Research Project

Load Packages

```
library(quantmod)
library(tidyverse)
library(XLConnect)
library(tseries)
library(car)
```

Function: Obtain Prices

```
get_prc <- function(symbol, start, end, compression = "m") {

    price <- get.hist.quote(instrument = symbol, start = start,
        end = end, compression = compression, quote = "Close",
        quiet = TRUE)

    Date <- index(price)

    price <- (price %>% as.data.frame() %>% mutate(Date = Date) %>%
        select(Date, everything()))

    return(price)
}
```

Function: Calculate Monthly Returns

```
get_return <- function(symbol, start, end, compression = "m") {

    price <- get.hist.quote(instrument = symbol, start = start,
        end = end, compression = compression, quote = "Close",
        quiet = TRUE)

    Date <- index(price)

    price <- (price %>% as.data.frame() %>% mutate(Date = Date) %>%
        select(Date, everything()))

    returns <- price %>% mutate(returns = Close/lag(Close) -
        1) %>% select(-Close) %>% filter(complete.cases(returns))

    returns <- returns %>% as.tibble()

    return(returns)
}
```

Function: Variance Inflation Factor Test

```
VIF_test <- function(df, y) {

    s <- 11
```

```
    # If VIF > 10, exclude factor

    while (sum(s > 10) != 0) {

        model <- lm(df[, y] ~ ., data = df[, names(df) != y])

        s <- vif(model)

        df <- df %>% select(-one_of(names(s[s > 10])))

    }

    # Remove factor with VIF > 4 after factors of high
    # collinearity (VIF > 10) has been removed

    while (sum(s > 4) != 0) {

        model <- lm(df[, y] ~ ., data = df[, names(df) != y])

        s <- vif(model)

        df <- df %>% select(-one_of(names(s[s > 4])))

    }

    return(df)

}
```

Data range and query stock

```
start <- "1998-12-31"

end <- "2018-06-02"

query_stock <- "MSFT"
```

I. Carhart four-factor model

1) Obtain stock returns

```
returns <- get_return(query_stock, start, end)

returns$Date <- as.yearmon(returns$Date)
```

2) Data: Fama French 3 factors

```
ff_factors <- read.csv("F-F_Research_Data_Factors.CSV", header = TRUE,
    skip = 3, nrows = 1102)

colnames(ff_factors)[1] <- "Date"
```

```r
# Format Date into yearmon

ff_factors$Date <- as.yearmon(as.Date(paste(ff_factors$Date,
    "01", sep = ""), format = "%Y%m%d"))

ff_factors[, -1] <- ff_factors[, -1]/100
```

3) Data: Fama French Momentum

```r
ff_mom <- read.csv("F-F_Momentum_Factor.CSV", header = TRUE,
    skip = 13, nrows = 1095)

colnames(ff_mom)[1] <- "Date"

# Format Date into yearmon

ff_mom$Date <- as.yearmon(as.Date(paste(ff_mom$Date, "01", sep = ""),
    format = "%Y%m%d"))

ff_mom[, -1] <- ff_mom[, -1]/100
```

4) Run Rolling Regression

```r
# Merge stock returns, ff_mom, ff_factors by Date

df <- Reduce(function(x, y) merge(x, y, by = "Date"), list(ff_factors,
    ff_mom, returns))

# Calculate excess stock return

df <- df %>% mutate(Ex.return = returns - RF)

# Run rolling regression with window length: 120 months

df <- df %>% select(-c(RF, returns))

ff_list <- list()

from <- 120

for (i in from:nrow(df)) {

    # Data within the window

    tem_data <- df[(i - from + 1):i, -1]

    # Regression summary

    tem_s <- summary(lm(Ex.return ~ ., data = tem_data))

    # Filter out factors that are significant at 95% confidence
    # level
```

```r
    tem_ff <- rownames(tem_s$coefficients)

    ff_list[[i]] <- tem_ff[tem_s$coefficients[, 4] < 0.05]
}

# Count significant factors occurence in the recent 60 months

table(do.call(rbind, tail(ff_list, 60)))
```

```
##
## Mkt.RF    SMB
##     90     30
```

>> According to the Carhart four-factor model, market return and SMB are significant for recent 60 months. Those two factors will be combined with valuation model.

II. Valuation Model

1) Load Quarterly Fundamentals

```r
# Fundamentals data frequenct: Quarterly

fund_qtr <- read.csv("Fundamentals.csv", header = T)
```

2) Fundamental Factors

a) Valuation Factors: Price/Sales, Price/Earnings, Dividend Yield

```r
Mod2_factors <- fund_qtr %>% mutate(Date = datadate, Price_Sales = Price/Sales,
    P_E = Price/NI, Div_yield = Div/Price)

# Format date

Mod2_factors$Date <- as.Date(as.character(Mod2_factors$Date),
    format = "%Y%m%d")
```

b) Growth Factors: 3-month Sales Growth, 1-year Sales Growth, 3-month EPS Growth, 1-year EPS Growth

```r
Mod2_factors <- Mod2_factors %>% mutate(Sales_g3M = Sales/lag(Sales,
    1) - 1, Sales_g1Y = Sales/lag(Sales, 3) - 1, EPS_g3M = EPS/lag(EPS,
    1) - 1, EPS_g1Y = EPS/lag(EPS, 3) - 1)
```

c) Quality Factors: Current Ratio, Asset/Equity, Working Capital/Asset

```r
Mod2_factors <- Mod2_factors %>% mutate(Current_ratio = CA/CL,
    Asset_Equity = TA/TE, WorkingCap_Asset = (CA - CL)/TA)
```

d) Efficiency Factors: Capex/Asset, Capex/Sales, Operating CF/Asset

```
Mod2_factors <- Mod2_factors %>% mutate(Capex_Asset = CapEx/TA,
    Capex_Sales = CapEx/Sales, OptingCF_Asset = OptingCF/TA)
```

e) Profitability Factors: ROE, ROA, ROIC

```
Mod2_factors <- Mod2_factors %>% mutate(NI_4Q = rollsum(NI, 4,
    fill = NA, align = "right"), EQ_2Q = rollmean(TE, 2, fill = NA,
    align = "right"), TA_2Q = rollmean(TA, 2, fill = NA, align = "right"),
    IC_2Q = rollmean(IC, 2, fill = NA, align = "right"), ROE = NI_4Q/EQ_2Q,
    ROA = NI_4Q/TA_2Q, ROIC = NI_4Q/IC_2Q)

Mod2_factors <- Mod2_factors %>% select(-one_of(c("NI_4Q", "EQ_2Q",
    "TA_2Q", "IC_2Q")))
```

f) Size Factors: Book/Market Value

```
Mod2_factors <- Mod2_factors %>% mutate(B_M = TE/Mkt.Value)
```

e) Valuation factor table

```
tem <- colnames(fund_qtr)

Mod2_factors <- Mod2_factors %>% select(-one_of(tem))
```

3) Price Factors: 6-month Momentum, 1-month Mean Reversion

```
# Obtain Prices Data Frequency: Monthly

query_price <- get_prc(query_stock, Mod2_factors$Date[1], Mod2_factors$Date[nrow(Mod2_factors)])

query_price$Date <- query_price$Date - 1

# Calculate price factors

prc_factors <- (query_price %>% mutate(Return = Close/lag(Close) -
    1, Mom_6M = Close/lag(Close, 2) - 1, Avg_12M = rollmean(Return,
    4, fill = NA, align = "right"), Std_12M = rollapply(Return,
    4, sd, fill = NA, align = "right"), MeanRev_1M = (Return -
    Avg_12M)/Std_12M) %>% select(Date, Return, Mom_6M, MeanRev_1M))
```

4) Fama-French factors: Market, SMB

```
mkt <- ff_factors %>% select(Date, Mkt.RF, SMB, RF)

mkt$Date <- as.Date(mkt$Date, frac = 1)
```

5) Market Risk Factor

```r
# Market beta from 60-month rolling regression Data
# Frequency: Monthly

# Obtain market excess returns and risk-free returns

tem1 <- ff_factors %>% select(Date, Mkt.RF, RF)

tem1$Date <- as.Date(tem1$Date, frac = 1)

# Obtain monthly stock returns

tem2 <- get_return(query_stock, tem1$Date[1], tem1$Date[nrow(tem1)])

tem2$Date <- tem2$Date - 1

# Calculate stock excess returns

Mod2_df <- merge(tem1, tem2) %>% mutate(Ex.Return = returns -
    RF)

# Run rolling regression and obtain betas

betas <- rollapply(data = Mod2_df[, c("Ex.Return", "Mkt.RF")],
    width = 60, FUN = function(x) {
        reg = lm(Ex.Return ~ Mkt.RF, data = as.data.frame(x))
        return(as.numeric(reg$coef[2]))
    }, by.column = FALSE, align = "right", fill = NA)
```

6) Lag Factors for Crtain Period and transform into quarterly data

a) Lag valuation factors for two quarter

```r
Mod2_factors$Date <- lead(Mod2_factors$Date, 2)
```

b) Lag price factors for one month

```r
prc_factors$Date <- lead(prc_factors$Date, 1)

prc_factors <- prc_factors %>% filter(Date %in% Mod2_factors$Date)
```

c) Lag market risk factor for one month

```r
Mod2_df <- (Mod2_df %>% mutate(beta = lag(betas)) %>% filter(Date %in%
    Mod2_factors$Date))

Mod2_df <- Mod2_df %>% select(Date, beta)
```

d) Lag Fama-French factors for one month

```
mkt$Date <- lead(mkt$Date, 1)

mkt <- mkt %>% filter(Date %in% Mod2_factors$Date)
```

5) Aggregate Factor Table

```
# Combine valuation factors, price factors, market risk
# factor and Fama-French factors

factors_all <- Reduce(function(x, y) merge(x, y, by = "Date"),
    list(Mod2_factors, prc_factors, Mod2_df, mkt))
```

6) Cope with Collinearity in Valuation Factors with Straightforward Method

```
# Give equal weights to highly correlated factors to create
# indexes

factors_all <- factors_all %>% mutate(quality = (Current_ratio +
    Asset_Equity + WorkingCap_Asset)/3, efficiency = (Capex_Asset +
    Capex_Sales)/2, growth1 = (Sales_g3M + Sales_g1Y)/2, growth2 = (EPS_g3M +
    EPS_g1Y)/2, Profitability = (ROA + ROE + ROIC)/3)

# Keep indexes and exclude those factors

exclude_fac <- c("Current_ratio", "Asset_Equity", "WorkingCap_Asset",
    "Capex_Asset", "Capex_Sales", "Sales_g3M", "Sales_g1Y", "ROA",
    "ROE", "ROIC", "EPS_g3M", "EPS_g1Y")

factors_all <- factors_all %>% select(-one_of(exclude_fac))
```

III. Factor Analysis of Contemporaneous Returns

```
# Calculate excess return of query stock

factors_all <- factors_all %>% mutate(Ex.return = Return - RF) %>%
    select(-Return, -RF)

output <- list()

# Data window: 60 quarters

from <- 60

# Filter factors with VIF test to avoid collinearity

for (i in from:nrow(factors_all)) {

    # Data within the window

    tem_data <- factors_all[(i - from + 1):i, ]
```

```r
    # Select factors with VIF test

    tem_factors <- VIF_test(tem_data[, -1], "Ex.return")

    # Output data into list

    output[[i]] <- summary(lm(Ex.return ~ ., data = tem_factors))

    # Name list elements by the date of contemporaneous Returns

    names(output)[i] <- toString(factors_all$Date[i])
}

# Remove empty lists

output[sapply(output, is.null)] <- NULL

# Print results

output
```

```
## $`2013-09-30`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.059852 -0.020243 -0.001987  0.022583  0.108926
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.003356   0.020628   0.163   0.8715
## P_E             -0.013466   0.035246  -0.382   0.7042
## OptingCF_Asset  -0.190971   0.113601  -1.681   0.0995 .
## Mom_6M           0.608639   0.066311   9.178 5.78e-12 ***
## MeanRev_1M       0.039143   0.007421   5.274 3.48e-06 ***
## beta            -0.012809   0.017346  -0.738   0.4640
## Mkt.RF          -0.348847   0.159914  -2.181   0.0343 *
## SMB              0.275370   0.143593   1.918   0.0614 .
## growth1          0.034557   0.048582   0.711   0.4805
## growth2          0.007729   0.010876   0.711   0.4809
## Profitability    0.125731   0.065207   1.928   0.0600 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03631 on 46 degrees of freedom
##   (3 observations deleted due to missingness)
## Multiple R-squared:  0.8615, Adjusted R-squared:  0.8314
## F-statistic: 28.61 on 10 and 46 DF,  p-value: < 2.2e-16
##
##
## $`2013-12-31`
##
```

```
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.060227 -0.019505 -0.002908  0.020213  0.112671
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.003678   0.018025  -0.204   0.8392
## P_E            -0.012889   0.034639  -0.372   0.7115
## OptingCF_Asset -0.129055   0.069198  -1.865   0.0683 .
## Mom_6M          0.598192   0.063658   9.397 1.86e-12 ***
## MeanRev_1M      0.038818   0.007057   5.501 1.44e-06 ***
## beta           -0.012612   0.017041  -0.740   0.4628
## Mkt.RF         -0.326949   0.154907  -2.111   0.0400 *
## SMB             0.269462   0.141198   1.908   0.0623 .
## growth1         0.054716   0.037985   1.440   0.1562
## Profitability   0.121797   0.063555   1.916   0.0613 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03576 on 48 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:   0.86,  Adjusted R-squared:  0.8338
## F-statistic: 32.77 on 9 and 48 DF,  p-value: < 2.2e-16
##
##
## $`2014-03-31`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.059341 -0.019886 -0.003438  0.021306  0.112330
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.005436   0.017766  -0.306   0.7609
## P_E            -0.012604   0.034463  -0.366   0.7161
## OptingCF_Asset -0.122178   0.068178  -1.792   0.0793 .
## Mom_6M          0.601360   0.063183   9.518 1.01e-12 ***
## MeanRev_1M      0.037540   0.006791   5.528 1.24e-06 ***
## beta           -0.013678   0.016890  -0.810   0.4219
## Mkt.RF         -0.347130   0.151534  -2.291   0.0263 *
## SMB             0.276767   0.140117   1.975   0.0539 .
## growth1         0.058770   0.037368   1.573   0.1222
## Profitability   0.122054   0.063235   1.930   0.0594 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03558 on 49 degrees of freedom
##   (1 observation deleted due to missingness)
```

```
## Multiple R-squared:  0.8597, Adjusted R-squared:  0.8339
## F-statistic: 33.35 on 9 and 49 DF,  p-value: < 2.2e-16
##
##
## $`2014-06-30`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.059180 -0.020143 -0.001887  0.022529  0.111788
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.005431   0.017601  -0.309   0.7590
## P_E            -0.015316   0.034674  -0.442   0.6606
## OptingCF_Asset -0.167511   0.102775  -1.630   0.1095
## Mom_6M          0.598483   0.063071   9.489 1.12e-12 ***
## MeanRev_1M      0.038237   0.006824   5.603 9.51e-07 ***
## beta           -0.014812   0.016849  -0.879   0.3836
## Mkt.RF         -0.357754   0.151241  -2.365   0.0220 *
## SMB             0.291473   0.139883   2.084   0.0424 *
## efficiency      0.162474   0.261460   0.621   0.5372
## growth1         0.057546   0.036226   1.589   0.1186
## Profitability   0.117200   0.063573   1.844   0.0713 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03547 on 49 degrees of freedom
## Multiple R-squared:  0.8606, Adjusted R-squared:  0.8321
## F-statistic: 30.24 on 10 and 49 DF,  p-value: < 2.2e-16
##
##
## $`2014-09-30`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.06774 -0.01781 -0.00338  0.02193  0.10873
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.014192   0.016760  -0.847   0.4012
## P_E           -0.019630   0.034257  -0.573   0.5692
## Mom_6M         0.631633   0.063562   9.937 1.99e-13 ***
## MeanRev_1M     0.034790   0.006922   5.026 6.79e-06 ***
## beta          -0.022227   0.017400  -1.277   0.2074
## Mkt.RF        -0.383780   0.151507  -2.533   0.0145 *
## SMB            0.254352   0.139497   1.823   0.0742 .
## efficiency    -0.148660   0.163276  -0.910   0.3669
## growth1        0.042494   0.035475   1.198   0.2366
```

```
## Profitability  0.123416   0.063298   1.950   0.0568 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03527 on 50 degrees of freedom
## Multiple R-squared:  0.8589, Adjusted R-squared:  0.8335
## F-statistic: 33.83 on 9 and 50 DF,  p-value: < 2.2e-16
##
##
## $`2014-12-31`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.06420 -0.01636 -0.00227  0.02042  0.11242
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.012694   0.017082  -0.743   0.4609
## P_E           -0.022249   0.034535  -0.644   0.5224
## Mom_6M         0.624861   0.066225   9.435 1.09e-12 ***
## MeanRev_1M     0.033172   0.006917   4.796 1.50e-05 ***
## beta          -0.019438   0.018065  -1.076   0.2871
## Mkt.RF        -0.381276   0.153372  -2.486   0.0163 *
## SMB            0.232722   0.142763   1.630   0.1094
## efficiency    -0.098733   0.158187  -0.624   0.5354
## growth1        0.043295   0.036340   1.191   0.2391
## Profitability  0.108892   0.063812   1.706   0.0941 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03564 on 50 degrees of freedom
## Multiple R-squared:  0.8283, Adjusted R-squared:  0.7974
## F-statistic: 26.79 on 9 and 50 DF,  p-value: 3.583e-16
##
##
## $`2015-03-31`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.05816 -0.02523 -0.00145  0.02530  0.10185
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.011804   0.016350  -0.722   0.4737
## P_E           -0.025136   0.033159  -0.758   0.4520
## Mom_6M         0.596928   0.064838   9.206 2.41e-12 ***
## MeanRev_1M     0.034603   0.006658   5.197 3.75e-06 ***
## beta          -0.010553   0.017760  -0.594   0.5551
```

```
## Mkt.RF        -0.295069   0.152853  -1.930   0.0592 .
## SMB           -0.236056   0.239081  -0.987   0.3282
## efficiency    -0.082439   0.151065  -0.546   0.5877
## growth1        0.055250   0.035049   1.576   0.1212
## Profitability  0.089671   0.061789   1.451   0.1530
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03419 on 50 degrees of freedom
## Multiple R-squared:  0.8298, Adjusted R-squared:  0.7992
## F-statistic: 27.09 on 9 and 50 DF,  p-value: 2.869e-16
##
##
## $`2015-06-30`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.04980 -0.02072  0.00106  0.01944  0.05757
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.007722   0.013993  -0.552    0.584
## P_E           -0.013824   0.028422  -0.486    0.629
## Mom_6M         0.506431   0.058783   8.615 1.89e-11 ***
## MeanRev_1M     0.035959   0.005694   6.315 7.08e-08 ***
## beta           0.015826   0.016354   0.968    0.338
## Mkt.RF        -0.189446   0.132358  -1.431    0.159
## SMB            0.009486   0.211818   0.045    0.964
## efficiency    -0.045276   0.129101  -0.351    0.727
## growth1        0.033704   0.030023   1.123    0.267
## Profitability  0.053376   0.053401   1.000    0.322
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02919 on 50 degrees of freedom
## Multiple R-squared:  0.8431, Adjusted R-squared:  0.8149
## F-statistic: 29.86 on 9 and 50 DF,  p-value: < 2.2e-16
##
##
## $`2015-09-30`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.052165 -0.019423  0.001044  0.018116  0.055990
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -0.010087   0.014463  -0.697    0.489
```

```
## P_E           -0.016240   0.028438  -0.571    0.571
## Mom_6M         0.490221   0.062391   7.857 2.77e-10 ***
## MeanRev_1M     0.036994   0.005730   6.456 4.26e-08 ***
## beta           0.010355   0.017653   0.587    0.560
## Mkt.RF        -0.160139   0.141966  -1.128    0.265
## SMB           -0.009472   0.214560  -0.044    0.965
## efficiency    -0.010465   0.123168  -0.085    0.933
## growth1        0.026431   0.029385   0.899    0.373
## Profitability  0.060412   0.054969   1.099    0.277
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02913 on 50 degrees of freedom
## Multiple R-squared:  0.832,  Adjusted R-squared:  0.8018
## F-statistic: 27.52 on 9 and 50 DF,  p-value: < 2.2e-16
##
##
## $`2015-12-31`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.057762 -0.016166  0.003027  0.015845  0.051583
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.008659   0.013963  -0.620   0.5380
## P_E            -0.009281   0.026704  -0.348   0.7297
## OptingCF_Asset -0.127773   0.072802  -1.755   0.0855 .
## Mom_6M          0.423420   0.063053   6.715 1.83e-08 ***
## MeanRev_1M      0.038656   0.005395   7.165 3.69e-09 ***
## beta            0.004285   0.016985   0.252   0.8019
## Mkt.RF         -0.147192   0.130245  -1.130   0.2639
## SMB            -0.029560   0.196462  -0.150   0.8810
## efficiency      0.243919   0.145465   1.677   0.0999 .
## growth1         0.025735   0.027643   0.931   0.3564
## Profitability   0.079829   0.051190   1.559   0.1253
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02721 on 49 degrees of freedom
## Multiple R-squared:  0.809,  Adjusted R-squared:   0.77
## F-statistic: 20.75 on 10 and 49 DF,  p-value: 2.395e-14
##
##
## $`2016-03-31`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
```

```
## -0.058342 -0.015115  0.002267  0.017588  0.052797
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.001176   0.013632  -0.086   0.9316
## P_E            -0.005546   0.026456  -0.210   0.8348
## OptingCF_Asset -0.152814   0.071413  -2.140   0.0374 *
## Mom_6M          0.433074   0.062819   6.894 9.68e-09 ***
## MeanRev_1M      0.037949   0.005371   7.065 5.26e-09 ***
## beta            0.002087   0.016897   0.124   0.9022
## Mkt.RF         -0.233348   0.138959  -1.679   0.0995 .
## SMB             0.003163   0.194496   0.016   0.9871
## efficiency      0.252568   0.143116   1.765   0.0838 .
## growth1         0.013888   0.027018   0.514   0.6095
## Profitability   0.071677   0.050136   1.430   0.1592
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0269 on 49 degrees of freedom
## Multiple R-squared:  0.8129, Adjusted R-squared:  0.7748
## F-statistic:  21.3 on 10 and 49 DF,  p-value: 1.455e-14
##
##
## $`2016-06-30`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.056860 -0.016984  0.002066  0.018616  0.051370
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.004787   0.013667  -0.350   0.7277
## P_E            -0.003557   0.026932  -0.132   0.8955
## OptingCF_Asset -0.130816   0.071320  -1.834   0.0727 .
## Mom_6M          0.420087   0.065900   6.375 6.18e-08 ***
## MeanRev_1M      0.038719   0.005520   7.014 6.31e-09 ***
## beta            0.003111   0.017554   0.177   0.8601
## Mkt.RF         -0.213054   0.144080  -1.479   0.1456
## SMB            -0.003637   0.200931  -0.018   0.9856
## efficiency      0.216711   0.143096   1.514   0.1363
## growth1         0.008072   0.027420   0.294   0.7697
## Profitability   0.078226   0.050815   1.539   0.1301
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02737 on 49 degrees of freedom
## Multiple R-squared:  0.8058, Adjusted R-squared:  0.7662
## F-statistic: 20.34 on 10 and 49 DF,  p-value: 3.513e-14
##
##
## $`2016-09-30`
```

```
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.055261 -0.018391  0.002667  0.017633  0.055873
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)     0.011206   0.008993   1.246    0.219
## P_E            -0.002735   0.027366  -0.100    0.921
## OptingCF_Asset -0.099766   0.068292  -1.461    0.150
## Mom_6M          0.427828   0.067933   6.298 7.52e-08 ***
## MeanRev_1M      0.038028   0.005579   6.816 1.16e-08 ***
## beta            0.019018   0.014301   1.330    0.190
## Mkt.RF         -0.265327   0.144338  -1.838    0.072 .
## SMB             0.007724   0.207274   0.037    0.970
## efficiency      0.169360   0.131078   1.292    0.202
## growth1         0.009445   0.027704   0.341    0.735
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02773 on 50 degrees of freedom
## Multiple R-squared:  0.7821, Adjusted R-squared:  0.7428
## F-statistic: 19.93 on 9 and 50 DF,  p-value: 1.145e-13
##
##
## $`2016-12-31`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.054434 -0.017809  0.003424  0.017661  0.054913
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)     0.010185   0.010106   1.008   0.3184
## P_E             0.129929   0.328674   0.395   0.6943
## OptingCF_Asset -0.083462   0.065796  -1.268   0.2105
## Mom_6M          0.434523   0.067031   6.482 3.87e-08 ***
## MeanRev_1M      0.037228   0.005407   6.885 9.07e-09 ***
## beta            0.020829   0.015329   1.359   0.1803
## Mkt.RF         -0.276589   0.143328  -1.930   0.0593 .
## SMB            -0.015918   0.204272  -0.078   0.9382
## efficiency      0.121640   0.107305   1.134   0.2624
## growth1         0.008616   0.027775   0.310   0.7577
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02782 on 50 degrees of freedom
## Multiple R-squared:  0.7808, Adjusted R-squared:  0.7414
```

```
## F-statistic: 19.79 on 9 and 50 DF,  p-value: 1.312e-13
##
##
## $`2017-03-31`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.050896 -0.014725  0.003025  0.020059  0.054684
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.002444   0.007990   0.306   0.7610
## P_E          0.106661   0.345774   0.308   0.7590
## Mom_6M       0.435747   0.067675   6.439 4.19e-08 ***
## MeanRev_1M   0.037347   0.005451   6.852 9.33e-09 ***
## beta         0.016149   0.014977   1.078   0.2860
## Mkt.RF      -0.253432   0.141435  -1.792   0.0791 .
## SMB         -0.033090   0.200435  -0.165   0.8695
## efficiency   0.055310   0.092649   0.597   0.5532
## growth1      0.004587   0.027877   0.165   0.8699
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02798 on 51 degrees of freedom
## Multiple R-squared:  0.7737, Adjusted R-squared:  0.7382
## F-statistic: 21.79 on 8 and 51 DF,  p-value: 5.834e-14
##
##
## $`2017-06-30`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.058790 -0.013477 -0.000053  0.017867  0.051051
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.089e-02  3.197e-02   0.653   0.5165
## Price_Sales -8.030e+00  3.817e+00  -2.104   0.0406 *
## P_E          4.621e-01  3.898e-01   1.185   0.2416
## Mom_6M       3.927e-01  7.006e-02   5.605 9.44e-07 ***
## MeanRev_1M   3.757e-02  5.358e-03   7.012 6.36e-09 ***
## beta         1.806e-03  1.687e-02   0.107   0.9152
## Mkt.RF      -1.913e-01  1.436e-01  -1.332   0.1892
## SMB         -5.046e-02  1.993e-01  -0.253   0.8012
## quality     -3.938e-04  1.971e-02  -0.020   0.9841
## efficiency   4.650e-02  9.328e-02   0.499   0.6203
## growth1     -1.392e-05  2.775e-02  -0.001   0.9996
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0275 on 49 degrees of freedom
## Multiple R-squared:  0.7849, Adjusted R-squared:  0.7411
## F-statistic: 17.89 on 10 and 49 DF,  p-value: 3.884e-13
##
##
## $`2017-09-30`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.057936 -0.013755  0.000543  0.018155  0.050958
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.0178404  0.0322246   0.554    0.582
## Price_Sales -6.2568952  4.8547185  -1.289    0.204
## P_E          0.4113729  0.3979890   1.034    0.306
## Mom_6M       0.3945153  0.0697998   5.652 8.00e-07 ***
## MeanRev_1M   0.0372201  0.0053637   6.939 8.24e-09 ***
## beta         0.0036647  0.0170853   0.214    0.831
## Mkt.RF      -0.1961889  0.1431672  -1.370    0.177
## SMB         -0.0797663  0.2027606  -0.393    0.696
## quality     -0.0007675  0.0196445  -0.039    0.969
## efficiency   0.0489114  0.0906499   0.540    0.592
## growth1      0.0002839  0.0276549   0.010    0.992
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.0274 on 49 degrees of freedom
## Multiple R-squared:  0.7683, Adjusted R-squared:  0.721
## F-statistic: 16.24 on 10 and 49 DF,  p-value: 2.233e-12
##
##
## $`2017-12-31`
##
## Call:
## lm(formula = Ex.return ~ ., data = tem_factors)
##
## Residuals:
##       Min        1Q    Median        3Q       Max
## -0.057188 -0.013638  0.001564  0.016593  0.049938
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.008524   0.031503   0.271    0.788
## Price_Sales  0.629906   5.906053   0.107    0.915
## P_E          0.399672   0.385218   1.038    0.305
## Mom_6M       0.393030   0.067361   5.835 4.20e-07 ***
## MeanRev_1M   0.036266   0.005206   6.967 7.47e-09 ***
## beta         0.012562   0.017230   0.729    0.469
```

```
## Mkt.RF      -0.177445   0.137903  -1.287    0.204
## SMB         -0.092957   0.193571  -0.480    0.633
## quality     -0.005337   0.019137  -0.279    0.782
## efficiency   0.066668   0.081831   0.815    0.419
## growth1      0.005633   0.026901   0.209    0.835
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.02652 on 49 degrees of freedom
## Multiple R-squared:  0.7639, Adjusted R-squared:  0.7158
## F-statistic: 15.86 on 10 and 49 DF,  p-value: 3.442e-12
```