Project 2 - Team 12

2025-03-14

Project 1 - Team 12

Needed packages

Exercise 6: Estimate the rolling Equity Beta

To determine the Equity Beta, we use the Russel3000 Index, which includes Alnylam Pharmaceuticals, as market portfolio estimate. We use the following rolling formula to determine the Equity Beta (coming from the CAPM), which measures the sensitivity of a stock's returns relative to the market portfolio:

$$\beta_t = \frac{\text{Cov}(R_{e,t}, R_{m,t})}{\text{Var}(R_{m,t})}$$

where: - β_t is the equity beta at time t, - $Cov(R_e, R_m) $ is the covariance between the return on the asset $ R_e $ and the return of the market portfolio $ R_m $, - $ Var(R_m) $ is the variance of the market return $ R_m $.

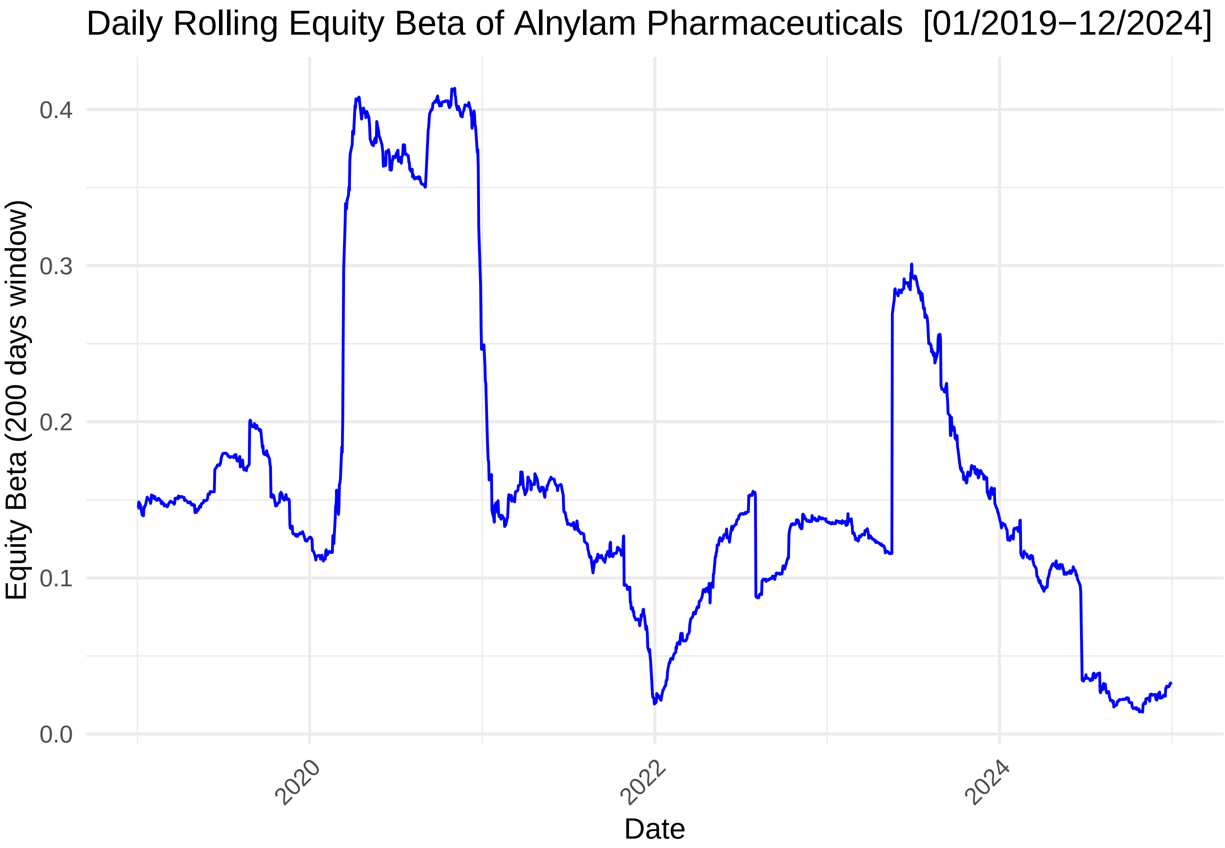
Download and clean the data:

```
ALNY_PX <- read.xlsx("Daily_Data_Case_1.xlsx", sheet = 2)
ALNY_PX$Date <- as.Date(ALNY_PX$Date,origin = "1899-12-30")

RUS_3_PX <- read.xlsx("Daily_Data_Case_1.xlsx", sheet = 1)
RUS_3_PX$Date <- as.Date(RUS_3_PX$Date,origin = "1899-12-30")

# Observe NA values

ALNY_NA <- sum(is.na(ALNY_PX$Last.Price))
RUS_3_NA <- sum(is.na(RUS_3_PX$Last.Price))

# One NA in ALNY_PX --> Lin. Interpolate

na <- which(is.na(ALNY_PX$Last.Price))

ALNY_PX$Last.Price[na] <- (ALNY_PX$Last.Price[na-1] + ALNY_PX$Last.Price[na+1]) * 0.5


# Combine the data frames to match the dates

Prices <- inner_join(ALNY_PX , RUS_3_PX , by = "Date")
colnames(Prices) <- c("Date", "ALNY", "RUS3")

# Create xts for quantmod
Prices_xts <- xts(Prices[,-1], order.by = as.Date(Prices$Date))
```

Equity Beta with daily returns

```r
ALNY_ret_d <- periodReturn(Prices_xts$ALNY, period = "daily", type = "arithmetic")
ALNY_ret_d <- data.frame(Date = index(ALNY_ret_d), coredata(ALNY_ret_d))

RUS3_ret_d <- periodReturn(Prices_xts$RUS3, period = "daily", type = "arithmetic")
RUS3_ret_d <- data.frame(Date = index(RUS3_ret_d), coredata(RUS3_ret_d))

Returns_daily <- inner_join(RUS3_ret_d  , ALNY_ret_d  , by = "Date")[-1,]
colnames(Returns_daily) <- c("Date", "ALNY", "RUS3")

start_date <- which(Returns_daily$Date == as.Date("2019-01-02")) - 200
Returns_daily <- Returns_daily[-(1:(start_date)),]

# Market Return Variance

Returns_daily$RUS3_var <- rollapply(Returns_daily$RUS3, width = 200, FUN = var, align = "right", fill =

Returns_daily$rolling_cov <- runCov(
  x = Returns_daily$ALNY,
  y = Returns_daily$RUS3,
  n = 200
)

Returns_daily <- Returns_daily %>%
  mutate(
    E_Beta_daily = rolling_cov / RUS3_var
  )

ggplot(Returns_daily, aes(x = Date, y = E_Beta_daily)) +
  geom_line(color = "blue") +
  labs(title = "Daily Rolling Equity Beta of Alnylam Pharmaceuticals  [01/2019-12/2024]",
       x = "Date",
       y = "Equity Beta (200 days window)") +
  xlim(as.Date("2019-01-02"), as.Date("2024-12-31")) +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

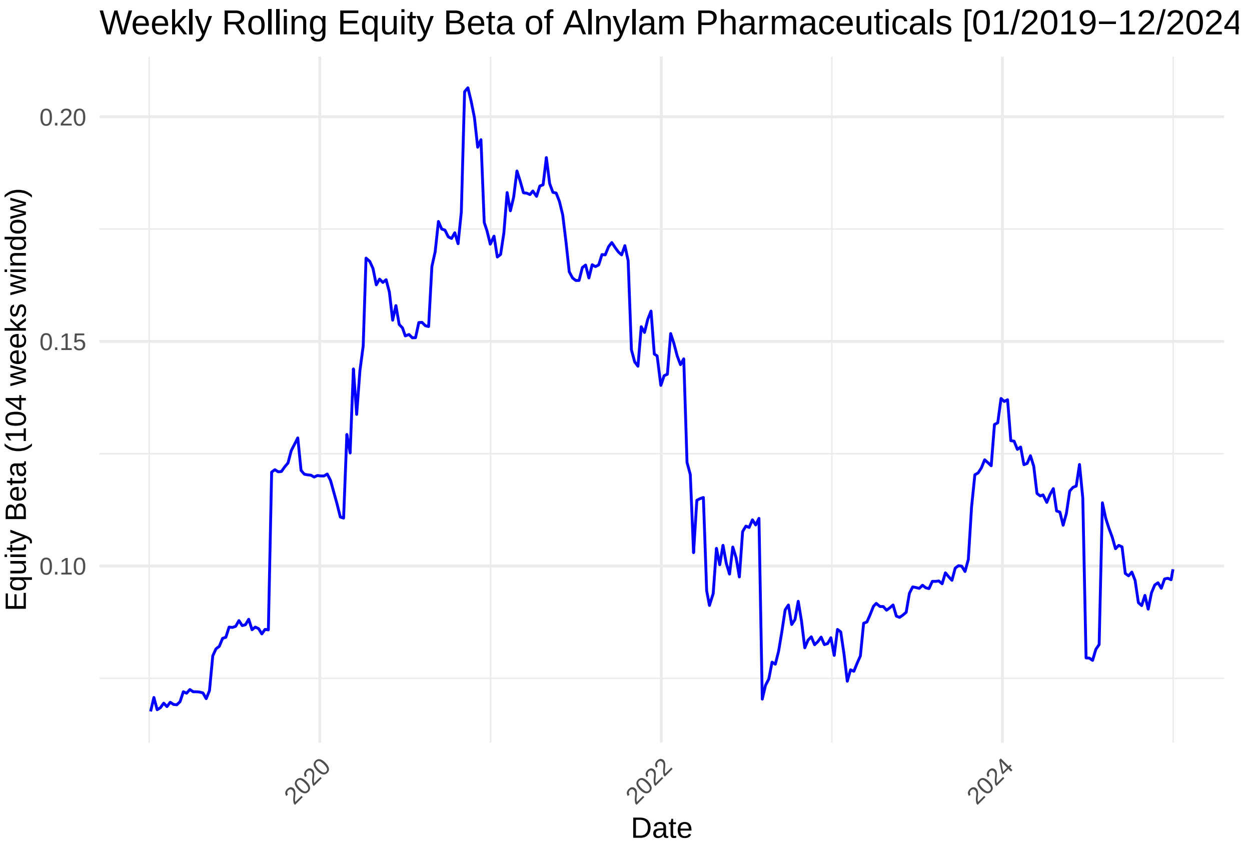
```
## Warning: Removed 199 rows containing missing values or values outside the scale range
## (`geom_line()`).
```



Equity Beta for weekly returns

```
ALNY_ret_w <- periodReturn(Prices_xts$ALNY, period = "weekly", type = "arithmetic")
ALNY_ret_w <- data.frame(Date = index(ALNY_ret_w), coredata(ALNY_ret_w))

RUS3_ret_w <- periodReturn(Prices_xts$RUS3, period = "weekly", type = "arithmetic")
RUS3_ret_w <- data.frame(Date = index(RUS3_ret_w), coredata(RUS3_ret_w))

Returns_weekly <- inner_join(RUS3_ret_w  , ALNY_ret_w  , by = "Date")[-1,]
colnames(Returns_weekly) <- c("Date", "ALNY", "RUS3")

start_date <- which(Returns_weekly$Date == as.Date("2019-01-04")) - 104
Returns_weekly <- Returns_weekly[-(1:(start_date)),]

# Market Return Variance

Returns_weekly$RUS3_var <- rollapply(Returns_weekly$RUS3, width = 104, FUN = var, align = "right", fill

Returns_weekly$rolling_cov <- runCov(
  x = Returns_weekly$ALNY,
  y = Returns_weekly$RUS3,
  n = 104
)

Returns_weekly <- Returns_weekly %>%
  mutate(
    E_Beta_weekly = rolling_cov / RUS3_var
  )

ggplot(Returns_weekly, aes(x = Date, y = E_Beta_weekly)) +
  geom_line(color = "blue") +
  labs(title = "Weekly Rolling Equity Beta of Alnylam Pharmaceuticals [01/2019-12/2024]",
       x = "Date",
       y = "Equity Beta (104 weeks window)") +
  xlim(as.Date("2019-01-04"), as.Date("2024-12-31")) +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

```
## Warning: Removed 103 rows containing missing values or values outside the scale range
## (`geom_line()`).
```

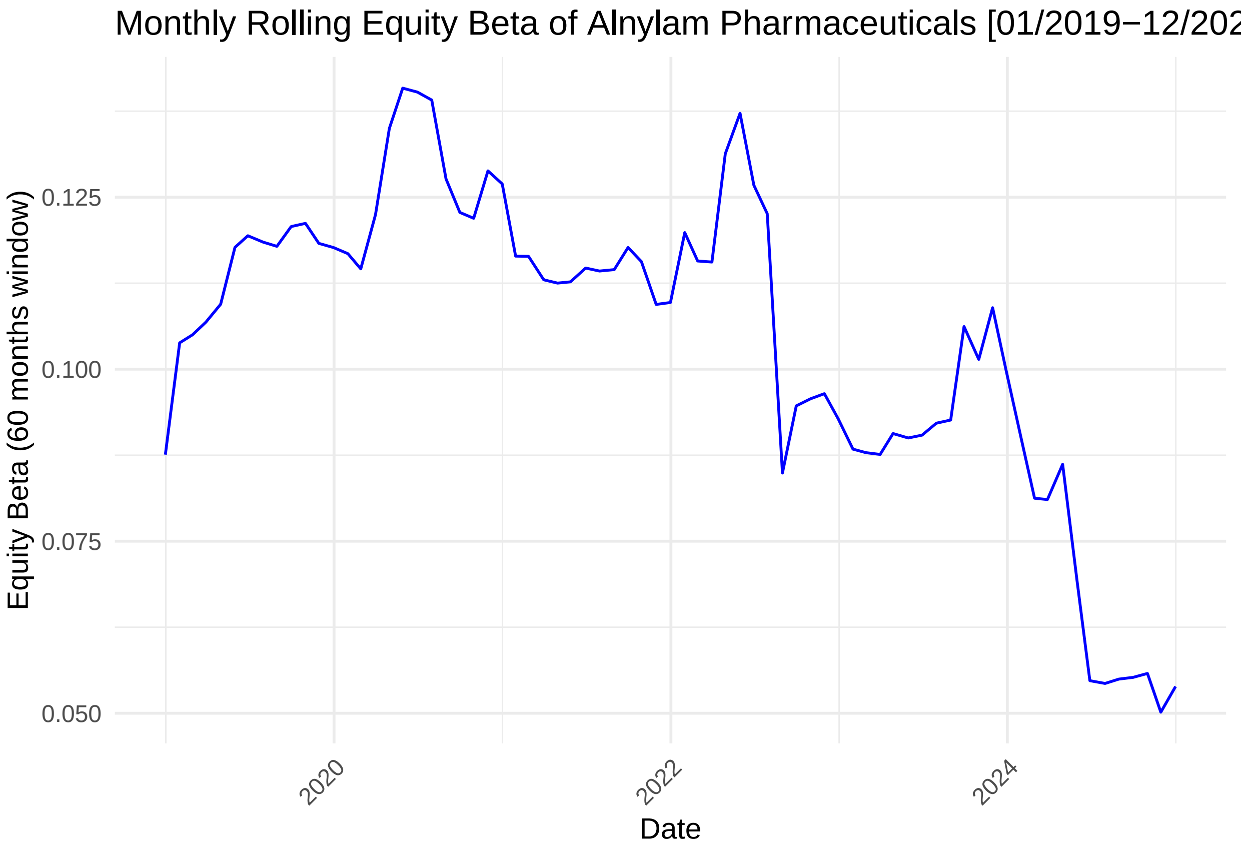


Equity Beta for monthly returns

```
ALNY_ret_m <- periodReturn(Prices_xts$ALNY, period = "monthly", type = "arithmetic")
ALNY_ret_m <- data.frame(Date = index(ALNY_ret_m), coredata(ALNY_ret_m))

RUS3_ret_m <- periodReturn(Prices_xts$RUS3, period = "monthly", type = "arithmetic")
RUS3_ret_m <- data.frame(Date = index(RUS3_ret_m), coredata(RUS3_ret_m))

Returns_monthly <- inner_join(RUS3_ret_m  , ALNY_ret_m  , by = "Date")[-1,]
colnames(Returns_monthly) <- c("Date", "ALNY", "RUS3")

start_date <- which(Returns_monthly$Date == as.Date("2018-12-31")) - 60
```

```r
Returns_monthly <- Returns_monthly[-(1:(start_date)),]

# Market Return Variance

Returns_monthly$RUS3_var <- rollapply(Returns_monthly$RUS3, width = 60, FUN = var, align = "right", fil

Returns_monthly$rolling_cov <- runCov(
  x = Returns_monthly$ALNY,
  y = Returns_monthly$RUS3,
  n = 60
)

Returns_monthly <- Returns_monthly %>%
  mutate(
    E_Beta_monthly = rolling_cov / RUS3_var
  )

ggplot(Returns_monthly, aes(x = Date, y = E_Beta_monthly)) +
  geom_line(color = "blue") +
  labs(title = "Monthly Rolling Equity Beta of Alnylam Pharmaceuticals [01/2019-12/2024]",
       x = "Date",
       y = "Equity Beta (60 months window)") +
  xlim(as.Date("2018-12-31"), as.Date("2024-12-31")) +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

```
## Warning: Removed 59 rows containing missing values or values outside the scale range
## (`geom_line()`).
```


Monthly Rolling Equity Beta of Alnylam Pharmaceuticals [01/2019−12/202
Equity Beta (60 months window)
0.125
0.100
0.075
0.050
2020
2022
2024
Date