CAPM Fitting and Testing

Thomas Fillebeen

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Abstract

Standard Capital Asset Pricing Model (CAPM) fitting and testing using Quandl data.

CAPM Assumptions 1. Identical investors who are price takers; 2. Investment over the same time horizon; 3. No transaction costs or taxes; 4. Can borrow and lend at risk-free rate; 5. Investors only care about portfolio expected return and variance; 6. Market consists of all publicly traded assets.

The Consumption-Oriented CAPM is analogous to the simple form of the CAPM. Except that the growth rate of per capita consumption has replaced the rate of return on the market porfolio as the influence effecting returns.

Contents

1 Fitting CAPM

1.1 Selected Returns Time Series

```
# 'Load the GARPFRM package and the CAPM dataset.
suppressMessages(library(GARPFRM))
options(digits = 3)
data(crsp.short)
data(cons)

stock.df <- largecap.ts[, 1:20]
cons <- xts(cons[, 2], index(largecap.ts))
colnames(cons) = c("CONS")
R.market <- largecap.ts[, "market"]
rfr <- largecap.ts[, "t90"]

colnames(stock.df)

##  [1] "AMAT" "AMGN" "CAT"  "DD"   "G"    "GENZ" "GM"   "HON"  "KR"   "LLTC"
## [11] "MSFT" "ORCL" "PG"   "PHA"  "SO"   "TXN"  "UTX"  "WM"   "WYE"  "YHOO"
```

Summarize the first and last data values corresponding to the first 5 dates for the first 5 returns.

```
head(stock.df[, 1:5])

##                 AMAT    AMGN     CAT       DD       G
## 1997-01-31  0.3739  0.0368 0.03688  0.16467  0.0634
## 1997-02-28  0.0253  0.0843 0.00805 -0.01647 -0.0409
## 1997-03-31 -0.0840 -0.0859 0.02556 -0.01166 -0.0821
## 1997-04-30  0.1833  0.0537 0.11402  0.00118  0.1734
## 1997-05-30  0.1891  0.1359 0.09691  0.02949  0.0456
## 1997-06-30  0.0852 -0.1308 0.09987  0.15765  0.0661

tail(stock.df[, 1:5])

##                  AMAT    AMGN      CAT      DD       G
## 2001-07-31 -0.06599  0.0335  0.10789 -0.1124 -0.0330
## 2001-08-31 -0.06040  0.0254 -0.09256 -0.0350  0.0997
## 2001-09-28 -0.33999 -0.0860 -0.10400 -0.0842 -0.0277
## 2001-10-31  0.19937 -0.0332  0.00603  0.0658  0.0487
## 2001-11-30  0.16505  0.1691  0.06038  0.1175  0.0518
## 2001-12-31  0.00906 -0.1504  0.10186 -0.0413  0.0214

# Count the number of rows
nrow(stock.df)

## [1] 60
```

1.2 Estimate Excess Returns

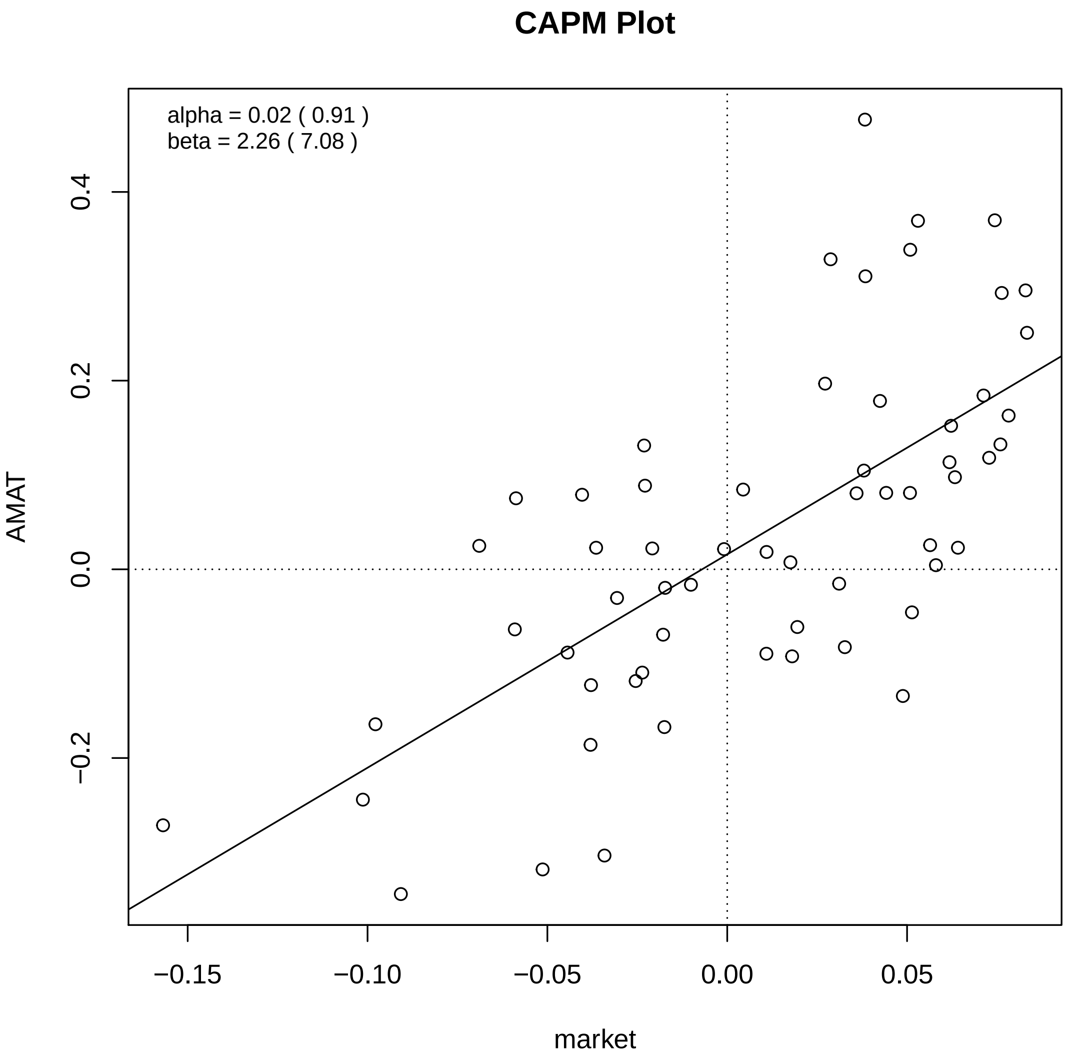
Estimate excess returns: subtracting off risk-free rate. To strip off the dates and just return a plain vector/matrix coredata() can be used.

```
# Excess Returns
exReturns <- Return.excess(stock.df, rfr)
colnames(exReturns) = c(colnames(stock.df))
```

1.3 Fitting CAPM Model: Univariate

Run CAPM regression for AMAT

```
# Univariate CAPM
uv <- CAPM(exReturns[, 1], R.market)
coef(summary(uv))

##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.0158     0.0174   0.909 3.67e-01
## Rmkt          2.2611     0.3192   7.085 2.11e-09

# Plot data with regression line
plot(uv)
```

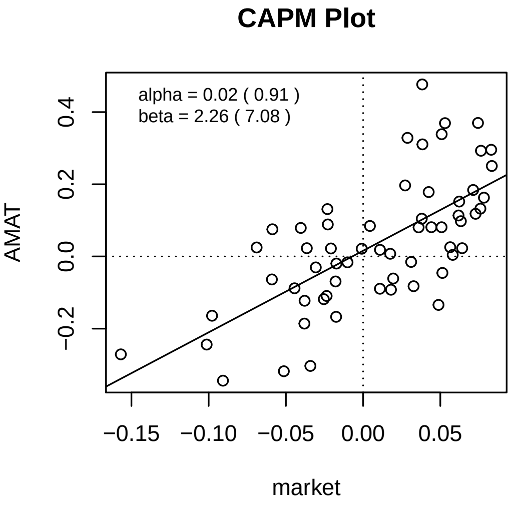


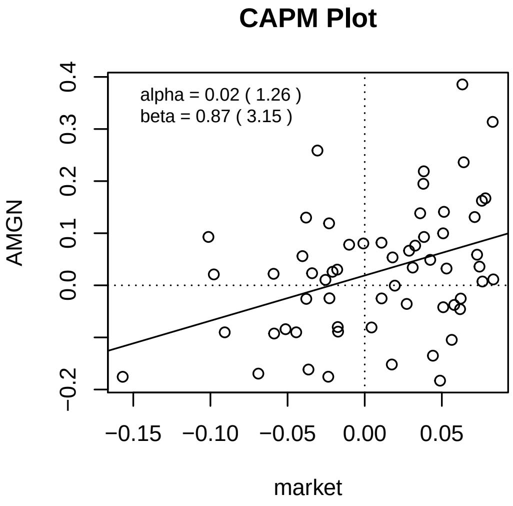
1.4 Fitting CAPM Model: Multiple Linear Model

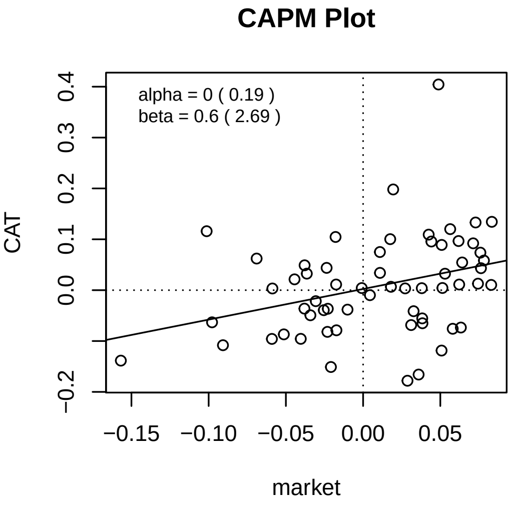
Run CAPM regression for AMAT

```
# MLM CAPM
mlm <- CAPM(exReturns[, 1:3], R.market)
coef(summary(mlm))

## Response AMAT :
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.0158     0.0174   0.909 3.67e-01
## Rmkt          2.2611     0.3192   7.085 2.11e-09
##
## Response AMGN :
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.0189      0.015    1.26   0.2142
## Rmkt          0.8686      0.276    3.15   0.0026
##
## Response CAT :
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.00231     0.0122    0.19  0.85033
## Rmkt         0.60218     0.2241    2.69  0.00938
```

```
# Plot data with regression line
plot(mlm)
```







2 Testing CAPM

2.1 Retrieve CAPM Statistics

Estimating CAPM with $\alpha = 0$ & $\beta = 1$ for asset.

```
getStatistics(uv)

##                Estimate Std. Error t value Pr(>|t|)
## alpha. AMAT    0.0158     0.0174   0.909 3.67e-01
## beta.  AMAT    2.2611     0.3192   7.085 2.11e-09
```

2.2 Estimate Significance and Test Beta Results

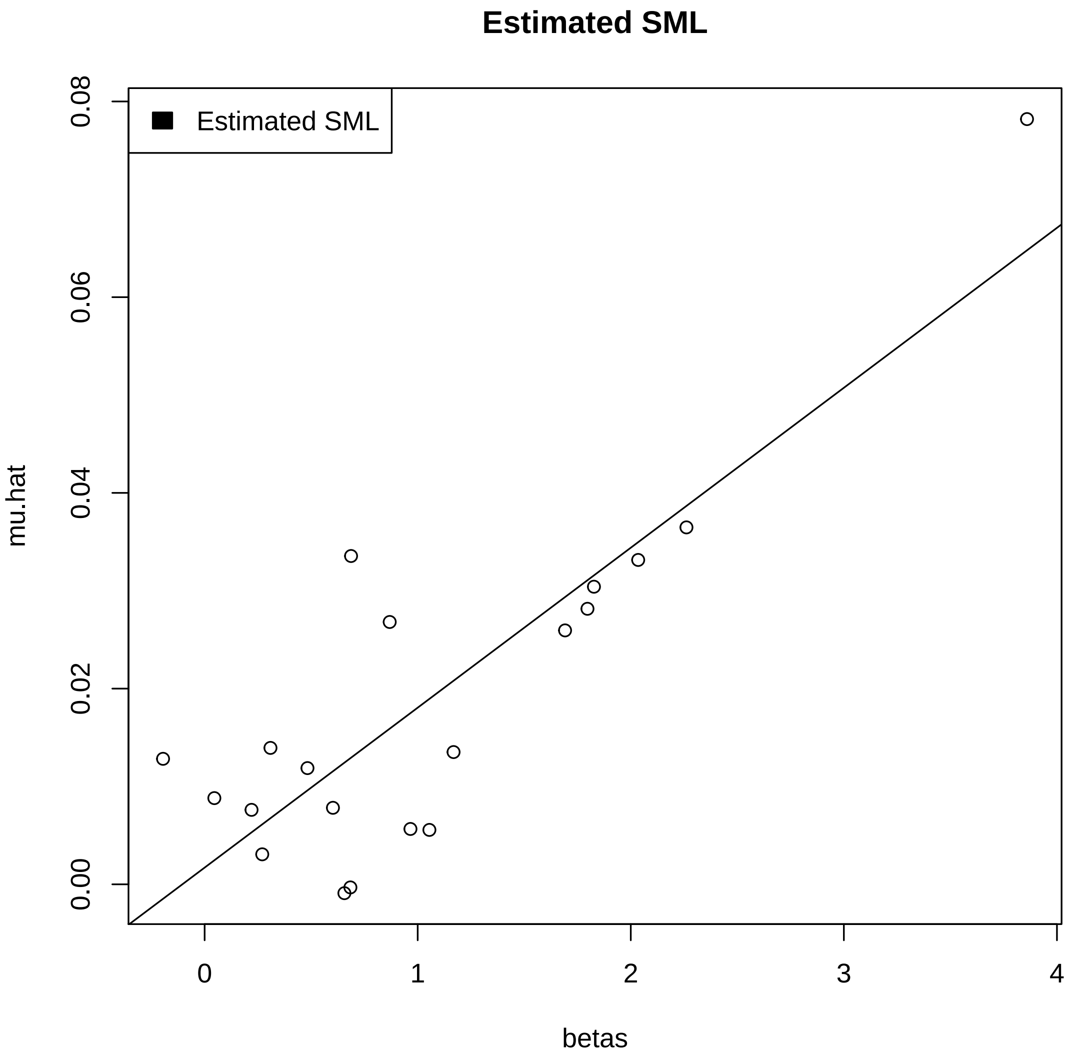
Retrieve tstats from function for assets.

```
# For uv
getBetas(uv)

## Rmkt
## 2.26

getAlphas(uv)

## (Intercept)
##      0.0158

hypTest(uv, CI = 0.05)

## $alpha
## [1] FALSE
##
## $beta
## [1] FALSE

# For mlm
getBetas(mlm)

## beta.  AMAT beta.  AMGN  beta.  CAT
##       2.261       0.869       0.602

getAlphas(mlm)

## alpha. AMAT alpha. AMGN  alpha. CAT
##     0.01580     0.01887     0.00231

hypTest(mlm, CI = 0.05)

## $alpha
## alpha. AMAT alpha. AMGN  alpha. CAT
##       FALSE       FALSE       FALSE
##
## $beta
## beta.  AMAT beta.  AMGN  beta.  CAT
##        TRUE       FALSE       FALSE
```

2.3 Estimate Expected Returns and Plot

Plot expected return versus beta. Estimate expected returns

```
# MLM CAPM
mlm <- CAPM(exReturns[, ], R.market)

# Plot expected returns versus betas
chartSML(mlm)
```

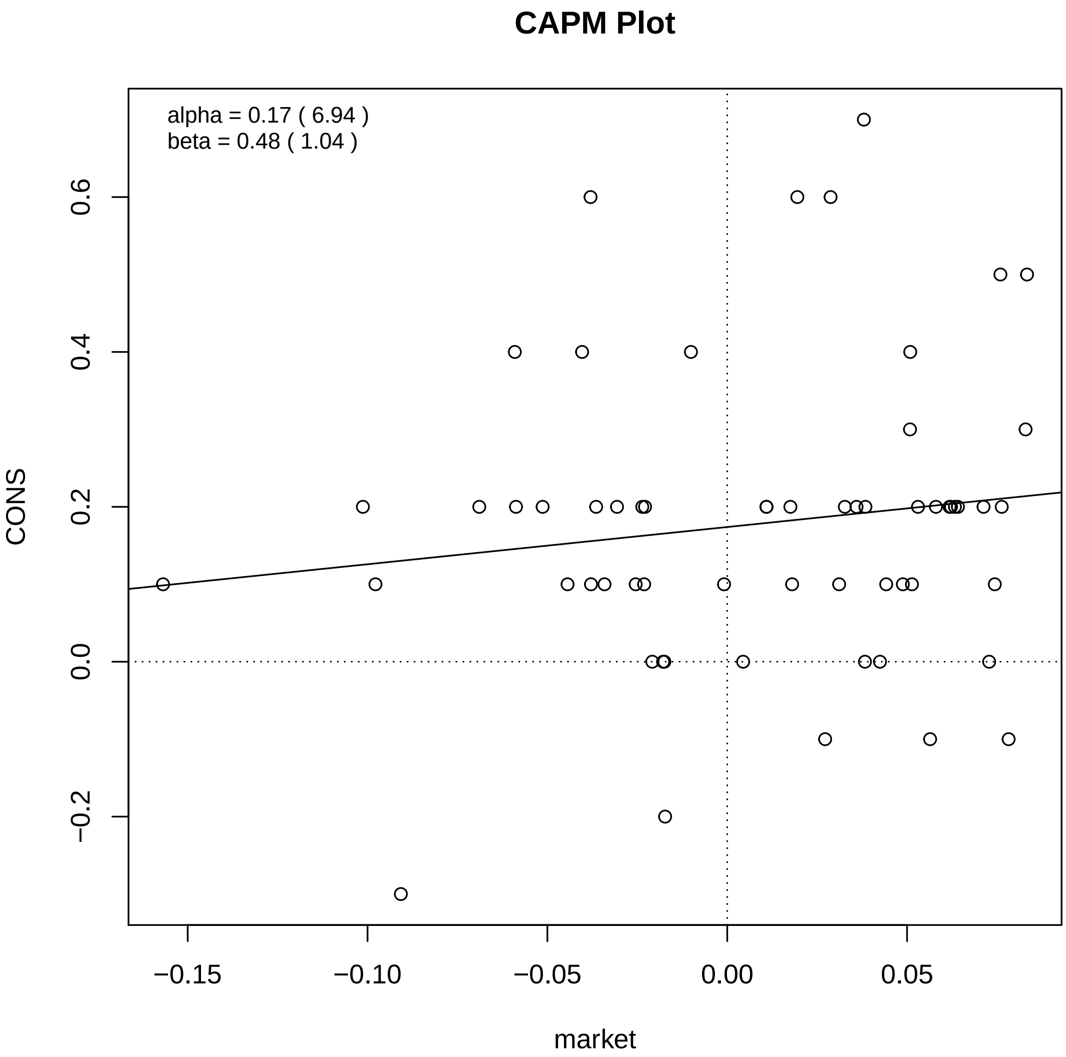


3 Consumption-Oriented CAPM

3.1 Fitting C-CAPM

Run C-CAPM regression for CONS (Consumption).

```
capm.cons = CAPM(cons, R.market)
summary(capm.cons)

##
## Call:
## lm(formula = R ~ Rmkt)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.4303 -0.0957 -0.0037  0.0516  0.5078
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.174      0.025    6.94  3.6e-09 ***
## Rmkt           0.481      0.460    1.04      0.3
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.191 on 58 degrees of freedom
## Multiple R-squared:  0.0185,Adjusted R-squared:  0.00153
## F-statistic: 1.09 on 1 and 58 DF,  p-value: 0.301

# Plot data with regression line
plot(capm.cons)
```



NOTE: Specific problems with CCAPM is that it suffers from two puzzles: the equity premium puzzle (EPP) and the risk-free rate puzzle (RFRP). EPP implies that investors are extremely risk averse to explain the existence of a market risk premium. While RFRP stipulates that investors save in TBills despite the low rate of return.