Problem Set 3

Momentum

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Question 1

Using CRSP stock data, define the universe of monthly returns that can be used in calculating momentum portfolios, as well as their ranking return, following the procedure in Daniel and Moskowitz (2016)

Input Data (Universe of stocks):

CRSP_Stocks from 1926 to 2018. The universe of stocks starts with all firms listed on NYSE, Amex, or Nasdaq (with CRSP exchange code of 1, 2 or 3) for the formation date, moreover, we required using only returns of common shares (with CSRP share code of 10 or 11).

Calculation process:

1) Data restrictions

according to the paper of momentum crash, we require a firm have a valid share price and number of shares as of the formation date and that there are a minimum eight monthly returns over past 11 months, skipping the most recent month, which is our formation period. Which means:

i) remove NAs for share price and number of shares;
ii) there are at least 8 valid returns in the period from (t-12) to (t-2);

From Notes on the Daniel-Moskowitz Momentum Portfolios, the restrictions are that:

iii) price at t-13 not missing;
iv) ret (t-2) not missing;
v) me (t-1) not missing.

2) Calculating lag market cap

Market cap was calculated using the absolute value of price and shares outstanding. Lag market cap is derived by shifting market up by one month.

3) Calculating returns

For stock i at time t, holding period returns: $r_{i,t}^{h}$ and delisting returns $r_{i,t}^{d}$

I used cum-dividend total returns:

$$r_{i,t} = \begin{cases} r_{i,t}^{h} & if\ r_{i,t}^{d}\ is\ missing \\ r_{i,t}^{d} & if\ r_{i,t}^{h}\ is\ missing \\ (1 + r_{i,t}^{h})(1 + r_{i,t}^{d}) - 1 & if\ both\ not\ missing \end{cases}$$

4) Calculating ranking returns

"total" means that the raking return for each firm is its cumulative log (1+return) from month t-12 through month t-2. First, I used rollapplyr function to sum 11 months return as ranking return. Then I used data restriction criteria listed in (1) to filter the data, and only keep observations which satisfy the criteria listed above.

Output:

The required output is trimmed to be from 1927 to 2018. The rows which have ranking returns as NA are not removed for this question.

```
> output1
         Year Month PERMNO EXCHCD  lag_Mkt_Cap       Ret Ranking_Ret
      1: 1987    01  10000      3 1.981566e+03 -0.212121          NA
      2: 1987    02  10000      3 1.581531e+03  0.000000 -2.13828196
      3: 1987    03  10000      3 1.581531e+03 -0.384615 -2.07944100
      4: 1987    04  10000      3 9.732500e+02 -0.062500 -2.39087744
      5: 1987    05  10000      3 9.124413e+02 -0.066667 -2.77258734
     ---
3250495: 2018    08  93436      3 5.086060e+07  0.011806  0.05847920
3250496: 2018    09  93436      3 5.146108e+07 -0.122290 -0.17708557
3250497: 2018    10  93436      3 4.542871e+07  0.274011 -0.12287431
3250498: 2018    11  93436      3 5.792898e+07  0.039013 -0.22485626
3250499: 2018    12  93436      3 6.018898e+07 -0.050445  0.08817641
```

Question 2

Define the monthly momentum portfolio decile of each stock as defined by both Daniel and Moskowitz (2016) and Kenneth R. French. Your output should be from 1927-2018.

Input Data:

The result from Question 1, including Year, Month, Share Code, Exchange Code, lag Market Cap, Return, and Ranking Return.

Calculation Process:

1) Data cleanup

Before we calculate the rankings for both types, the rows which have ranking returns as NA needs to be removed. Without doing this, we could not rank the return accurately.

2) Breakpoints

i) Based on DM, breakpoints for the decile portfolios are based on all-firms (i.e.,NYSE, AMEX, and NASDAQ). For the all-firm breakpoint portfolios have an equal number of firms in each portfolio as of the formation date. Based on which decile the stock's ranking return is in, a rank is given. 1 means the lowest-ranking return decile and 10 means the highest-ranking return decile.

ii) Based on KRF, breakpoints for the decile portfolio are based on just NYSE firms. For the NYSE-breakpoint portfolios, there are an equal number of NYSE firms in each portfolio as of each formation date. All the stocks are now ranked using these breakpoints.

iii) Note in the case of KRF, the number of stocks in each decile may not be the same, as the breakpoints were calculated based on NYSE stocks only.

iv) Moreover, since KRF decile could not cover full stocks, to increase the accuracy, I observations whose KRF decile is NA, I make the KRF decile equal to the DM decile.

Output:

```
> output2
         Year Month PERMNO  lag_Mkt_Cap       Ret DM_decile KRF_decile
      1: 1987    02  10000 1.581531e+03  0.000000         1          1
      2: 1987    03  10000 1.581531e+03 -0.384615         1          1
      3: 1987    04  10000 9.732500e+02 -0.062500         1          1
      4: 1987    05  10000 9.124413e+02 -0.066667         1          1
      5: 1987    06  10000 8.515938e+02  0.000000         1          1
     ---
3162168: 2018    08  93436 5.086060e+07  0.011806         5          5
3162169: 2018    09  93436 5.146108e+07 -0.122290         2          1
3162170: 2018    10  93436 4.542871e+07  0.274011         3          2
3162171: 2018    11  93436 5.792898e+07  0.039013         2          2
3162172: 2018    12  93436 6.018898e+07 -0.050445         7          8
```

Question 3

Calculate the monthly momentum portfolio decile returns as defined by both Daniel and Moskowitz (2016) and Kenneth R. French. Your output should be from 1927-2018.

Input Data:

Apart from the output from the 2nd question, the Fama French data factors needs to be retrieved from the website, in order to get the risk-free rate.

Calculation Process:

For every year, month, decile combination, I calculated value weighted return of all the stocks. To reach this objective,

1) First, I computed weight by every year, month and decile combination:

$$weight = \frac{me_{i,t-1}}{\sum_i me_{i,t-1}}$$

2) Then, by date and decile, I calculated return with respect to different date(t) and decile(i):

$$Return_{i,t} = sum_{i,t}(weight * Return)$$

3) After that we could merge the result with the Fama French factors, in order to get the risk-free rate for each month-year combination.

Output:

```
> output3
       Year Month DM_decile       DM_Ret KRF_decile      KRF_Ret     Rf
    1: 1927    01         1 -0.032149162          1 -0.032149162 0.0025
    2: 1927    01         2 -0.039636616          2 -0.039636616 0.0025
    3: 1927    01         3  0.019708143          3  0.019708143 0.0025
    4: 1927    01         4  0.004212304          4  0.004212304 0.0025
    5: 1927    01         5 -0.005907735          5 -0.005907735 0.0025
   ---
11036: 2018    12         6 -0.103888845          6 -0.102173345 0.0019
11037: 2018    12         7 -0.085487776          7 -0.087433051 0.0019
11038: 2018    12         8 -0.084584703          8 -0.083863322 0.0019
11039: 2018    12         9 -0.086422739          9 -0.089132038 0.0019
11040: 2018    12        10 -0.096714354         10 -0.082738420 0.0019
```

Question 4

Replicate Table 1 in Daniel and Moskowitz (2016), except for α, t(α), β, and sk(d) rows, and the Market column. Match the format and methodology to the extent possible.

Input Data:

CRSP Stocks Momentum returns from Question 3.

Calculation Process:

1) **Mean:** mean is calculated for the returns of every year, month and decile combination and then is annualized on an arithmetic basis (i.e. Mean $Return_{annual} = Mean\ Return_{monthly} * 12$), then I time the result by 100 to make it into percentage term.
2) **Standard Deviation:** Standard deviations of for the returns of every year, month and decile combination and then is annualized on an arithmetic basis (i.e. $sd_{annual} = sd_{monthly} * 12$), , then I time the result by 100 to make it into percentage term.
3) **Sharpe Ratio:** Sharpe ratio for different are calculated as:

$$Sharpe\ Ratio = \frac{Excess\ Return}{Volatility}$$

4) **Skewness:** With the build in function moments, I calculate excess skewness of log returns (log(1+return)), of every year, month and decile combination.
5) **WML:** WML refers to winner minus loser portfolio, it is a portfolio formed by using winner portfolio (decile 10) minus loser portfolio (decile 1) for each specific year and month combination. Compute Stats using the same method listed above.

Output:

The output is listed below, which is very close to the table in the paper.

```
> output4
           Decile1    Decile2    Decile3    Decile4    Decile5    Decile6    Decile7     Decile8    Decile9
mean_DM -2.6507490  3.0099793  3.2137766  6.6368113  7.4539586  7.2639021  9.1605578 10.34747305 11.3704195
SD_DM   36.1841429 30.0140434 25.3598804 22.5567280 21.0752804 19.9204528 19.0415311 18.71034143 19.9978847
SR_DM   -0.0732572  0.1002857  0.1267268  0.2942276  0.3536825  0.3646454  0.4810830  0.55303497  0.5685811
Sk_DM    1.5248378  1.5918700  1.2346086  1.3590461  1.1364135  0.8113881  0.1295807 -0.02530782 -0.2772734
          Decile10        WML
mean_DM 15.4666755 18.1174245
SD_DM   23.4462749 29.7449997
SR_DM    0.6596645  0.6090914
Sk_DM   -0.3755707 -5.0219212
```

Question 5

Calculate the correlation of your portfolio returns with the Daniel and Moskowitz (2016) breakpoints (by decile), to the portfolio returns on Daniel's website. Also calculate the correlation of your portfolio returns with the Kenneth R. French breakpoints (by decile), to the portfolio returns on French's website. Round to 4 decimal places. Correlations should be calculated from 1927-2018.

Input Data:

To calculate the correlation between our KRF decile returns and DM decile returns, we downloaded KRF and DM data from the corresponding websites.

The data for KRF is available from 1927 to 2016, the file name is m_m_pt_tot.xlsx.

For DM, it is available from1927 to 2019, the file name is 10_Portfolios_Prior_12_2.csv.

Calculation Process:

1) Data match

The data needs to be formatted to fit my result from Question 4. For KRF data, since its time span is shorter than 2018, I deleted some observations for my KRF returns. Differently for DM, its time span is longer, I trimmed it to the time period from 1927 to 2018.

2) Correlation:

To make the correlation calculation process easier, I transformed the data set form to matrix (number of rows=number of combinations for every year and month, number of columns= number of combinations for every year and month).

The correlation between my calculated DM/KRF returns and corresponding DM/KRF returns from the website. This is done for every decile portfolio and the WHL portfolio, here returns I used the simple portfolio returns.

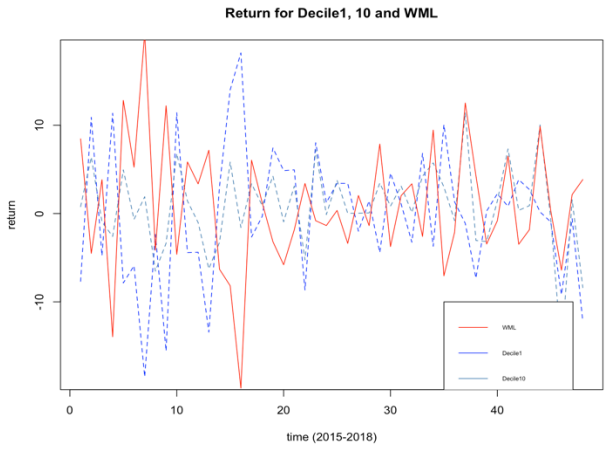
Output

```
> cor
                Decile1 Decile2 Decile3 Decile4 Decile5 Decile6 Decile7 Decile8 Decile9 Decile10    HML
DM Correlation   0.9981  0.9983  0.9984  0.9981  0.9982  0.9985  0.9986  0.9991  0.9989   0.9986 0.9963
KRF Correlation  0.9979  0.9985  0.9981  0.9979  0.9977  0.9976  0.9976  0.9988  0.9985   0.9990 0.9960
```

Question 6

Has the momentum anomaly worked in the past few years? Show some empirical evidence

When we observe the portfolio return of the momentum strategy recently, we can notice that obviously momentum strategy doesn't work as well as it used to be. This might be because of the depressed financial market pulls down the return for momentum strategy. Moreover, it may also because that more and more investors are trading on momentum strategy, and it makes momentum trading are not as profitable as before.



Question 7

Would you implement this trading strategy if you were running your own fund? What are the main implementation challenges to consider?

In healthy financial environment, as we could see from Question 4, the momentum strategy could generate a significant and strong positive return. But when the economy is depressed, momentum strategy is not that effective any more. For current years, the momentum strategy is underperforming the market, so I would not implement this strategy.

Main challenges to consider: 1) For momentum strategy, since we need to rebalance it frequently, high transaction fee is a concern; 2) Moreover, this strategy may include illiquid stocks, which may also a concern when executing the strategy; 3) And it is not sure whether this strategy still works or not.