Week 10 Assignment Part 2 (R/RMarkdown)

Due Nov 25, 2022 by 11:59pm **Points** 5 **Submitting** a file upload
Available until Nov 25, 2022 at 11:59pm

This assignment was locked Nov 25, 2022 at 11:59pm.

This assignment will give you some more practice with pivots and joins, and an opportunity to try writing functions and loops to do some repetitive tasks. The analysis you'll be doing is centered on the **Capital Asset Pricing Model (CAPM)** (https://www.investopedia.com/terms/c/capm.asp), which is a bedrock of finance. CAPM is used to describe the relationship between the expected return of a security (usually a stock or a portfolio of stocks) and the overall "systematic" risk of the market. To help you understand what you're doing in this assignment and why, I'll start with a quick description of the model and how it works, followed by your instructions for this assignment.

A brief introduction to CAPM

Let:

- R_{it} denote the rate of return of security i in time period t,
- R_{mt} denote the rate of return for the market as a whole in time period t,
- R_{ft} denote the risk-free rate of return in time period t.

In this assignment, a time period will be one month. The market rate of return R_{mt} is usually measured using the return of a well-known market index; in this assignment you will use the **TSX Composite Index** (https://en.wikipedia.org/wiki/S&P/TSX_Composite_Index). The risk-free rate of return R_{ft} is usually measured using the return on 90-day Treasury Bills; that's what you'll do in this assignment as well.

Define:

- the *excess return of security* i in time period t as $Y_{it} = R_{it} - R_{ft}$,
- the *excess return of the market* in time period t as $X_{mt} = R_{mt} - R_{ft}$.

CAPM is based on a simple linear regression model: $\widehat{Y}_{it} = \widehat{\alpha} + \widehat{\beta} X_{mt}$. In words: the predicted excess return of security i, $\widehat{Y}_{it}$, is equal to a constant $\widehat{\alpha}$, plus $\widehat{\beta}$ times the excess return of the market, X_{mt}.

In this model, $\widehat{\alpha}$ measures a security's predicted excess return when the market return is zero; this is sometimes interpreted as "manager quality." Similarly, $\widehat{\beta}$ measures the sensitivity of the security's excess return to the market excess return. This is usually called a security's ***beta*** (https://awgmain.morningstar.com/webhelp/glossary_definitions/mutual_fund/glossary_all_Beta.html). If

$\widehat{\beta} = 0$ then the security's return is unrelated to the overall market; if $\widehat{\beta} < 0$ then the security's return tends to have the opposite sign as the overall market (e.g., it goes up when the market goes down); and if $\widehat{\beta} > 0$ then the security's return tends to have the same sign as the overall market (i.e., it goes up when the market goes up). Most securities have $\widehat{\beta} > 0$, and the focus is on whether beta is greater or less than one. If beta is less than one, then the security's return is *less* volatile than the overall market (e.g., if the market gains/loses 10%, the security usually gains/loses *less* than 10%); this is usually interpreted as being "less risky" than the overall market. In contrast, if beta is greater than one, then the security's return is *more* volatile than the overall market (e.g., if the market gains/loses 10%, the security usually gains/loses *more* than 10%); this is usually interpreted as being "more risky" than the overall market.

Several other quantities of interest arise from CAPM. One is a security's R^2. This is the proportion of variation in a security's return that is explained by the overall market. More specifically, R^2 describes how well the CAPM regression fits the data; it's inversely-related to MSFE (which we have discussed) and is measured on a scale from zero to one. If $R^2 = 0$ then market returns do not predict the security's return at all; if $R^2 = 1$ then market returns perfectly predict the security's return. Typically, R^2 is between these two extremes and tells us how closely the security's returns track the overall market; a value closer to one means it tracks the market more closely.

Finally, a security's *Sharpe Ratio* is a common measure of its risk-adjusted return. It is defined as a security's average excess return divided by the standard deviation of its excess return. The standard deviation is usually interpreted as a measure of volatility (or risk). So a security with a large Sharpe ratio is one that has high average returns and low volatility (risk), which is a good thing if you're an investor! In contrast, a security with a small Sharpe ratio is one that has low average returns and high volatility (not so good!). With monthly return data like you're using in this assignment, we usually estimate a security's *annualized Sharpe Ratio*, which is defined as $S_i = \sqrt{12}\frac{\overline{Y}_{it}}{s.d.(Y_{it})}$, where $\overline{Y}_{it}$ is the mean of security i's monthly excess return and $s.d.(Y_{it})$ is the standard deviation of its monthly excess return.

<u>Your assignment</u>

In this assignment, you'll be working with monthly return data for seven securities traded on the Toronto Stock Exchange: [BCE (https://www.google.com/finance/quote/BCE:TSE)](https://www.google.com/finance/quote/BCE:TSE), [BLDP (https://www.google.com/finance/quote/BLDP:TSE)](https://www.google.com/finance/quote/BLDP:TSE), [FTS (https://www.google.com/finance/quote/FTS:TSE)](https://www.google.com/finance/quote/FTS:TSE), [RCI (https://www.google.com/finance/quote/RCI.B:TSE)](https://www.google.com/finance/quote/RCI.B:TSE), [RY (https://www.google.com/finance/quote/RY:TSE)](https://www.google.com/finance/quote/RY:TSE), [TRP (https://www.google.com/finance/quote/TRP:TSE)](https://www.google.com/finance/quote/TRP:TSE), [XBB (https://www.google.com/finance/quote/XBB:TSE)](https://www.google.com/finance/quote/XBB:TSE) (follow the links if you're interested in knowing what the securities are, but it's not necessary to complete the assignment). Your data for this assignment are contained in this zip file: [Week10data.zip (https://canvas.sfu.ca/courses/73572/files/20318687?wrap=1)](https://canvas.sfu.ca/courses/73572/files/20318687?wrap=1) (https://canvas.sfu.ca/courses/73572/files/20318687/download?download_frd=1) . In the zip file you will find one .csv file for each of those seven securities; each .csv file contains the security's return in each month (R_{it} in the notation above).

You will find two additional .csv files in Week10data.zip:

- (https://canvas.sfu.ca/courses/73572/files/20318687?wrap=1) T90.csv contains the monthly return on 90-day Treasury Bills in each month; use this as the risk-free rate of return (R_{ft}, in the notation above).
- TSX.csv contains the monthly return of the TSX Composite Index in each month; use this as the market rate of return (R_{mt}, in the notation above).

Your instructions are as follows:

1. Download the zip file, unzip it, and read each of the .csv files into R. Do all of the .csv files cover the same time period? If not, which one(s) begin earliest, and which begin latest? *Note: because you have nine .csv files to read into R there's quite a lot of repetition in this step. Try and write a loop to read in all nine files; bonus marks if you succeed!*
2. Join the return data for the seven securities, 90-day Treasury Bills, and the TSX Composite Index into a single data object **by date**. Take care when doing this to ensure that all of the return data end up in your joined data object (i.e., don't forget that the returns data don't all begin in the same year)! *Note: there's quite a bit of repetition in this step. Can you use a loop for the joins?*
3. Subset the data to only keep observations between 2001 and 2021.
4. Produce a nicely-formatted table of summary statistics using `sumtable()`. Which security has the highest average monthly return in these data? Which has the lowest? Which security has the most volatile monthly returns (i.e., the highest standard deviation)? Which has the lowest?
5. Compute the excess return for each security and the TSX Composite Index (Y_{it} and X_{mt} in the above notation).
6. Compute the annualized Sharpe Ratio for each security (S_i in the notation above). Which security has the highest risk-adjusted return? Which has the lowest?
7. Estimate the CAPM regression for each security. Plot their monthly excess returns against the TSX (a scatter plot) overlaid with the estimated CAPM regression function, and report the model's α, β, and R^2. There should be one plot for each security. *Note: again, there's lots of repetition in this step. Try and write a function that estimates the CAPM regression and does the plot to eliminate code repetition; bonus marks if you succeed!*