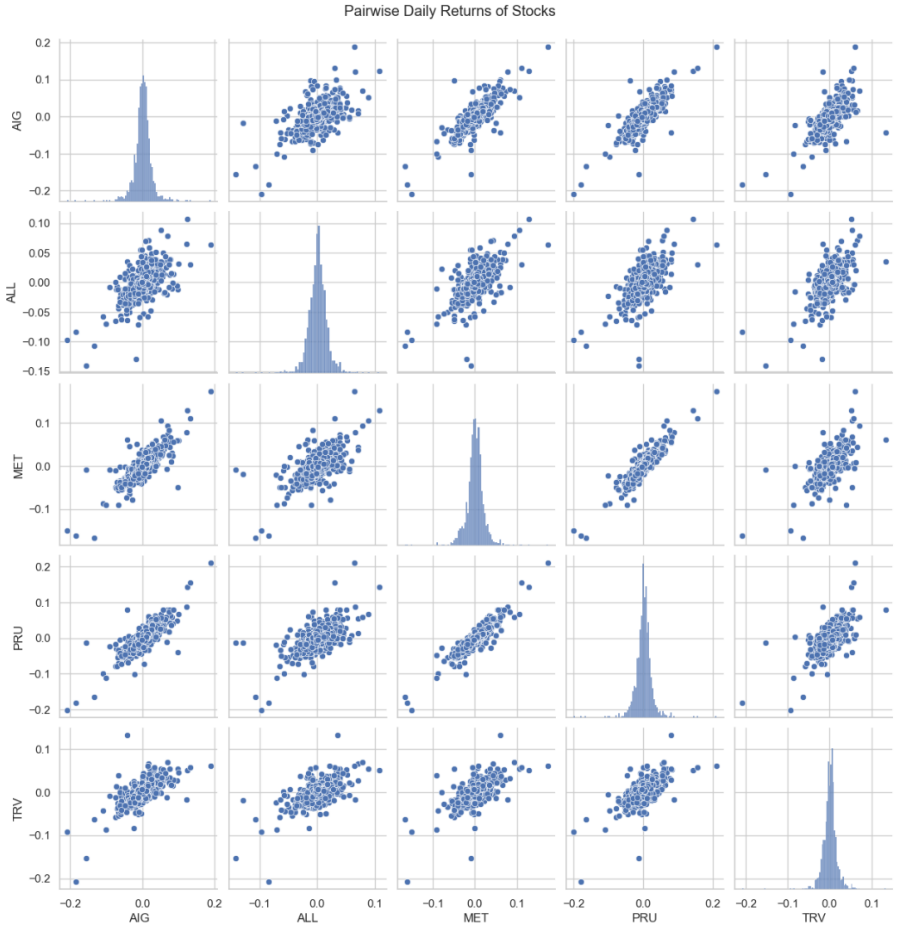




Risk-Return Plot:



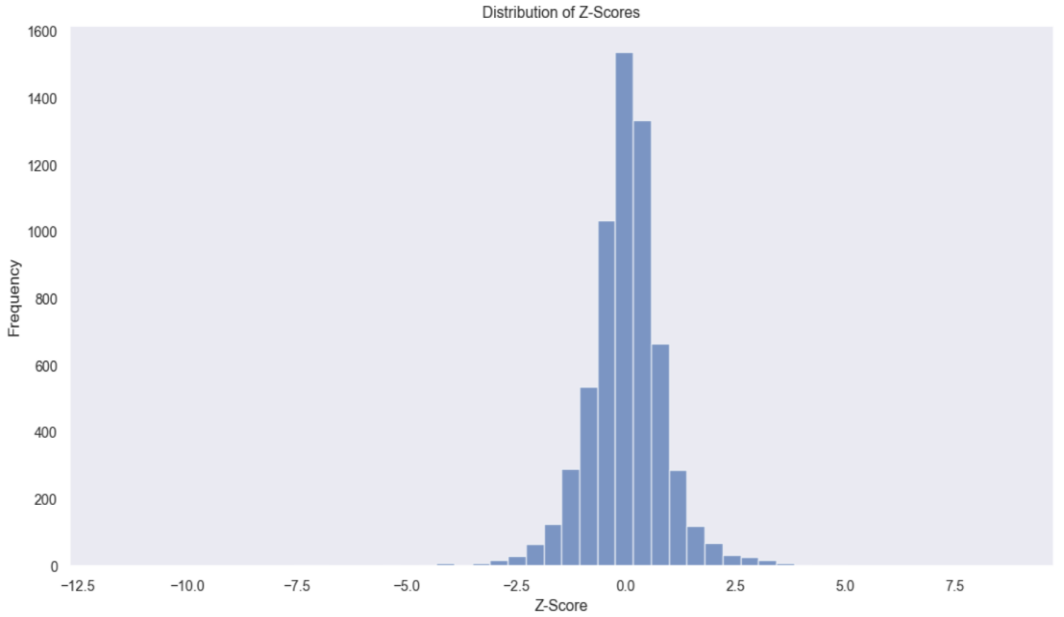
Pair Wise Analysis:



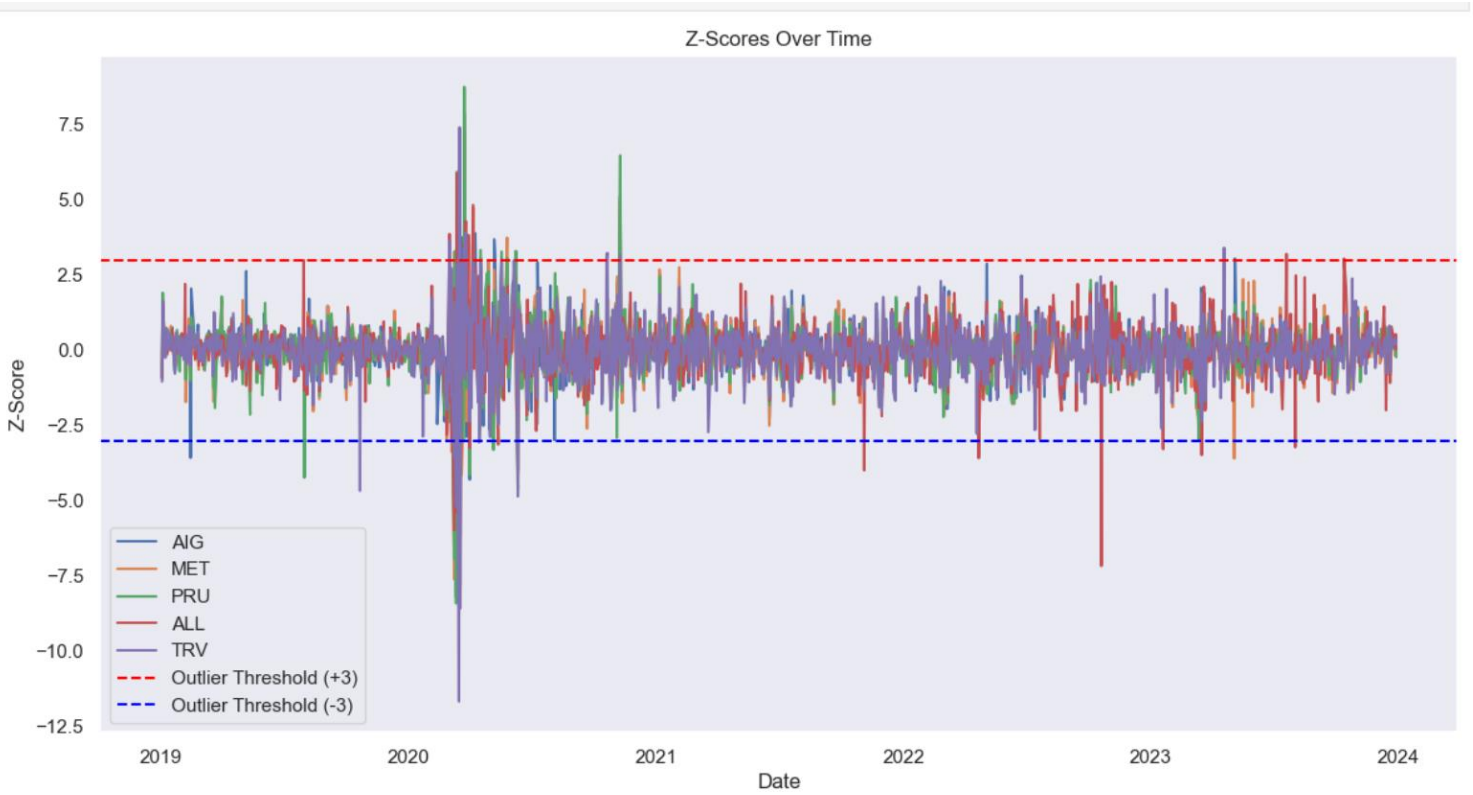
Z-Scores:

Outlier Z-Scores:

Ticker	AIG	ALL	MET	PRU	TRV
Date					
2019-02-14 00:00:00+00:00	-3.572206	NaN	NaN	NaN	NaN
2019-08-01 00:00:00+00:00	NaN	NaN	NaN	-4.231672	NaN
2019-10-22 00:00:00+00:00	NaN	NaN	NaN	NaN	-4.668880
2020-03-02 00:00:00+00:00	NaN	3.855427	NaN	NaN	3.636551
2020-03-05 00:00:00+00:00	NaN	NaN	-3.365704	NaN	NaN
2020-03-09 00:00:00+00:00	-5.241779	-5.982077	-7.604017	-6.934316	-3.561067
2020-03-10 00:00:00+00:00	NaN	NaN	3.252669	3.284780	NaN
2020-03-11 00:00:00+00:00	NaN	-3.649536	NaN	-3.275758	-3.294824
2020-03-12 00:00:00+00:00	-8.200508	-5.378660	-6.864325	-8.409585	-5.209529
2020-03-13 00:00:00+00:00	4.834256	5.873680	5.800418	5.919839	NaN
2020-03-16 00:00:00+00:00	-7.250905	-4.676133	-7.342573	-7.563702	-11.664822
2020-03-17 00:00:00+00:00	NaN	NaN	NaN	3.259544	7.394397
2020-03-18 00:00:00+00:00	-6.143916	-7.819905	NaN	NaN	-8.571880
2020-03-19 00:00:00+00:00	3.762796	NaN	NaN	NaN	NaN
2020-03-20 00:00:00+00:00	NaN	NaN	-4.141785	NaN	NaN
2020-03-23 00:00:00+00:00	NaN	NaN	NaN	-3.025592	NaN
2020-03-24 00:00:00+00:00	7.334672	3.498955	7.853168	8.737520	3.368207
2020-03-25 00:00:00+00:00	4.732971	3.562489	3.474939	3.606236	NaN
2020-03-26 00:00:00+00:00	NaN	4.287032	4.233110	NaN	3.900356
2020-03-30 00:00:00+00:00	NaN	3.820265	NaN	NaN	NaN
2020-04-01 00:00:00+00:00	-4.299081	-3.247519	-4.007234	-4.135927	NaN
2020-04-06 00:00:00+00:00	NaN	4.819166	4.740992	NaN	NaN
2020-04-07 00:00:00+00:00	3.133745	NaN	NaN	NaN	NaN
2020-04-09 00:00:00+00:00	3.878923	NaN	NaN	NaN	NaN
2020-04-15 00:00:00+00:00	NaN	NaN	NaN	NaN	-3.063615
2020-04-17 00:00:00+00:00	NaN	NaN	3.066857	3.320629	NaN
2020-05-06 00:00:00+00:00	NaN	NaN	NaN	-3.312003	NaN
2020-05-07 00:00:00+00:00	3.680420	NaN	NaN	NaN	NaN
2020-05-08 00:00:00+00:00	3.235958	NaN	NaN	NaN	NaN
2020-05-13 00:00:00+00:00	NaN	-3.135332	NaN	NaN	NaN
2020-05-18 00:00:00+00:00	NaN	NaN	NaN	3.270712	3.053267
2020-05-26 00:00:00+00:00	NaN	NaN	3.731386	3.066944	NaN
2020-06-08 00:00:00+00:00	3.284698	NaN	NaN	3.282560	NaN
2020-06-11 00:00:00+00:00	-3.989611	-3.932333	-4.145492	-4.650579	-4.855781
2020-10-20 00:00:00+00:00	NaN	NaN	NaN	NaN	3.098446
2020-10-21 00:00:00+00:00	NaN	NaN	NaN	NaN	3.225550
2020-11-09 00:00:00+00:00	5.117254	NaN	4.977505	6.463596	3.168918
2021-11-04 00:00:00+00:00	NaN	-3.988397	NaN	NaN	NaN
2022-04-22 00:00:00+00:00	NaN	-3.583928	NaN	NaN	NaN
2022-10-20 00:00:00+00:00	NaN	-7.165449	NaN	NaN	NaN
2023-01-19 00:00:00+00:00	NaN	-3.287207	NaN	NaN	NaN
2023-03-13 00:00:00+00:00	NaN	NaN	NaN	-3.012542	NaN
2023-03-17 00:00:00+00:00	NaN	-3.482255	NaN	NaN	NaN
2023-04-19 00:00:00+00:00	NaN	NaN	NaN	NaN	3.399864
2023-05-04 00:00:00+00:00	NaN	NaN	-3.598323	NaN	NaN
2023-05-05 00:00:00+00:00	3.037097	NaN	NaN	NaN	NaN
2023-07-20 00:00:00+00:00	NaN	3.193385	NaN	NaN	NaN
2023-08-02 00:00:00+00:00	NaN	-3.224259	NaN	NaN	NaN
2023-10-13 00:00:00+00:00	NaN	3.033860	NaN	NaN	NaN



Z-Scores:


Z-Scores Over Time
Z-Score
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0
−12.5
AIG
MET
PRU
ALL
TRV
Outlier Threshold (+3)
Outlier Threshold (-3)
2019
2020
2021
2022
2023
2024
Date

CAPM Analysis:

CAPM Results for PRU:

OLS Regression Results

Dep. Variable:	PRU	R-squared:	0.554
Model:	OLS	Adj. R-squared:	0.554
Method:	Least Squares	F-statistic:	1559.
Date:	Mon, 02 Dec 2024	Prob (F-statistic):	2.58e-222
Time:	12:32:08	Log-Likelihood:	3412.3
No. Observations:	1257	AIC:	-6821.
Df Residuals:	1255	BIC:	-6810.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.0564	0.001	38.056	0.000	0.054	0.059
^GSPC	1.3303	0.034	39.486	0.000	1.264	1.396

Omnibus:	227.131	Durbin-Watson:	2.068
Prob(Omnibus):	0.000	Jarque-Bera (JB):	3844.616
Skew:	0.285	Prob(JB):	0.00
Kurtosis:	11.549	Cond. No.	74.6

CAPM Results for MET:

OLS Regression Results

Dep. Variable:	MET	R-squared:	0.538
Model:	OLS	Adj. R-squared:	0.538
Method:	Least Squares	F-statistic:	1464.
Date:	Mon, 02 Dec 2024	Prob (F-statistic):	5.86e-213
Time:	12:32:08	Log-Likelihood:	3500.9
No. Observations:	1257	AIC:	-6998.
Df Residuals:	1255	BIC:	-6988.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.0511	0.001	36.986	0.000	0.048	0.054
^GSPC	1.2014	0.031	38.266	0.000	1.140	1.263

Omnibus:	119.534	Durbin-Watson:	1.948
Prob(Omnibus):	0.000	Jarque-Bera (JB):	771.102
Skew:	0.108	Prob(JB):	3.61e-168
Kurtosis:	6.831	Cond. No.	74.6

CAPM Results for AIG:

OLS Regression Results

Dep. Variable:	AIG	R-squared:	0.443
Model:	OLS	Adj. R-squared:	0.443
Method:	Least Squares	F-statistic:	998.1
Date:	Mon, 02 Dec 2024	Prob (F-statistic):	1.14e-161
Time:	12:32:08	Log-Likelihood:	3195.0
No. Observations:	1257	AIC:	-6386.
Df Residuals:	1255	BIC:	-6376.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.0539	0.002	30.578	0.000	0.050	0.057
^GSPC	1.2652	0.040	31.593	0.000	1.187	1.344

Omnibus:	172.523	Durbin-Watson:	1.938
Prob(Omnibus):	0.000	Jarque-Bera (JB):	1977.238
Skew:	0.121	Prob(JB):	0.00
Kurtosis:	9.139	Cond. No.	74.6

CAPM Analysis:

CAPM Results for ALL:

OLS Regression Results

Dep. Variable:	ALL	R-squared:	0.382
Model:	OLS	Adj. R-squared:	0.381
Method:	Least Squares	F-statistic:	774.3
Date:	Mon, 02 Dec 2024	Prob (F-statistic):	3.98e-133
Time:	12:32:08	Log-Likelihood:	3560.9
No. Observations:	1257	AIC:	-7118.
Df Residuals:	1255	BIC:	-7108.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.0356	0.001	27.025	0.000	0.033	0.038
^GSPC	0.8329	0.030	27.826	0.000	0.774	0.892

Omnibus:	293.791	Durbin-Watson:	1.974
Prob(Omnibus):	0.000	Jarque-Bera (JB):	3591.357
Skew:	-0.718	Prob(JB):	0.00
Kurtosis:	11.155	Cond. No.	74.6

CAPM Results for TRV:

OLS Regression Results

Dep. Variable:	TRV	R-squared:	0.374
Model:	OLS	Adj. R-squared:	0.373
Method:	Least Squares	F-statistic:	748.6
Date:	Mon, 02 Dec 2024	Prob (F-statistic):	1.19e-129
Time:	12:32:08	Log-Likelihood:	3568.2
No. Observations:	1257	AIC:	-7132.
Df Residuals:	1255	BIC:	-7122.
Df Model:	1		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.0348	0.001	26.545	0.000	0.032	0.037
^GSPC	0.8143	0.030	27.361	0.000	0.756	0.873

Omnibus:	271.905	Durbin-Watson:	2.165
Prob(Omnibus):	0.000	Jarque-Bera (JB):	4506.221
Skew:	-0.524	Prob(JB):	0.00
Kurtosis:	12.216	Cond. No.	74.6

Betas for All Stocks:

AIG: Beta = 1.2652, Alpha = 0.0539

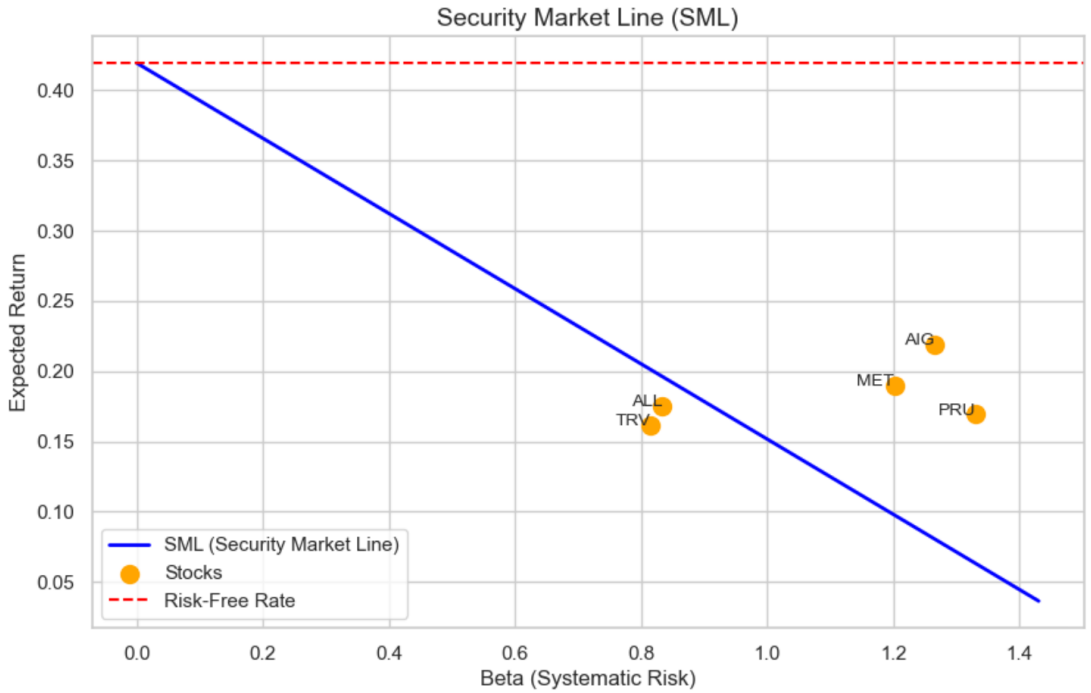
MET: Beta = 1.2014, Alpha = 0.0511

PRU: Beta = 1.3303, Alpha = 0.0564

ALL: Beta = 0.8329, Alpha = 0.0356

TRV: Beta = 0.8143, Alpha = 0.0348

Security Market Line:

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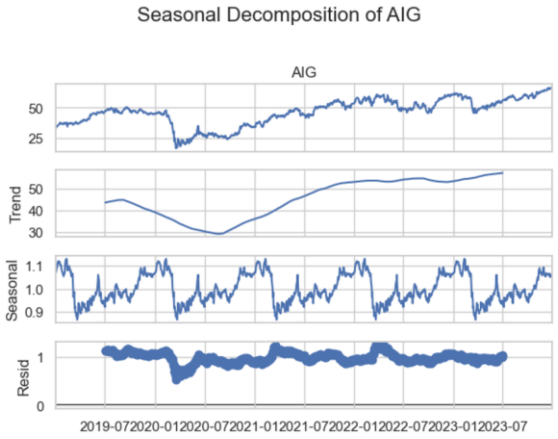
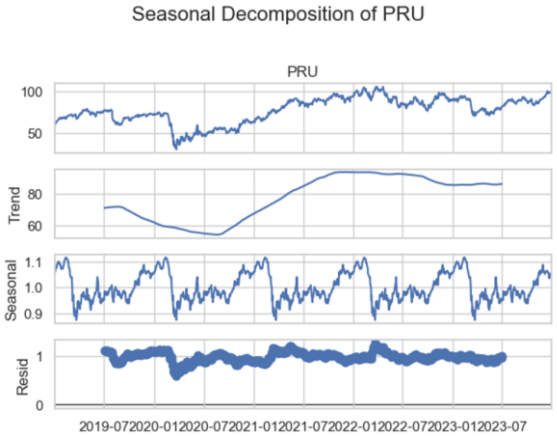
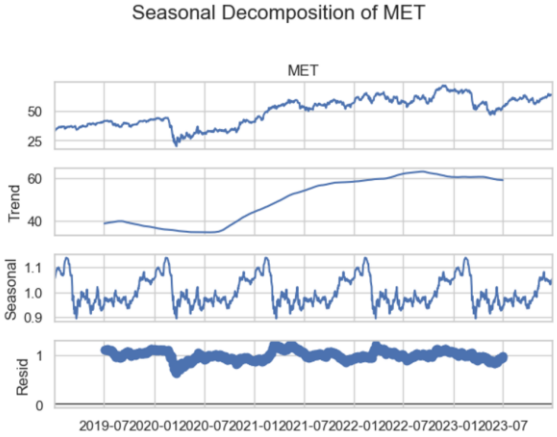
Sharpe Ratios:
Ticker
AIG     0.435642
ALL     0.462150
MET     0.423877
PRU     0.334266
TRV     0.421423
dtype: float64

Treynor Ratios:
AIG     0.172685
ALL     0.209839
MET     0.158047
PRU     0.127254
TRV     0.198468
dtype: float64
```

Decomposition:







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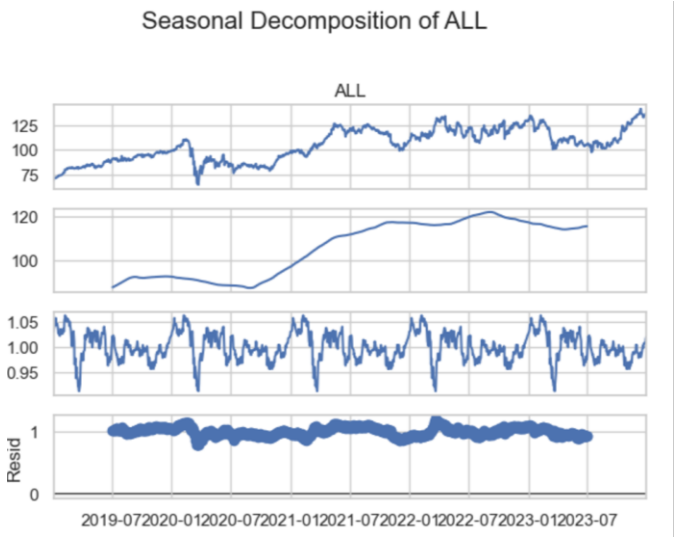
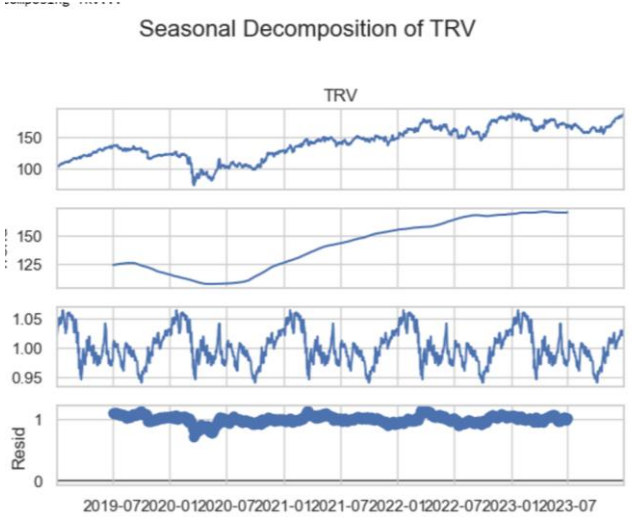
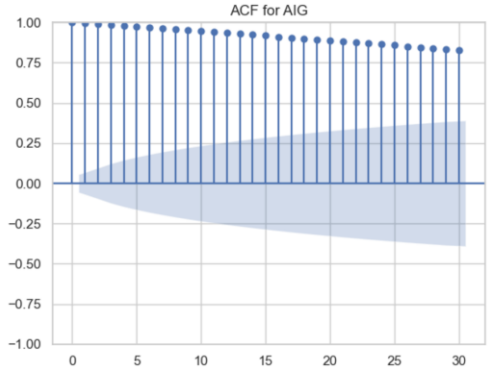
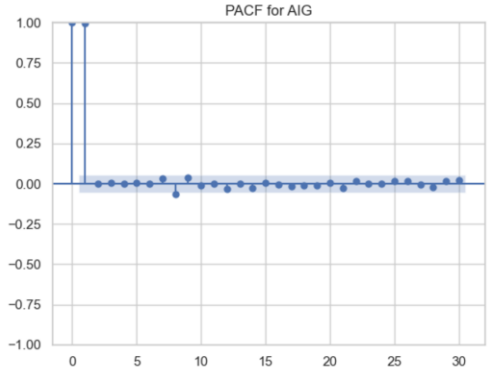




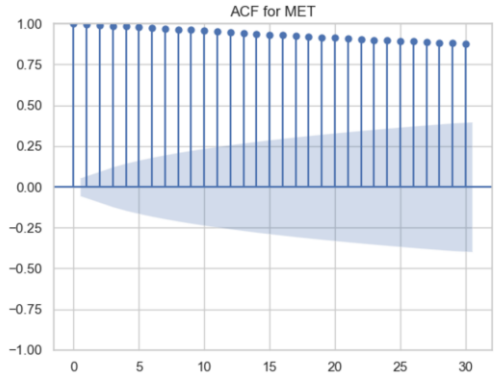
ACF and PACF:

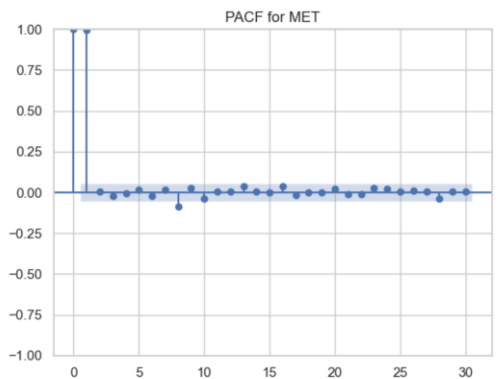
AIG:



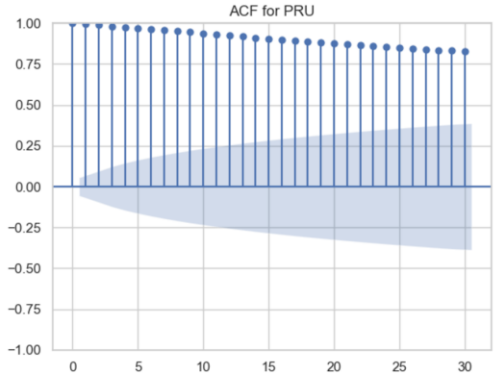


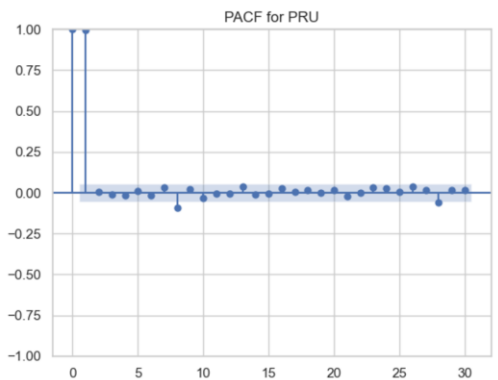
MET:





PRU:





ACF and PACF:

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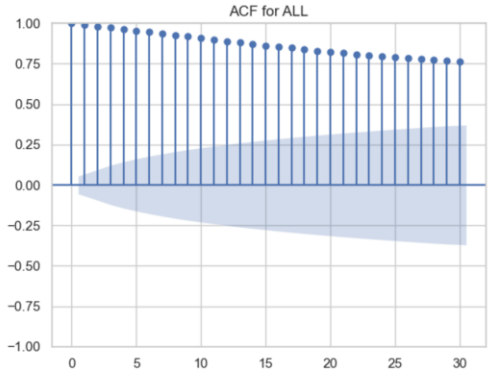

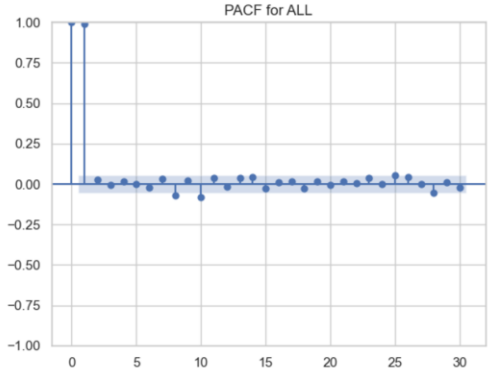

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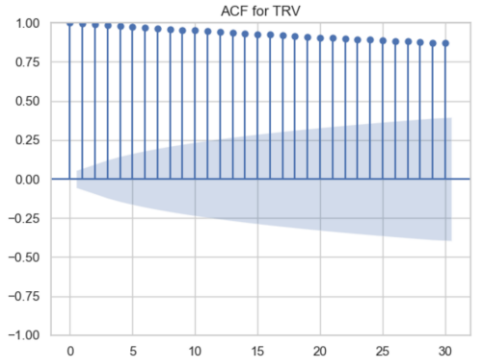

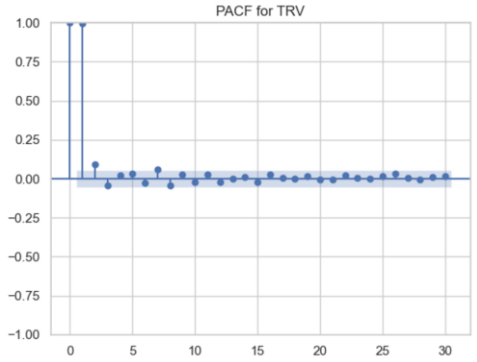

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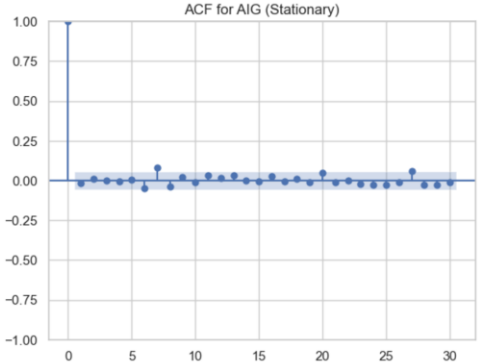
ACF for AIG (Stationary)
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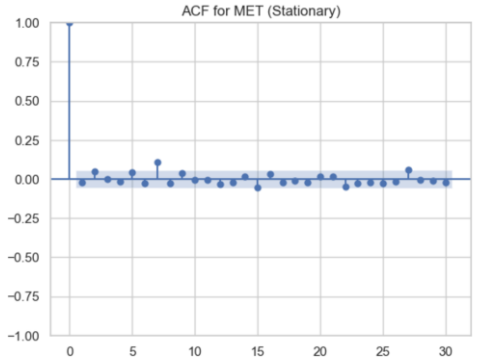
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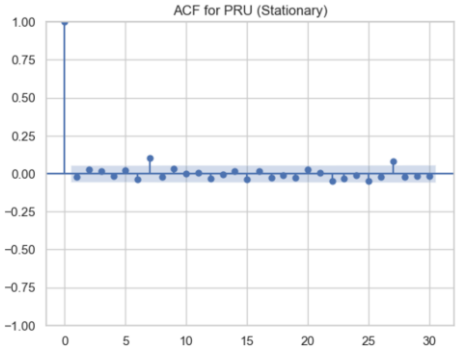
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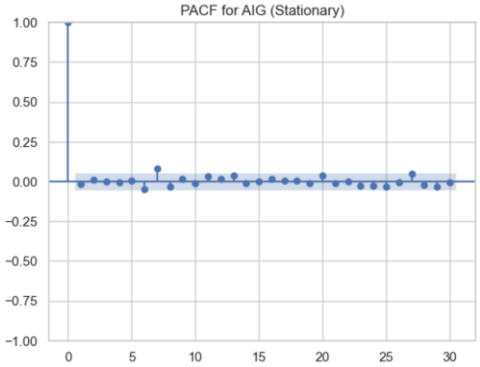
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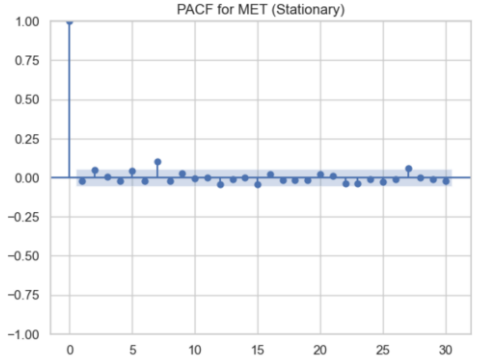
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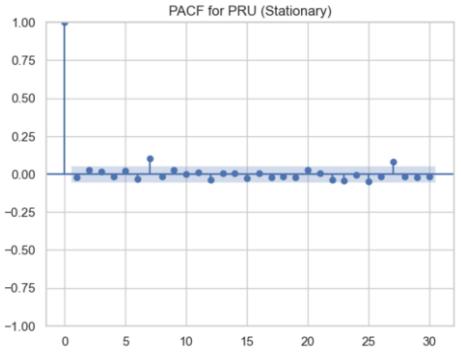
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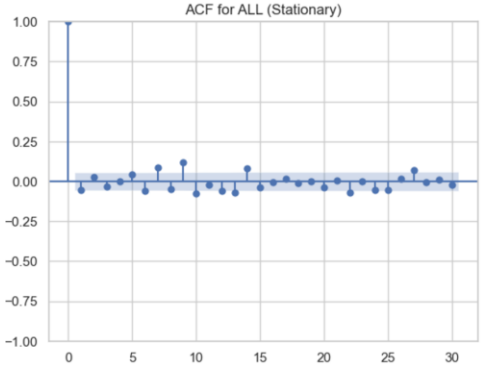
ACF and PACF: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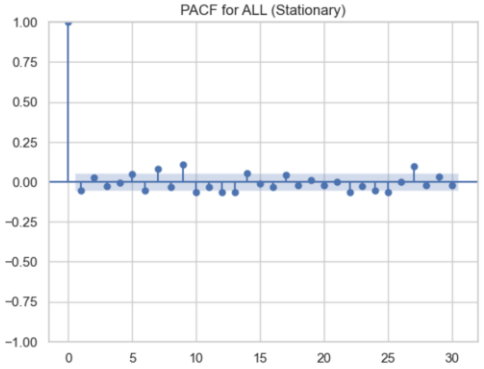
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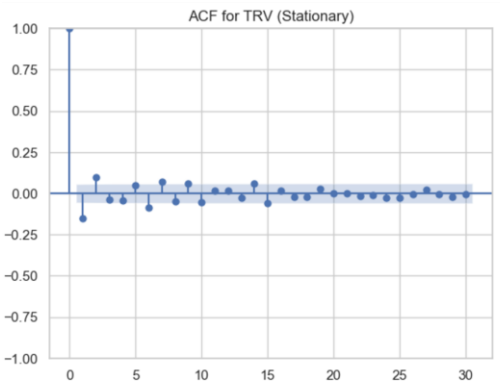
ACF for TRV (Stationary)
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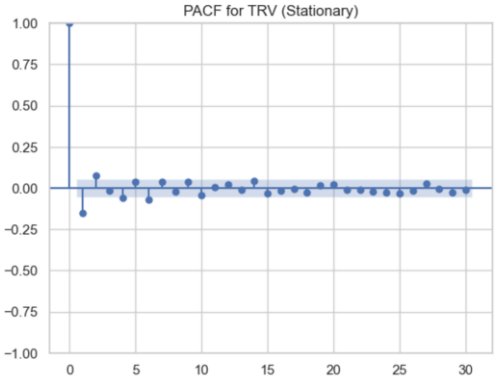
PACF for TRV (Stationary)
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10
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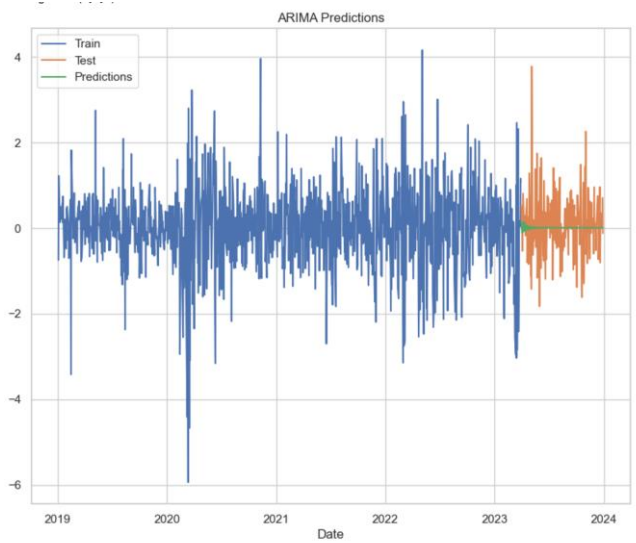
30

ARIMA Forecast:



parameters for AIG mae_ma mse_ma rmse_ma
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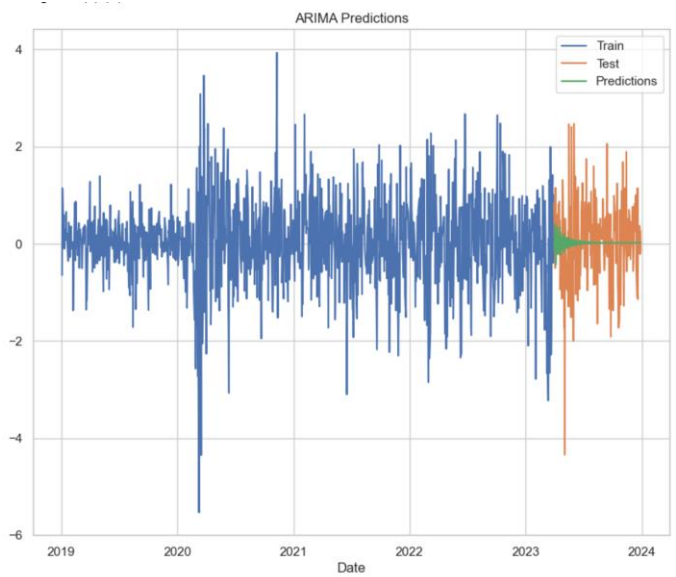
ARIMA Forecast:



parameters for MET mae_ma mse_ma rmse_ma
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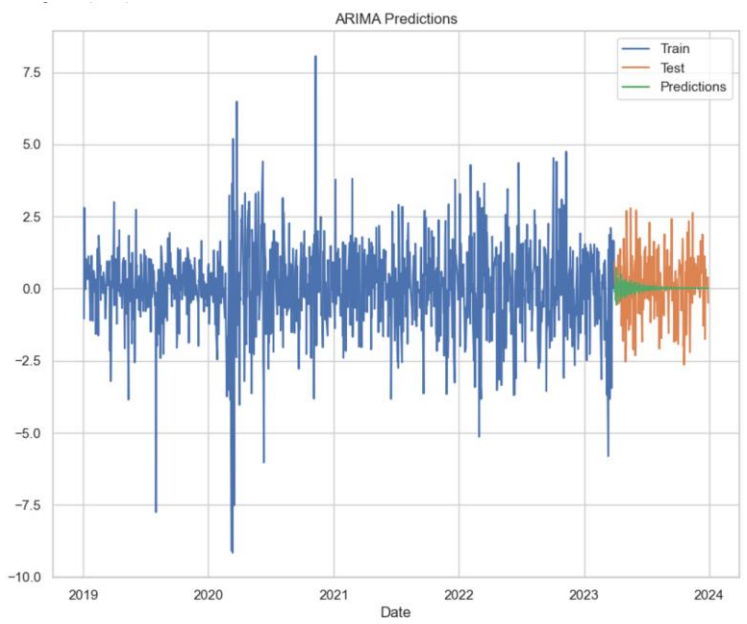
ARIMA Forecast:



parameters for PRU	mae_ma	mse_ma	rmse_ma
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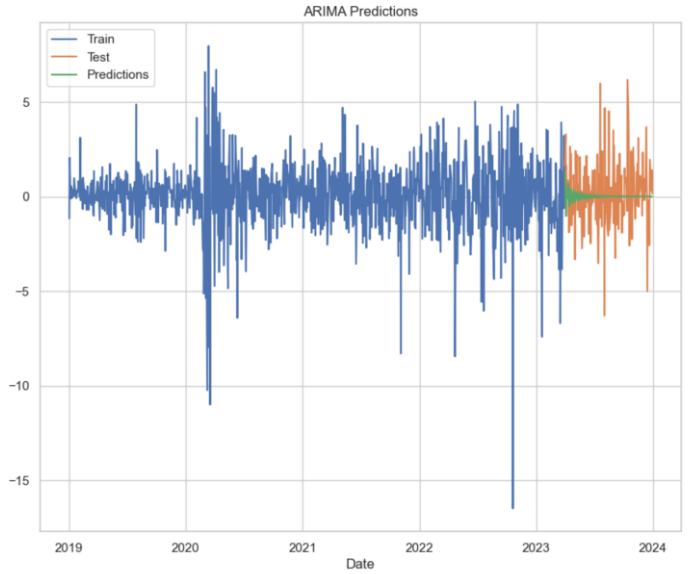
ARIMA Forecast:



parameters for ALL	mae_ma	mse_ma	rmse_ma
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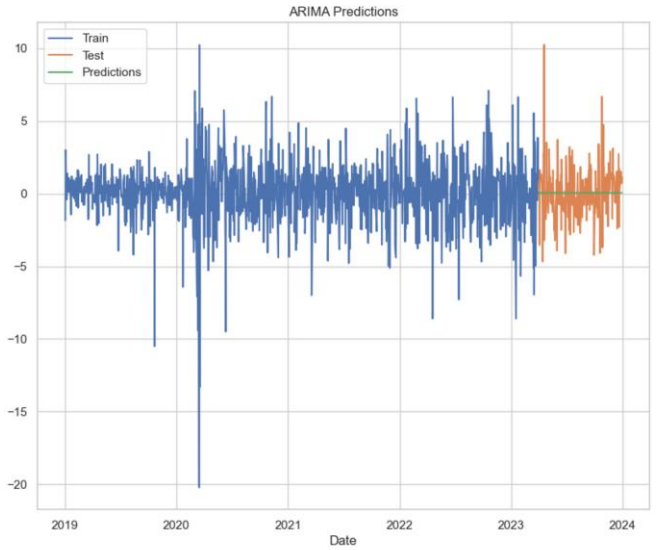
ARIMA Forecast:



parameters for TRV mae_ma mse_ma rmse_ma
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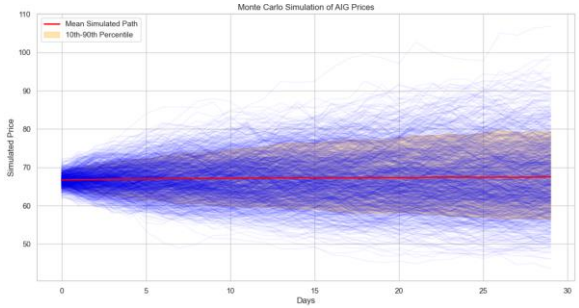
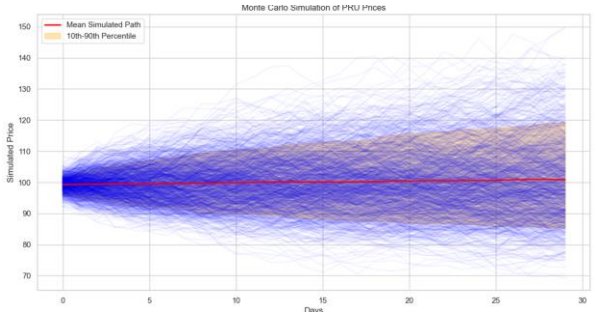
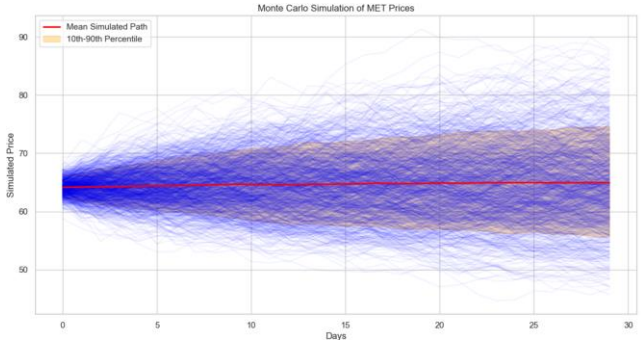
Monte Carlo Simulation:







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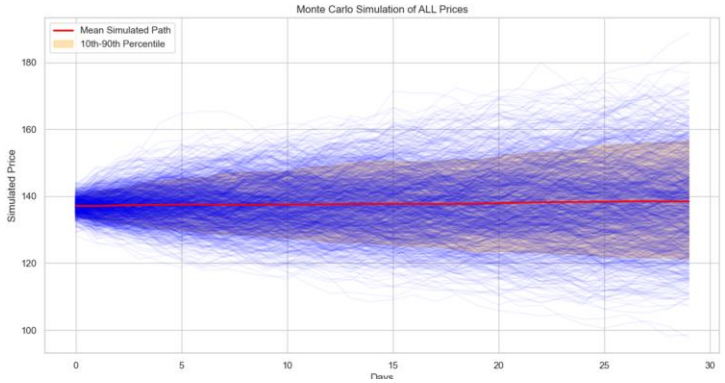
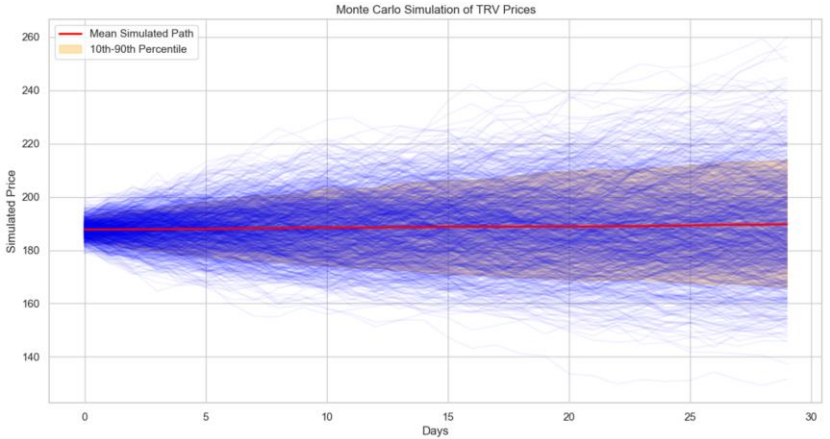
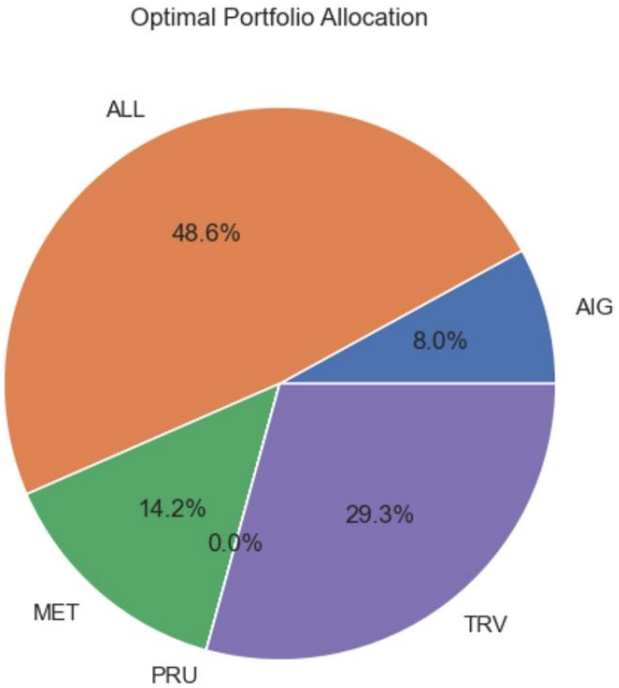
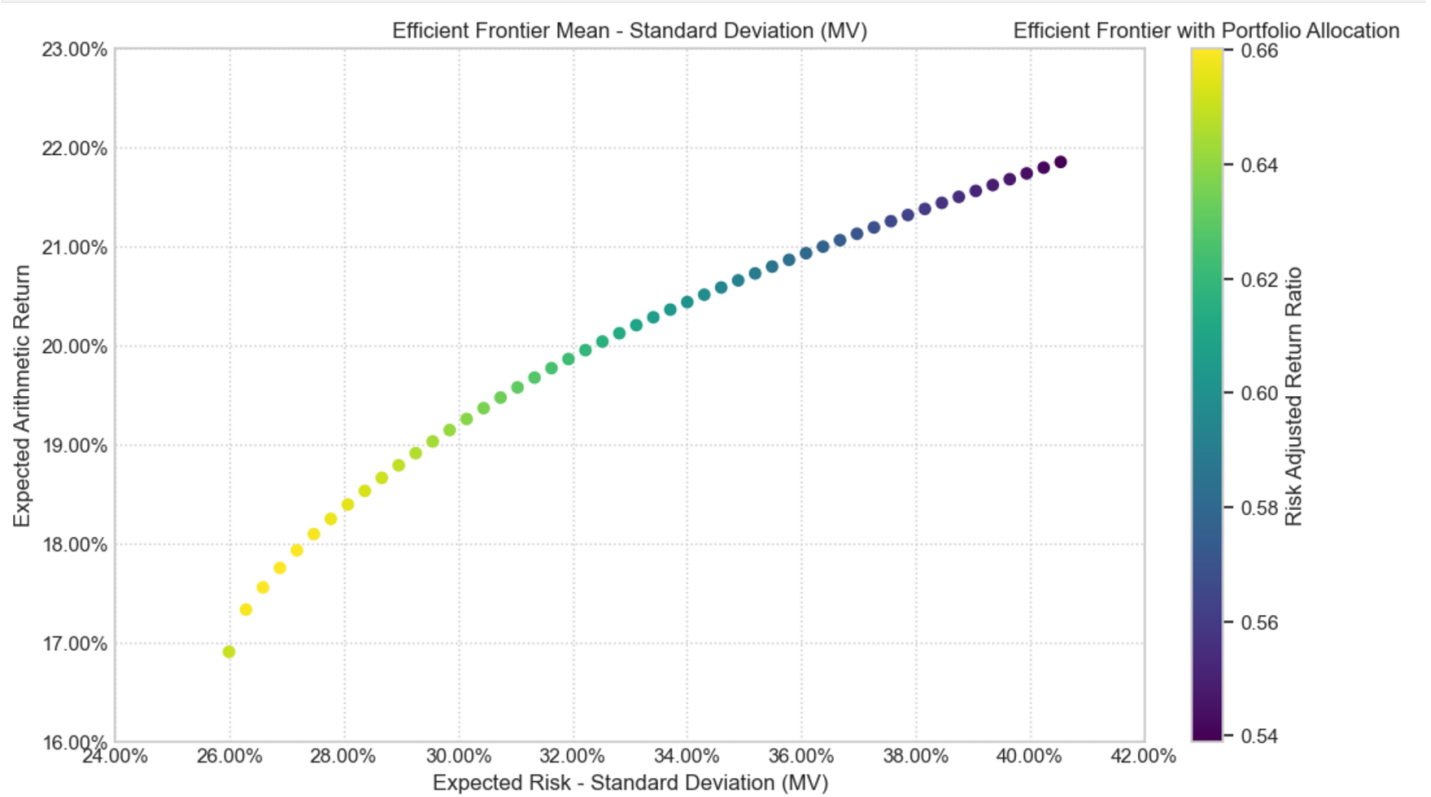




Portfolio Optimization:



Efficient Frontier:



Conclusion:

Volatility and Risk Analysis
AIG and MET exhibited higher volatility, making them suitable for aggressive investment strategies, while TRV displayed lower volatility, ideal for risk-averse investors.
Volatility spikes during 2020 highlighted significant market sensitivity to macroeconomic shocks.

Impact of Economic Trends
All stocks experienced recovery trends post-2020 crash, with TRV and ALL demonstrating resilience.
Long-term growth trajectories reflect alignment with industry benchmarks.

CAPM Analysis
AIG and MET are undervalued according to the SML, promising more than expected returns for their beta.
TRV and PRU show overvaluation or inefficiencies in the market and should be invested in with care.

Risk-Adjusted Returns
Sharpe and Treynor ratios confirm ALL as the most efficient in risk-adjusted performance.
High Sharpe ratios in AIG and MET indicate good returns in relation to their risks.

Portfolio Analysis Using Modern Portfolio Theory (MPT)
The efficient frontier analysis underlines the benefits of diversification by balancing high-beta stocks with stable performers.
Aggressive portfolio strategies are dominated by AIG and MET, while TRV and ALL provide the supporting defense.

Conclusion:

- AIG and MET are promising stocks to deliver higher risk-adjusted returns and could be used by investors seeking growth-oriented portfolios.
- TRV and ALL help balance portfolios due to lower volatility, hence offering stability during times of economic turmoil.
- Rebalancing: Periodically review and rebalance such portfolios in line with changeable market dynamics, especially for stocks with high beta.
- Correlation Management: Implement insights from correlation analysis to steer clear of overexposure to strongly correlated stocks to minimize systemic risk.
- Market Hedging: Utilize TRV and ALL as defensive investments, in particular during market downturns, to protect portfolio value.

Thank You!!