Assignment 2 – Question 2

1. Report which stocks you have chosen and how you’ve converted the annualised interest rates into monthly interest rates.

I have chosen to use the twelve largest companies on the ASX for my individual stocks: BHP Group (BHP), Commonwealth Bank of Australia (CBA), Rio Tinto (RIO), CSL Limited (CSL), National Australia Bank (NAB), Westpac (WBC), ANZ Bank (ANZ), Wesfarmers (WES), Macquarie Group (MQC), Woolworths (WOW), Telstra (TLS), Fortescue Metals (FMG).

To convert the annualised interest rate into monthly interest rates I first divided them by one hundred to get them in decimal form as the RBA data values are given as whole numbers (e.g. 6.1% = 6.1). I then applied the standard conversion for effectives rates under monthly compounding: . The denominator of the power of this term is used to delineate between different data frequencies (e.g. ¼ would indicate quarterly interest rates).

1. For each of the 12 stocks run a CAPM time series regression and report a table of the estimates.

Table: CAPM estimates

|  |  |
| --- | --- |
| Stock |  |
| ANZ | 1.21 |
| BHP | 0.92 |
| CBA | 1.18 |
| CSL | 0.59 |
| FMG | 0.80 |
| MQG | 1.43 |
| NAB | 1.26 |
| RIO | 0.63 |
| TLS | 0.63 |
| WBC | 1.23 |
| WES | 1.02 |
| WOW | 0.57 |

*Note: R code available in appendix.*

1. Now run a cross-section regression on these estimates as specified in the questions.
2. Report the regression results, in particular and . How does it compare with the sample average excess market return?

My regression results are reported below in the table, where is estimated as 0.77 and is estimated as -0.06. However, it is important to note both estimates have large p-values, meaning we cannot reject the null hypothesis that their values are different from zero. Importantly, we also find an F-test p-value of 0.94, indicating this regression is jointly insignificant as well.

I calculate the sample average excess market return as 0.71, which is very different to the sample excess market return ( I estimate of -0.06. This is likely a function of the fact that the 12 largest stocks on the ASX have very similar returns – there is not a lot of variation between them.

Table: Cross-section regression results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Term | Estimate | Standard error | T-stat | P-value |
|  | 0.77 | 0.69 | 1.11 | 0.29 |
|  | -0.06 | 0.69 | -0.08 | 0.94 |

*Note: R code available in appendix.*

1. Plot the average excess returns on each stock against their estimated betas, and plot the estimated regression line on the same figure.

A graph with red lines and black dots

AI-generated content may be incorrect.

1. Test some hypotheses (not jointly). and .

The first null hypothesis of is already tested for in my reporting of regression results in Q3Ci as this is the default null hypothesis for a linear regression in R. This p-value is large at 0.29, therefore we cannot reject this null hypothesis at any reasonable significance level.

For the latter null hypothesis, I calculate the t-statistic by dividing it’s estimate by its standard error. I then calculate a one-sided p-value, which tests whether is significantly less than or equal to 0 (more information available in R appendix). The p-value I generate is 0.47, meaning against that we cannot reject the null hypothesis at any reasonable value significance level.

1. Briefly discuss whether your results provide evidence supporting or against the standard or Black CAPM

To summarise our results: we do not find evidence of any significant coefficients in our cross-section regression. Our inability to reject the null hypothesis supports the standard CAPM, as zero exposure to the market’s excess return should imply no return at all. However, the fact that I am unable to reject either null hypothesis on (equal to 0 or less then or equal to zero) is particularly problematic and does not imply support for either the standard or Black CAPM. All it tells us is that there is no relationship between excess market returns and the excess return of a stock.

There are likely a few reasons for this:

* As I have pointed out before, these are the 12 largest companies on the ASX, which are generally more stable than other companies. There many ’s which are near 1, therefore it’s likely difficult for the model to detect a statistically significant relationship with excess returns.
  + This is well illuminated by the (approximately)flat dotted line shown in Q2Cii. This implies that on average, the excess returns of all these stocks are extremely similar.
  + This is a common problem in the literature, hence why authors tend to use portfolios of stocks rather than specific stocks.
* We have used a sample of just 10 years for our analysis, which is a very short/small for financial data. We might get better results if we extend our sample out further into history and using a larger range of stocks across a broader range of factors (e.g. market capitalisation, sector, etc).
* As per Roll’s 1977 famous critique of the validity of the empirical tests, we have just used the ASX200 as our proxy for market returns. In reality, we should try to be relying on a more fulsome measure of market returns using a measure that covers more than just equities.

**Appendix – R code**

library(tidyverse)

library(tidyquant)

library(stringr)

library(readrba)

library(janitor)

library(broom)

################################################################################

############################### QUESTION 3A ####################################

################################################################################

# ASX Data #####################################################################

asx\_tickers <- c(

"BHP.AX", # BHP Group

"CBA.AX", # Commonwealth Bank of Australia

"RIO.AX", # Rio Tinto

"CSL.AX", # CSL Limited

"NAB.AX", # National Australia Bank

"WBC.AX", # Westpac

"ANZ.AX", # ANZ Bank

"WES.AX", # Wesfarmers

"MQG.AX", # Macquarie Group

"WOW.AX", # Woolworths

"TLS.AX", # Telstra

"FMG.AX", # Fortescue Metals

"^AXJO" # ASX 200

)

raw\_data <- tq\_get(asx\_tickers,

get = "stock.prices",

from = "2014-12-31",

to = "2024-12-31")

data <- raw\_data %>%

select(name = symbol, date, price = close) %>%

mutate(name = str\_remove(name, "\\.AX$")) %>%

mutate(name = str\_replace\_all(name, "\\^", "")) %>%

#Creating monthly price series (using final trading day of month)

mutate(month = format(date, "%Y-%m")) %>%

group\_by(name, month) %>%

summarise(price = last(price)) %>%

ungroup() %>%

# Creating returns

arrange(name, month) %>%

group\_by(name) %>%

mutate(return = (price / lag(price)\* 100 - 100)) %>%

ungroup() %>%

select(name, date = month, value = return) %>%

na.omit() %>%

pivot\_wider(names\_from = name,

values\_from = value) %>%

clean\_names()

# RBA Data #####################################################################

rba\_data <- read\_rba\_seriesid("FIRMMBAB90") %>%

select(date,value) %>%

mutate(monthly\_rate = (1 + value / 100)^(1/12) - 1) %>%

mutate(month = format(date, "%Y-%m")) %>%

select(date = month, rf\_rate = monthly\_rate)

# Connecting data sources ######################################################

data <- data %>%

inner\_join(rba\_data, by = "date")

################################################################################

############################# QUESTION 3B #####################################

################################################################################

# Computing excess returns #####################################################

capm\_data <- data %>%

mutate(market\_excess = axjo - rf\_rate) %>%

mutate(

across(

.cols = -c(date, axjo, rf\_rate, market\_excess),

.fn = ~.x - rf\_rate,

.names = "{.col}\_excess"

)

) %>%

select(date, matches("\_excess$"))

# Producing CAPM regression results ############################################

# Extracting column names

excess\_columns <- colnames(capm\_data)[grepl("\_excess$", colnames(capm\_data))]

# Fit CAPM models and extract the beta coefficients

betas <- map(excess\_columns, function(col) {

model <- lm(as.formula(paste(col, "~ market\_excess")), data = capm\_data)

coef(model)["market\_excess"]

})

# Convert the list of betas to a dataframe

betas\_df <- data.frame(name = excess\_columns, beta = unlist(betas)) %>%

mutate(beta = round(beta,3)) %>%

mutate(name = str\_remove(name, "\_excess"))

print(betas\_df)

# Write to csv for inclusion in report

write\_csv(betas\_df, "capm\_betas\_df.csv")

################################################################################

############################# QUESTION 3C ######################################

################################################################################

##################################### i ########################################

# Need to first calculate average returns

avg\_returns <- data %>%

pivot\_longer(cols = -date,

names\_to = "name",

values\_to = "value") %>%

group\_by(name) %>%

summarise(avg\_returns = mean(value, na.rm = TRUE)) %>%

ungroup() %>%

filter(name != "axjo")

print(avg\_returns)

# Average rf return

avg\_rf\_return <- avg\_returns %>%

filter(name == "rf\_rate") %>%

pull(avg\_returns)

# Now excess returns

excess\_returns <- avg\_returns %>%

filter(name != "rf\_rate") %>%

mutate(rf\_rate = avg\_rf\_return) %>%

mutate(excess\_returns = avg\_returns - rf\_rate) %>%

select(name, excess\_returns)

# Match with earlier returns

excess\_regression\_data <- excess\_returns %>%

inner\_join(betas\_df, by = "name")

# Produce regression

excess\_returns\_cross\_section\_regression <- lm(excess\_returns ~ beta, data = excess\_regression\_data)

summary(excess\_returns\_cross\_section\_regression)

excess\_returns\_cross\_section\_regression\_tidy <- excess\_returns\_cross\_section\_regression %>%

tidy()

write\_csv(avg\_returns\_regression\_tidy, "avg\_returns\_regression.csv")

# Producing average excess returns

overall\_avg\_returns <- excess\_returns %>%

summarise(average\_excess\_returns = mean(excess\_returns))

##################################### ii #######################################

p <- ggplot(excess\_regression\_data, aes(beta,excess\_returns)) +

geom\_point() +

geom\_abline(intercept = 0.7686, slope = -0.0562, color = "red", linetype = "dashed", size = 1) +

annotate(

"text",

x = 0, # adjust position as needed

y = 1,

label = "Excess returns = 0.77 - 0.06\*Beta",

hjust = 0,

vjust = 1,

color = "red",

size = 4

) +

labs(

title = "Relationship between excess-returns and CAPM beta",

caption = "Note: The red dotted line reflect the estimated regression line from Q3Cii."

) +

theme(plot.caption = element\_text(hjust = 0))

ggsave("q3cii.jpg", plot = p)

##################################### iii ######################################

coefficients <- coef(avg\_returns\_regression)

beta <- as.numeric(coef(avg\_returns\_regression)["beta"])

se <- summary(avg\_returns\_regression)$coefficients["beta", "Std. Error"]

t\_stat <- beta / se

df <- df.residual(avg\_returns\_regression)

p\_value <- pt(t\_stat, df = df, lower.tail = TRUE)

print(p\_value)