

Research

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Initialize Data

```
Market_Data <- read_excel("C:/Users/caste/Desktop/PSTAT199/Market Data.xlsx")
MD <- Market_Data
MD = MD[-1,]
MD = MD[-1,]
MD = MD[-1,]
MD = MD[-1,]
MD = MD[-1,]
MD$`Price Earnings Ratio One-Year Earnings`[143:146] = c(17.03, 18.15, 20.02, 22.18)
MD$`Price Earnings Ratio Ten-Year Earnings`[144:146] = c(24.86, 26.49, 24.21)
GDP <- data.matrix(MD[2:2])
S_P <- read_excel("C:/Users/caste/Desktop/PSTAT199/Market Data.xlsx",
                  sheet = "S&P Daily")
SPY <- data.matrix(S_P[8])
```

Adjusting for Inflation and finding D(t)

```
Adj_inf <- MD$CPI[80:147]/MD$CPI[80]## Adjusted inflation relative 1950
SPY = SPY[1:68,]/Adj_inf
D_t <- matrix(nrow = 66, ncol = 1)
for(i in 2:66){D_t[i-1] = (SPY[i]/SPY[i-1])-1}
D_t = D_t[-66,]
```

```
PE1_lm = lm(D_t~MD$`Price Earnings Ratio One-Year Earnings`[80:144])
CPI_lm = lm(D_t~MD$CPI[80:144])
GDP_lm = lm(D_t[11:65]~MD$`GDP (current US$)`[90:144])
PE10_lm = lm(D_t~MD$`Price Earnings Ratio Ten-Year Earnings`[80:144])
LongBond_lm = lm(D_t~MD$`Long Government Bond Yield 10yrpost53`[80:144])
RD_lm = lm(D_t[1:63]~MD$`RealD S&P Dividend`[80:142])
Consump_lm = lm(D_t[1:60]~MD$`Real Per Capita Consumption (in 2005 dollars)`[80:139])
GDPDEfl_lm = lm(D_t[12:65]~MD$`Inflation, GDP deflator (annual %)`[91:144])
Earning_lm = lm(D_t[1:62]~MD$`RealE Earnings`[80:141])
IntRate_lm = lm(D_t[1:62]~MD$`One-Year Interest Rate`[80:141])
SPComp_lm = lm(D_t~MD$`S&P Composite Stock Price Index`[80:144])
DivIn_lm = lm(D_t[1:64]~MD$`Dividends Accuring to Index`[80:143])
Full = lm(D_t[12:60]~ MD$`Price Earnings Ratio One-Year Earnings`[91:139] + MD$`Price Earnings Ratio Ten-Year Earnings`[144:146])
```

GDP

```
summary(GDP_lm)
```

```
##
## Call:
## lm(formula = D_t[11:65] ~ MD$`GDP (current US$)`[90:144])
##
```

```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.36105 -0.05412  0.01063  0.08729  0.27104
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      1.610e-02  2.815e-02   0.572   0.570
## MD$`GDP (current US$)`[90:144] 3.225e-15  3.414e-15   0.945   0.349
##
## Residual standard error: 0.1331 on 53 degrees of freedom
## Multiple R-squared:  0.01656,    Adjusted R-squared:  -0.001994
## F-statistic: 0.8926 on 1 and 53 DF,  p-value: 0.3491
```

Price Earning ratio 1 year

```
summary(PE10_lm)
```

```
##
## Call:
## lm(formula = D_t ~ MD$`Price Earnings Ratio Ten-Year Earnings`[80:144])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.33291 -0.07531  0.00455  0.08894  0.31118
##
## Coefficients:
##              Estimate Std. Error
## (Intercept)      0.086385   0.045427
## MD$`Price Earnings Ratio Ten-Year Earnings`[80:144] -0.002131   0.002257
##              t value Pr(>|t|)
## (Intercept)      1.902   0.0618 .
## MD$`Price Earnings Ratio Ten-Year Earnings`[80:144] -0.944   0.3487
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.135 on 63 degrees of freedom
## Multiple R-squared:  0.01395,    Adjusted R-squared:  -0.001702
## F-statistic: 0.8913 on 1 and 63 DF,  p-value: 0.3487
```

Dividends

```
summary(RD_lm)
```

```
##
## Call:
## lm(formula = D_t[1:63] ~ MD$`RealD S&P Dividend`[80:142])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.32904 -0.08228  0.00912  0.08453  0.30993
```

```
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.109629   0.075375   1.454   0.151
## MD$`RealD S&P Dividend`[80:142] -0.003545   0.003878  -0.914   0.364
##
## Residual standard error: 0.1352 on 61 degrees of freedom
## Multiple R-squared:  0.01351,    Adjusted R-squared:  -0.002663
## F-statistic: 0.8353 on 1 and 61 DF,  p-value: 0.3643
```

Bond Yield 10yr

```
summary(LongBond_lm)
```

```
##
## Call:
## lm(formula = D_t ~ MD$`Long Government Bond Yield 10yrpost53`[80:144])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.34840 -0.07517 -0.00140  0.08502  0.31887
##
## Coefficients:
##               Estimate Std. Error
## (Intercept)      0.058897   0.039087
## MD$`Long Government Bond Yield 10yrpost53`[80:144] -0.002131   0.006073
##               t value Pr(>|t|)
## (Intercept)      1.507   0.137
## MD$`Long Government Bond Yield 10yrpost53`[80:144]  -0.351   0.727
##
## Residual standard error: 0.1358 on 63 degrees of freedom
## Multiple R-squared:  0.001951,    Adjusted R-squared:  -0.01389
## F-statistic: 0.1232 on 1 and 63 DF,  p-value: 0.7268
```

Consumption Per Capita

```
summary(Consump_lm)
```

```
##
## Call:
## lm(formula = D_t[1:60] ~ MD$`Real Per Capita Consumption (in 2005 dollars)`[80:139])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.32509 -0.07974  0.00565  0.08220  0.31277
##
## Coefficients:
##               Estimate
## (Intercept)      7.912e-02
## MD$`Real Per Capita Consumption (in 2005 dollars)`[80:139] -2.182e-06
```

```
##                                Std. Error
## (Intercept)                    4.895e-02
## MD$`Real Per Capita Consumption (in 2005 dollars)`[80:139] 2.574e-06
##                                t value
## (Intercept)                    1.616
## MD$`Real Per Capita Consumption (in 2005 dollars)`[80:139] -0.848
##                                Pr(>|t|)
## (Intercept)                    0.111
## MD$`Real Per Capita Consumption (in 2005 dollars)`[80:139] 0.400
##
## Residual standard error: 0.1382 on 58 degrees of freedom
## Multiple R-squared: 0.01224, Adjusted R-squared: -0.004795
## F-statistic: 0.7185 on 1 and 58 DF, p-value: 0.4001
```

GDP Deflator

```
summary(GDPDefl_lm)
```

```
##
## Call:
## lm(formula = D_t[12:65] ~ MD$`Inflation, GDP deflator (annual %)`[91:144])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.35755 -0.05464  0.00194  0.07958  0.27878
##
## Coefficients:
##                                Estimate Std. Error
## (Intercept)                    0.094061   0.031664
## MD$`Inflation, GDP deflator (annual %)`[91:144] -0.017328   0.007707
##                                t value Pr(>|t|)
## (Intercept)                    2.971   0.00449 **
## MD$`Inflation, GDP deflator (annual %)`[91:144] -2.248   0.02882 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1287 on 52 degrees of freedom
## Multiple R-squared: 0.0886, Adjusted R-squared: 0.07107
## F-statistic: 5.055 on 1 and 52 DF, p-value: 0.02882
```

Earnings

```
summary(Earning_lm)
```

```
##
## Call:
## lm(formula = D_t[1:62] ~ MD$`RealE Earnings`[80:141])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

```
## -0.32515 -0.06177 -0.00178 0.08942 0.34043
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.018410   0.044684   0.412   0.682
## MD$`RealE Earnings`[80:141] 0.000571   0.001016   0.562   0.576
##
## Residual standard error: 0.1367 on 60 degrees of freedom
## Multiple R-squared: 0.005236, Adjusted R-squared: -0.01134
## F-statistic: 0.3158 on 1 and 60 DF, p-value: 0.5762
```

Intrest Rate

```
summary(IntRate_lm)
```

```
##
## Call:
## lm(formula = D_t[1:62] ~ MD$`One-Year Interest Rate`[80:141])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.35011 -0.07165 -0.00804  0.09087  0.31130
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.070668   0.033180   2.130   0.0373
## MD$`One-Year Interest Rate`[80:141] -0.005273   0.005132  -1.027   0.3083
##
## (Intercept) *
## MD$`One-Year Interest Rate`[80:141]
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1358 on 60 degrees of freedom
## Multiple R-squared: 0.01729, Adjusted R-squared: 0.0009111
## F-statistic: 1.056 on 1 and 60 DF, p-value: 0.3083
```

S&P Price Index

```
summary(SPComp_lm)
```

```
##
## Call:
## lm(formula = D_t ~ MD$`S&P Composite Stock Price Index`[80:144])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.33840 -0.07586  0.00112  0.08750  0.32343
##
## Coefficients:
```

```
##                                Estimate Std. Error t value
## (Intercept)                    4.920e-02  2.237e-02   2.199
## MD$`S&P Composite Stock Price Index`[80:144] -6.003e-06  3.290e-05  -0.182
##                                Pr(>|t|)
## (Intercept)                    0.0315 *
## MD$`S&P Composite Stock Price Index`[80:144]   0.8558
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1359 on 63 degrees of freedom
## Multiple R-squared:  0.0005281, Adjusted R-squared:  -0.01534
## F-statistic: 0.03329 on 1 and 63 DF,  p-value: 0.8558
```

Dividend Accruing to Index

```
summary(DivIn_lm)
```

```
##
## Call:
## lm(formula = D_t[1:64] ~ MD$`Dividends Accruing to Index`[80:143])
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.34886 -0.06976  0.00064  0.08397  0.33042
##
## Coefficients:
##                                Estimate Std. Error t value
## (Intercept)                    0.0415254  0.0257113   1.615
## MD$`Dividends Accruing to Index`[80:143] 0.0003474  0.0019657   0.177
##                                Pr(>|t|)
## (Intercept)                    0.111
## MD$`Dividends Accruing to Index`[80:143]   0.860
##
## Residual standard error: 0.1364 on 62 degrees of freedom
## Multiple R-squared:  0.0005034, Adjusted R-squared:  -0.01562
## F-statistic: 0.03123 on 1 and 62 DF,  p-value: 0.8603
```

Full Model with all parameters

```
summary(Full)
```

```
##
## Call:
## lm(formula = D_t[12:60] ~ MD$`Price Earnings Ratio One-Year Earnings`[91:139] +
##   MD$`Price Earnings Ratio Ten-Year Earnings`[91:139] + MD$CPI[91:139] +
##   MD$`S&P Composite Stock Price Index`[91:139] + MD$`GDP (current US$)`[91:139] +
##   MD$`Long Government Bond Yield 10yrpost53`[91:139] + MD$`RealD S&P Dividend`[91:139] +
##   MD$`Real Per Capita Consumption (in 2005 dollars)`[91:139] +
##   MD$`Inflation, GDP deflator (annual %)`[91:139] + MD$`RealE Earnings`[91:139] +
##   MD$`One-Year Interest Rate`[91:139] + MD$`S&P Composite Stock Price Index`[91:139] +
```

```

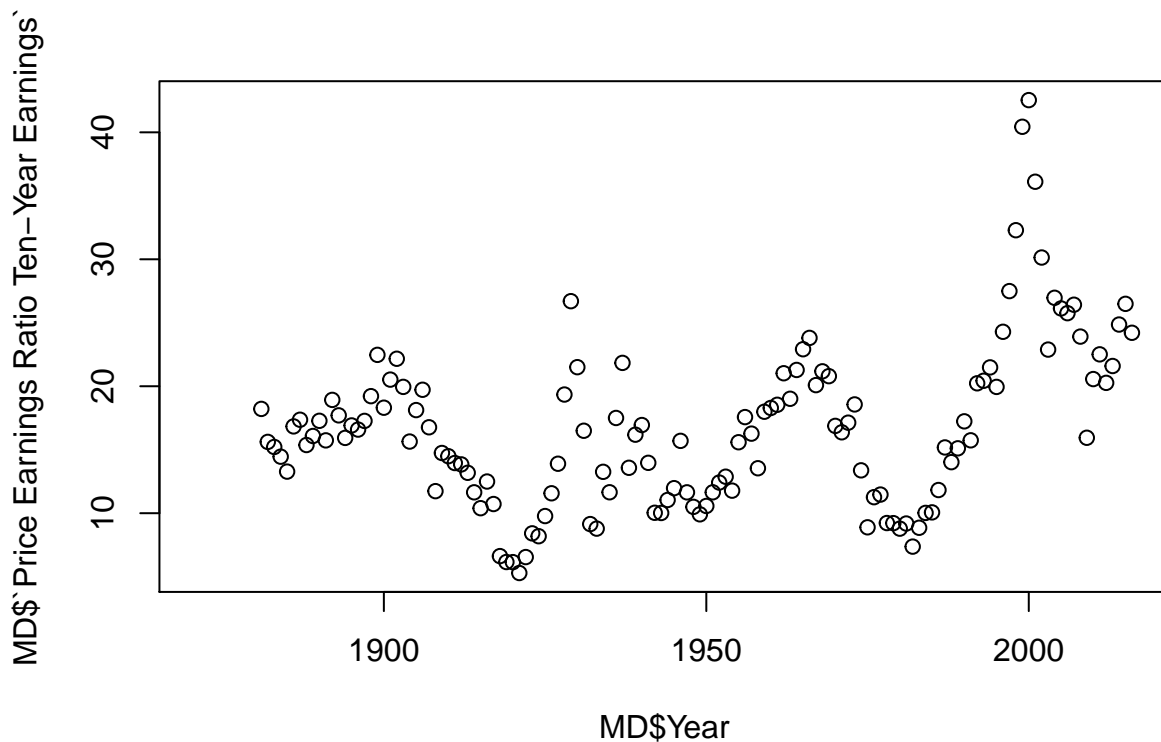
##      MD$`Dividends Accuring to Index`[91:139])
##
## Residuals:
##      Min          1Q      Median          3Q          Max
## -0.142627 -0.073871 -0.003367  0.060026  0.215707
##
## Coefficients:
##                                     Estimate
## (Intercept)                        1.456e-01
## MD$`Price Earnings Ratio One-Year Earnings`[91:139] -2.917e-03
## MD$`Price Earnings Ratio Ten-Year Earnings`[91:139] -9.548e-03
## MD$CPI[91:139]                        8.849e-03
## MD$`S&P Composite Stock Price Index`[91:139]      2.126e-04
## MD$`GDP (current US$)`[91:139]                  -7.612e-15
## MD$`Long Government Bond Yield 10yrpost53`[91:139] 3.208e-02
## MD$`RealD S&P Dividend`[91:139]                  2.641e-02
## MD$`Real Per Capita Consumption (in 2005 dollars)`[91:139] -6.492e-05
## MD$`Inflation, GDP deflator (annual %)`[91:139]   -1.857e-02
## MD$`RealE Earnings`[91:139]                     6.805e-03
## MD$`One-Year Interest Rate`[91:139]               -2.379e-02
## MD$`Dividends Accuring to Index`[91:139]          -3.970e-02
##                                     Std. Error
## (Intercept)                        3.974e-01
## MD$`Price Earnings Ratio One-Year Earnings`[91:139] 4.032e-03
## MD$`Price Earnings Ratio Ten-Year Earnings`[91:139] 1.420e-02
## MD$CPI[91:139]                     5.465e-03
## MD$`S&P Composite Stock Price Index`[91:139]      4.637e-04
## MD$`GDP (current US$)`[91:139]                    9.279e-14
## MD$`Long Government Bond Yield 10yrpost53`[91:139] 2.594e-02
## MD$`RealD S&P Dividend`[91:139]                  2.868e-02
## MD$`Real Per Capita Consumption (in 2005 dollars)`[91:139] 2.529e-05
## MD$`Inflation, GDP deflator (annual %)`[91:139]   1.443e-02
## MD$`RealE Earnings`[91:139]                     1.866e-03
## MD$`One-Year Interest Rate`[91:139]               1.426e-02
## MD$`Dividends Accuring to Index`[91:139]          3.985e-02
##                                     t value
## (Intercept)                        0.366
## MD$`Price Earnings Ratio One-Year Earnings`[91:139] -0.723
## MD$`Price Earnings Ratio Ten-Year Earnings`[91:139] -0.673
## MD$CPI[91:139]                      1.619
## MD$`S&P Composite Stock Price Index`[91:139]      0.459
## MD$`GDP (current US$)`[91:139]                  -0.082
## MD$`Long Government Bond Yield 10yrpost53`[91:139] 1.237
## MD$`RealD S&P Dividend`[91:139]                  0.921
## MD$`Real Per Capita Consumption (in 2005 dollars)`[91:139] -2.567
## MD$`Inflation, GDP deflator (annual %)`[91:139]   -1.287
## MD$`RealE Earnings`[91:139]                     3.647
## MD$`One-Year Interest Rate`[91:139]              -1.669
## MD$`Dividends Accuring to Index`[91:139]          -0.996
##                                     Pr(>|t|)
## (Intercept)                        0.716263
## MD$`Price Earnings Ratio One-Year Earnings`[91:139] 0.474109
## MD$`Price Earnings Ratio Ten-Year Earnings`[91:139] 0.505483
## MD$CPI[91:139]                        0.114131

```

```
## MD$`S&P Composite Stock Price Index`[91:139] 0.649281
## MD$`GDP (current US$)`[91:139] 0.935072
## MD$`Long Government Bond Yield 10yrpost53`[91:139] 0.224273
## MD$`RealD S&P Dividend`[91:139] 0.363186
## MD$`Real Per Capita Consumption (in 2005 dollars)`[91:139] 0.014552 *
## MD$`Inflation, GDP deflator (annual %)`[91:139] 0.206367
## MD$`RealE Earnings`[91:139] 0.000833 ***
## MD$`One-Year Interest Rate`[91:139] 0.103828
## MD$`Dividends Accuring to Index`[91:139] 0.325802
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1014 on 36 degrees of freedom
## Multiple R-squared:  0.5852, Adjusted R-squared:  0.447
## F-statistic: 4.233 on 12 and 36 DF, p-value: 0.0003705
```

Plots of PE ratios over years

```
plot(MD$Year, MD$`Price Earnings Ratio Ten-Year Earnings`)
```




```
plot(MD$Year, MD$`Price Earnings Ratio One-Year Earnings`)
```

