Problem Set 3

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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). Your output should be from 1927-2017.

Before calculating the portfolio time series returns, I conduct a series of data cleaning as part of my PS3_Q1 function. Next, I describe my data cleaning process and their respective assumptions:

1. **Universe of Bonds**: I have used the security data from CRSP from December 1925 to December 2017. I have then filtered the data to include only rows with SHRCD=10 or 11 and EXCHCD = 1,2, or 3.
2. **Missing Returns**: I use the rule given on slide 29/110 in the Lecture_1_2018_MFE.pdf. I take $r_{i,t}$ as:

   $r^h_{i,t}$ if $r^d_{i,t}$ is missing,

   $r^d_{i,t}$ if $r^h_{i,t}$ is missing, and

   $(1 + r^h_{i,t})(1 + r^d_{i,t}) - 1$ if both are not missing.

   If both are missing, I ignore all the data of that day for that stock.

   I set the returns which are in non-numeric format (like "C") and zero as missing
3. **Lagegd Market Capitalization Calculation**: I calculated the market capitalization on every day for every stock by multiplying the price (PRC) by the number of shares outstanding (SHROUT). To deal with negative values in PRC or SHROUT, I took the absolute value of the respective PRC or SHROUT values.

   I then lag this market capitalization by 1 month for every PERMNO
4. **Cumulative Log Returns (Ranking Returns)**: As described in the paper by Daniel and Moskowitz, I calculate the cumulative logarithmic returns from $t - 12$ to $t - 2$ conditional on at least 8 or more returns being available (not missing), for every date and group by PERMNO.
5. **Other Restrictions**: Next, I subset my data as per the following restrictions:

1.

If Price at t-13 is missing, Ranking Return at t is made missing.

2.

If Net Return at t-2 is missing, Ranking Return at t is made missing.

3.

If Market Equity at t-2 is missing, Ranking Return at t is made missing.

Having done the above steps, I remove all the rows which contain missing values for the column Ranking Returns (which would only occur if the above restrictions could not be satisfied).

Next, I filter the output so that it contains data from January 1927 to December 2017.

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 1927-2017.

I take the data obtained from Question 1 function PS1_Q1 and use it to create deciles as defined by Daniel & Moskowitz (DM_deciles) and Kenneth R. French (KRF_deciles)

1. **Construction of DM_deciles**: To construct the DM_deciles, I use the Ranking Returns for each date as obtained from Q1 and divide the returns into 10 quantiles. I put the returns in the first quantiles in the first decile, second quantiles in the second deciles, and so on.
2. **Construction of KRF_deciles**: To construct the KRF deciles, I use a similar method as used for DM deciles, but only with data having $EXCHCD = 1$ (ie, only the NYSE stocks). Now, after having equal number of NYSE stocks in each decile, using the quantiles, I create breakpoints in the data for NYSE only, and then, using these breakpoints, distribute the other firms (with EXCHCD=2 & EXCHCD=3) among the 10 deciles.

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 1927-2017.

I calculated the value-weighted returns for every decile as follows:

i) To calculate weights, for each day, I calculated the ratio of market capitalization (lagged) for each share and the total market capitalization (also lagged) for that month

ii) I multiplied the weight of each stock on a given day with it's total return $r_{i,t}$ calculated above and summed this product for all stocks to get the market return on a particular date.

I obtained the data for monthly risk free rate from Kenneth French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ftp/F-F_Research_Data_Factors_CSV.zip

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.

I use the data from Question 3 and calculate the excess returns for every decile for every date ($R^e_t = R_t - R_f$).

The data used in the paper Momentum Crashes (2016) is from January 2017 to March 2013. So, I only take the same sample from my data to compare.

1. **Annualized Mean**: Using the monthly values of $r_t - r_t^f$ (where r_t^f is the risk-free rate at time t) in decimal form, I do the following calculation:

$$\mu_{monthly}^{excess} = \frac{1}{T}\sum_{t=1}^{T}(r_t - r_t^f)$$
$$\mu_{annualized}^{excess} = 12 \times \mu_{monthly}$$

2. **Annualized Standard Deviation**: Using the monthly values of $r_t - r_t^f$ in the decimal form, I calculate the standard deviation $\sigma_{monthly}$ using the inbuilt "sd()" function in R, and then do the following:

$$\sigma_{annualized} = \sigma_{monthly}\sqrt{12}$$

3. **Annualized Sharpe Ratio**: I calculate the Annualized Sharpe ratio by dividing the Annualized mean by Annualized Standard deviation

$$SR_{annualized} = \frac{\mu_{annualized}}{\sigma_{annualized}}$$

4. **Skewness of monthly log returns**: I calculate the skewness using the "skewness()" function of the moments package in R for monthly log returns ($log(1 + r)$)

The results are as follows:

Table 1: Momentum Portfolio Characteristics (January 1927:March 2013)

	$\overline{r - r_f}$ (%)	σ (%)	SR	sk(m)
Decile 1	-2.83	36.68	-0.07	0.07
Decile 2	2.65	30.38	0.09	-0.12
Decile 3	3.08	25.96	0.12	-0.12
Decile 4	6.51	23.10	0.28	0.20
Decile 5	7.28	21.53	0.34	-0.11
Decile 6	7.13	20.42	0.35	-0.21
Decile 7	8.88	19.53	0.45	-0.60
Decile 8	10.40	19.16	0.54	-0.49
Decile 9	11.43	20.51	0.55	-0.76
Decile 10	15.85	23.99	0.66	-0.81
WML (10-1)	18.68	29.99	0.62	-4.79

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 1927-2017.

I download the monthly data from two sources:

Kenneth French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ftp/10_Portfolios_Prior_12_2_CSV.zip

Daniel & Moskowitz's website: http://www.kentdaniel.net/data/momentum/DM_data_2017_03.tar.gz

It is observed that the data from Kenneth French's website contains data from January 1927 to March 2018 and the data from Daniel & Moskowitz's website contains data from January 1927 to December 2016.

So, I subset my data accordingly and calculate the correlations which are as listed below:

Table 2: Correlations

	DM Correlation	KRF Correlation
Decile 1	0.9963	0.9962
Decile 2	0.9949	0.9960
Decile 3	0.9960	0.9954
Decile 4	0.9955	0.9954
Decile 5	0.9940	0.9938
Decile 6	0.9952	0.9947
Decile 7	0.9944	0.9938
Decile 8	0.9966	0.9964
Decile 9	0.9965	0.9968
Decile 10	0.9974	0.9977
WML (10-1)	0.9268	0.9206

Question 6

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

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Read 96.4% of 4418266 rows
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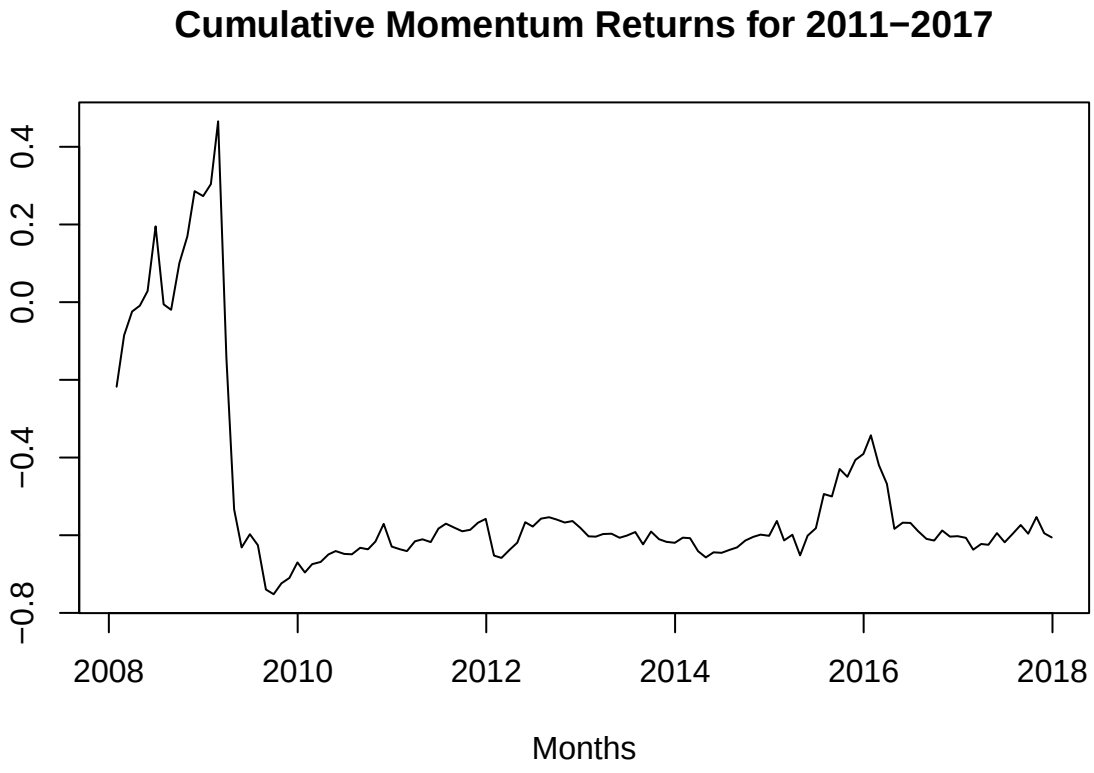

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## [1] -1.640088
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I plot the cumulative returns from January 2007 to December 2017 for the WML (Winners: decile 10 minus Losers: decile 1) portfolio. I observe that there are periods where momentum anomaly is observed, such as in the beginning (corresponding to January 2008 to October 2008), there seems to be a weak positive correlation. I also observe momentum crashes such as those around March 2009 and March 2013.

Question 7

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

No. I would not implement a momentum trading strategy because for the data given, I observe a negative skewness of cumulative returns. This implies that the losses are more extreme than gains.

In fact, as observed in Question 4, the skewness for most of the deciles over the entire sample has been negative. This shows that momentum is an anomaly in the markets and when corrections occur due to other factors, "momentum crashes" are imminent.

Also, momentum strategies require frequent rebalancing. This brings in unwanted transaction costs which would further reduce the returns.