Probability of Recession

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2022-11-13

Summary

Forecast the probability of a recession in the next 3 months using the following predictors:

1. Spread between 10Y CMT and Effective Federal Funds Rate

Extract Historical Data

Refer to this vignette for FRED data access.

```
library(tidyverse)
library(lubridate)
library(caTools)
library(scam)
library(fredr)
library(effects)
library(car)
library(MLmetrics)

series_id <- c("FEDFUNDS", "GS10", "USREC")

full_data <- map_dfr(series_id, function(x) {
  fredr(
    series_id = x,
    observation_start = as.Date("1950-01-01"),
    observation_end = as.Date("2022-12-01")
  )
})
```

Pivot Wider

```
full_data_wide <- full_data %>%
  select(date, series_id, value) %>%
  pivot_wider(id_cols=date, names_from = series_id, values_from = value)
```

Recession in next 3 months

```
full_data_wide <- full_data_wide %>%
  arrange(date) %>%
  mutate(USREC_LEAD1 = lead(USREC, 1),
         USREC_LEAD2 = lead(USREC, 2),
         USREC_LEAD3 = lead(USREC, 3),
         USREC_3MOS = pmax(USREC_LEAD1, USREC_LEAD2, USREC_LEAD3)) %>%
  drop_na()
```

Calculate Features/Predictors

```
full_data_wide <- full_data_wide %>%
  mutate(SPRD_10YCMT_FEDFUNDS = GS10 - FEDFUNDS) %>%
  select(-USREC, -USREC_LEAD1, -USREC_LEAD2, -USREC_LEAD3)
```

Split Train/Test

```
set.seed(1)

train_id <- sample.split(full_data_wide$USREC_3MOS, SplitRatio = 0.80)

train_data <- full_data_wide[train_id,]
test_data <- full_data_wide[!train_id,]

summary(train_data)
```

```
##       date               FEDFUNDS          GS10          USREC_3MOS
##  Min.   :1954-07-01   Min.   : 0.050   Min.   : 0.620   Min.   :0.0000
##  1st Qu.:1970-10-01   1st Qu.: 1.760   1st Qu.: 3.720   1st Qu.:0.0000
##  Median :1987-04-01   Median : 4.250   Median : 5.140   Median :0.0000
##  Mean   :1988-01-09   Mean   : 4.689   Mean   : 5.704   Mean   :0.1501
##  3rd Qu.:2005-02-01   3rd Qu.: 6.510   3rd Qu.: 7.500   3rd Qu.:0.0000
##  Max.   :2022-07-01   Max.   :19.100   Max.   :15.320   Max.   :1.0000
##  SPRD_10YCMT_FEDFUNDS
##  Min.   :-6.510
##  1st Qu.: 0.260
##  Median : 1.180
##  Mean   : 1.015
##  3rd Qu.: 2.110
##  Max.   : 3.780
```

Logistic Regression

```
logit_mod <- glm(USREC_3MOS ~ SPRD_10YCMT_FEDFUNDS, data=train_data, family=binomial)

summary(logit_mod)
```

```
##
## Call:
## glm(formula = USREC_3MOS ~ SPRD_10YCMT_FEDFUNDS, family = binomial,
##     data = train_data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.0358  -0.5719  -0.4548  -0.3362   2.4810
##
## Coefficients:
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)          -1.41385    0.11908 -11.873  < 2e-16 ***
## SPRD_10YCMT_FEDFUNDS -0.51483    0.07112  -7.239 4.53e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 552.23  on 652  degrees of freedom
## Residual deviance: 491.41  on 651  degrees of freedom
## AIC: 495.41
##
## Number of Fisher Scoring iterations: 5
```

Logit with Knot

```
logit_mod_knot <- glm(USREC_3MOS ~ SPRD_10YCMT_FEDFUNDS +
                        pmax(0,SPRD_10YCMT_FEDFUNDS),
                      data=train_data, family=binomial)

summary(logit_mod_knot)
```

```
##
## Call:
## glm(formula = USREC_3MOS ~ SPRD_10YCMT_FEDFUNDS + pmax(0, SPRD_10YCMT_FEDFUNDS),
##     family = binomial, data = train_data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.1948  -0.5577  -0.4603  -0.3577   2.4195
##
## Coefficients:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                    -1.5196     0.1933  -7.861 3.81e-15 ***
## SPRD_10YCMT_FEDFUNDS           -0.5889     0.1296  -4.545 5.48e-06 ***
## pmax(0, SPRD_10YCMT_FEDFUNDS)   0.1582     0.2252   0.703    0.482
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 552.23  on 652  degrees of freedom
```

```
## Residual deviance: 490.92  on 650  degrees of freedom
## AIC: 496.92
##
## Number of Fisher Scoring iterations: 5
```

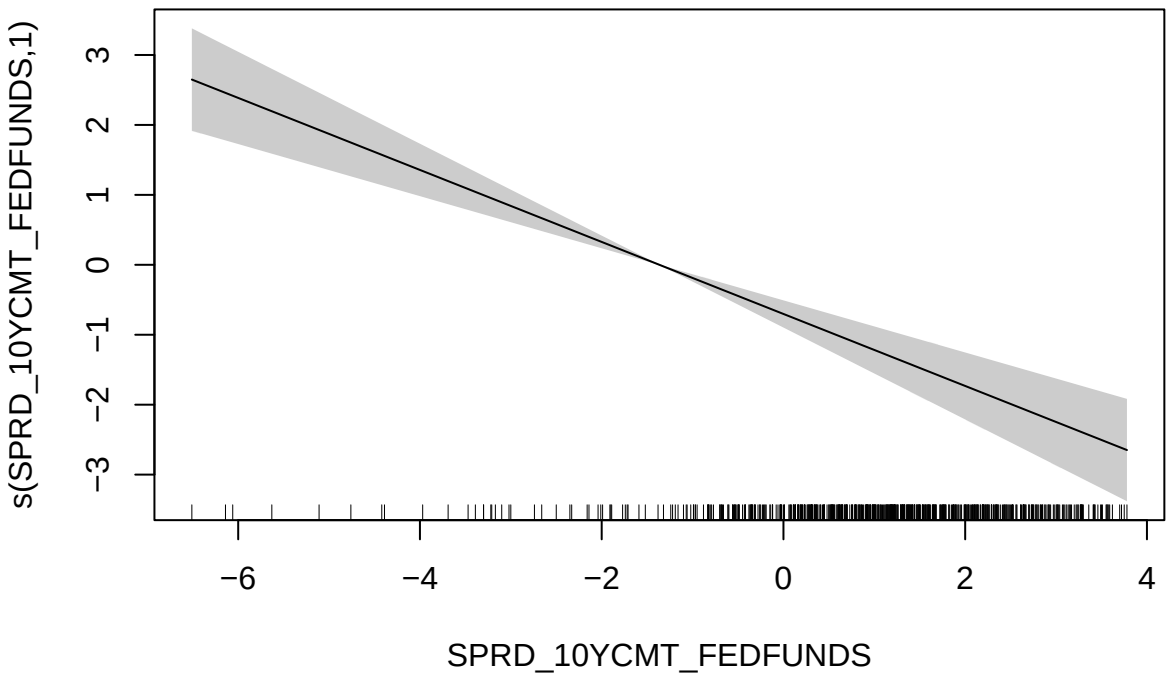
Shape-Constrained GAM

```
scam_mod <- scam(USREC_3MOS ~ s(SPRD_10YCMT_FEDFUNDS, bs="mpd"),
                 data=train_data, family=binomial())

summary(scam_mod)
```

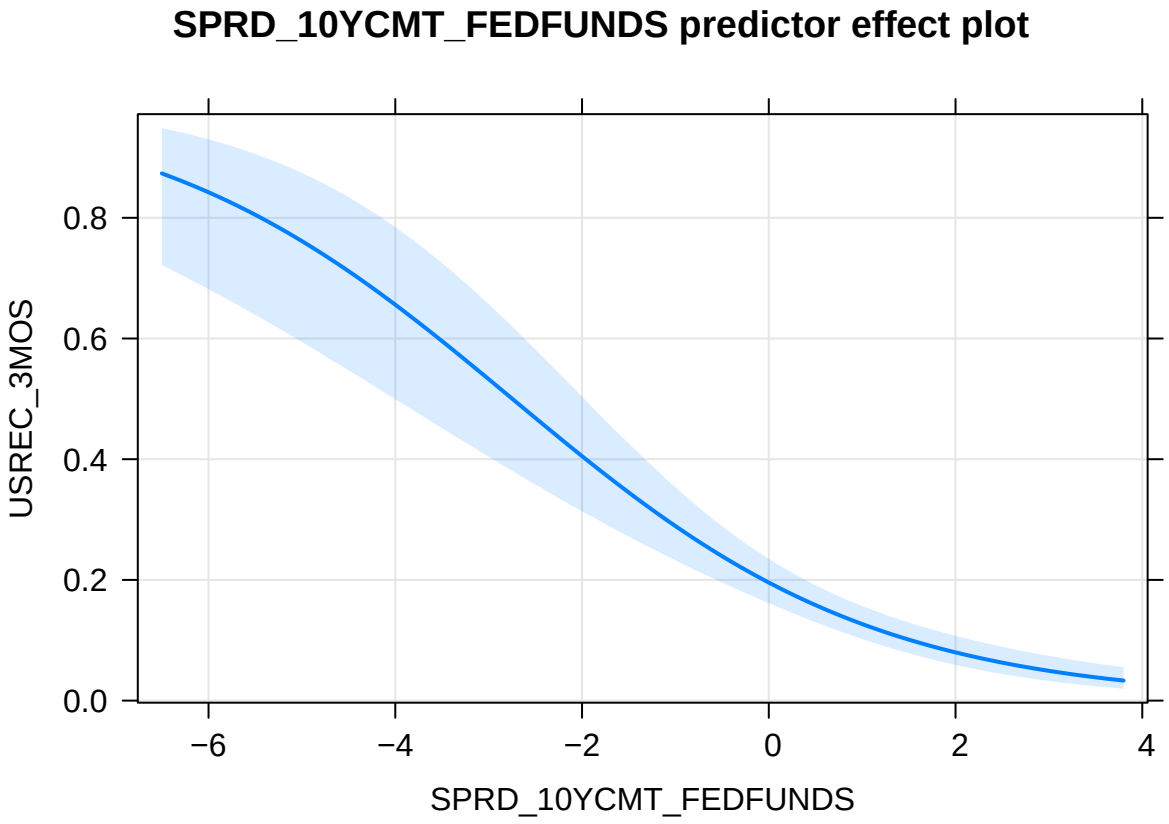
```
##
## Family: binomial
## Link function: logit
##
## Formula:
## USREC_3MOS ~ s(SPRD_10YCMT_FEDFUNDS, bs = "mpd")
##
## Parametric coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   2.6945     0.6036   4.464 8.05e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                           edf Ref.df Chi.sq  p-value
## s(SPRD_10YCMT_FEDFUNDS)   1      1  52.32 4.76e-13 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.1214   Deviance explained =   11%
## UBRE score = -0.24132  Scale est. = 1         n = 653
```

```
plot(scam_mod,pages=1,shade=TRUE)
```



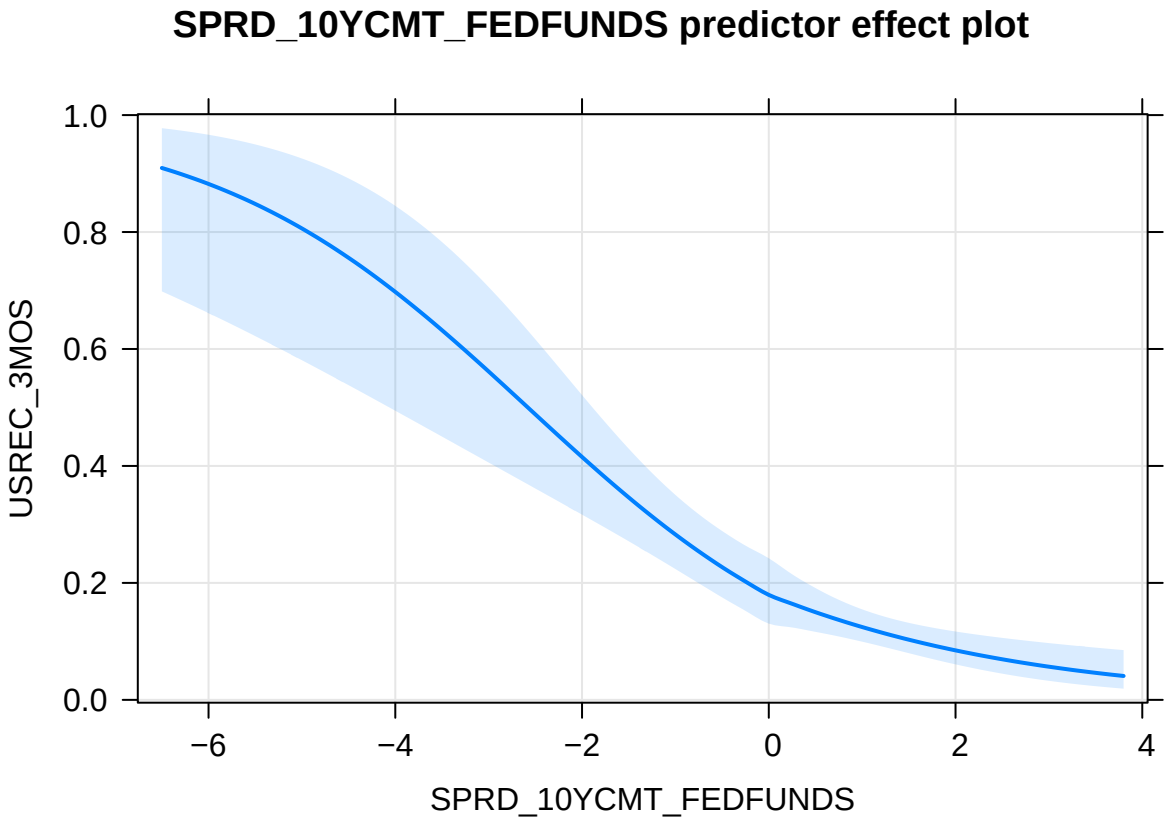
Effect Plot

```
plot(predictorEffects(logit_mod),
     axes = list(
       grid = TRUE,
       x = list(rug = FALSE),
       y = list(type = "response")
     ))
```



Effect Plot with knot

```
plot(predictorEffects(logit_mod_knot),
     axes = list(
       grid = TRUE,
       x = list(rug = FALSE),
       y = list(type = "response")
     ))
```



Null Model

```
null_mod <- glm(USREC_3MOS ~ 1, data=train_data, family=binomial)

summary(null_mod)
```

```
##
## Call:
## glm(formula = USREC_3MOS ~ 1, family = binomial, data = train_data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.5703  -0.5703  -0.5703  -0.5703   1.9476
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -1.7340     0.1096  -15.82   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 552.23  on 652  degrees of freedom
```

```
## Residual deviance: 552.23  on 652  degrees of freedom
## AIC: 554.23
##
## Number of Fisher Scoring iterations: 4
```

Performance Metric

```
test_preds <- predict(logit_mod, newdata=test_data, type="response")
null_preds <- predict(null_mod, newdata=test_data, type="response")
knot_preds <- predict(logit_mod_knot, newdata=test_data, type="response")


perf <- function(lst_preds, f_metric=caTools::colAUC, metricname="ROC-AUC"){
  map_dfr(lst_preds, function(x){
  f_metric(x, test_data$USREC_3MOS)
}) %>%
  pivot_longer(everything(), names_to="model", values_to=metricname) %>%
  knitr::kable()
}

myPreds <- list(logit_reg=test_preds, null_model=null_preds,
                knot_reg=knot_preds)

perf(myPreds, caTools::colAUC, "ROC-AUC")
```

model	ROC-AUC
logit_reg	0.723741
null_model	0.500000
knot_reg	0.723741

```
perf(myPreds, MLmetrics::LogLoss, "LogLoss")
```

model	LogLoss
logit_reg	0.3811439
null_model	0.4269384
knot_reg	0.3827391

Probability of Recession (11/11/2022)

10Y CMT = 3.82

Eff. FFR = 3.84

```
curr_data = data.frame(SPRD_10YCMT_FEDFUNDS = 3.82 - 3.84)

mods <- list(logistic_reg=logit_mod,
                               scam_mod=scam_mod,
```

```
                              knot_mod=logit_mod_knot,
                              baseline=null_mod)

map_dfc(mods, function(x){
  predict(x, newdata=curr_data, type="response")
}) %>%
  pivot_longer(everything(), names_to = "model",
               values_to = "prob_rec") %>%
  knitr::kable(.)
```

model	prob_rec
logistic_reg	0.1972536
scam_mod	0.1972524
knot_mod	0.1812655
baseline	0.1500766

Relative to the historical baseline, a slightly negative spread between the 10Y CMT and effective federal funds rate increases the chances of a recession in the next 3 months.