Problem Set 4: Size and Value

Jiaming Huang

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Name: Jiaming Huang

Names of whom I discussed this problem set with: [Yanxiang Zhao]

Question 1

Prepare data for analysis. Combine necessary CRSP and Compustat datasets needed to define size and book-to-market decile portfolios as defined in Fama and French (1992b)1, as well as the HML and SMB factors as defined in Fama and French (1993)2. Detail which datasets you use, how you merged them, how you calculated the portfolios, and any differences between the building of the decile portfolios and the factors. Output should be between January 1973 and December 2018.

Firstly I will show the result of portfolios:

```
##        Year Month port      Size_Ret      BtM_Ret     HML_Ret      SMB_Ret
##    1: 1974     2    1  0.0121497569 -0.023774856 0.045474926 -0.002823376
##    2: 1974     2    2 -0.0034698174 -0.004800041 0.045474926 -0.002823376
##    3: 1974     2    3  0.0101327730  0.008546383 0.045474926 -0.002823376
##    4: 1974     2    4  0.0072336880  0.009068963 0.045474926 -0.002823376
##    5: 1974     2    5 -0.0005416128  0.021329631 0.045474926 -0.002823376
##   ---
## 5386: 2018    12    6 -0.1205931436 -0.103168740 0.001028712 -0.032057897
## 5387: 2018    12    7 -0.1191489852 -0.110535859 0.001028712 -0.032057897
## 5388: 2018    12    8 -0.1073704677 -0.102154306 0.001028712 -0.032057897
## 5389: 2018    12    9 -0.0956822679 -0.120154789 0.001028712 -0.032057897
## 5390: 2018    12   10 -0.0878478101 -0.139700728 0.001028712 -0.032057897
```

Then I will talk more about how I got this result:

1. Data

Following the Fama French???s paper, the datasets are from CRSP and Compustat in WRDS. ??? Monthly CRSP US equity Data (CRSP) ??? Fundamental Annual Updates for North America (Compustat) ??? Pension Annual (Compustat) ??? Linking Table (CRSP Compustat merged)

2. CRSP Data Cleaning

The sample is to common shares(share code 10 and 11) and to securities traded in the New York Stock Exchange, American Stock Exchange, or the Nasdaq Stock Exchange (exchange codes 1, 2, and 3)

Dataset from CRSP Monthly from 1960 Jan to 2018 Dec

2.1 Delisting Return

To calculate the cum-dividend return, return equals to RET when DLRET is missing. If DLRET is not missing and RET is missing,cum-dividend return equals to DLRET. If both are not missing,Ret = (1 + DLRET)(1 + RET) - 1.

2.2 Market Capitalization

As some prices are negative, I take the absolute value for price and multiply it with share outstanding to get the market capitalisation. As the CRSP data needs to be merged with Compustat which uses millions as its base unit, divide the market cap by 1000 so as to have the same base unit in the merged data.

3. Compustat Data Cleaning

3.1 Non-Finance Company

As financial companies have to be removed. The variable indfmt identifies financial firm as FS and non-financial firm as INDL. Filter out the financial firms from the dataset.

3.2 Merge Pension data and Compustat data

As fundemental data is all from database Combined CRSP and Compustat from CRSP, and Pension data(PRBA) is from Compustat database, the two datasets needs to be merged. ??? Using the gvkey and the year to merge.

3.3 Calculation of Book to Market Equity

3.c Calculation of book equity Following the instructions on the problem set, there are the steps I used to calculate book equity. ??? Calculate shareholder???s equity (SHE): it is equal to stockholders equity - total (SEQ) ??? if not available, use common/ordinary equity - total (CEQ) + Preferred/Preference Stock (Capital) - Total (PSTK) ??? if not available, use Assets - Total (AT) - Liabilities - Total (LT) - Minority Interest (Balance Sheet) (MIB) ??? if not available, use AT - LT ??? Calculate Deferred taxes (DT): it is equal to Deferred Taxes and Investment Tax Credit (TXDITC) ??? if not available, use Investment Tax Credit (Balance Sheet) (ITCB) + Deferred Taxes (Balance Sheet) (TXDB) ??? if not available, sum up what is not missing ??? Calculate preferred stock (PS): it is equal to Preferred Stock Redemption Value (PSTKRV) ??? if not available, use Preferred Stock Liquidating Value (PSTKL) ??? if not available, use Preferred/Preference Stock (Capital) - Total (PSTK) ??? Calculate book equity (BE): BE = SHE - PS + DT - PRBA, PRBA comes from the pension dataset which we have merged earlier on. ??? If SHE is not available, assign BE to NA, otherwise, include other variables in the calculation if not missing. ??? Historical book equity data from Fama French website will be merged later on as it has only PERMNO as unique ID

4. Merge Compustat and CRSP data

merge the CRSP data with Compustat by variable PERMCO(as one company may have multiple securities) and year. Do not remove the NAs in the dataset.

5. Formation of Size decile portfolio

??? Step 1: Size portfolio is calculated by matching Market cap at June of year t with return from July of year t to June of year t + 1. The rebalancing is done at the end of June annually. Therefore, I firstly extract Market Capitalization data from June every year. ??? Step 2: Sorted June Market Capitalization into deciles from 1 to 10. The breakpoint is set based on Market Capitalization of NYSE stock of that particular year. ??? Step 3: The size decile has now been obtained for each stock across years. Then, according to French's paper, compute the equal-weighted return within each decile to get monthly return for decile portfolio. ??? Step 4: Create a long short portfolio by going long on the 1st decile and shorting the 10th decile

Formation of BE/ME decile portfolio

??? Step 1: BE/ME portfolio is calculated by matching Market cap and book equity at December of year t-1 with return from July of year t to June of year t + 1. The rebalancing is done at end of June annually. So firstly I extract data on December for BE/ME decile sorting. ??? Step 2: The stocks are sorted into deciles from 1 to 10. The breakpoint is set based on BE(eliminating those stocks with negative BE value)/ME of NYSE stock in December of that particular year. ??? Step 3: The BE/ME decile has now been obtained for each stock across years. Then, according to French's paper, compute the equal-weighted return within each decile to get monthly return for decile portfolio. ??? Step 4: Create a long short portfolio by going long on the 1st decile and shorting the 10th decile

Formation of SMB and HML portfolio

??? Step 1: Using the same way as to construct Size and BE/ME portfolio, only differece is that the decile for SMB and HML is (0.5,0.5),(0.3,0.4,0.3). ??? Step 2: Merge the two portfolios so as to get 6 differnet combinations of portfolios(SL,SM,SH,BL,BM,BH), then calculate the value-weighted portfolio based on lagged market cap.

Question 2

For each size decile and the long-short portfolio, report the annualized average excess returns, annualized volatility, Sharpe Ratio, and skewness. Also report the correlation between the port- folios that you have constructed (the 10 portfolios and the long-short portfolio) and those from French???s website.

Firstly I will show the result:

```
##             Statistic   Decile1     Decile2     Decile3     Decile4
## 1: Excess Mean Return 0.1247132  0.08772758  0.09520982  0.09199239
## 2:         Volatility 0.2154963  0.22222686  0.21231380  0.20727652
## 3:        Sharp Ratio 0.5787256  0.39476589  0.44843914  0.44381482
## 4:           Skewness 0.1752427 -0.12019041 -0.28302803 -0.35911356
## 5:        Correlation 0.9990205  0.99900333  0.99892466  0.99868956
##        Decile5    Decile6     Decile7     Decile8     Decile9    Decile10
## 1:  0.09567993  0.0891262  0.09274489  0.08419085  0.08292215  0.06768636
## 2:  0.20508093  0.1917606  0.18617760  0.18159473  0.17148928  0.16175123
## 3:  0.46654717  0.4647785  0.49815280  0.46361945  0.48354131  0.41845964
## 4: -0.31435892 -0.3605286 -0.33458396 -0.41501217 -0.33144154 -0.32780459
## 5:  0.99813116  0.9979565  0.99815299  0.99854621  0.99915550  0.99963847
##    Long_Short_Portfolio
## 1:           0.05702688
## 2:           0.16472420
## 3:           0.34619611
```

```
## 4:           0.99093719
## 5:           0.99805409
```

1. Annualized Excess Return: Annualized excess return for decile 1 to 10 (Return above risk free) = Average of excess return multiply by 12. Annualize return for long short portfolio = average of return of (decile 1 - decile 10)
2. Annualized Volatility: Compute portfolio standard deviation as the sample standard deviation across years for each decile and long short and annualize it by multiplying by square root of 12.
3. Sharp Ratio: Compute the sharp ratio using the following formula: Sharp ratio = Annualized Excess Return / Annualized Volatility
4. Skewness: Compute the skewness of the return using the following formula: skewness(monthly return), where skewness is the function from library moments to calculate the skewness.
5. Correlation: Find the correlation between the replicated decile and long short portfolio and the one on Fama French website

Question 3

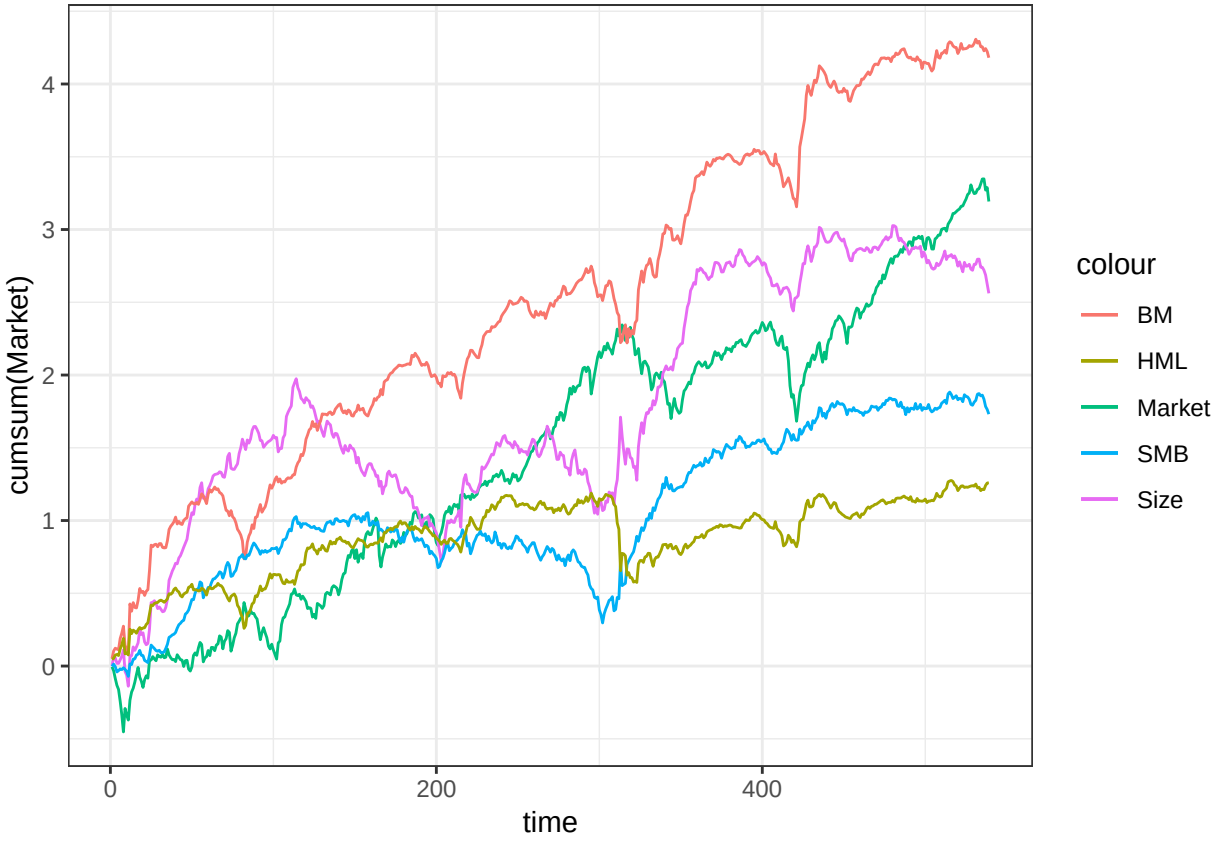
For each book-to-market decile and the long-short portfolio, report the annualized average excess returns, annualized volatility, Sharpe Ratio, and skewness. Also report the correlation between the portfolios that you have constructed (the 10 portfolios and the long-short portfolio) and those from French???s website.

```
##             Statistic     Decile1     Decile2     Decile3     Decile4
## 1: Excess Mean Return  0.07554138  0.07970625  0.09467035  0.08924106
## 2:         Volatility  0.19767303  0.18134370  0.18012450  0.17268229
## 3:        Sharp Ratio  0.38215320  0.43953139  0.52558287  0.51679332
## 4:           Skewness -0.47593202 -0.65274488 -0.64439676 -0.66513230
## 5:        Correlation  0.92972061  0.92069116  0.93074482  0.94007038
##        Decile5     Decile6     Decile7    Decile8   Decile9  Decile10
## 1:  0.09646483  0.09799968  0.09770387 0.12128825 0.1383460 0.1686140
## 2:  0.17064260  0.16833368  0.16610550 0.16834458 0.1783553 0.2198680
## 3:  0.56530334  0.58217513  0.58820370 0.72047616 0.7756764 0.7668873
## 4: -0.58639338 -0.41024997 -0.20896956 0.05031967 0.2851747 0.9353142
## 5:  0.94254802  0.95598749  0.95702222 0.95640173 0.9570536 0.9434023
##    Long_Short_Portfolio
## 1:           -0.09307262
## 2:            0.14586409
## 3:           -0.63807767
## 4:           -1.60400949
## 5:            0.69107805
```

1. Annualized Excess Return: Annualized excess return for decile 1 to 10 (Return above risk free) = Average of monthly excess return multiply by 12. Annualize return for long short portfolio = average of return of (decile 1 - decile 10)
2. Annualized Volatility: Compute portfolio standard deviation as the sample standard deviation across years for each decile and long short and annualize it by multiplying by square root of 12.
3. Sharp Ratio: Compute the sharp ratio using the following formula: Sharp ratio = Annualized Excess Return / Annualized Volatility
4. Skewness: Compute the skewness of the return using the following formula: skewness(monthly return), where skewness is the function from library moments to calculate the skewness.
5. Correlation: Find the correlation between the replicated decile and long short portfolio and the one on Fama French website

Question 4

Has the value and size anomaly worked in the past few years? Show some empirical evidence.



As we can see from the plot, Size and BE/ME factors worked well in the 1900's but did really bad job in the past few years.

Question 5

For both HML and SMB portfolios, report the annualized average excess returns, annualized volatility, Sharpe Ratio, and skewness. Report correlations between the replicated factors and the factor from French???s website. Have the factors been consistent across time? Show some empirical evidence.

```
##             Statistic          SMB         HML
## 1: Excess Mean Return -0.006769381 -0.01727744
## 2:         Volatility  0.110541742  0.09991299
## 3:        Sharp Ratio -0.061238230 -0.17292486
## 4:           Skewness  0.583010075 -1.30844861
## 5:        Correlation  0.841536021  0.67692019
```

1. Annualized Excess Return: Annualized excess return = Average of monthly return minus Fama French risk free rate and multiply by 12.
2. Annualized Volatility: Compute portfolio standard deviation as the sample standard deviation across years for each decile annualize it by multiplying by square root of 12.
3. Sharp Ratio: Compute the sharp ratio using the following formula: Sharp ratio = Annualized Excess Return / Annualized Volatility
4. Skewness: Compute the skewness of the return using the following formula: skewness(monthly return), where skewness is the function from library moments to calculate the skewness.

5. Correlation: Find the correlation between the replicated SMB and HMl portfolio and the one in Fama French website.

Question 6

Compare and contrast using the characteristic portfolios (Fama and French 1992) and the factor portfolios (Fama and French 1993).

Characteristics (1992 paper)

Scope: Assets are common stocks only Set of variables: size (ME) and book-to-market ratio (BE/ME) The approach to testing asset-pricing model: Fama and French (1992a) use the cross-section regressions of Fama and MacBeth (1973): the cross-section of stock returns is regressed on variables hypothesized to explain average returns. Summary of the result: Two easily measured variables, ME and BE/ME, provide a simple and powerful characterization of the cross-section of average stock returns for the 1963-1990 period. The result suggests that: ??? Beta doesn???t seems to help explain the cross-section of average stock returns ??? The combination of size and book-to-market equity seems to absorb the roles of leverage and E/P in average stock returns, at least during our 1963-1990 sample period. ??? Stock risks are multidimensional. One dimension of risk is proxied by size, ME. Another dimension of risk is proxied by BE/ME,

Factors (1993 paper)

Scope: Assets are common stocks and U.S. government and corporate bonds Set of variables: ME BE/ME and term structure variables for bonds The approach to testing asset-pricing model:This paper uses the time-series regression approach of Black, Jensen, and Scholes (1972). Monthly returns on stocks and bonds are regressed on the returns to a market portfolio of stocks and mimicking portfolios for size, book-to-market equity (BE/ME), and term-structure risk factors in returns. Summary of the result: For stocks, portfolios constructed to mimic risk factors related to size and BE/ME capture strong common variation in returns, no matter what else is in the time-series regressions. This is evidence that ME and BE/ME equity indeed proxy for sensitivity to common risk factors in stock returns. Moreover, for the stock portfolios we examine, the intercepts from three-factor regressions that include the excess market return and the mimicking returns for size and BE/ME factors are close to 0. Thus a market factor and our proxies for the risk factors related to ME and BE/ME equity seem to do a good job explaining the cross-section of average stock returns. For bonds, the mimicking portfolios for the two term-structure factors (a term premium and a default premium) capture most of the variation in the returns on our government and corporate bond portfolios. The term-structure factors also ???explain??? the average returns on bonds, but the average premiums for the term-structure factors, like the average excess bond returns, are close to 0. Thus, the hypothesis that all the corporate and government bond portfolios have the same long-term expected returns also cannot be rejected.