Problem Set 1: Market Portfolio

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Question1

Construct the value-weighted market return using CRSP data, replicating the market return time series available in Kenneth French website. Also calculate the equal-weighted market return, and the lagged total market capitalization. Your output should be from January 1926 to December 2018, at a monthly frequency.

Answer :

Firstly, I will show the result of my replicating portfolio:

```
##       Year Month  Stock_Ew_Ret Stock_Vw_Ret Stock_lag_MV
##    1: 1926     2 -0.0544178487 -0.033995142     27.01714
##    2: 1926     3 -0.0974007715 -0.065039268     26.10889
##    3: 1926     4  0.0315465408  0.036800249     24.37618
##    4: 1926     5  0.0009044843  0.012281930     25.31610
##    5: 1926     6  0.0498888332  0.054591484     25.49873
##   ---
## 1111: 2018     8  0.0342379074  0.036029518  28766.64967
## 1112: 2018     9 -0.0159992470  0.002091349  29698.35223
## 1113: 2018    10 -0.1020678630 -0.074876387  29596.51898
## 1114: 2018    11 -0.0030364487  0.018690871  27240.64703
## 1115: 2018    12 -0.1292800866 -0.093611743  27587.15157
```

Then I will explain detailedly about my process getting the replicating portfolio of market portfolio:

Before calculating the portfolio time series, I conduct a series of data cleaning as part of my PS Q1 function. Next, I describe my data cleaning process and their respective assumptions:

1. Missing returns

For Price column, as convention, some dates when close prices were not recorded, those prices are presented as negative, which mean they are recorded as bid/ask prices rather than close prices. Therefore, I use abs operator to extract true value of the price.

For RET column and DLRET column, not all data is numeric. RET contains some dates which RETs are B or C, also for DELRET, there are some dates which values are A, S, P or T. My solution to these abnormal data is to replace them with 0, since for those dates, they do have prices and share outstandings, which means they make contribution to market. Therefore, we cannot just drop them, instead I replacing them with 0.

2. Universe of stocks

Due to Ken French Procedure, I filter the data 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).

3. Delisting return calculation

To calculate Cum-dividend return, when delisting return and return both exist, follow the formula$r_{i,t} = (1 + r^d_{i,t})(1 + r^h_{i,t}) - 1$. When only delisting return or return exist, just use that return.

4. Market Capitalization calculation

To calculate ME, simply multiply the price and the market sharehold outstanding.

5. Portfolio weights

Using shift function to the datatable to get last month's ME for each PERMNO as the portfolio weights.

6. Calculating value-weighted return and equal-weighted return.

Calculating value-weighted return for each months based on last month's ME. Calculating equal-weighted return for each months.

Question 2

Using the risk-free rate of return from French's website, report the following moments of the market excess returns for both time series (4 decimal digits): annualized return, annualized volatility, annualized Sharpe ratio, skewness, and excess kurtosis. Annualized values should be calculated geometrically. You should be comparing between July 1926 to December 2018, at a monthly frequency.

Answer:

The summary statistics are in Table below. I report the following five statistics: annualized mean, annualized standard deviation, annualized sharpe ratio, skewness, and excess kurtosis. In Column 2, I report the statistics for the replicated value-weighted market portfolio of stocks calculated in the previous question. In Column 1, I report the statistics for the value-weighted market portfolio of stocks from Ken French's website.

```
##                             Stats     French Replication
## 1:                Annualized Mean 0.07808973  0.07800095
## 2: Annualized Standard Deviation 0.18477282  0.18469788
## 3:        Annualized Sharp Ratio 0.42262563  0.42231642
## 4:                      Skewness 0.18400663  0.18061502
## 5:                      Kurtosis 7.83095038  7.81262382
```

From question, we have a times series of value-weighted market returns, namely $r_t{}_{t=1}^{T}$ Let the market return from French's website be given by $r_t^F{}_{t=1}^{T}$ I compute these statistics as follows:

Sample period

Monthly from July 1926 to December 2018

Annualized Mean

As the output from Q1 and the actual market excess return from FF research are both monthly return. Therefore, I use formula below:

$$AnnualizedMean = 12 * MonthlyMean$$

Annualized Standard Deviation

The formula to calculate annualized standard deviation is:

$$AnnualizedStandardDeviation = \sqrt{12}MonthlyStandardDeviation$$

Annualized SharpRatio

The formula to calculate annualized sharp ratio is:

$$AnnualizedSharpRatio = \frac{AnnualizedMean}{AnnualizedStandardDeviation}$$

Skewness and Kurtosis

Using skewness and kurtosis function from DistributionUtils to calculate two moments.

Question 3

Report (up to 8 decimal digits) the correlation between your time series and French's time series, and the maximum absolute difference between the two time series. It is zero? If not, justify whether the difference is economically negligible or not. What are the reasons a nonzero difference? You should be comparing between July 1926 to December 2018, at a monthly frequency.

Answer :

In Table 2 below, I report the time-series correlation between the replicated value-weighted market portfolio of stocks and the value-weighted market portfolio of stocks from Ken French's website. I also report the maximum difference between the two series.

I limit the sample to be between July 1926 and December 2018.

```
##    Correlation Max.difference
## 1:   0.9999931    0.002716206
```

Explain:

The correlation is almost one, but there is still 0.0027 max difference.

The difference between the replicated portfolio and the one from French's website is not zero.

I explore this for the following reason:

1. the decimal, my replicating portfolio has 9 decimal precise while for FF research, there is 4 digit decimal.
2. the way to deal with abnormal value of return and delist return maybe different.