Each question is worth 12 points. There are 10 questions, therefore 120 points in total.

**Investing in U.S. stock market:**

Imagine that you are at 3 years from now. You have a stable and well-paid job, so you are thinking about investing part of your money. You do not have time to take care of a new business,

e.g., owning a restaurant or coffee shop, so you limit your attention to financial assets. You find U.S. stock market might be a good place to go. You would like to understand how good the U.S. stock market is. In particular, you want to know how lucrative and how safe it is for you who has not dealt with stock before.

You start with collecting the historical data of stocks. Center of Research for Security and Price (CRSP) has all the security related information (download ‘CRSP\_2021.csv’ from Canvas under section “Data and other Resources”), and you start your investigation.

PERMNO and Ticker are unique firms’ identifications. Date is the month-end date (yyyymmdd), and the stock price (PRC) is measured at the end of that date. Monthly return (RET) is the stock return measured from the last month-end date to the current date.

Since we are interested in publicly tradable common shares, we only consider firms with SHRCD equal to 10 and 11. There are many stock exchanges in U.S., while we consider only the biggest three, NYSE, AMEX, and Nasdaq, with PRIMEXCH N, A, and Q respectively as they are most liquid, that is, you can buy and sell with ease.

The firms’ market equity (or market cap or size) is defined as the stock price per share (PRC) times total number of shares (SHROUT). However, please note that PRC contains negative values because if the stock was not traded for a while before the month-end, CRSP records some alternative price measures and puts a negative sign in the front. Therefore, you have to take the absolute value of PRC before times it with SHROUT.

1. Descriptive analysis:

What is the starting and ending month of the sample period? Show the Tickers and other information for largest (market cap) 10 firms by the end of the sample? If you find both

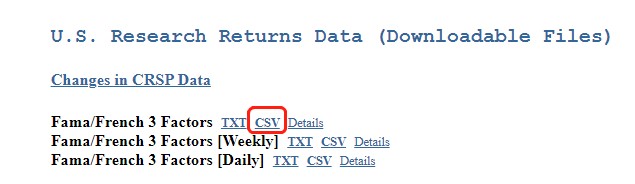
“GOOG” and “GOOGL”, do not be surprised. That is because google has double-class shares.

1. Since you do not have superior information relative to others, especially the financial institutions, you plan to invest in a broad market index which contains all stocks traded (after screening for SHRCD and PRIMEXCH). Calculate the monthly equal-weighted average return from the beginning to the end of the sample period. (Please define the variable name as “RET.ew”) Note that some stocks have missing RET data in some months. That is probably because they are suspended from trading for a few months. Let’s take missing RET as zero and then calculate the equal-weighted average monthly returns. If you are using R, print out the result.

1. Probably a more interesting return measure is the value-weighted monthly returns, that is, you take a weighted average of the firm returns in each month and the weights are the firms’ **last month**’s market equity (call it ME). So, you lag the market equity for one month for all firms (call it ME.lag). Note that you need to lag market equity for each firm, not lag the entire column. If you are using R, print out the generated column.

1. Take the value-weighted average of monthly returns (call it RET.vw). We may have not covered this in the class, but it is simple. Search “weighted average in Excel (or R)” in Google, you will find the function and how to use it. In addition, please note that ME.lag may contain missing values, let’s exclude the firms with missing ME.lag. If you are using R, print out the result.

1. Before you do further analysis. Let’s verify whether you just did it correctly. You need to go to Kenneth French’s data library: *http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\_library.html* And download the following dataset:



Import the dataset and note that if you are using R, skip the first 2 rows.

You need to take the sum of column “Mkt-Rf” and “RF” from “F-F\_Research\_Data\_Factors” (call it Mkt) which will give you the value-weighted monthly return you just calculated. You combine the two columns, Mkt and RET.vw, by either manually copy-paste or merging them by primary key “Date”. Save the output and call it “Verify\_Mkt.csv”.

1. What are the expected values and variance of RET.ew, RET.vw, Mkt? (Note Kenneth French gives the percentage return, so you need to times RET.ew and RET.vw by 100 to match) What is the correlation between them? If RET.vw and Mkt have a correlation below 95%, please check your calculation. If you pass the 95% bar, let’s proceed. Open question: will you invest in such a broad index of U.S. stocks?

Starting from this point, you use Kenneth French’s Mkt as the market return.

1. Let’s do some visualizations. Calculate the cumulative return of the Mkt. For example, if a stock has a return 10% last month and 20% this month, the cumulative return of these two months is

(1+10%) \*(1+20%)-1 = 32%. Plot the cumulative return of Mkt from January 1981 to December 2000 and from January 2001 to December 2020 separately. If you are using R, cumprod() function can help. If you are using Excel, there is an easy trick, and you can google for help.

1. Plot a histogram for Mkt. What type of distribution may be reasonable to describe it? Change the number of bins to 30. What do you observe on the two tails?

1. Let’s suppose that you work for Lyft. Since your human capital, including your salary, stock options, and bonus etc., is highly related to the company, you are planning to hedge this risk. You come up with an idea – you want to hold Uber’s stock. Your argument is, if Lyft does not do well in the future, Uber will take the whole market and therefore has a good return. You go to Yahoo finance to download the stock price history and calculate the monthly return based on the adjusted stock price. What is the correlation between Uber stock and Mkt?

Suppose you invest half of your asset into Uber and half into Mkt, what are the mean, standard deviation, 1st quartile, and 3rd quartile of the return of your strategy in the history, which is not quite long.

1. You are also planning for buying a house but also worry about the risk of housing price, especially, the return correlation between housing price and your stock portfolio, which is the market index (Mkt). You download the housing prices index from Zillow -- [https://www.zillow.com/research/data/.](https://www.zillow.com/research/data/)

Suppose that you live in Boston area, so you use only the housing index data of Boston. You compute both the monthly return and the cumulative monthly return of Boston housing price, by assuming that you can invest in the “ZHVI” index of Zillow. Specially, the monthly return in

month t by investing in ZHVI of Boston is 𝑍𝑍𝐻𝐻𝐻𝐻𝐻𝐻𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵,𝐵𝐵 − 𝑍𝑍𝐻𝐻𝐻𝐻𝐻𝐻𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵,𝐵𝐵−1.

𝑍𝑍𝐻𝐻𝐻𝐻𝐻𝐻𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵𝐵,𝐵𝐵−1

Give two plots: (1) cumulative return of both ZHVI Boston and Mkt, (2) monthly return of both ZHVI Boston and Mkt.

Describe what you find, especially about the subprime crisis period.