Instructions for Project 2—Using Leverage and Stock Market Information to Estimate Cost of Equity for Non-Listed Firms

Do NOT circulate this material outside of class

Your project will have the following steps:

- Obtain data from CRSP and Compustat
- Use nonlist.csv, which will be provided for data on non-listed firms
- Write the program to perform the task
- Include detailed comments, explaining every step of your code

Submit the code as a Python program on Bb.

- CRSP data

  1. 2015/01 – 2020/12 – 72 monthly observations (6 years), varies by firm
  2. Retrieve the following variables
     - CUSIP
     - RET (holding period return)
     - ewretd (equal-weighted return, including distributions)
  3. Conditions set at the time of retrieving data
     - CUSIP – non-missing
     - RET – non-missing

- COMPUSTAT data

  1. Retrieve the following variables
     - FYEAR fiscal year
     - FYR fiscal year end
     - CUSIP
     - SIC standard industry classification code
     - DT total debt including current
     - PRCC_F price close – annual – fiscal
     - CSHO common shares outstanding
  2. Conditions set at the time of retrieving data
     - FYEAR = 2020
     - FYR = 12
     - CUSIP – non-missing
     - SIC – non-missing

- DT >= 0
- PRCC_F > 0
- CSHO > 0

Your task is to estimate the cost of equity (R_e) for hypothetical non-listed firms in various industries (nonlist.csv) using market information on US public firms operating in the same industries and the leverage ratios of these non-listed firms.

The main steps are:

- Estimate equity betas for the public firms using monthly returns on their shares and monthly returns on the market portfolio over the same period. You will do this by estimating an OLS (Ordinary Least Squares) regression for each company with at least the minimum required number of observations, which is 30, using a model known as the *market model*:

  $$RET_{it} = intercept_t + \beta_i \times Market\ return_t + \varepsilon_{it}$$

  β_i will be the estimate of each company's beta or systematic risk. For market return you will use the equal-weighted average return on a stock index available from CRSP.

  You will extract all betas, along with corresponding company codes (cusips), in a separate dataframe to then merge with company data from Compustat, which has information on their leverage (D/E ratio).

- Since the companies in the sample may have debt in their capital structure, the estimated betas are levered. To estimate industry average beta, you will need to first un-lever the betas of these companies to remove the financial risk effect due to their leverage and leave only business risk. You will use company D/E ratios to perform this task.

- After un-levering the betas you will sort the firms into industries based on their SIC codes (3-digit) and will calculate the average unlevered beta for each industry. To obtain good quality estimates, only industries with at least 5 firms will be used. The rest will be discarded. Industry average un-levered betas and industry codes will be extracted in a new dataframe to merge with the list of non-listed firms (to be provided) to calculate their cost of equity.

To write the code please use the following steps to guide yourself.

- Import the following Python libraries
    1. pandas
    2. statsmodels.api
- Read both data files
- Display the first and last few rows and eyeball the data
- Check what types of variables you have—objects & numbers (integers or floats)
- Show the descriptive statistics for both dataframes
- From the dataframe that has the stock market data, keep only those firms (CUSIPS) that have at least 30 monthly returns.
- Estimate the market model for each company separately and extract the beta coefficient as follows:

    <u>Method 1</u>

    1. Define a function that would execute an OLS regression with an intercept and return the parameters (params) from the regression
    2. Apply the function to your dataframe that has stock market data, grouped by CUSIP, with the dependent (y) variable as RET and the independent (x) variable as the return on the stock index (vwretd or ewretd). The dataframe with the extracted regression parameters and CUSIPs should be named **params.**

    OR

    <u>Method 2</u>

    Apply the *lambda x* one-line function directly to extract the model parameters.

- Print and take a look at **params**. The coefficient of the market index, which is your estimated beta, has the same name as the market index (ewretd), rename it as *beta*.

- In the dataframe with Compustat data:

    1. extract the first 8 digits from variable cusip and create variable CUSIP, comparable to the CUSIP variable in CRSP;
    2. create variable sic3 based on sic;
    3. calculate DE ratio as: total debt / (price per share * #shares outstanding);

4. drop extra columns that you will not be using.

- Create a new dataframe by merging **params** and the dataframe that has the DE ratio, based on CUSIP.

- Print and take a look at the new dataframe.

- Create a new variable and name it **beta0**, by using the DE ratio and un-levering the estimated betas. Assume that tax rate is 30% and $\beta_D = 0$.

- Check how many firms are in each sic3 code with the help of groupby().count()

- Keep only industries (sic3) that have at least 5 observations (that is, 5 firms).

- Create a new dataframe, which has the industry means for the calculated **beta0**, grouped by sic3, and name the new dataframe **ibetas**.

- Print and take a look at **ibetas.**

- Read the 'nonlist.csv' file and create a dataframe named **nl**. This is a file with information on hypothetical non-listed firms with their sic3 codes and D/E ratios.

- Take a look at **nl**.

- Create a new dataframe by merging **ibetas** and non-listed firms based on sic3 and take a look at it. Each non-listed firm now has an un-levered beta estimate based on the industry average of un-levered betas of its publicly traded industry counterparts.

- Using the target D/E ratios (de) of non-listed firms, estimate their cost of equity, R_e. Assume that the risk free rate is 4.5%, the market risk premium is 8%, the tax rate is 30%, and $\beta_D = 0$. Note, we have assumed that $\beta_D = 0$, that is, debt is risk-free, which means that the borrowing rate is the same as the risk-free rate, 4.5%.

  There are two ways you can go:

  1. Lever up the un-levered beta, then use CAPM to get R_e.
  2. Use CAPM with un-levered beta to get R_0, then use Proposition II to get R_e.