# Problem Set 3

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**Names of whom I discussed this problem set with:**

## 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.*

## Approach –

**Data Source** – WRDS →CRSP > Annual Update > Stock / Security Files > CRSP Monthly Stock. Take the entire stock data available.
File imported in R and date is formatted as YYYY-MM-DD (R date format). And passed it as input to PS3_Q1 function.

**Data cleaning steps:**

1. **Universe of stocks**: Following Daniel and Moskowitz procedure, I restrict the sample to common shares (share codes 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).

2. **Missing returns**: Returns which are marked with characters(non-numeric) due to reasons viz. No valid comparison for an excess return, no listing information, no valid previous price, Off-exchange, Out of Range, no valid price has been marked as NA.

3. **Delisting return calculation**: All non-numeric delisting returns have been converted to NA

4. **Adjusted holding period Return:** Following method has been used to calculated adjusted holding period return from "holding period return" $r^{h}_{i,t}$ and delisting return $r^{d}_{i,t.}$

$$r_{i,t} = \begin{cases} r^h_{i,t} & \text{if } r^d_{i,t} \text{ missing} \\ r^d_{i,t} & \text{if } r^h_{i,t} \text{ missing} \\ (1 + r^h_{i,t})(1 + r^d_{i,t}) - 1 & \text{if both not missing} \end{cases}$$

5. **Negative Price**: Negative price in CRSP data is bid-ask average. Absolute value of price has been taken.

6. **Share outstanding:** Share outstanding has been multiplied by 1000 (as the value in CRSP is in 000's).

7. **Lagged Market Capitalization**: price of stock has been multiplied with outstanding shares and it has been lagged by 1 month.

8. **Portfolio weights**: Weight for each stock has been calculated dividing lagged market cap of each stock by sum of total lagged market cap for each month.

9. **Sample period**: Sample period taken is Jan 1927 to Dec 2017.

10. **Data Restrictions**: If price at t-3 is missing or if return at t-2 is missing or if market equity at t-1 is missing, a flag has been created as 0/1 (0 if any of these are missing and 1 if none are missing). Entire table is filtered for flag ==1 to take only the compliant data.

11. **Log Return:** Log return = log (1+adjusted return)

12. **Ranking Return:** Ranking return has been calculated as cumulative log return for t-2 to t-12 ignoring NA if any. (Here I made all NA log returns as 0 before calculating ranking return).

13. **Year Month:** Date has been formatted as Year Month.

**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.*

**Approach –**

1. **Daniel and Moskowitz (DM) Decile:** Based on quantile of ranking return of all the stocks in each month Ranking return has been cut into 10 deciles.

2. **Kenneth R. French. (KRF) Decile:** Based on quantile of ranking return of the stocks where exchange code is 1 (NYSE) has been taken each month to calculated KRF decile of Ranking return of all the stocks.

**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.*

**Approach –**

For this analysis, we downloaded the Fama/French 3 Factors file (F-F_Research_Data_Factors.csv).

Value weighted monthly return has been calculated using adjusted return (from holding period return and delisting return as calculated above in question 1 point 4) for each decile for KRF and DM portfolios.
RF rate has been merged from Fama French 3 factor portfolio.

## 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.*

## Approach –

| | Decile1 | Decile2 | Decile3 | Decile4 | Decile5 | Decile6 | Decile7 | Decile8 | Decile9 | Decile10 | WML |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $r-r_f$ | -2.00 | 2.90 | 3.40 | 6.90 | 7.50 | 7.60 | 9.30 | 10.60 | 11.40 | 15.40 | 17.40 |
| sigma | 36.30 | 29.90 | 25.40 | 22.60 | 21.10 | 19.90 | 19.10 | 18.70 | 19.90 | 23.30 | 29.80 |
| SR | -0.06 | 0.10 | 0.13 | 0.30 | 0.36 | 0.38 | 0.49 | 0.57 | 0.57 | 0.66 | 0.59 |
| sk (m) | 0.07 | -0.09 | -0.16 | 0.16 | -0.10 | -0.23 | -0.57 | -0.57 | -0.78 | -0.82 | -5.01 |

The following values have been calculated for each decile and also for winner – loser (WML) Decile10-Decile1 portfolio –

- Annualized Mean Excess Return i.e. mean ($r - r_f$) = 12* mean (DM_ret – RF)
- Annualized Sigma (standard deviation of return) = sqrt (12) * standard deviation (DM_ret)
- Sharpe Ratio (SR) = Annualized Mean Excess Return / Annualized standard deviation
- Sk(m) (skewness) = skewness(1+DM_ret)

On comparing these result with the actual paper data, we find that the result is quite close to the result shown in paper. There is minor difference, which can be attributed to difference of annualizing methods.

**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.*

**Approach –**

**Data Source** – For this exercise, I downloaded data from *Daniel and Moskowitz* website for decile wise return and from Jan 1927 to Dec 2017.
Also 10-portfolio Fama French return has been downloaded from Ken French website. Ken French returns have been divided by 100 to make it into decimal value.
Dates have been formatted as Year Month in both the file.
KRF 10 portfolio data has been melt to make a long decile wise data.

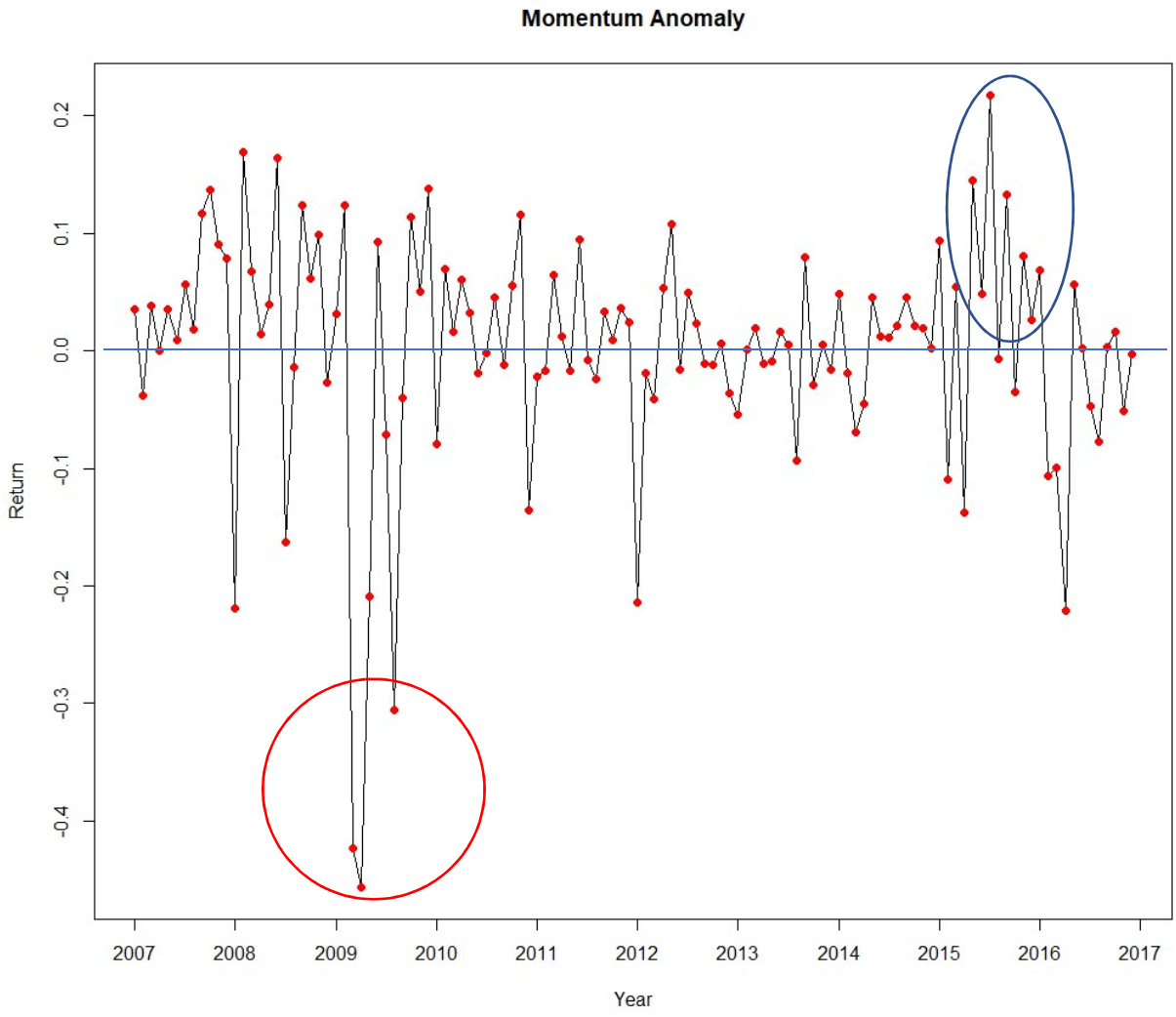
Now I calculated, the correlation of decile return calculated from question 3 for DM and KRF to actual returns from data in DM and KRF website.

| | Decile 1 | Decile 2 | Decile 3 | Decile 4 | Decile 5 | Decile 6 | Decile 7 | Decile 8 | Decile 9 | Decile 10 | WML |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DM_correlation | 0.9977 | 0.9984 | 0.9991 | 0.9990 | 0.9991 | 0.9993 | 0.9994 | 0.9995 | 0.9992 | 0.9992 | 0.9962 |
| KRF_correlation | 0.9985 | 0.9989 | 0.9987 | 0.9988 | 0.9989 | 0.9979 | 0.9982 | 0.9990 | 0.9989 | 0.9994 | 0.9971 |

In the above table, we can see the correlation up to 4 decimal places. They are quite close to 1.

**Question 6**

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




If we look at the graph plotted from data 2006 onward for momentum portfolio based on winner – loser of Daniel and Moskowitz method, we can observe that just after financial crisis in 2009, opposite of momentum anomaly is visible (the red circle). As explained in the paper, following a multiyear market downturn or high market volatility, the high beta stocks which went down heavily during crisis than the low beta stocks and became part of loser in our momentum portfolio, experience strong gain as the market condition ameliorates and hence momentum anomaly is visible just after 2009.

During 2015-2016, we can observe positive return from momentum anomaly.

**Question 7**

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

Yes.

This momentum anomaly seems to work well when market is doing well. Only if there is huge market correction or downward trend when momentum anomaly seems to work in opposite direction. Momentum anomaly need to be timed based on expected market downturn.

To avoid losses during momentum crashes, we need to predict the future volatility and expected market downturn and hence the asymmetry in the winner minus loser exposure to market returns during extreme times.

Main implementation challenges would be –

1. Accurately predicting a market crash or downturn in advance
2. An appropriate ex ante estimation of volatility to forecast conditional mean and variance of momentum strategy.
3. Reversing momentum exposure in case of continuous market downturn.

**References-**


- Wharton Research Data Services (WRDS) CRSP data taken on Apr 27, 2018 (CRSP > Annual Update > Stock / Security Files > CRSP Monthly Stock).
- http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html (FF -3 factor file)
- http://www.kentdaniel.net/data/momentum/ DM_data_2017_03.tar.gz, file m_m_pt_tot.txt