Analysis of Treasury Yield Curve in Relation to Macroeconomic indicators

Group 8: The Treasurer

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Significance of the Problem

- As a **benchmark** for risk-free returns, movements in Treasury bills reflect investor sentiment and economic conditions. Understanding their relationship with key economic indicators can provide insights into **market dynamics and monetary policy effects**.

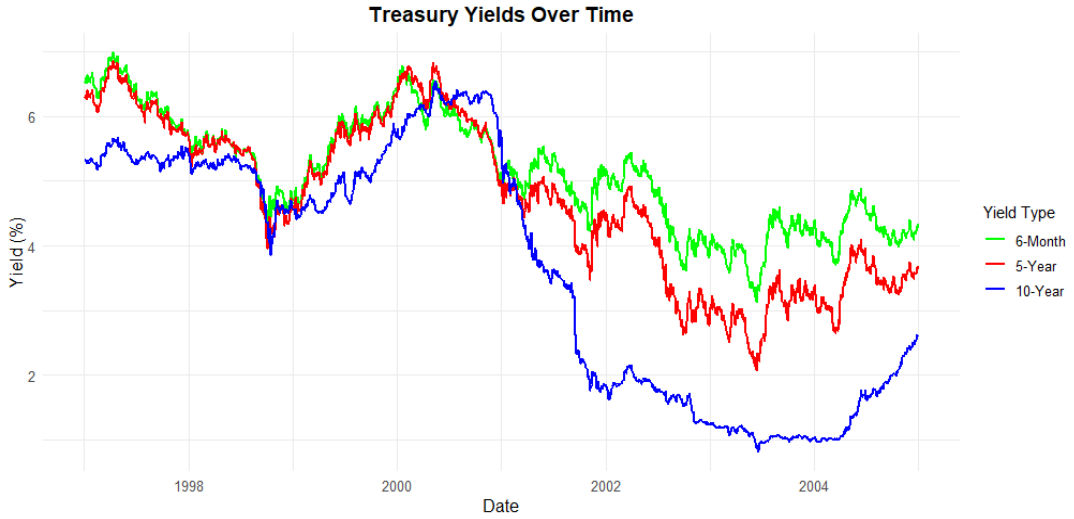
Workflow

- DATA COLLECTION
- EXPLORATORY DATA ANALYSIS (EDA)
- CORRELATION ANALYSIS
- REGRESSION ANALYSIS
- MODEL SUMMARY AND INTERPRETATION

The Dot-Com Bubble: Rise and Fall

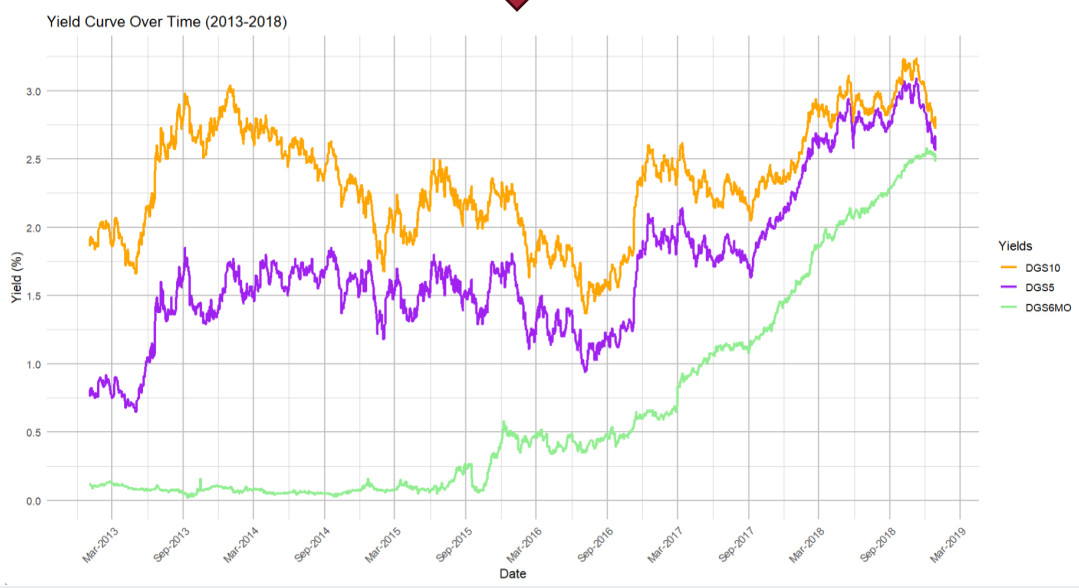
1997 - 2004

Treasury Yield During Dot-Com Bubble



- Period : 1997 – 2004
- "Yields show sharp movements during the dot-com bubble, with a significant drop in the early 2000s."(market instability)

- Period : 2013 – 2018
- "Post-financial crisis, Treasury yields rise steadily, reflecting economic recovery and Fed's gradual rate hikes".

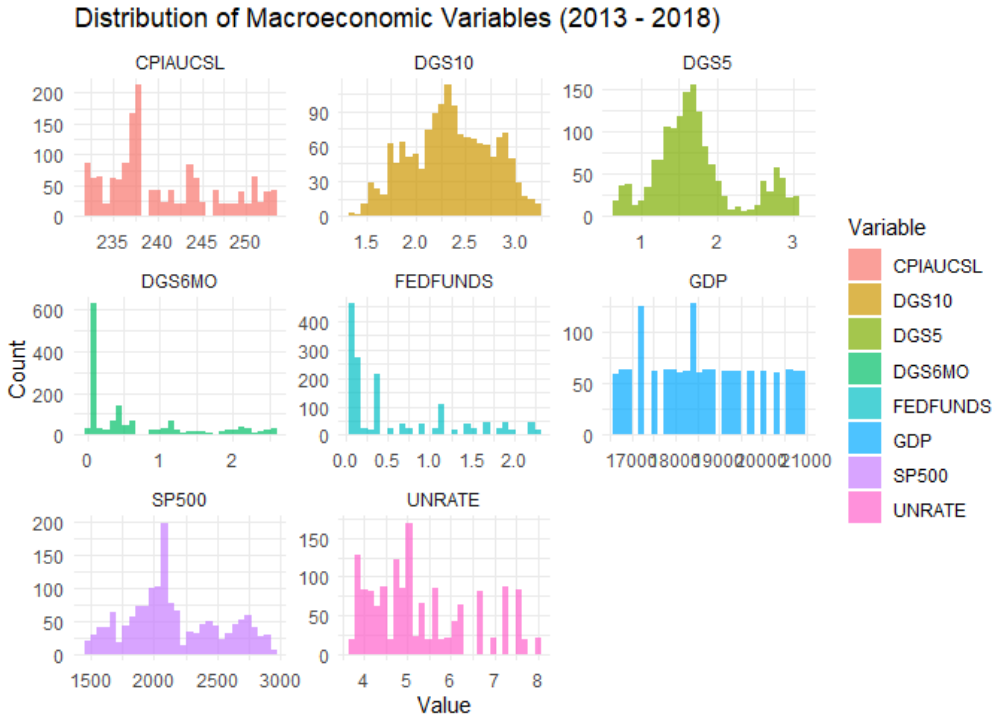


Data Sources and Preprocessing

- Sources
  - FRED
  - Yahoo Finance

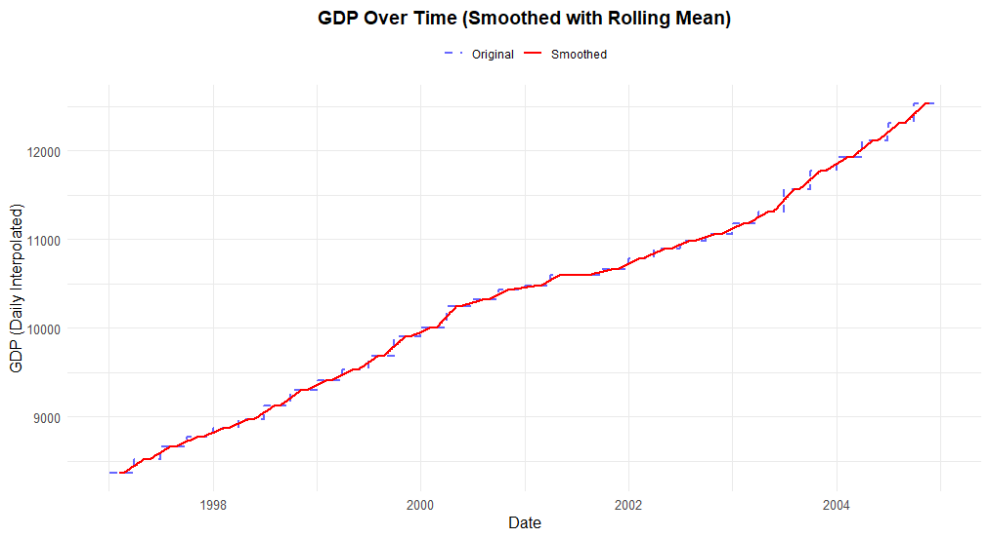
```
> summary(data)
      date             GSPC.Adjusted       DGS6MO           DGS5           DGS10
 Min.   :1997-01-02   Min.   : 737.0   Min.   :0.820   Min.   :2.080   Min.   :3.130
 1st Qu.:1998-12-30   1st Qu.: 975.2   1st Qu.:1.710   1st Qu.:3.520   1st Qu.:4.380
 Median :2000-12-26   Median :1117.7   Median :4.515   Median :4.780   Median :5.160
 Mean   :2000-12-29   Mean   :1124.8   Mean   :3.677   Mean   :4.734   Mean   :5.153
 3rd Qu.:2002-12-31   3rd Qu.:1272.5   3rd Qu.:5.322   3rd Qu.:5.830   3rd Qu.:5.860
 Max.   :2004-12-30   Max.   :1527.5   Max.   :6.550   Max.   :6.860   Max.   :6.980
   GDP_Daily     Inflation_Daily FedFunds_Daily  Unemployment_Daily
 Min.   : 8363   Min.   :159.4   Min.   :0.980   Min.   :3.80
 1st Qu.: 9294   1st Qu.:164.4   1st Qu.:1.730   1st Qu.:4.30
 Median :10436   Median :174.6   Median :4.760   Median :4.90
 Mean   :10338   Mean   :174.0   Mean   :3.762   Mean   :4.96
 3rd Qu.:11090   3rd Qu.:182.0   3rd Qu.:5.510   3rd Qu.:5.70
 Max.   :12527   Max.   :191.7   Max.   :6.540   Max.   :6.30
```

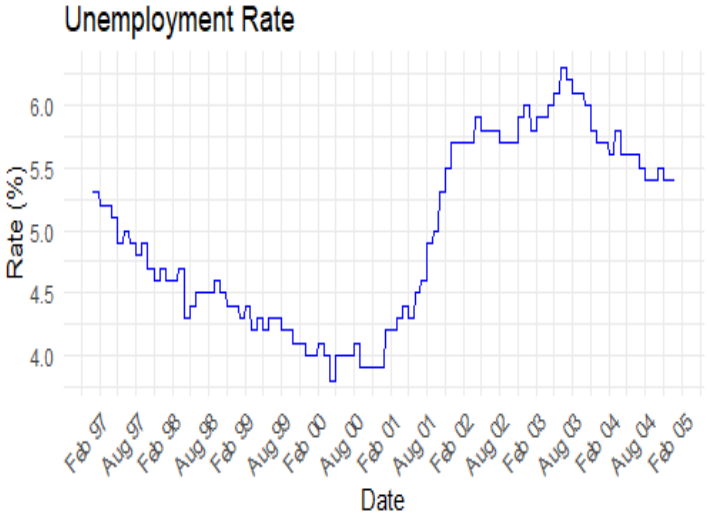
```
> head(data)
        date GSPC.Adjusted DGS6MO DGS5 DGS10 GDP_Daily Inflation_Daily FedFunds_Daily
1 1997-01-02        737.01   5.35 6.30  6.54  8362.655           159.4           5.25
2 1997-01-03        748.03   5.34 6.28  6.52  8362.655           159.4           5.25
3 1997-01-06        747.65   5.31 6.30  6.54  8362.655           159.4           5.25
4 1997-01-07        753.23   5.30 6.32  6.57  8362.655           159.4           5.25
5 1997-01-08        748.41   5.30 6.34  6.60  8362.655           159.4           5.25
6 1997-01-09        754.85   5.27 6.27  6.52  8362.655           159.4           5.25
  Unemployment_Daily
1                5.3
2                5.3
3                5.3
4                5.3
5                5.3
6                5.3
```

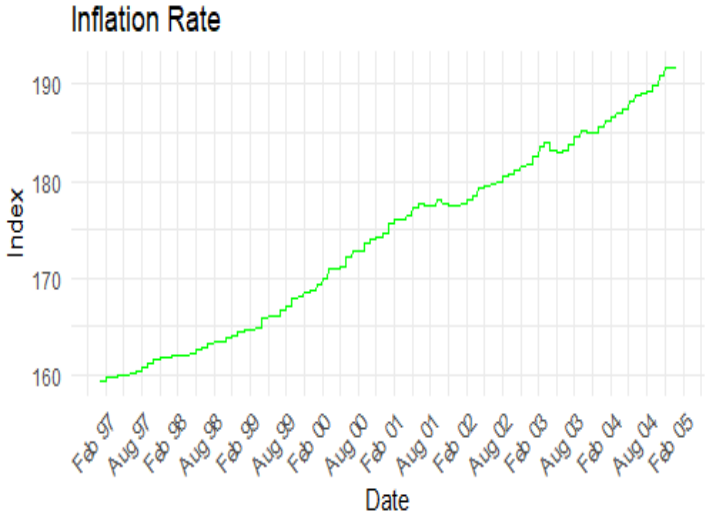


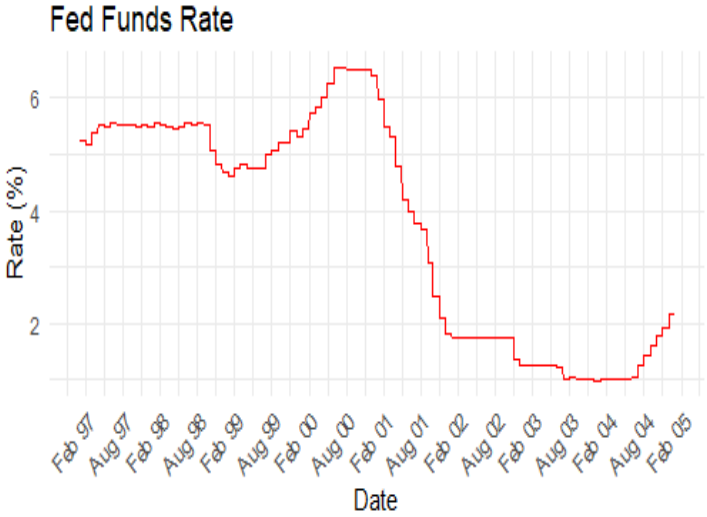
Macroeconomic Indicators Insights

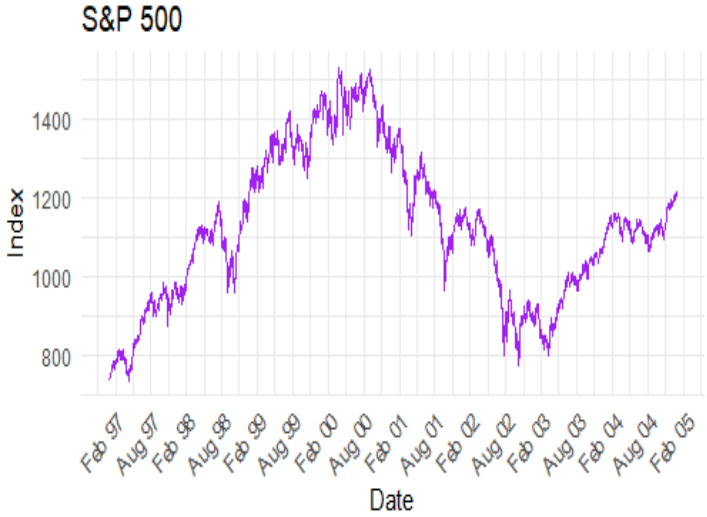
- S&P500
- GDP
- Inflation
- Fed Funds Rate
- Unemployment





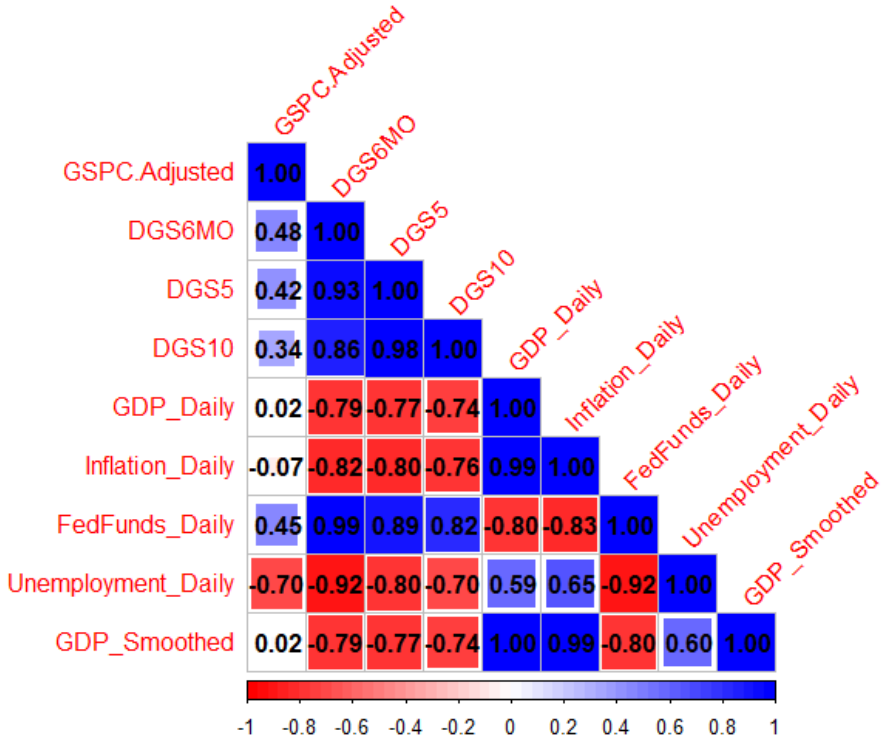




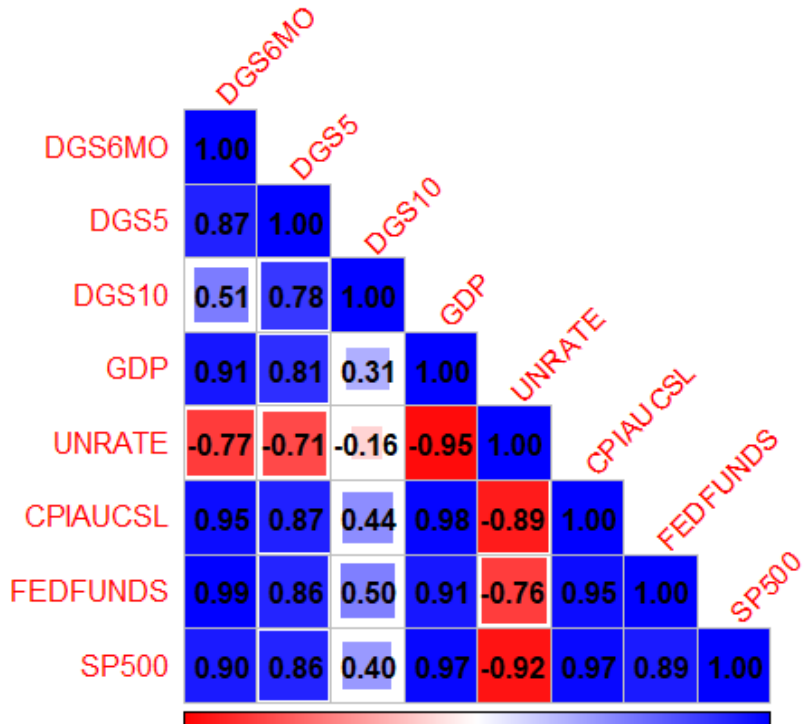


Correlation Matrix

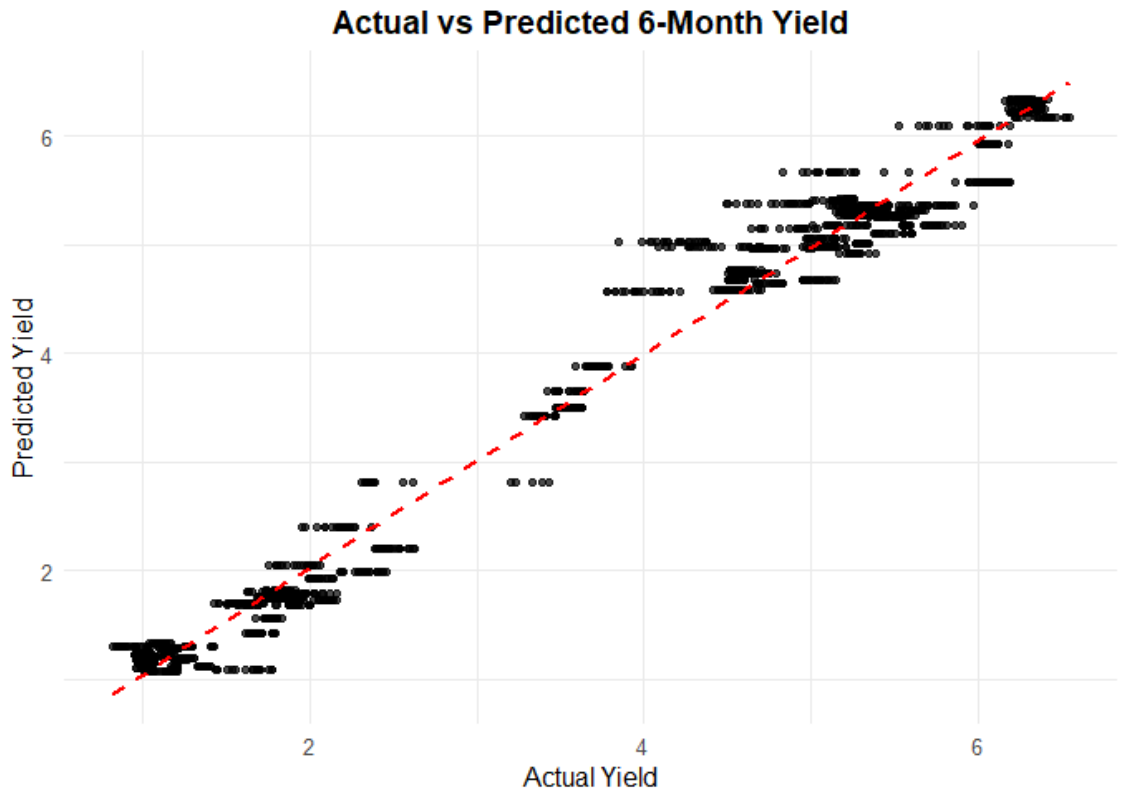
1997-2004



2003-2018



REGRESSION MODEL : OVER 6 MONTHS TREASURY YEILD



- **Strong Alignment:** Predicted and actual values align closely along the diagonal, indicating a strong predictive performance for short-term yields.

- **Minimal Deviation:** Few outliers are observed, suggesting lower variability and strong model fit for 6-month maturities.

Model Summary – Part I 6 - Month Comparison

DGS6MO ~ GDP_Daily + Inflation_Daily + FedFunds_Daily + Unemployment_Daily

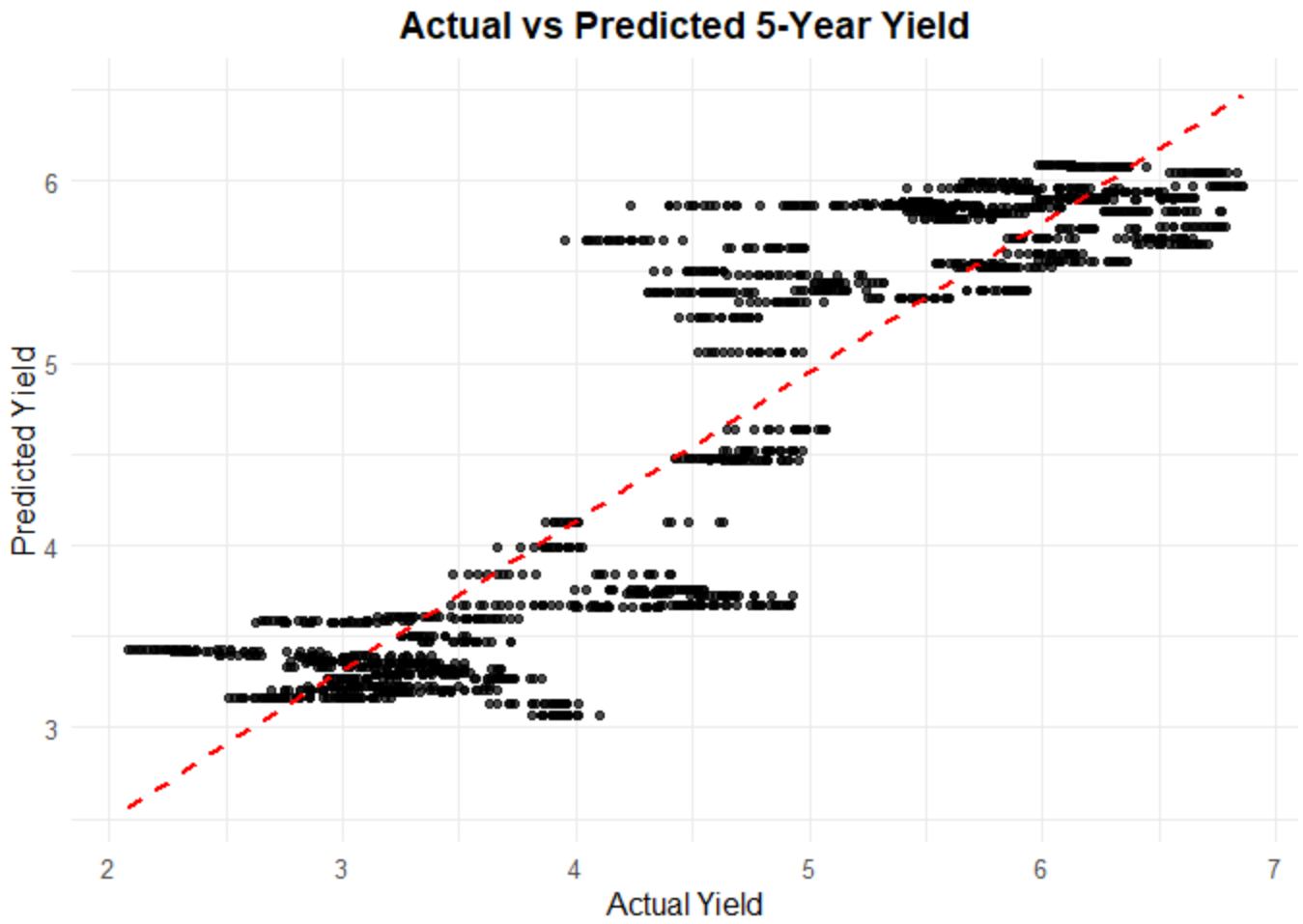
```
Call:
lm(formula = DGS6MO ~ GDP_Daily + Inflation_Daily + FedFunds_Daily +
    Unemployment_Daily, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.18427 -0.12601 -0.01136  0.13305  0.71458

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)         8.267e+00  5.458e-01  15.147  < 2e-16 ***
GDP_Daily           8.293e-04  5.254e-05  15.784  < 2e-16 ***
Inflation_Daily    -1.012e-01  6.332e-03 -15.985  < 2e-16 ***
FedFunds_Daily      9.735e-01  1.182e-02  82.364  < 2e-16 ***
Unemployment_Daily  1.589e-01  2.692e-02   5.903 4.19e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2512 on 1991 degrees of freedom
Multiple R-squared:  0.9828,    Adjusted R-squared:  0.9828
F-statistic: 2.852e+04 on 4 and 1991 DF,  p-value: < 2.2e-16
```

R-squared: 98 %

```
Call:
lm(formula = DGS6MO ~ GDP_Lag1 + UNRATE_Lag1 + FEDFUNDS_Lag1 +
    CPIAUCSL_Lag1 + SP500_Lag1, data = all_data_lagged)

Residuals:
     Min       1Q   Median       3Q      Max
-1.43499 -0.10190  0.03936  0.14006  0.83643

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)    9.046e+00  7.128e-01  12.690  < 2e-16 ***
GDP_Lag1      -3.836e-04  5.139e-05  -7.465 1.56e-13 ***
UNRATE_Lag1    4.567e-02  9.044e-03   5.050 5.08e-07 ***
FEDFUNDS_Lag1  9.025e-01  1.930e-02  46.755  < 2e-16 ***
CPIAUCSL_Lag1 -1.655e-02  4.961e-03  -3.336 0.000875 ***
SP500_Lag1    -1.263e-04  1.045e-04  -1.209 0.227073
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2612 on 1251 degrees of freedom
Multiple R-squared:  0.9848,    Adjusted R-squared:  0.9848
F-statistic: 1.624e+04 on 5 and 1251 DF,  p-value: < 2.2e-16
```

R-squared: 98 %

REGRESSION MODEL : OVER 5 YEARS TREASURY YEILD



- **Moderate Fit:** While the trend aligns with the diagonal, there is increased scatter compared to the 6-month yield, indicating moderate prediction accuracy for medium-term yields.

- **Clustered Variability:** Notable clusters of deviation from the diagonal suggest the need for refinement in modeling medium-term dynamics.

Model Summary – Part II [5 - Year Maturity]

DGS6MO ~ GDP_Daily + Inflation_Daily + FedFunds_Daily + Unemployment_Daily

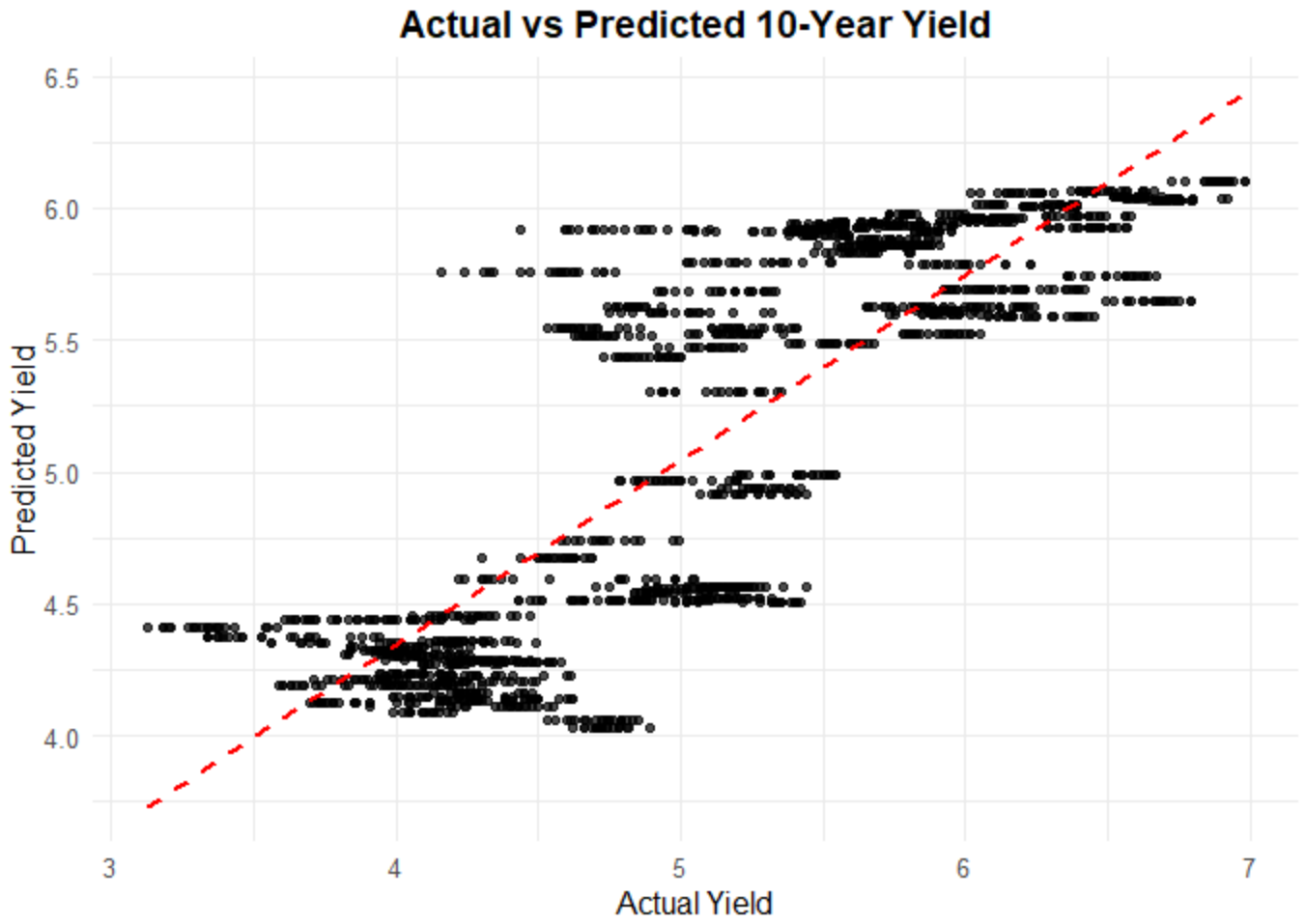
```
5-Year Treasury Yield Regression Summary:
> print(summary_5yr)

Call:
lm(formula = DGS5 ~ GDP_Daily + Inflation_Daily + FedFunds_Daily +
    Unemployment_Daily, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.72325 -0.33364 -0.00605  0.36805  1.24536

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)       12.8143156  1.1630330  11.018  < 2e-16 ***
GDP_Daily          0.0006561  0.0001120   5.860 5.41e-09 ***
Inflation_Daily   -0.1040467  0.0134940  -7.711 1.96e-14 ***
FedFunds_Daily     0.5272810  0.0251861  20.935  < 2e-16 ***
Unemployment_Daily 0.2536438  0.0573667   4.421 1.03e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.5353 on 1991 degrees of freedom
Multiple R-squared:  0.817,     Adjusted R-squared:  0.8166
F-statistic:  2222 on 4 and 1991 DF,  p-value: < 2.2e-16
```

R-squared: 81 %

```
Call:
lm(formula = DGS5 ~ GDP + UNRATE + CPIAUCSL + FEDFUNDS, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.66432 -0.16235  0.06502  0.19246  0.56905

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.988e+01  1.617e+00 -12.297  < 2e-16 ***
GDP         -6.581e-04  6.006e-05 -10.957  < 2e-16 ***
UNRATE      -2.099e-01  3.668e-02  -5.722 1.27e-08 ***
CPIAUCSL     1.448e-01  7.129e-03  20.306  < 2e-16 ***
FEDFUNDS     3.024e-01  5.038e-02   6.003 2.42e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2496 on 1504 degrees of freedom
Multiple R-squared:  0.7976,    Adjusted R-squared:  0.7971
F-statistic:  1482 on 4 and 1504 DF,  p-value: < 2.2e-16
```

R-squared: 79 %

REGRESSION MODEL : OVER 10 YEARS TREASURY YEILD



- **Higher Dispersion:** The scatter widens significantly, indicating less accurate predictions for long-term yields compared to shorter maturities.
- **Systematic Pattern:** The consistent deviation at higher yield levels implies potential biases in the model for long-term projections.

Model Summary – Part III [10 - Year Maturity]

DGS6MO ~ GDP_Daily + Inflation_Daily + FedFunds_Daily + Unemployment_Daily

```
10-Year Treasury Yield Regression Summary:
> print(summary_10yr)

Call:
lm(formula = DGS10 ~ GDP_Daily + Inflation_Daily + FedFunds_Daily +
    Unemployment_Daily, data = regression_data)

Residuals:
    Min      1Q  Median      3Q     Max
-1.6002 -0.3109 -0.0023  0.3555  1.1392

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)         9.422e+00  1.038e+00   9.081  < 2e-16 ***
GDP_Daily           3.615e-04  9.988e-05   3.620 0.000302 ***
Inflation_Daily    -6.360e-02  1.204e-02  -5.284 1.41e-07 ***
FedFunds_Daily      3.775e-01  2.247e-02  16.800  < 2e-16 ***
Unemployment_Daily  3.309e-01  5.118e-02   6.466 1.26e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.4775 on 1991 degrees of freedom
Multiple R-squared:  0.7015,    Adjusted R-squared:  0.7009
F-statistic:  1170 on 4 and 1991 DF,  p-value: < 2.2e-16
```

R-squared: 70 %

```
Residual standard error: 0.2496 on 1504 degrees of freedom
Multiple R-squared:  0.7976,    Adjusted R-squared:  0.7971
F-statistic:  1482 on 4 and 1504 DF,  p-value: < 2.2e-16


Call:
lm(formula = DGS10 ~ GDP + UNRATE + CPIAUCSL + FEDFUNDS, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.76794 -0.15398  0.06439  0.18736  0.58546

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -2.383e+01  1.804e+00 -13.205  < 2e-16 ***
GDP         -1.044e-03  6.701e-05 -15.585  < 2e-16 ***
UNRATE      -1.266e-01  4.092e-02  -3.094  0.00201 **
CPIAUCSL     1.920e-01  7.955e-03  24.133  < 2e-16 ***
FEDFUNDS     2.625e-01  5.621e-02   4.670 3.28e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2785 on 1504 degrees of freedom
Multiple R-squared:  0.5422,    Adjusted R-squared:  0.541
F-statistic: 445.3 on 4 and 1504 DF,  p-value: < 2.2e-16
```

R-squared: 54 %

Key Comparison:

Between two time periods

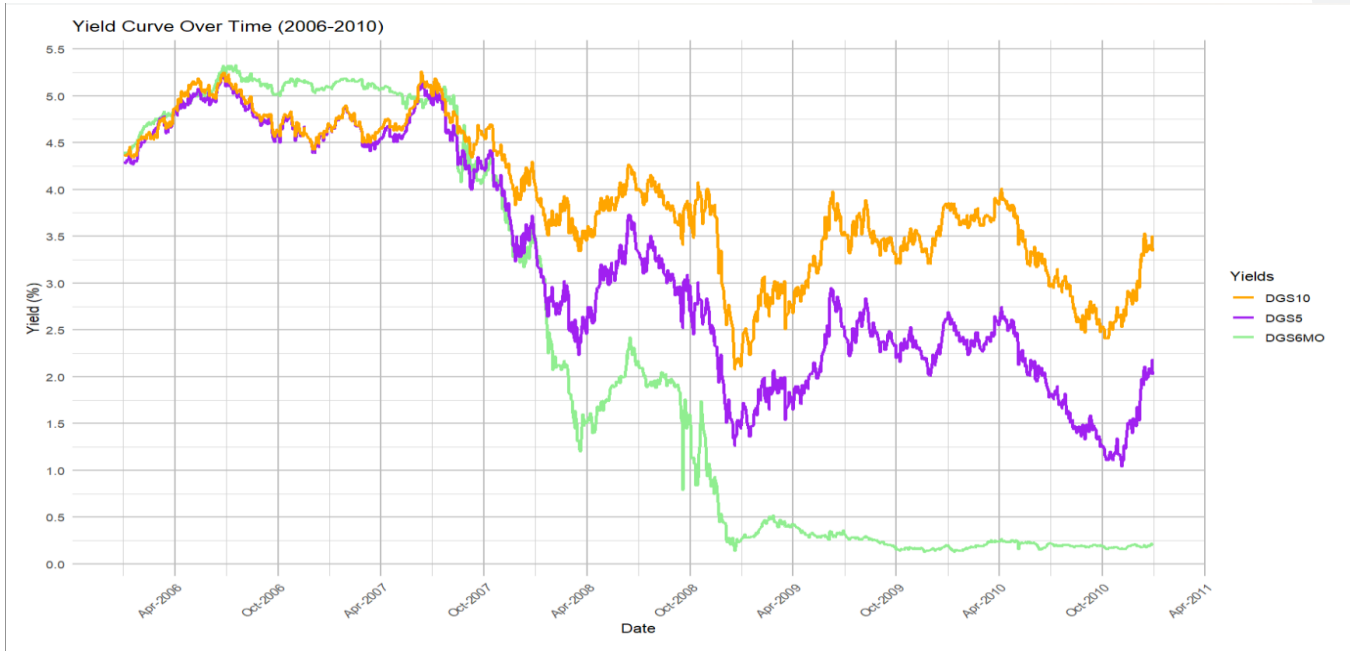
- 1997 - 2004 and 2013 - 2018

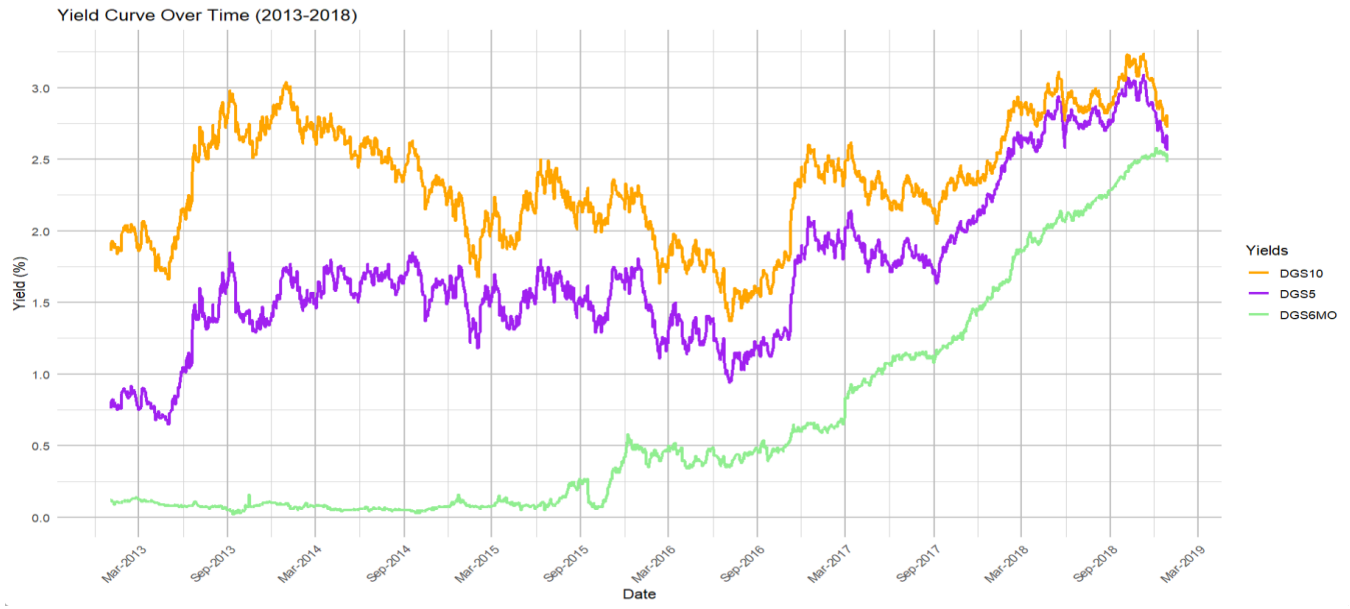
- **Predictive Power (R^2):** The 1997-2004 period has consistently higher R^2 for all models except the 6-month yields, indicating better fit and stronger relationships in this earlier period.

- **Fed Funds Rate Influence:** The Fed Funds Rate is the strongest predictor across all timeframes and maturities but has a slightly larger effect in the 1997-2004 data.

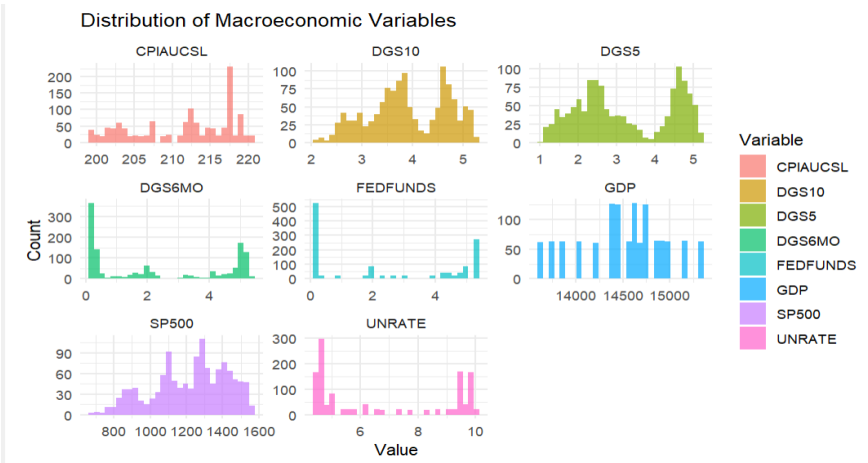
- **Long-Term Yields (10-Year):** The 1997-2004 model explains 70% of variance ($R^2 = 0.7015$), while the 2013-2018 model only captures 54% ($R^2 = 0.5422$), suggesting a more stable relationship with predictors in the earlier period.

2008 Financial Crisis: Insights from Treasury Yield Movements





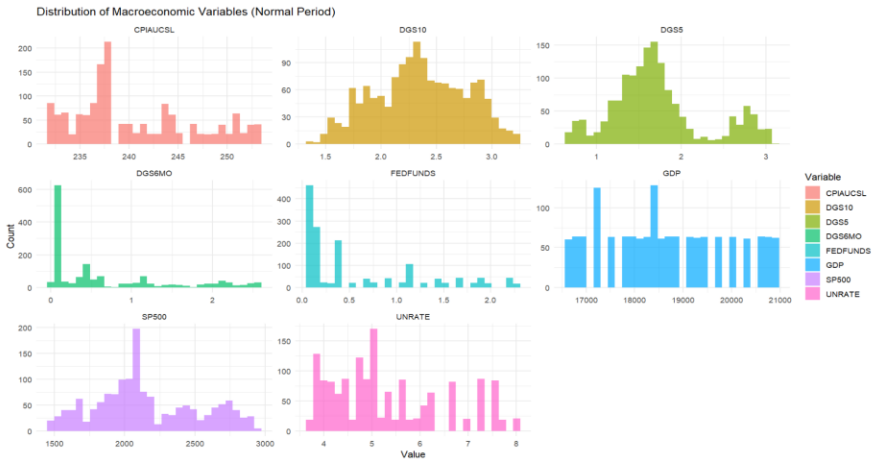
Dataset and Exploratory Data Analysis (EDA)




```
      Date                DGS6MO            DGS5            DGS10            GDP
 Min.   :2006-01-03   Min.   :0.130   Min.   :1.040   Min.   :2.080   Min.   :13599
 1st Qu.:2007-04-04   1st Qu.:0.240   1st Qu.:2.232   1st Qu.:3.393   1st Qu.:14381
 Median :2008-07-02   Median :1.835   Median :2.900   Median :3.840   Median :14608
 Mean   :2008-07-02   Mean   :2.344   Mean   :3.218   Mean   :3.912   Mean   :14519
 3rd Qu.:2009-09-30   3rd Qu.:4.930   3rd Qu.:4.560   3rd Qu.:4.630   3rd Qu.:14866
 Max.   :2010-12-30   Max.   :5.330   Max.   :5.230   Max.   :5.260   Max.   :15309
     UNRATE          CPIAUCSL        FEDFUNDS         SP500
 Min.   : 4.400   Min.   :199.3   Min.   :0.110   Min.   : 676.5
 1st Qu.: 4.700   1st Qu.:205.9   1st Qu.:0.180   1st Qu.:1083.5
 Median : 5.800   Median :212.7   Median :2.000   Median :1261.2
 Mean   : 6.787   Mean   :211.4   Mean   :2.446   Mean   :1218.8
 3rd Qu.: 9.500   3rd Qu.:217.3   3rd Qu.:4.990   3rd Qu.:1387.1
 Max.   :10.000   Max.   :220.5   Max.   :5.260   Max.   :1565.2
```

2006 to 2010

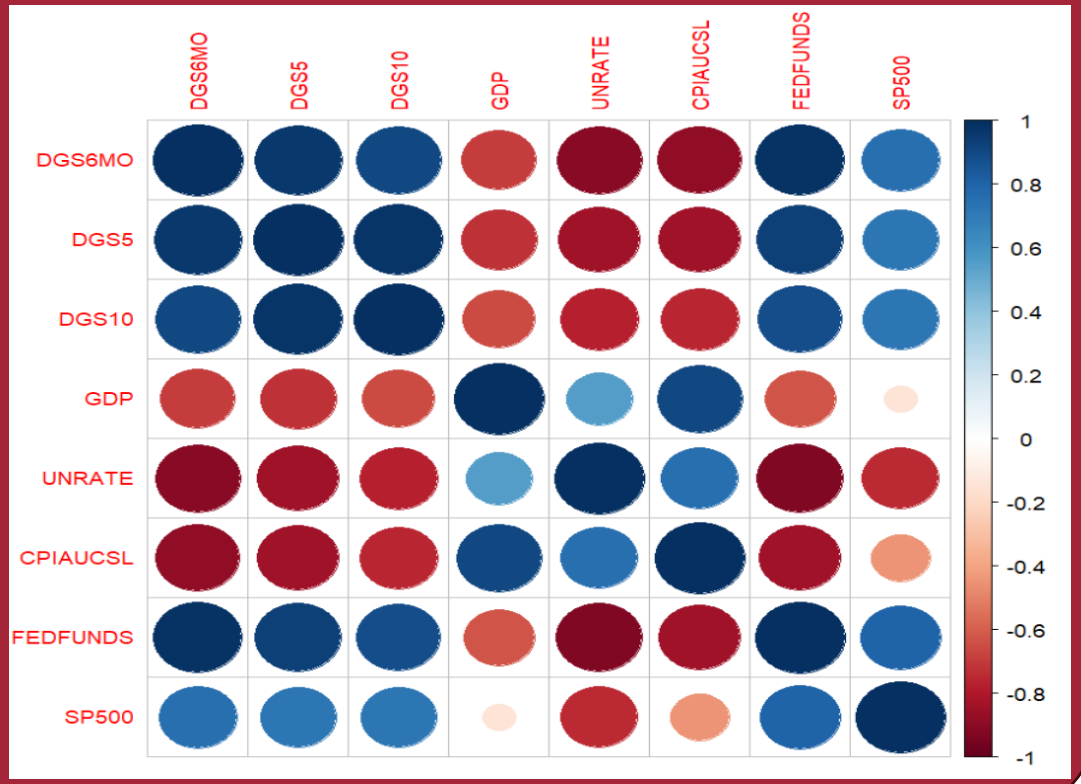
```
      Date                DGS6MO            DGS5            DGS10            GDP
 Min.   :2013-01-02   Min.   :0.0200   Min.   :0.650   Min.   :1.370   Min.   :16648
 1st Qu.:2014-07-02   1st Qu.:0.0800   1st Qu.:1.380   1st Qu.:2.050   1st Qu.:17804
 Median :2015-12-30   Median :0.3700   Median :1.640   Median :2.340   Median :18435
 Mean   :2015-12-30   Mean   :0.6643   Mean   :1.723   Mean   :2.352   Mean   :18642
 3rd Qu.:2017-06-29   3rd Qu.:1.1100   3rd Qu.:1.920   3rd Qu.:2.670   3rd Qu.:19439
 Max.   :2018-12-28   Max.   :2.5800   Max.   :3.090   Max.   :3.240   Max.   :20918
     UNRATE          CPIAUCSL        FEDFUNDS         SP500
 Min.   :3.700   Min.   :231.7   Min.   :0.0700   Min.   :1457
 1st Qu.:4.400   1st Qu.:236.2   1st Qu.:0.1000   1st Qu.:1904
 Median :5.000   Median :238.0   Median :0.2400   Median :2088
 Mean   :5.319   Mean   :240.5   Mean   :0.5916   Mean   :2154
 3rd Qu.:6.100   3rd Qu.:244.2   3rd Qu.:1.0400   3rd Qu.:2433
 Max.   :8.000   Max.   :252.8   Max.   :2.2700   Max.   :2931
```



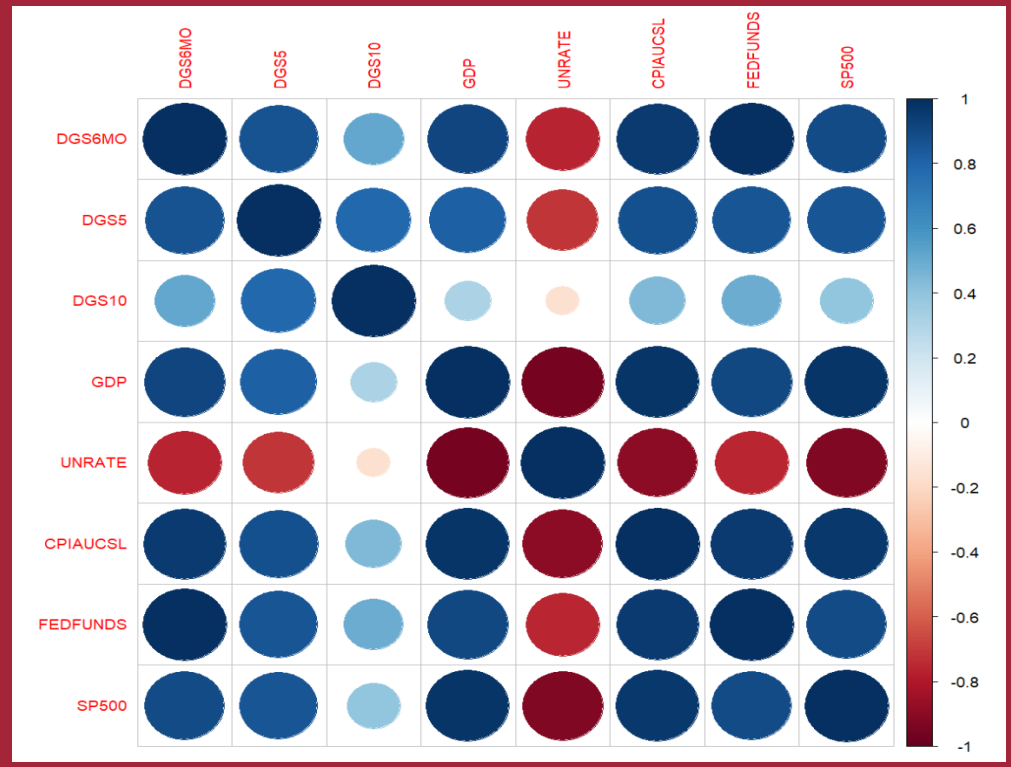
2013 to 2018

Correlation Plots

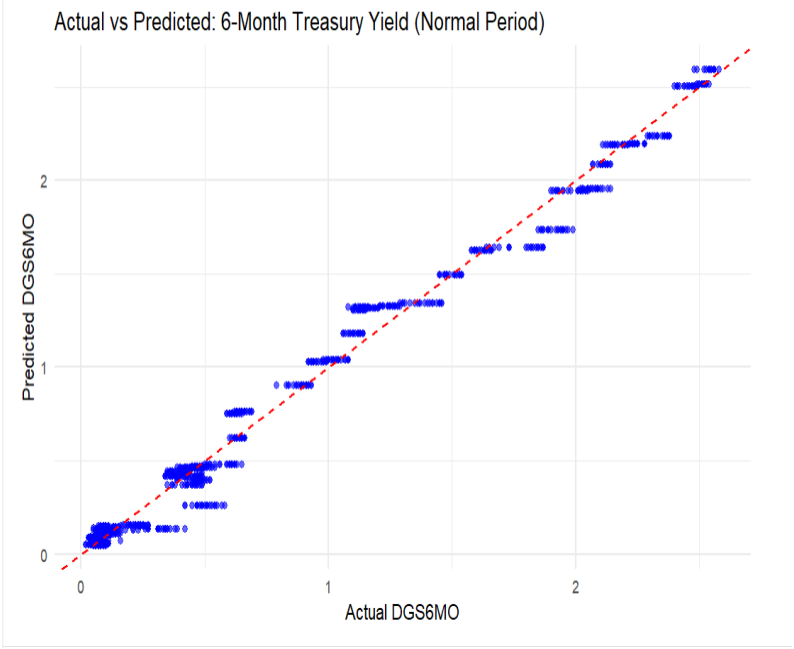
2006 to 2010

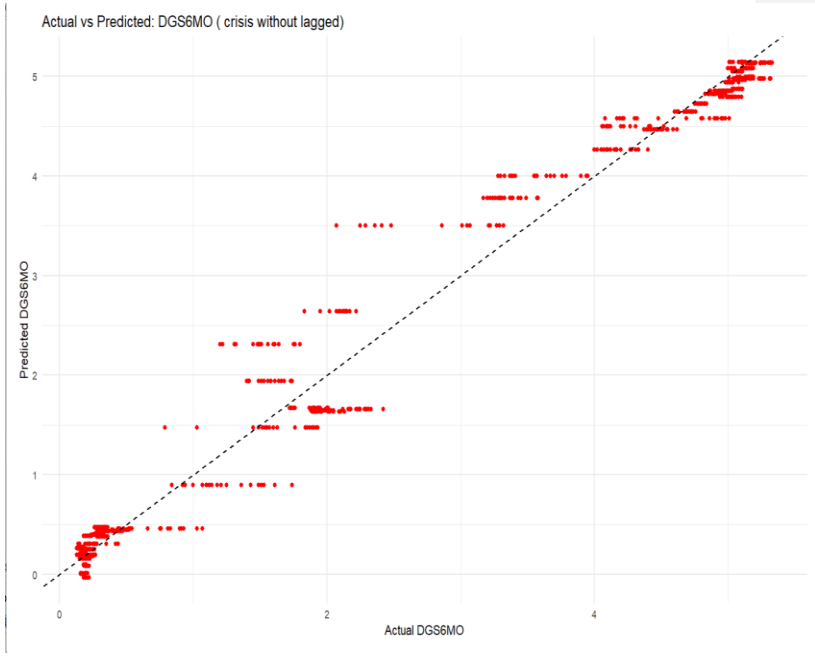


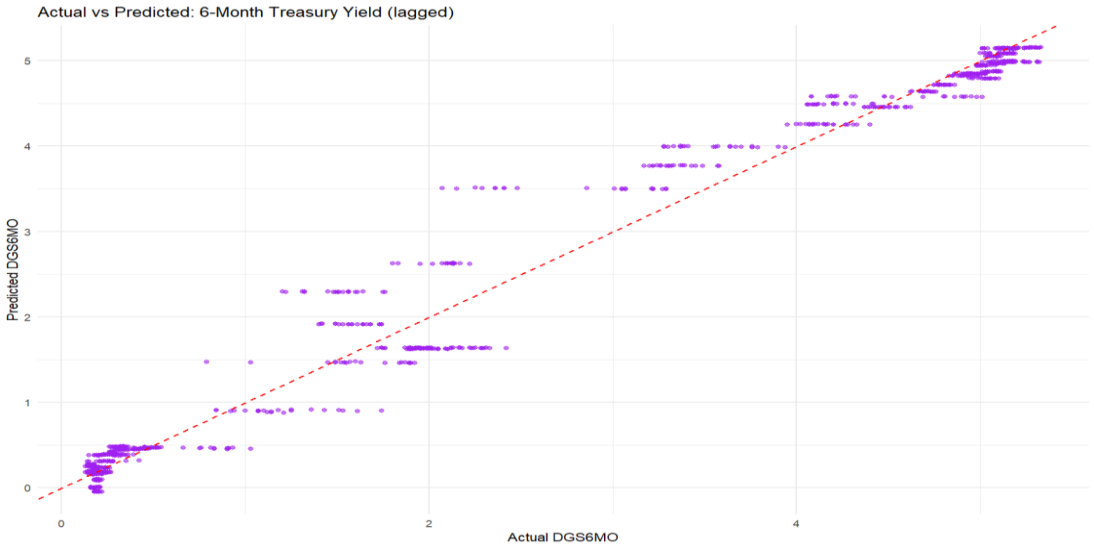
2013 to 2018



REGRESSION MODEL : OVER 6 MONTHS TREASURY YEILD







Model results (6 months) :

2006 to 2010 (without lag)

```
Model Summary for DGS6MO:
> print(summary(model_6mo))

Call:
lm(formula = DGS6MO ~ GDP + UNRATE + CPIAUCSL + FEDFUNDS, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.43422 -0.10445  0.03656  0.13647  0.84452

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  9.358e+00  5.447e-01  17.179  < 2e-16 ***
GDP         -4.070e-04  4.673e-05  -8.709  < 2e-16 ***
UNRATE       4.080e-02  8.666e-03   4.707 2.79e-06 ***
CPIAUCSL    -1.678e-02  4.768e-03  -3.519 0.000449 ***
FEDFUNDS     8.852e-01  1.193e-02  74.210  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2577 on 1253 degrees of freedom
Multiple R-squared:  0.9852,    Adjusted R-squared:  0.9852
F-statistic: 2.087e+04 on 4 and 1253 DF,  p-value: < 2.2e-16

>
> cat("\nModel Summary for DGS5:\n")
```

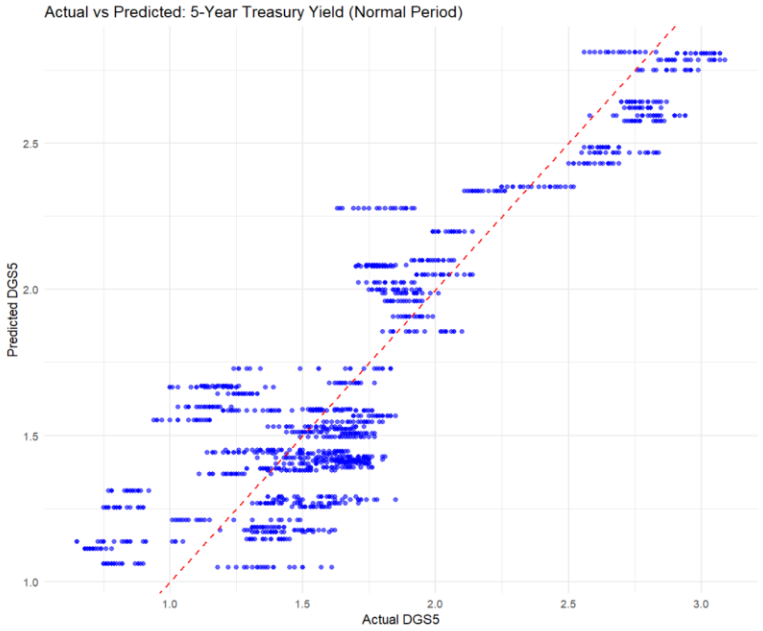
2006 to 2010 (lagged variable)

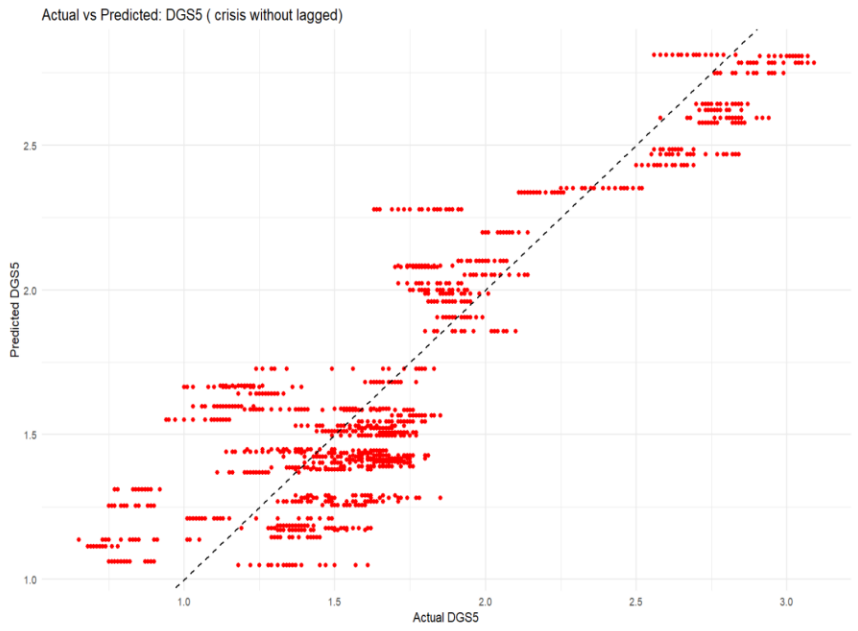
```
Call:
lm(formula = DGS6MO ~ GDP_Lag1 + UNRATE_Lag1 + FEDFUNDS_Lag1 +
    CPIAUCSL_Lag1 + SP500_Lag1, data = all_data_lagged)

Residuals:
     Min       1Q   Median       3Q      Max
-1.43499 -0.10190  0.03936  0.14006  0.83643

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)    9.046e+00  7.128e-01  12.690  < 2e-16 ***
GDP_Lag1      -3.836e-04  5.139e-05  -7.465 1.56e-13 ***
UNRATE_Lag1    4.567e-02  9.044e-03   5.050 5.08e-07 ***
FEDFUNDS_Lag1  9.025e-01  1.930e-02  46.755  < 2e-16 ***
CPIAUCSL_Lag1 -1.655e-02  4.961e-03  -3.336 0.000875 ***
SP500_Lag1    -1.263e-04  1.045e-04  -1.209 0.227073
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2612 on 1251 degrees of freedom
Multiple R-squared:  0.9848,    Adjusted R-squared:  0.9848
F-statistic: 1.624e+04 on 5 and 1251 DF,  p-value: < 2.2e-16
```

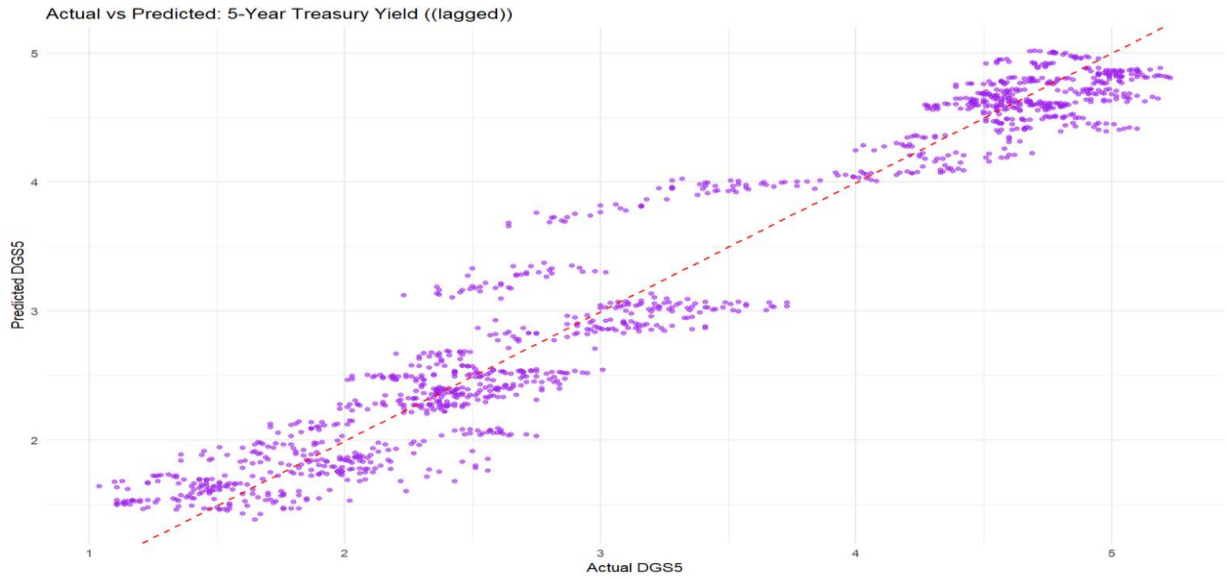
2013 to 2018 (Neutral Period)

```
Regression Model Summaries for Normal Period:
> print(summary(model_6mo))

Call:
lm(formula = DGS6MO ~ GDP + UNRATE + CPIAUCSL + FEDFUNDS, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.24307 -0.03794 -0.00526  0.03014  0.31915

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.561e+00  5.053e-01  -3.088  0.00205 **
GDP          3.273e-05  1.877e-05   1.744  0.08132 .
UNRATE       1.260e-02  1.146e-02   1.099  0.27175
CPIAUCSL     3.760e-03  2.228e-03   1.688  0.09169 .
FEDFUNDS     1.088e+00  1.574e-02  69.102  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.07799 on 1504 degrees of freedom
Multiple R-squared:  0.9896,    Adjusted R-squared:  0.9896
F-statistic: 3.572e+04 on 4 and 1504 DF,  p-value: < 2.2e-16
```

REGRESSION MODEL : OVER 5 years TREASURY YEILD







Model results (5 year) :

2006 to 2010 (without lag)

```
Model Summary for DGS5:
> print(summary(model_5yr))

Call:
lm(formula = DGS5 ~ GDP + UNRATE + CPIAUCSL + FEDFUNDS, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.22273 -0.22047  0.02505  0.20074  0.86368

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -2.981e-01  6.684e-01  -0.446    0.656
GDP         -1.593e-03  5.734e-05 -27.781   <2e-16 ***
UNRATE       1.050e-01  1.063e-02   9.877   <2e-16 ***
CPIAUCSL     1.146e-01  5.851e-03  19.587   <2e-16 ***
FEDFUNDS     6.970e-01  1.464e-02  47.617   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3162 on 1253 degrees of freedom
Multiple R-squared:  0.9343,    Adjusted R-squared:  0.9341
F-statistic:  4454 on 4 and 1253 DF,  p-value: < 2.2e-16

>
```

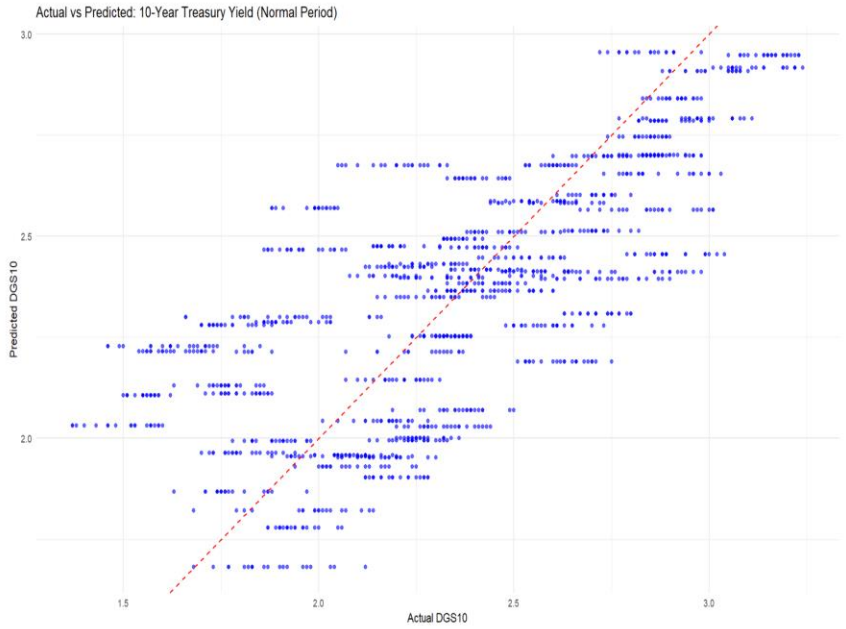
2006 to 2010 (lagged variable)

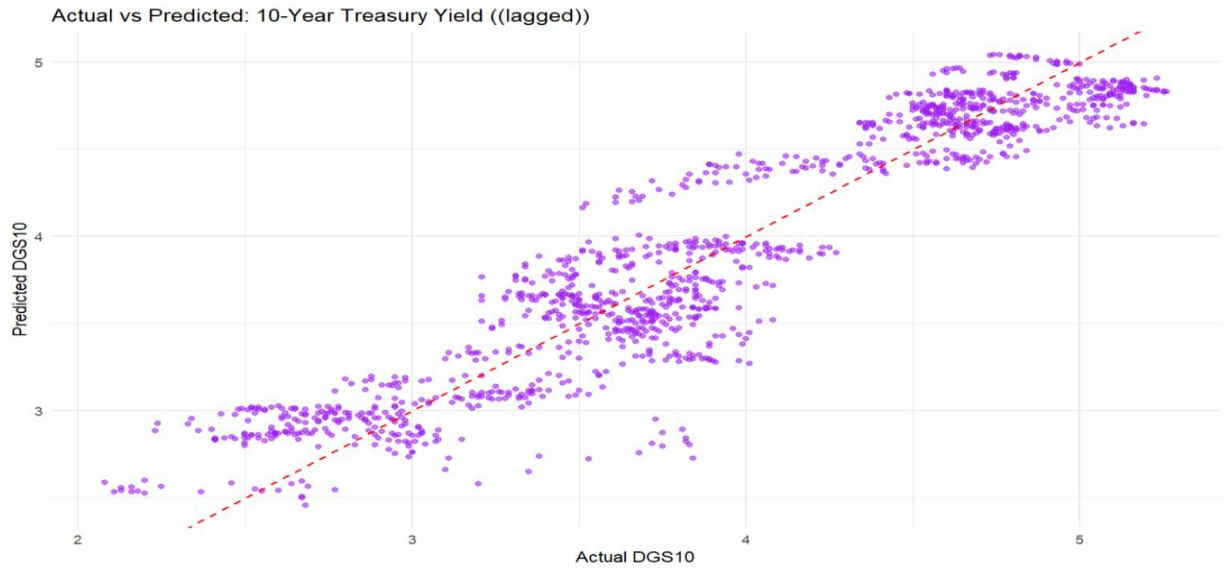
```
Summary for DGS5 (5-Year Treasury Yield):
> print(summary(model_5yr))

Call:
lm(formula = DGS5 ~ GDP_Lag1 + UNRATE_Lag1 + FEDFUNDS_Lag1 +
    CPIAUCSL_Lag1 + SP500_Lag1, data = all_data_lagged)

Residuals:
     Min       1Q   Median       3Q      Max
-1.04133 -0.18756  0.02655  0.20394  0.79668

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)    6.366e+00  8.162e-01   7.800 1.29e-14 ***
GDP_Lag1      -1.887e-03  5.884e-05 -32.071  < 2e-16 ***
UNRATE_Lag1    7.479e-02  1.036e-02   7.222 8.85e-13 ***
FEDFUNDS_Lag1  4.787e-01  2.210e-02  21.661  < 2e-16 ***
CPIAUCSL_Lag1  9.806e-02  5.681e-03  17.262  < 2e-16 ***
SP500_Lag1     1.510e-03  1.196e-04  12.625  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.299 on 1251 degrees of freedom
Multiple R-squared:  0.9413,    Adjusted R-squared:  0.9411
F-statistic:  4013 on 5 and 1251 DF,  p-value: < 2.2e-16
```

2013 to 2018 (Neutral Period)

```
Call:
lm(formula = DGS5 ~ GDP + UNRATE + CPIAUCSL + FEDFUNDS, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.66432 -0.16235  0.06502  0.19246  0.56905

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.988e+01  1.617e+00 -12.297  < 2e-16 ***
GDP         -6.581e-04  6.006e-05 -10.957  < 2e-16 ***
UNRATE      -2.099e-01  3.668e-02  -5.722 1.27e-08 ***
CPIAUCSL     1.448e-01  7.129e-03  20.306  < 2e-16 ***
FEDFUNDS     3.024e-01  5.038e-02   6.003 2.42e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2496 on 1504 degrees of freedom
Multiple R-squared:  0.7976,    Adjusted R-squared:  0.7971
F-statistic:  1482 on 4 and 1504 DF,  p-value: < 2.2e-16
```

REGRESSION MODEL : OVER 10 years TREASURY YEILD





Model results (10 year):

2006 to 2010 (without lag)

```
Model Summary for DGS10:
> print(summary(model_10yr))

Call:
lm(formula = DGS10 ~ GDP + UNRATE + CPIAUCSL + FEDFUNDS, data = regression_data)

Residuals:
    Min      1Q  Median      3Q     Max
-0.8461 -0.2076  0.0061  0.2067  1.0763

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -4.4276127  0.6096548  -7.262 6.66e-13 ***
GDP         -0.0013274  0.0000523 -25.381  < 2e-16 ***
UNRATE       0.1219576  0.0096998  12.573  < 2e-16 ***
CPIAUCSL     0.1203838  0.0053368  22.557  < 2e-16 ***
FEDFUNDS     0.5465522  0.0133510  40.937  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2885 on 1253 degrees of freedom
Multiple R-squared:  0.8613,    Adjusted R-squared:  0.8608
F-statistic:  1945 on 4 and 1253 DF,  p-value: < 2.2e-16
```

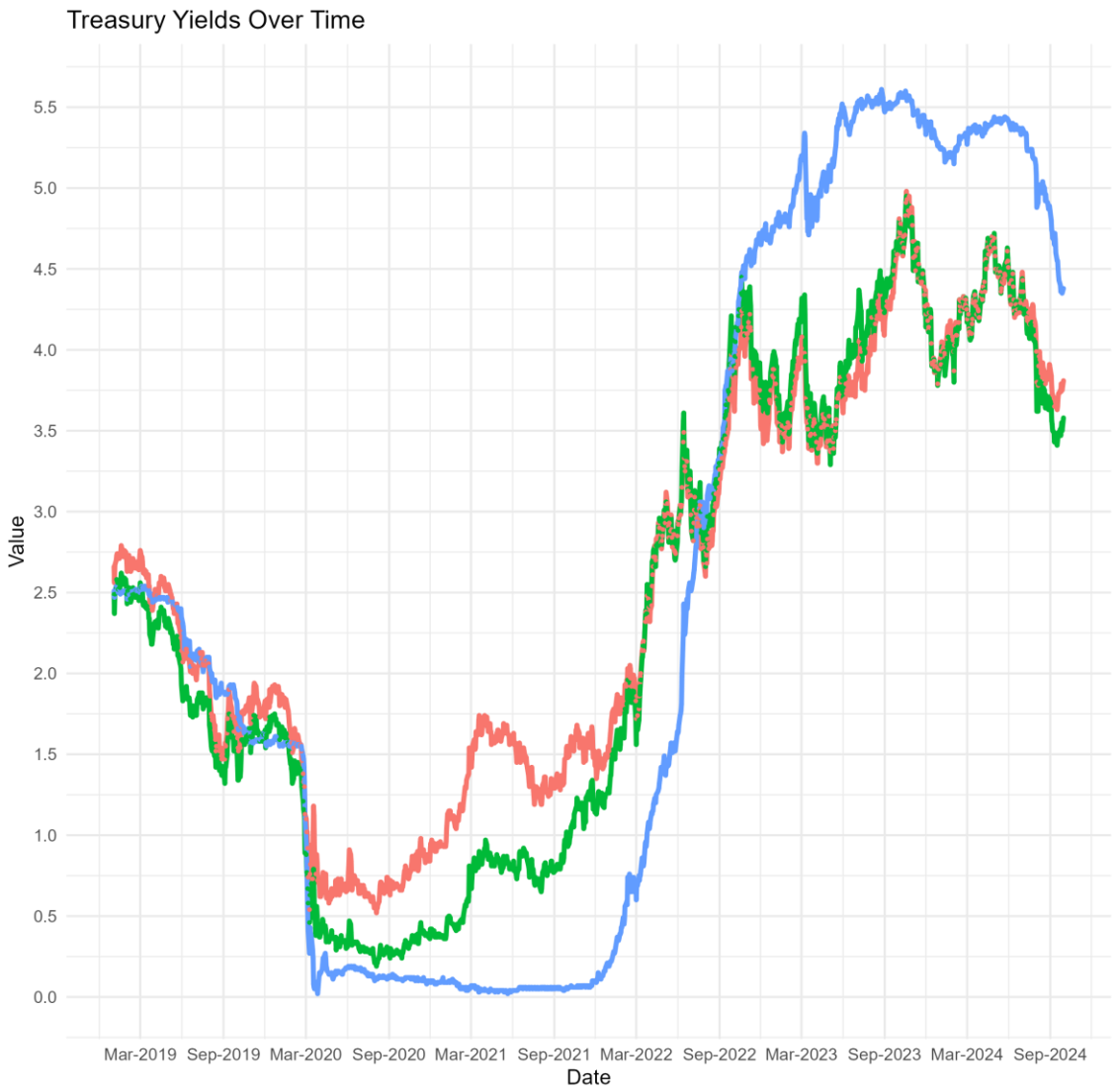
2006 to 2010 (lagged variable)

```
Call:
lm(formula = DGS10 ~ GDP_Lag1 + UNRATE_Lag1 + FEDFUNDS_Lag1 +
    CPIAUCSL_Lag1 + SP500_Lag1, data = all_data_lagged)

Residuals:
    Min      1Q  Median      3Q     Max
-0.6837 -0.1960 -0.0074  0.1914  1.1145

Coefficients:
               Estimate Std. Error t value Pr(>|t|)
(Intercept)    1.855e+00  7.344e-01   2.526   0.0117 *
GDP_Lag1      -1.616e-03  5.294e-05 -30.527   <2e-16 ***
UNRATE_Lag1    9.344e-02  9.318e-03  10.028   <2e-16 ***
FEDFUNDS_Lag1  3.391e-01  1.989e-02  17.054   <2e-16 ***
CPIAUCSL_Lag1  1.054e-01  5.112e-03  20.630   <2e-16 ***
SP500_Lag1     1.450e-03  1.076e-04  13.469   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2691 on 1251 degrees of freedom
Multiple R-squared:  0.8795,    Adjusted R-squared:  0.879
F-statistic:  1825 on 5 and 1251 DF,  p-value: < 2.2e-16
```

2013 to 2018 (Neutral Period)

```
> print(summary(model_10yr))

Call:
lm(formula = DGS10 ~ GDP + UNRATE + CPIAUCSL + FEDFUNDS, data = regression_data)

Residuals:
     Min       1Q   Median       3Q      Max
-0.76794 -0.15398  0.06439  0.18736  0.58546

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -2.383e+01  1.804e+00 -13.205  < 2e-16 ***
GDP         -1.044e-03  6.701e-05 -15.585  < 2e-16 ***
UNRATE      -1.266e-01  4.092e-02  -3.094  0.00201 **
CPIAUCSL     1.920e-01  7.955e-03  24.133  < 2e-16 ***
FEDFUNDS     2.625e-01  5.621e-02   4.670 3.28e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2785 on 1504 degrees of freedom
Multiple R-squared:  0.5422,    Adjusted R-squared:  0.541
F-statistic: 445.3 on 4 and 1504 DF,  p-value: < 2.2e-16
```

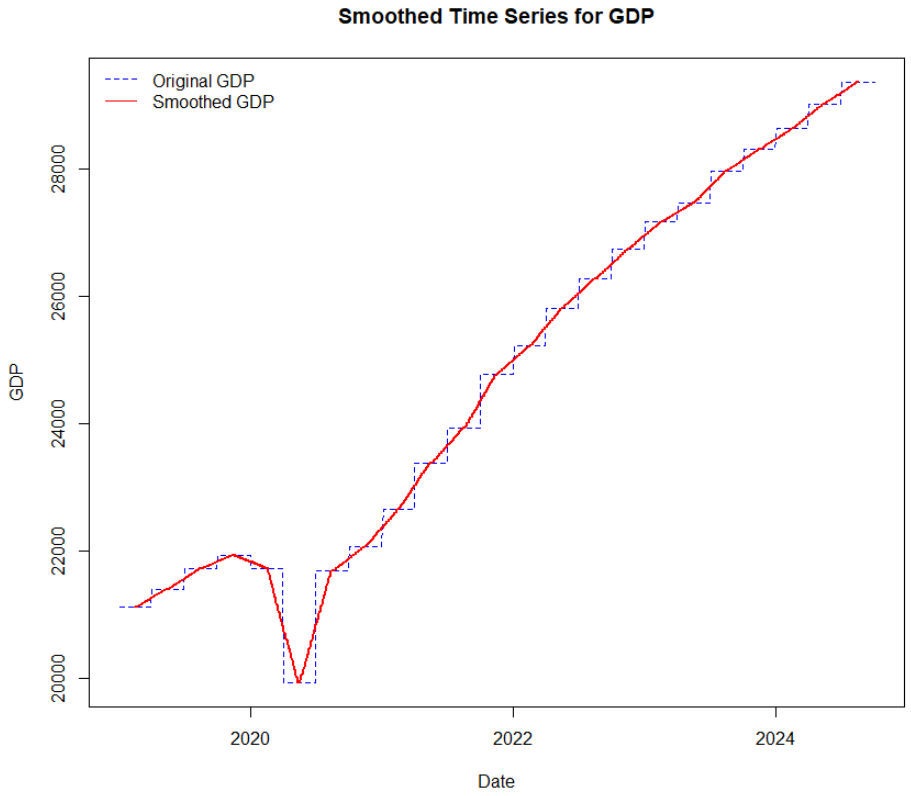
Treasury Yields During COVID(2019-2024)

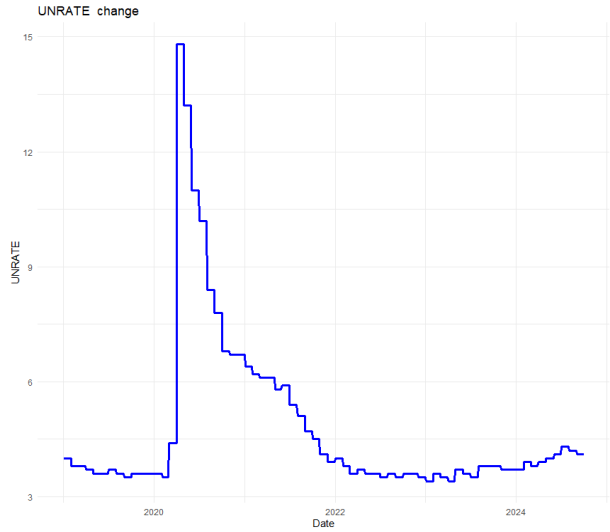


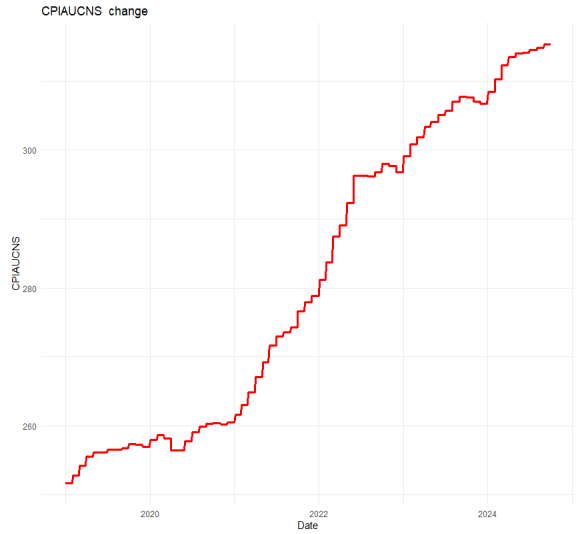
Economic Events:

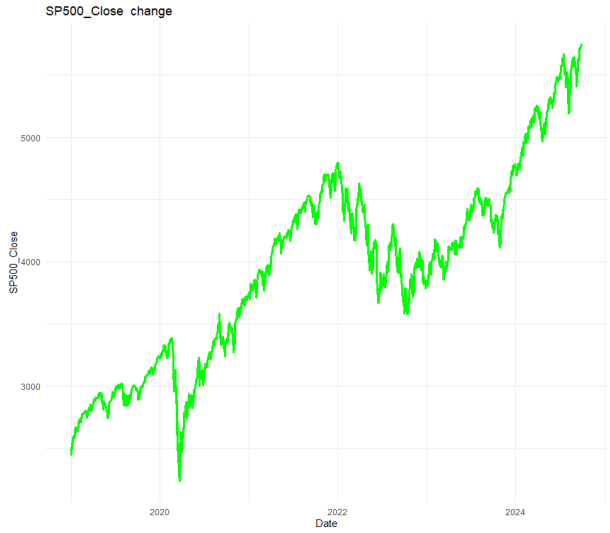
- COVID-19 Pandemic
- March 2020, Russia–Saudi Arabia Oil Price War
- Feb 2022: Russian Invasion of Ukraine
- March 2023: Banking Crisis
- Aug 2023: Fed Funds rate rise to 5.33

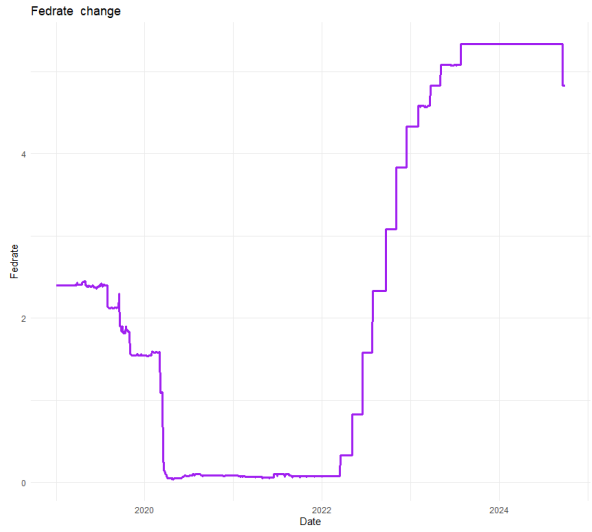
Macroeconomic Indicators Change



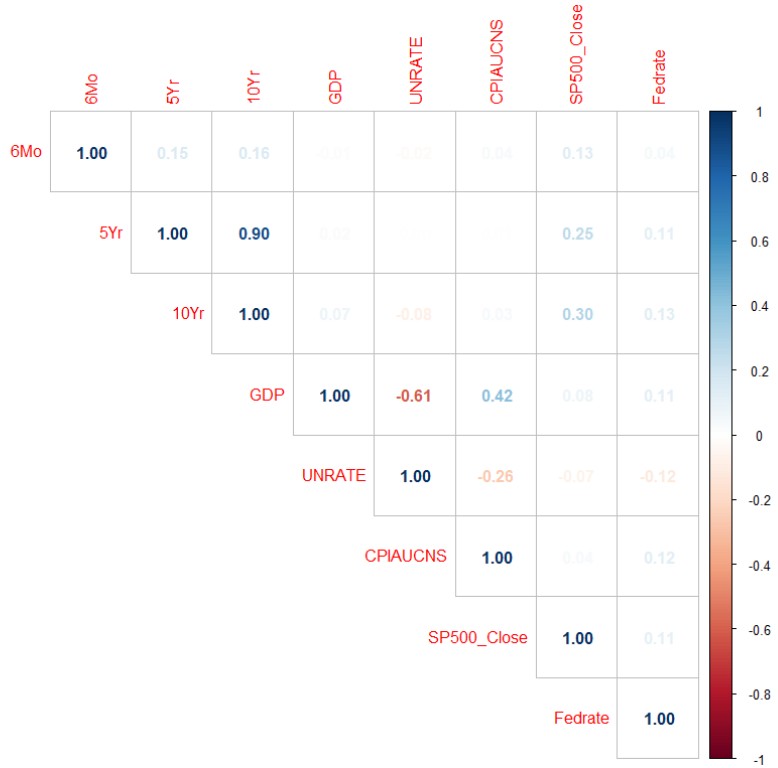


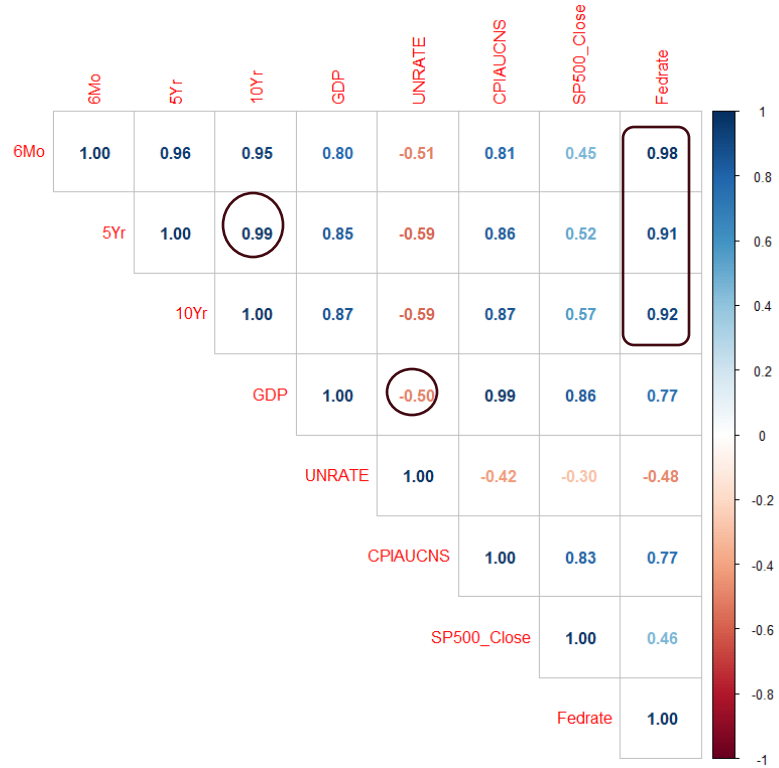


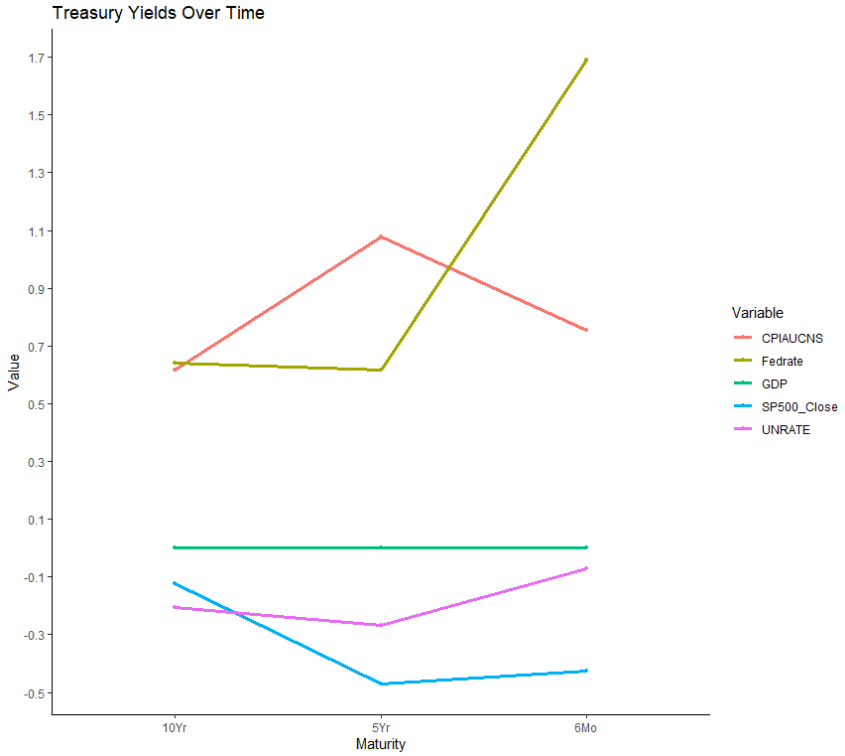


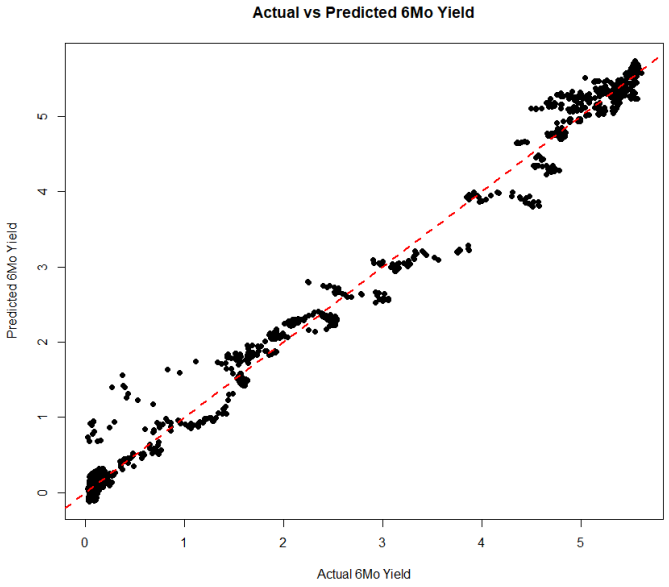


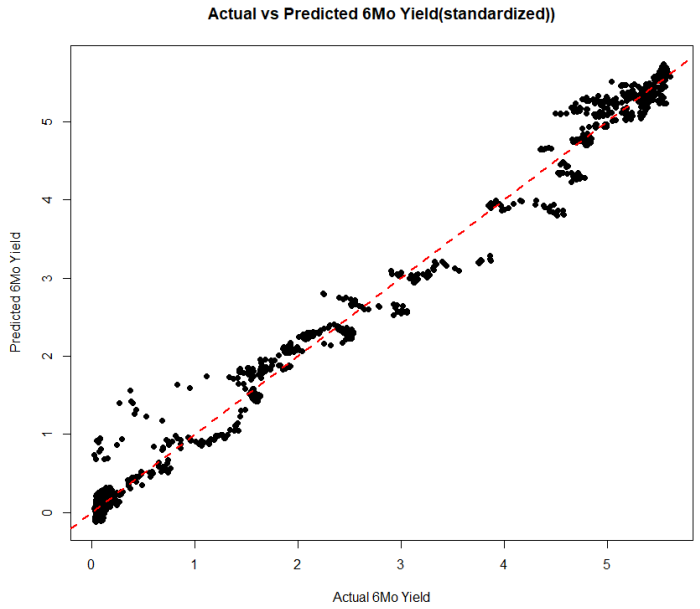
Correlation Matrix











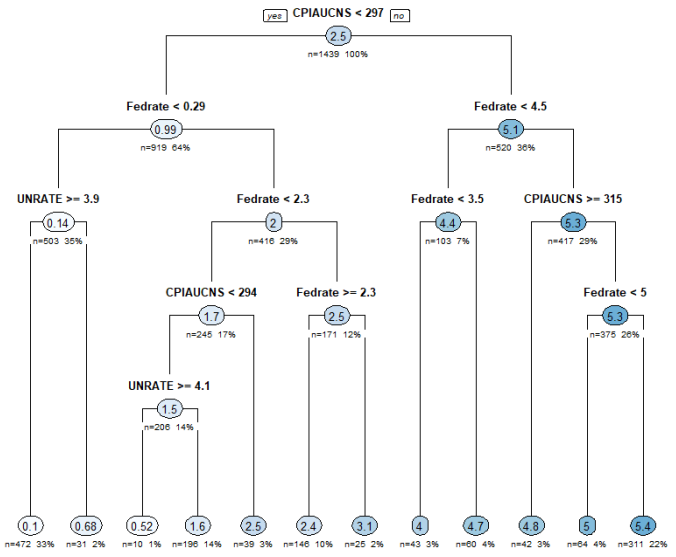
Linear Regression

```
Call:
lm(formula = `6Mo` ~ GDP + UNRATE + CPIAUCNS + SP500_Close +
    Fedrate, data = data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.18797 -0.09449 -0.00084  0.10621  0.77097

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -8.691e+00  1.957e-01 -44.401  < 2e-16 ***
GDP         -1.500e-04  2.201e-05  -6.816 1.37e-11 ***
UNRATE      -5.786e-02  4.042e-03 -14.313  < 2e-16 ***
CPIAUCNS     5.557e-02  2.359e-03  23.562  < 2e-16 ***
SP500_Close -5.831e-04  1.922e-05 -30.336  < 2e-16 ***
Fedrate      7.866e-01  4.912e-03 160.134  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2023 on 1433 degrees of freedom
Multiple R-squared:  0.9912,    Adjusted R-squared:  0.9912
F-statistic: 3.239e+04 on 5 and 1433 DF,  p-value: < 2.2e-16
```

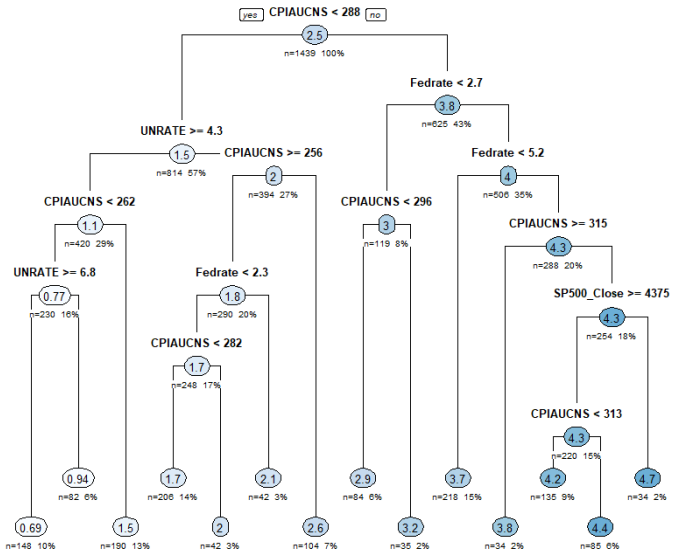
```
Call:
lm(formula = `6Mo` ~ GDP + UNRATE + CPIAUCNS + SP500_Close +
    Fedrate, data = standardized_data)

Residuals:
     Min       1Q   Median       3Q      Max
-1.18797 -0.09449 -0.00084  0.10621  0.77097

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.474295   0.005333 463.956  < 2e-16 ***
GDP         -0.437742   0.064220  -6.816 1.37e-11 ***
UNRATE      -0.128968   0.009011 -14.313  < 2e-16 ***
CPIAUCNS     1.222791   0.051897  23.562  < 2e-16 ***
SP500_Close -0.458328   0.015108 -30.336  < 2e-16 ***
Fedrate      1.668337   0.010418 160.134  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2023 on 1433 degrees of freedom
Multiple R-squared:  0.9912,    Adjusted R-squared:  0.9912
F-statistic: 3.239e+04 on 5 and 1433 DF,  p-value: < 2.2e-16
```

Tree Based Model

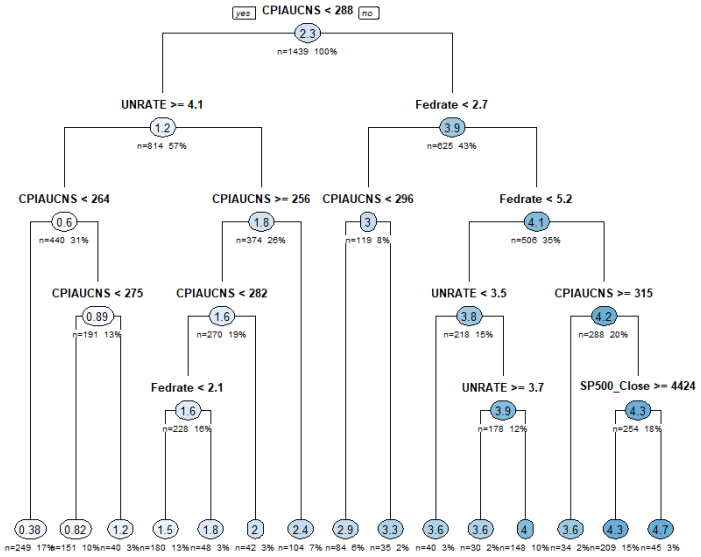
Decision Tree for 6Mo Yield Prediction



Decision Tree for 10Yr Yield Prediction



Decision Tree for 5Yr Yield Prediction




```
Call:
rpart(formula = `6Mo` ~ UNRATE + CPIAUCNS + SP500_Close + Fedrate,
    data = data, method = "anova", control = rpart.control(cp = 0.001,
        minsplit = 15, maxdepth = 10))
  n= 1439

           CP nsplit   rel error      xerror         xstd
1  0.841604762      0 1.000000000 1.000980815 0.0171845799
2  0.119358384      1 0.158395238 0.158618647 0.0049736834
3  0.009838889      2 0.039036854 0.039236856 0.0021650375
4  0.008780723      3 0.029197965 0.030350114 0.0018992425
5  0.004530932      4 0.020417241 0.022476089 0.0014009918
6  0.001832531      5 0.015886310 0.014969079 0.0009262441
7  0.001776676      6 0.014053779 0.013332860 0.0008664389
8  0.001757811      7 0.012277103 0.013022000 0.0008517006
9  0.001575574      8 0.010519292 0.011979226 0.0007868288
10 0.001451769      9 0.008943718 0.010744541 0.0007314851
11 0.001287317     10 0.007491950 0.009231312 0.0006368442
12 0.001000000     11 0.006204633 0.007267640 0.0005166773

Variable importance
    Fedrate     CPIAUCNS SP500_Close      UNRATE
         39          38          15           9
```

```
Call:
rpart(formula = `10Yr` ~ UNRATE + CPIAUCNS + SP500_Close + Fedrate,
    data = data, method = "anova", control = rpart.control(cp = 0.001,
        minsplit = 15, maxdepth = 10))
  n= 1439

           CP nsplit  rel error      xerror         xstd
1  0.796822174      0 1.00000000 1.00233273 0.0211391815
2  0.070878466      1 0.20317783 0.20389161 0.0062913672
3  0.045538797      2 0.13229936 0.13281629 0.0043339838
4  0.021420075      3 0.08676056 0.08735785 0.0023403186
5  0.020361499      4 0.06534049 0.07145016 0.0023612504
6  0.016246606      5 0.04497899 0.04539937 0.0018861081
7  0.003385540      6 0.02873238 0.02910692 0.0011627771
8  0.002390405      7 0.02534684 0.02643167 0.0010209499
9  0.001824001      8 0.02295644 0.02358283 0.0009055748
10 0.001500185     10 0.01930844 0.02069979 0.0008460893
11 0.001410125     11 0.01780825 0.01940653 0.0007969474
12 0.001014343     12 0.01639813 0.01731798 0.0006663330
13 0.001000000     13 0.01538378 0.01672499 0.0006441515

Variable importance
   CPIAUCNS     Fedrate SP500_Close      UNRATE
         36          30          18          16
```

Model Summary

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Conclusion

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THANK **YOU**

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