Assignment 2 Report

2023-11-12

Overall Market from 1990 - 2022

We used 4 different methods to extract information about the predictors for the overall market. The methods are OLS, Ridge regression, LASSO and elastic nets.

Models

```
##                  OLS      Ridge      LASSO Elastic Net
## RMSE       12.0360081 11.7442966 11.6637846  11.5604532
## R-Squared   0.6213557  0.5999511  0.5876202   0.5694470
```

Models Discussion

OLS suffers from multicollinearity and fails to do feature selection. It will generally result in high RMSE and is not very good at prediction. However, OLS is unbiased and is very good when you have already done feature selection and got rid of multicolinear variables.

LASSO can perform feature selection and introduce sparsity but suffers from multicolinearity. It is also unknown why LASSO will choose a certain feature over another when 2 variables have high correlation. It is very good when there are very few, high leverage predictors.

Ridge Regression take care of multicolinearity but fails to do feature selection leading to a higher RMSE when there are only a few features that contribute to predicting the data It is very good when all features are useful in predicting the data.

Elastic Net combines LASSO and Ridge, providing a balance between feature selection and multicollinearity handling. However, it is very difficult to find optimal alpha and lambda values. Hence, it is time consuming and resource costly.

Findings

Lowest RMSE is OLS but the model suffers from multicollinearity, hence a better model would be the elastic net.

Overall, it is very difficult to provide a coherent picture as most model has low determination coefficient and have major problems. In addition, the data is heterogenous meaning some factors that are very important to a certain time period may not be important to other time periods. However, by using feature selection and domain knowledge we can infer some general results.

```
##   Predictor                                       Weight
## 1 Agricultural Policy EMV Tracker                 -2.90731619274599
## 2 Labor Disputes EMV Tracker                      2.34660896658684
## 3 Immigration EMV Tracker                         -1.98992099686191
## 4 Energy and Environmental Regulation EMV Tracker 1.70557945726351
## 5 Macro - Trade EMV Tracker                       -1.10439134005488
```

Labor disputes have the highest positive impact on VIX. Meaning as these EMV's increase, VIX also increases hence more fear in the stock market. Labour disputes generally means potential strikes hence cause fear.

On the other hand, Agricultural Policy has the highest negative impact. I hypothesize that when newspapers talk about agricultural policy, there is nothing more urgent going on which leads to more market stability.

Different Market Time Periods

1990/01 - 1998/06

```
##   Predictor                                   Weight
## 1 Labor Regulations EMV Tracker               3.55377652344022
## 2 Labor Disputes EMV Tracker                  1.54094280674923
## 3 Trade Policy EMV Tracker                    -1.53914578815474
## 4 Litigation Matters EMV Tracker              -1.48808006328735
## 5 Government-Sponsored Enterprises EMV Tracker -1.3133262812298
```

During this period of general stability, there are many predictors that impact VIX negatively. Interestingly, due to the gulf war, the petroleum markets EMV tracker has a decent amount of weight for predicting VIX.

1998/07 - 2003/03

```
##   Predictor                                           Weight
## 1 Labor Disputes EMV Tracker                          2.08771506061196
## 2 Food and Drug Policy EMV Tracker                    1.58684555921369
## 3 Macro - Trade EMV Tracker                           1.31963023348586
## 4 Other Regulation EMV Tracker                        1.12233972612809
## 5 Macro - Business Investment and Sentiment EMV Tracker 0.915305272171663
```

During this time of market volatility, there are no significant factors that contribute to VIX negatively. All features selected by the elastic net model have a positive impact on VIX. Housing and land management is among those those significant factors as the housing market at this point is experiencing a downturn.

2003/04 - 2007/12

```
##   Predictor                                         Weight
## 1 Energy and Environmental Regulation EMV Tracker   4.1297524376882
## 2 Other Regulation EMV Tracker                      1.99878139407305
## 3 Macro - Trade EMV Tracker                         -1.09878483352996
## 4 Fiscal Policy EMV Tracker                         0.591203839637963
## 5 Macro - Other Financial Indicators EMV Tracker    0.532418886254143
```

2008/01 - 2009/09

```
##   Predictor                                Weight
## 1 Intellectual Property Policy EMV Tracker 5.84008622170313
## 2 Other Regulation EMV Tracker             -4.3789098483575
## 3 Labor Regulations EMV Tracker            1.66327742548635
## 4 Trade Policy EMV Tracker                 1.51458742802369
## 5 Healthcare Policy EMV Tracker            1.09644702349825
```

2008 was one of the worst financial crashes in history and the predictors reflect that since many people lost their jobs and international trade was very difficult to conduct due to the poor economies.

2009/10 - 2019/12

```
##   Predictor                                Weight
## 1 Intellectual Property Policy EMV Tracker 4.42678493881778
## 2 Agricultural Policy EMV Tracker          -3.31416152123556
```

```
## 3 Immigration EMV Tracker                    -2.96674531176061
## 4 Macro - Trade EMV Tracker                   2.02255663916497
## 5 Macro - Real Estate Markets EMV Tracker  1.28908559580454
```

During this long period of economic prosperity, immigration was high as many people moved to the US in search of a better life. In addition, since there is not much market volatility and significant world events, agricultural policy was often reported thus leading to its negative correlation. Infectious disease at this point is actually a negative predictor for VIX which is very interesting as COVID-19 heavily impacts the market in the next segment.

2020/01 - 2022/12

```
##    Predictor                                  Weight
## 1 Exchange Rates EMV Tracker                  3.28546355091863
## 2 Trade Policy EMV Tracker                    2.40839306788746
## 3 Energy and Environmental Regulation EMV Tracker 2.36275818324386
## 4 Intellectual Property Matters EMV Tracker   1.88847669829068
## 5 Competition Policy EMV Tracker              1.63969176160534
```

Interestingly, infectious disease is not a major predictor during the COVID-19 economic crisis. I believe that is because it is too highly correlated with rest of the predictors especially since it was highly politicized in a very controversial election in the US.

Findings

By inspecting some of the results that is in the Appendix B, I have noticed a few things between periods of high volatility and low volatility. In periods of high volatility, there is usually close to 0 features that is negatively related to VIX. In general Another thing I noticed is that labor related features are always very significant. I believe this is due to the frequent mentioning of unemployment rates by newspapers and the media in general.

General Conclusion and findings

In general, it is very difficult to predict the market. Many of the models created have around 50% - 60% determination coefficient even when using data that is homogeneous. However, we can still extract valuable information from our models. The features extracted are usually a good indicator of what was actually heavily impacting the market at that period of time.

Appendix A: Code

```
# packages
library(tidyverse)
library(readxl)
library(caret)
library(glmnet)
set.seed(314)
data = read_excel("~/Desktop/UofTears Code/STA314/A2/EMV_VIX_Data.xlsx")
#split into different time periods
tp1 <- data[1:102,]
tp2 <- data[103:159,]
tp3 <- data[160:216,]
tp4 <- data[217:237,]
tp5 <- data[238:360,]
tp6 <- data[361:395,]
```

```r
#OLS
y <- data$VIX
x <- data.matrix(data[-47][-1])
ols <- glmnet(x,y,alpha=0, lambda = 0)
ols.fit <- ols %>% predict(x) %>% as.vector()
coef(ols)
RMSE(ols.fit,y)
ols$dev.ratio

#Ridge
y <- data$VIX
x <- data.matrix(data[-47][-1])
ridge.cv <- cv.glmnet(x,y,alpha=0, family ="gaussian", nfolds = 10, nlambda = 500, standarize = TRUE, ty
ridge <- glmnet(x,y,alpha=0,lambda=ridge.cv$lambda.min)
ridge.fit <- ridge %>% predict(x) %>% as.vector()
coef(ridge)
RMSE(ridge.fit,y)
ridge$dev.ratio

#LASSO
y <- data$VIX
x <- data.matrix(data[-47][-1])
lasso.cv <- cv.glmnet(x,y,alpha=1, family ="gaussian", nfolds = 10, nlambda = 500, standarize = TRUE, ty
lasso <- glmnet(x,y,alpha=1,lambda=lasso.cv$lambda.min)
lasso.fit <- lasso %>% predict(x) %>% as.vector()
coef(lasso)
RMSE(lasso.fit,y)
lasso$dev.ratio

# Elastic Net finding optimal alpha and lambda
y <- data$VIX
x <- data.matrix(data[-47][-1])
cv_method = trainControl(method = "cv", number = 10)
init <- glmnet(x, y,
              family = "gaussian",
              nlambda = 100,
              alpha = .5)
lambda <- unique(init$lambda)
lambda <- lambda[-c(1, length(lambda))]
lambda <- lambda[1:min(length(lambda), 100)]
lambda_grid <- seq(0, 1, 0.01)
alpha_grid <- seq(0, 1, 0.001)
srchGrid <- expand.grid(.alpha = alpha_grid, .lambda = lambda)
elnet.train = train(
  VIX ~.,
    data = data[-1],
    method = "glmnet",
    tuneGrid = srchGrid,
    preProcess = c("center", "scale"),
  trControl = cv_method,
    metric = "MSE"
)

# Elastic Net model
elnet.train$bestTune$alpha
```

```
elnet.train$bestTune$lambda
elnet <- glmnet(x,y,alpha= elnet.train$bestTune$alpha, lambda = elnet.train$bestTune$lambda)
elnet.fit <- elnet %>% predict(x) %>% as.vector
coef(elnet)
RMSE(elnet.fit, y)
elnet$dev.ratio
```

```
# Phase 2 finding elastic net model for each time period
for (t in 1:6) {
    period = paste("tp",t,sep="")
    alpha = paste("a",t,sep="")
    lambda = paste("l",t,sep="")
    hit_elnet = train(
        VIX ~. -Date,
        data = eval(parse(text = period)),
        method = "glmnet",
        tuneLength = 100,
        preProcess = c("center", "scale"),
        trControl = trainControl(method = "cv", number = nrow(eval(parse(text = period))))
    )
    assign(alpha, hit_elnet$bestTune$alpha)
    assign(lambda, hit_elnet$bestTune$lambda)
}
```

Appendix B: Phase 2 Individual Model Diagonistics + Coefficients

```
# Phase 2 finding elastic net model for each time period
a1
```

```
## [1] 0.3272727
```

```
l1
```

```
## [1] 0.5582699
```

```
y <- tp1$VIX
x <- data.matrix(tp1[-47][-1])
model1 <- glmnet(x,y,alpha=a1, lambda = l1)
coef(model1)
```

```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                                           s0
## (Intercept)                                      10.42658982
## EMV                                               0.03395635
## Political Uncertainty Tracker                               .
## Infectious Disease EMV Tracker                   -0.05298806
## Macroeconomic News and Outlook EMV Tracker                  .
## Macro - Broad Quantity Indicators EMV Tracker               .
## Macro - Inflation EMV Indicator                             .
## Macro - Interest Rates EMV Tracker               -0.48801804
## Macro - Other Financial Indicators EMV Tracker    0.65569174
## Macro - Labor Markets EMV Tracker                           .
## Macro - Real Estate Markets EMV Tracker           0.43233184
## Macro - Trade EMV Tracker                        -1.27852476
## Macro - Business Investment and Sentiment EMV Tracker       .
```

```
## Macro - Consumer Spending and Sentiment EMV Tracker             .
## Commodity Markets EMV Tracker                          0.48430429
## Financial Crises EMV Tracker                                    .
## Exchange Rates EMV Tracker                                      .
## Healthcare Matters EMV Tracker                        -0.84292967
## Litigation Matters EMV Tracker                        -1.48808006
## Competition Matters EMV Tracker                       -0.04603371
## Labor Disputes EMV Tracker                             1.54094281
## Intellectual Property Matters EMV Tracker                       .
## Fiscal Policy EMV Tracker                                       .
## Taxes EMV Tracker                                               .
## Government Spending, Deficits, and Debt EMV Tracker   -0.35532176
## Entitlement and Welfare Programs EMV Tracker                    .
## Monetary Policy EMV Tracker                                     .
## Regulation EMV Tracker                                          .
## Financial Regulation EMV Tracker                        1.18629811
## Competition Policy EMV Tracker                                  .
## Intellectual Property Policy EMV Tracker                        .
## Labor Regulations EMV Tracker                           3.55377652
## Immigration EMV Tracker                                         .
## Energy and Environmental Regulation EMV Tracker         0.71197499
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker   .
## Housing and Land Management EMV Tracker                         .
## Other Regulation EMV Tracker                                    .
## National Security Policy EMV Tracker                            .
## Government-Sponsored Enterprises EMV Tracker           -1.31332628
## Trade Policy EMV Tracker                               -1.53914579
## Healthcare Policy EMV Tracker                           0.82848522
## Food and Drug Policy EMV Tracker                                .
## Transportation, Infrastructure, and Public Utilities EMV Tracker  .
## Elections and Political Governance EMV Tracker         -0.12960065
## Agricultural Policy EMV Tracker                                 .
## Petroleum Markets EMV Tracker                           0.57437035
```

```
model1$dev.ratio
```

```
## [1] 0.5826445
```

```
a2
```

```
## [1] 0.2636364
```

```
l2
```

```
## [1] 2.435019
```

```
y <- tp2$VIX
x <- data.matrix(tp2[-47][-1])
model2 <- glmnet(x,y,alpha=a2, lambda = l2)
coef(model2)
```

```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                                           s0
## (Intercept)                                      19.15737951
## EMV                                                        .
## Political Uncertainty Tracker                             .
## Infectious Disease EMV Tracker                            .
## Macroeconomic News and Outlook EMV Tracker               .
```

```
## Macro - Broad Quantity Indicators EMV Tracker                    .
## Macro - Inflation EMV Indicator                                  .
## Macro - Interest Rates EMV Tracker                               .
## Macro - Other Financial Indicators EMV Tracker                   .
## Macro - Labor Markets EMV Tracker                                .
## Macro - Real Estate Markets EMV Tracker                          .
## Macro - Trade EMV Tracker                               1.31963023
## Macro - Business Investment and Sentiment EMV Tracker   0.91530527
## Macro - Consumer Spending and Sentiment EMV Tracker              .
## Commodity Markets EMV Tracker                                    .
## Financial Crises EMV Tracker                                     .
## Exchange Rates EMV Tracker                                       .
## Healthcare Matters EMV Tracker                                   .
## Litigation Matters EMV Tracker                                   .
## Competition Matters EMV Tracker                                  .
## Labor Disputes EMV Tracker                               2.08771506
## Intellectual Property Matters EMV Tracker                        .
## Fiscal Policy EMV Tracker                                0.11534442
## Taxes EMV Tracker                                        0.07399495
## Government Spending, Deficits, and Debt EMV Tracker              .
## Entitlement and Welfare Programs EMV Tracker                     .
## Monetary Policy EMV Tracker                                      .
## Regulation EMV Tracker                                           .
## Financial Regulation EMV Tracker                         0.07587939
## Competition Policy EMV Tracker                                   .
## Intellectual Property Policy EMV Tracker                         .
## Labor Regulations EMV Tracker                                    .
## Immigration EMV Tracker                                          .
## Energy and Environmental Regulation EMV Tracker          0.25350166
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker     .
## Housing and Land Management EMV Tracker                   0.12692924
## Other Regulation EMV Tracker                             1.12233973
## National Security Policy EMV Tracker                             .
## Government-Sponsored Enterprises EMV Tracker                     .
## Trade Policy EMV Tracker                                 0.02693440
## Healthcare Policy EMV Tracker                                    .
## Food and Drug Policy EMV Tracker                         1.58684556
## Transportation, Infrastructure, and Public Utilities EMV Tracker  .
## Elections and Political Governance EMV Tracker                   .
## Agricultural Policy EMV Tracker                                  .
## Petroleum Markets EMV Tracker                                    .
```

```
model2$dev.ratio
```

```
## [1] 0.4170293
```

```
a3
```

```
## [1] 0.3909091
```

```
l3
```

```
## [1] 0.9290849
```

```
y <- tp3$VIX
x <- data.matrix(tp3[-47][-1])
model3 <- glmnet(x,y,alpha=a3, lambda = l3)
```

```
coef(model3)
```

```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                                                      s0
## (Intercept)                                                  8.96202634
## EMV                                                          .
## Political Uncertainty Tracker                                .
## Infectious Disease EMV Tracker                               .
## Macroeconomic News and Outlook EMV Tracker                   .
## Macro - Broad Quantity Indicators EMV Tracker                .
## Macro - Inflation EMV Indicator                              .
## Macro - Interest Rates EMV Tracker                           .
## Macro - Other Financial Indicators EMV Tracker               0.53241889
## Macro - Labor Markets EMV Tracker                            .
## Macro - Real Estate Markets EMV Tracker                      0.05054758
## Macro - Trade EMV Tracker                                   -1.09878483
## Macro - Business Investment and Sentiment EMV Tracker        .
## Macro - Consumer Spending and Sentiment EMV Tracker          .
## Commodity Markets EMV Tracker                                .
## Financial Crises EMV Tracker                                 .
## Exchange Rates EMV Tracker                                   .
## Healthcare Matters EMV Tracker                               .
## Litigation Matters EMV Tracker                               .
## Competition Matters EMV Tracker                              .
## Labor Disputes EMV Tracker                                   0.35205619
## Intellectual Property Matters EMV Tracker                    .
## Fiscal Policy EMV Tracker                                    0.59120384
## Taxes EMV Tracker                                            0.52288229
## Government Spending, Deficits, and Debt EMV Tracker          .
## Entitlement and Welfare Programs EMV Tracker                -0.52822989
## Monetary Policy EMV Tracker                                  .
## Regulation EMV Tracker                                       .
## Financial Regulation EMV Tracker                             .
## Competition Policy EMV Tracker                               .
## Intellectual Property Policy EMV Tracker                     .
## Labor Regulations EMV Tracker                                .
## Immigration EMV Tracker                                      .
## Energy and Environmental Regulation EMV Tracker              4.12975244
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker .
## Housing and Land Management EMV Tracker                      .
## Other Regulation EMV Tracker                                 1.99878139
## National Security Policy EMV Tracker                         .
## Government-Sponsored Enterprises EMV Tracker                 .
## Trade Policy EMV Tracker                                     .
## Healthcare Policy EMV Tracker                               -0.18846852
## Food and Drug Policy EMV Tracker                             .
## Transportation, Infrastructure, and Public Utilities EMV Tracker  .
## Elections and Political Governance EMV Tracker              -0.14494030
## Agricultural Policy EMV Tracker                              .
## Petroleum Markets EMV Tracker                                .
```

```
model3$dev.ratio
```

```
## [1] 0.5049895
```

```
a4
```

```
## [1] 0.1
```

```
l4
```

```
## [1] 17.34995
```

```
y <- tp4$VIX
x <- data.matrix(tp4[-47][-1])
model4 <- glmnet(x,y,alpha=a4, lambda = l4)
coef(model4)
```

```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                                                  s0
## (Intercept)                                             19.40829806
## EMV                                                      0.02702259
## Political Uncertainty Tracker                            0.03752506
## Infectious Disease EMV Tracker                           .
## Macroeconomic News and Outlook EMV Tracker               0.01380164
## Macro - Broad Quantity Indicators EMV Tracker            0.01120130
## Macro - Inflation EMV Indicator                          .
## Macro - Interest Rates EMV Tracker                       .
## Macro - Other Financial Indicators EMV Tracker           .
## Macro - Labor Markets EMV Tracker                        0.22948561
## Macro - Real Estate Markets EMV Tracker                  .
## Macro - Trade EMV Tracker                                .
## Macro - Business Investment and Sentiment EMV Tracker    .
## Macro - Consumer Spending and Sentiment EMV Tracker      .
## Commodity Markets EMV Tracker                            .
## Financial Crises EMV Tracker                             0.15189618
## Exchange Rates EMV Tracker                               .
## Healthcare Matters EMV Tracker                           0.54522304
## Litigation Matters EMV Tracker                           .
## Competition Matters EMV Tracker                          .
## Labor Disputes EMV Tracker                               .
## Intellectual Property Matters EMV Tracker                0.64714149
## Fiscal Policy EMV Tracker                                0.12160448
## Taxes EMV Tracker                                        0.11645815
## Government Spending, Deficits, and Debt EMV Tracker      0.72831989
## Entitlement and Welfare Programs EMV Tracker             0.18952684
## Monetary Policy EMV Tracker                              .
## Regulation EMV Tracker                                   0.13976260
## Financial Regulation EMV Tracker                         0.23420505
## Competition Policy EMV Tracker                           0.19927402
## Intellectual Property Policy EMV Tracker                 5.84008622
## Labor Regulations EMV Tracker                            1.66327743
## Immigration EMV Tracker                                  .
## Energy and Environmental Regulation EMV Tracker          .
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker   .
## Housing and Land Management EMV Tracker                  .
## Other Regulation EMV Tracker                            -4.37890985
## National Security Policy EMV Tracker                     0.10560259
## Government-Sponsored Enterprises EMV Tracker             0.08548887
## Trade Policy EMV Tracker                                 1.51458743
## Healthcare Policy EMV Tracker                            1.09644702
```

```
## Food and Drug Policy EMV Tracker                              .
## Transportation, Infrastructure, and Public Utilities EMV Tracker  .
## Elections and Political Governance EMV Tracker                 .
## Agricultural Policy EMV Tracker                                .
## Petroleum Markets EMV Tracker                                  .
```

```
model4$dev.ratio
```

```
## [1] 0.6539538
```

```
a5
```

```
## [1] 0.9636364
```

```
l5
```

```
## [1] 0.176641
```

```
y <- tp5$VIX
x <- data.matrix(tp5[-47][-1])
model5 <- glmnet(x,y,alpha=a5, lambda = l5)
coef(model5)
```

```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                                          s0
## (Intercept)                                       7.8161451
## EMV                                               .
## Political Uncertainty Tracker                     .
## Infectious Disease EMV Tracker                   -0.9417760
## Macroeconomic News and Outlook EMV Tracker        .
## Macro - Broad Quantity Indicators EMV Tracker     .
## Macro - Inflation EMV Indicator                   .
## Macro - Interest Rates EMV Tracker                .
## Macro - Other Financial Indicators EMV Tracker    0.7906063
## Macro - Labor Markets EMV Tracker                 .
## Macro - Real Estate Markets EMV Tracker           1.2890856
## Macro - Trade EMV Tracker                         2.0225566
## Macro - Business Investment and Sentiment EMV Tracker   .
## Macro - Consumer Spending and Sentiment EMV Tracker     .
## Commodity Markets EMV Tracker                     .
## Financial Crises EMV Tracker                      .
## Exchange Rates EMV Tracker                        .
## Healthcare Matters EMV Tracker                   -1.1438774
## Litigation Matters EMV Tracker                   -0.3600769
## Competition Matters EMV Tracker                   0.9148150
## Labor Disputes EMV Tracker                        0.2120721
## Intellectual Property Matters EMV Tracker         0.9311957
## Fiscal Policy EMV Tracker                         .
## Taxes EMV Tracker                                 .
## Government Spending, Deficits, and Debt EMV Tracker     .
## Entitlement and Welfare Programs EMV Tracker      0.1949610
## Monetary Policy EMV Tracker                       .
## Regulation EMV Tracker                            .
## Financial Regulation EMV Tracker                  0.9982673
## Competition Policy EMV Tracker                    .
## Intellectual Property Policy EMV Tracker          4.4267849
## Labor Regulations EMV Tracker                    -0.2184232
## Immigration EMV Tracker                          -2.9667453
```

```
## Energy and Environmental Regulation EMV Tracker                          .
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker              .
## Housing and Land Management EMV Tracker                         -0.7551125
## Other Regulation EMV Tracker                                              .
## National Security Policy EMV Tracker                                      .
## Government-Sponsored Enterprises EMV Tracker                              .
## Trade Policy EMV Tracker                                                  .
## Healthcare Policy EMV Tracker                                             .
## Food and Drug Policy EMV Tracker                                          .
## Transportation, Infrastructure, and Public Utilities EMV Tracker   .
## Elections and Political Governance EMV Tracker                  -0.2032903
## Agricultural Policy EMV Tracker                                 -3.3141615
## Petroleum Markets EMV Tracker                                    0.1417057
```

```r
model5$dev.ratio
```

```
## [1] 0.7016757
```

```r
a6
```

```
## [1] 0.1
```

```r
l6
```

```
## [1] 6.446584
```

```r
y <- tp6$VIX
x <- data.matrix(tp6[-47][-1])
model6 <- glmnet(x,y,alpha=a6, lambda = l6)
coef(model6)
```

```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                                                  s0
## (Intercept)                                             24.87613914
## EMV                                                               .
## Political Uncertainty Tracker                                     .
## Infectious Disease EMV Tracker                                    .
## Macroeconomic News and Outlook EMV Tracker                        .
## Macro - Broad Quantity Indicators EMV Tracker            0.02173463
## Macro - Inflation EMV Indicator                                   .
## Macro - Interest Rates EMV Tracker                                .
## Macro - Other Financial Indicators EMV Tracker          -0.63917898
## Macro - Labor Markets EMV Tracker                                 .
## Macro - Real Estate Markets EMV Tracker                           .
## Macro - Trade EMV Tracker                                         .
## Macro - Business Investment and Sentiment EMV Tracker    1.35987957
## Macro - Consumer Spending and Sentiment EMV Tracker      0.38267524
## Commodity Markets EMV Tracker                                     .
## Financial Crises EMV Tracker                                      .
## Exchange Rates EMV Tracker                               3.28546355
## Healthcare Matters EMV Tracker                                    .
## Litigation Matters EMV Tracker                                    .
## Competition Matters EMV Tracker                                   .
## Labor Disputes EMV Tracker                                        .
## Intellectual Property Matters EMV Tracker                1.88847670
## Fiscal Policy EMV Tracker                               -0.08081061
## Taxes EMV Tracker                                       -0.14082991
## Government Spending, Deficits, and Debt EMV Tracker     -0.39893812
```

```
## Entitlement and Welfare Programs EMV Tracker                              .
## Monetary Policy EMV Tracker                                               .
## Regulation EMV Tracker                                           -0.35584145
## Financial Regulation EMV Tracker                                          .
## Competition Policy EMV Tracker                                    1.63969176
## Intellectual Property Policy EMV Tracker                                  .
## Labor Regulations EMV Tracker                                    -1.26283491
## Immigration EMV Tracker                                                   .
## Energy and Environmental Regulation EMV Tracker                   2.36275818
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker     -0.59448957
## Housing and Land Management EMV Tracker                                   .
## Other Regulation EMV Tracker                                              .
## National Security Policy EMV Tracker                              0.15908447
## Government-Sponsored Enterprises EMV Tracker                              .
## Trade Policy EMV Tracker                                          2.40839307
## Healthcare Policy EMV Tracker                                             .
## Food and Drug Policy EMV Tracker                                  0.51322391
## Transportation, Infrastructure, and Public Utilities EMV Tracker  .
## Elections and Political Governance EMV Tracker                    1.12434209
## Agricultural Policy EMV Tracker                                            .
## Petroleum Markets EMV Tracker                                              .
```

```
model6$dev.ratio
```

```
## [1] 0.4994268
```

Appendix C: Tables of Coefficients for Phase 1

```
coef(ols)
```

```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                                                     s0
## (Intercept)                                                 9.009045434
## EMV                                                         0.278469982
## Political Uncertainty Tracker                               0.537812250
## Infectious Disease EMV Tracker                              0.155137929
## Macroeconomic News and Outlook EMV Tracker                  0.293156968
## Macro - Broad Quantity Indicators EMV Tracker               0.536534749
## Macro - Inflation EMV Indicator                             1.045640000
## Macro - Interest Rates EMV Tracker                         -1.425338675
## Macro - Other Financial Indicators EMV Tracker             -0.447143473
## Macro - Labor Markets EMV Tracker                           0.134525558
## Macro - Real Estate Markets EMV Tracker                    -0.105777370
## Macro - Trade EMV Tracker                                  -2.288871499
## Macro - Business Investment and Sentiment EMV Tracker       0.940026290
## Macro - Consumer Spending and Sentiment EMV Tracker        -0.024569471
## Commodity Markets EMV Tracker                              -0.138569969
## Financial Crises EMV Tracker                                0.105286918
## Exchange Rates EMV Tracker                                  0.352675689
## Healthcare Matters EMV Tracker                             -1.028767772
## Litigation Matters EMV Tracker                             -1.316049590
## Competition Matters EMV Tracker                             0.078829218
## Labor Disputes EMV Tracker                                  3.120912437
## Intellectual Property Matters EMV Tracker                   2.936314541
```

```
## Fiscal Policy EMV Tracker                                                0.450765973
## Taxes EMV Tracker                                                        -0.759373627
## Government Spending, Deficits, and Debt EMV Tracker                      -1.167177092
## Entitlement and Welfare Programs EMV Tracker                              0.449752096
## Monetary Policy EMV Tracker                                              -0.494109618
## Regulation EMV Tracker                                                   -1.048824457
## Financial Regulation EMV Tracker                                          1.701843048
## Competition Policy EMV Tracker                                            0.865233429
## Intellectual Property Policy EMV Tracker                                 -0.836320043
## Labor Regulations EMV Tracker                                             0.361703711
## Immigration EMV Tracker                                                  -1.063141135
## Energy and Environmental Regulation EMV Tracker                           3.736413268
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker             1.398141152
## Housing and Land Management EMV Tracker                                   0.011877792
## Other Regulation EMV Tracker                                             -3.861534738
## National Security Policy EMV Tracker                                     -0.076204817
## Government-Sponsored Enterprises EMV Tracker                              0.540483725
## Trade Policy EMV Tracker                                                 -0.531910666
## Healthcare Policy EMV Tracker                                            -0.057282845
## Food and Drug Policy EMV Tracker                                          0.971674765
## Transportation, Infrastructure, and Public Utilities EMV Tracker -0.473343775
## Elections and Political Governance EMV Tracker                           -0.002833047
## Agricultural Policy EMV Tracker                                          -7.016809832
## Petroleum Markets EMV Tracker                                            -0.080352172
```

coef(ridge)
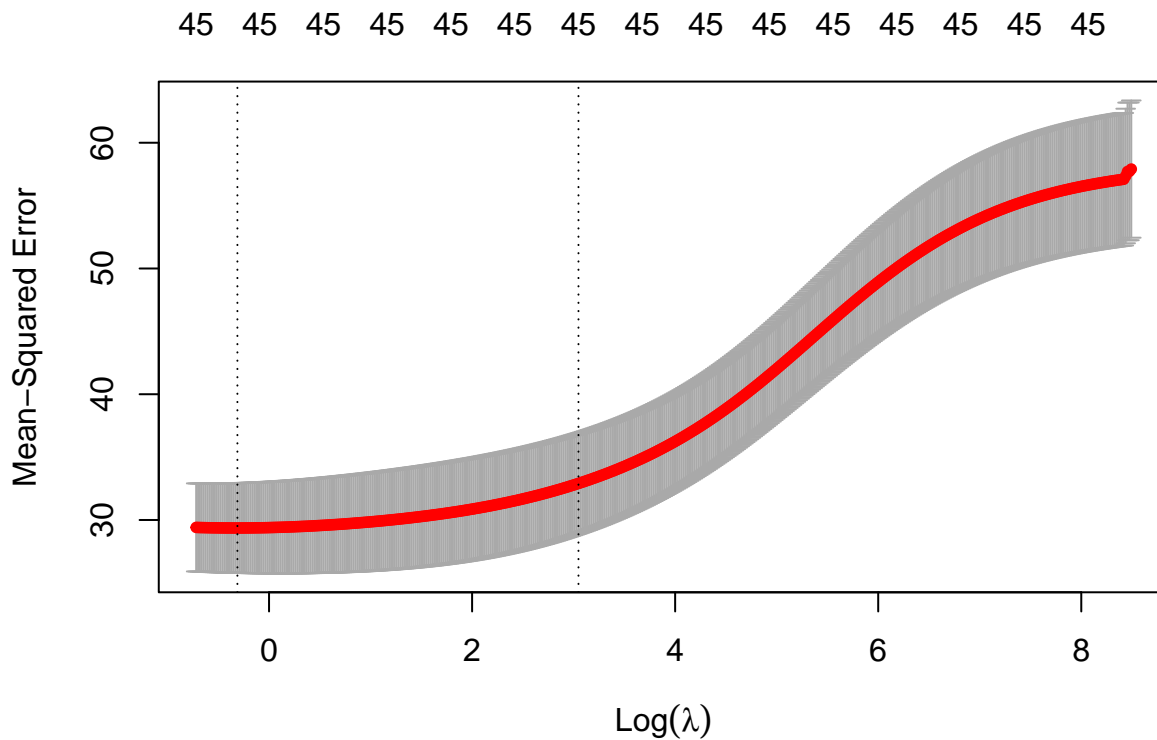
```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                                                        s0
## (Intercept)                                                     8.46401009
## EMV                                                             0.14565962
## Political Uncertainty Tracker                                   0.20140938
## Infectious Disease EMV Tracker                                  0.14417004
## Macroeconomic News and Outlook EMV Tracker                      0.11537016
## Macro - Broad Quantity Indicators EMV Tracker                   0.31212339
## Macro - Inflation EMV Indicator                                 0.49704551
## Macro - Interest Rates EMV Tracker                             -0.77812647
## Macro - Other Financial Indicators EMV Tracker                 -0.19018045
## Macro - Labor Markets EMV Tracker                               0.22401302
## Macro - Real Estate Markets EMV Tracker                        -0.01186008
## Macro - Trade EMV Tracker                                      -1.86147141
## Macro - Business Investment and Sentiment EMV Tracker           0.36242586
## Macro - Consumer Spending and Sentiment EMV Tracker             0.20941579
## Commodity Markets EMV Tracker                                   0.14063412
## Financial Crises EMV Tracker                                    0.03988545
## Exchange Rates EMV Tracker                                      0.11661497
## Healthcare Matters EMV Tracker                                 -0.41470133
## Litigation Matters EMV Tracker                                 -1.06782152
## Competition Matters EMV Tracker                                 0.28995929
## Labor Disputes EMV Tracker                                      2.53358597
## Intellectual Property Matters EMV Tracker                       2.22979494
## Fiscal Policy EMV Tracker                                       0.04813277
## Taxes EMV Tracker                                              -0.11832052
## Government Spending, Deficits, and Debt EMV Tracker            -0.60692640
## Entitlement and Welfare Programs EMV Tracker                    0.54868008
```

```
## Monetary Policy EMV Tracker                                              -0.27076074
## Regulation EMV Tracker                                                     0.01458061
## Financial Regulation EMV Tracker                                           0.87109251
## Competition Policy EMV Tracker                                             0.86528930
## Intellectual Property Policy EMV Tracker                                   0.56974352
## Labor Regulations EMV Tracker                                             -0.54563648
## Immigration EMV Tracker                                                   -2.00354445
## Energy and Environmental Regulation EMV Tracker                            3.33577021
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker             -0.07514940
## Housing and Land Management EMV Tracker                                    0.08347814
## Other Regulation EMV Tracker                                              -2.35827159
## National Security Policy EMV Tracker                                       0.04406125
## Government-Sponsored Enterprises EMV Tracker                               0.54506271
## Trade Policy EMV Tracker                                                  -0.53947307
## Healthcare Policy EMV Tracker                                             -0.60947536
## Food and Drug Policy EMV Tracker                                           0.65328829
## Transportation, Infrastructure, and Public Utilities EMV Tracker  0.21909251
## Elections and Political Governance EMV Tracker                            -0.17415004
## Agricultural Policy EMV Tracker                                           -5.79210597
## Petroleum Markets EMV Tracker                                             -0.08045424
```

`plot(ridge.cv)`

`coef(lasso)`

```
## 46 x 1 sparse Matrix of class "dgCMatrix"
##                                              s0
## (Intercept)                          8.35385499
## EMV                                  0.35912864
## Political Uncertainty Tracker                 .
## Infectious Disease EMV Tracker       0.10128598
## Macroeconomic News and Outlook EMV Tracker    .
```
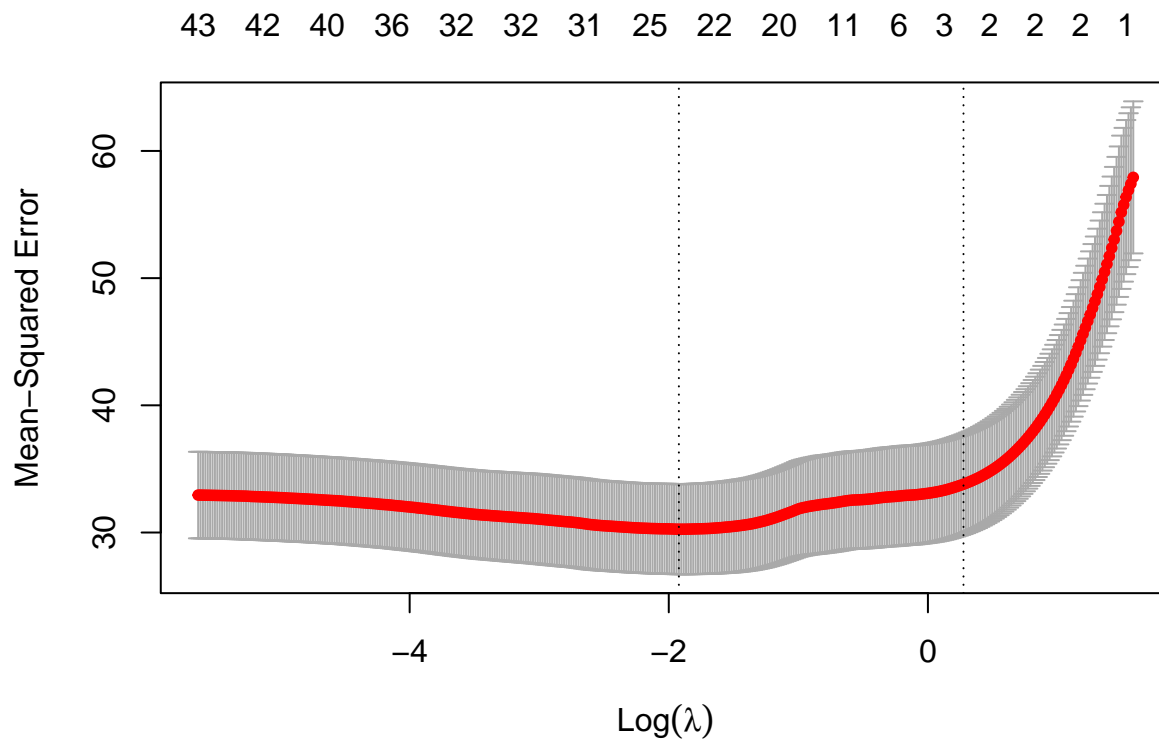
```
## Macro - Broad Quantity Indicators EMV Tracker                          0.30887986
## Macro - Inflation EMV Indicator                                        0.54621266
## Macro - Interest Rates EMV Tracker                                     -0.97940313
## Macro - Other Financial Indicators EMV Tracker                         .
## Macro - Labor Markets EMV Tracker                                      0.05310517
## Macro - Real Estate Markets EMV Tracker                                .
## Macro - Trade EMV Tracker                                              -1.24613934
## Macro - Business Investment and Sentiment EMV Tracker                  .
## Macro - Consumer Spending and Sentiment EMV Tracker                    0.11900587
## Commodity Markets EMV Tracker                                          .
## Financial Crises EMV Tracker                                           .
## Exchange Rates EMV Tracker                                             .
## Healthcare Matters EMV Tracker                                         .
## Litigation Matters EMV Tracker                                         -0.56400375
## Competition Matters EMV Tracker                                        .
## Labor Disputes EMV Tracker                                             2.53209468
## Intellectual Property Matters EMV Tracker                              1.51845600
## Fiscal Policy EMV Tracker                                              .
## Taxes EMV Tracker                                                      .
## Government Spending, Deficits, and Debt EMV Tracker                    -0.46075488
## Entitlement and Welfare Programs EMV Tracker                           0.23782463
## Monetary Policy EMV Tracker                                            .
## Regulation EMV Tracker                                                 .
## Financial Regulation EMV Tracker                                       0.88196989
## Competition Policy EMV Tracker                                         0.63030549
## Intellectual Property Policy EMV Tracker                               .
## Labor Regulations EMV Tracker                                          .
## Immigration EMV Tracker                                                -2.20888399
## Energy and Environmental Regulation EMV Tracker                        2.28112500
## Lawsuit and Tort Reform, Supreme Court Decisions EMV Tracker           .
## Housing and Land Management EMV Tracker                                .
## Other Regulation EMV Tracker                                           -0.99628844
## National Security Policy EMV Tracker                                   0.02084727
## Government-Sponsored Enterprises EMV Tracker                           0.32375266
## Trade Policy EMV Tracker                                               -0.37612007
## Healthcare Policy EMV Tracker                                          -0.30868926
## Food and Drug Policy EMV Tracker                                       .
## Transportation, Infrastructure, and Public Utilities EMV Tracker       .
## Elections and Political Governance EMV Tracker                         -0.07155775
## Agricultural Policy EMV Tracker                                        -3.89479816
## Petroleum Markets EMV Tracker                                          .
```

```
plot(lasso.cv)
```

Appendix D: Table Generation Code

Phase 1

```r
ols.data <- c(RMSE(ols.fit,y), ols$dev.ratio)
ridge.data <- c(RMSE(ridge.fit, y), ridge$dev.ratio)
LASSO.data <- c(RMSE(lasso.fit, y), lasso$dev.ratio)
enet.data <- c(RMSE(elnet.fit, y), elnet$dev.ratio)
findings <- cbind(ols.data, ridge.data, LASSO.data, enet.data)
colnames(findings) <- c("OLS", "Ridge", "LASSO", "Elastic Net")
rownames(findings) <- c("RMSE", "R-Squared")
as.table(findings)
```

Phase 2

```r
#change model1 to model2 for table code for model2 and onwards
coefficients <- coef(model1)
sorted_indices <- order(abs(coefficients[-1]), decreasing = TRUE)
sorted_coefficients <- coefficients[-1][sorted_indices]
top_indices <- sorted_indices[1:5]
predictor_names <- colnames(data)[-1]
top_predictors <- predictor_names[top_indices]
Predictor <- c(top_predictors[1:5])
Weight<- c(sorted_coefficients[1:5])
result = cbind(Predictor,Weight)
rownames(result) = seq(1,5,1)
as.table(result)
```