

## Problem Set 3: Momentum

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Due on Sunday 5/10 midnight PST. This is an **individual assignment**, but you can discuss it with your classmates. If you discuss with other classmates, indicate their names in your write-up. Please submit R code as well as a separate write-up. Explain the procedure and your answers clearly in the write-up (such that someone unfamiliar with the problem could solve it). Code must be formatted as instructed in order to receive a grade. Use CCLE to submit your answers.

You should submit two files:

- .R **PS3\_YourStudentID** (for example, PS3\_012345678.R), with **only** the functions described below and the packages needed to run them
- .pdf **PS3\_YourStudentID** (for example, PS3\_012345678.pdf), with discussion on how you answered the questions written below, as well as responses to any particular questions asked

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) <sup>1</sup>. Your output should be from 1927-2019.

- Function name: **PS3\_Q1**
  - Input
    - \* data.table **CRSP\_Stocks**, with columns:

Variable Name	Variable type
PERMNO	Integer
date	Date
SHRCD	Integer
EXCHCD	Integer
RET	Factor
DLRET	Factor
PRC	Numeric
SHROUT	Integer

- This should be the data as pulled from WRDS, with one exception. Format the date column as a Date type. This should be the full dataset available on WRDS; do not pre-filter by SHRCD, EXCHCD, or date.

<sup>1</sup>“Momentum Crashes” by Kent Daniel, and Tobias J. Moskowitz (2016, Journal of Financial Economics).

## – Output

\* data.table, with each row corresponding to a PERMNO/Year/Month, with columns

Variable Name	Variable type	Variable description
Year	Integer	Year
Month	Integer	Month
PERMNO	Integer	
EXCHCD	Integer	
lag_Mkt_Cap	Numeric	Firm's market value the previous month (in millions)
Ret	Numeric	Firm's returns
Ranking_Ret	Numeric	Firm's ranking returns

· Note: Returns should be formatted in decimal proportion (not percent).

## • Hints:

- Kent Daniel's website has some very useful notes about data construction: [http://www.kentdaniel.net/data/momentum/mom\\_data.pdf](http://www.kentdaniel.net/data/momentum/mom_data.pdf). This document discusses difference between French's and Daniel-Moskowitz's momentum-sorted portfolios. It's all about the breaking points.

**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 1927-2019.

• Function name: **PS3\_Q2**

## – Input

\* data.table **CRSP\_Stocks\_Momentum**, the output of **PS3\_Q1**

## – Output

\* data.table, with each row corresponding to a stock-year-month. Data table has columns

Variable Name	Variable type	Variable description
Year	Integer	Year
Month	Integer	Month
PERMNO	Integer	
lag_Mkt_Cap	Numeric	Firm's market value the previous month (in millions)
Ret	Numeric	Firm's returns
DM_decile	Integer	Firm's momentum decile as defined by Daniel & Moskowitz
KRF_decile	Integer	Firm's momentum decile as defined by Kenneth R. French

· Note: Returns should be formatted in decimal proportion (not percent).

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 1927-2019.

- Function name: **PS3\_Q3**

- Inputs

- \* data.table **CRSP\_Stocks\_Momentum\_decile**, the output of **PS3\_Q2**
- \* data.table **FF\_mkt** (as defined in **PS1\_Q2**), with columns

Variable Name	Variable type
Year	Integer
Month	Integer
Market_minus_Rf	Numeric
SMB	Numeric
HML	Numeric
Rf	Numeric

- Note: Returns should be formatted in decimal proportion (not percent).

- Output

- \* data.table, with each row corresponding to a year-month-decile. Data table has columns

Variable Name	Variable type	Variable description
Year	Integer	Year
Month	Integer	Month
decile	Integer	Momentum decile
DM_Ret	Numeric	Decile (as defined by Daniel & Moskowitz (2016)) return
KRF_Ret	Numeric	Decile (as defined by Kenneth R. French) return
Rf	Numeric	Riskless rate

- Note: Returns should be formatted in decimal proportion (not percent).

4. Replicate Table 1 in Daniel and Moskowitz (2016), except for  $\alpha$ ,  $t(\alpha)$ ,  $\beta$ , and  $sk(d)$  rows, and the Market column. Match the format and methodology to the extent possible.

- Function name: **PS3\_Q4**

- Input

- \* data.table **CRSP\_Stocks\_Momentum\_returns**, the output of **PS3\_Q3**

- Output

- \*  $4 \times 11$  numeric matrix, reproducing part of Table 1 in Daniel & Moskowitz (2016). Match the format and methodology to the extent possible.

- Rows:  $\overline{r - r_f}$ ,  $\sigma$ , SR,  $s\kappa(m)$ .
- Columns: Decile 1, Decile 2, Decile 3, Decile 4, Decile 5, Decile 6, Decile 7, Decile 8, Decile 9, Decile 10, WML

**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 1927-2019.

- Function name: **PS3.Q5**

- Inputs

- \* data.table **CRSP\_Stocks\_Momentum\_returns**, the output of **PS3.Q3**
- \* data.table **DM\_returns** (momentum portfolio returns from Daniel's website). Each row corresponds to a year-month-decile, with columns

Variable Name	Variable type
Year	Integer
Month	Integer
decile	Integer
DM_Ret	Numeric

- Note: Returns should be formatted in decimal proportion (not percent).
- \* data.table **KRF\_returns** (momentum portfolio returns from French's website). Each row corresponds to a year-month-decile, with columns

Variable Name	Variable type
Year	Integer
Month	Integer
decile	Integer
KRF_Ret	Numeric

- Note: Returns should be formatted in decimal proportion (not percent).

- Output

- \*  $2 \times 11$  numeric matrix, with the correlations between your estimated DM momentum portfolio returns and the DM momentum portfolio returns on Daniel's website, and the correlations between your estimated KRF momentum portfolio returns and the KRF momentum portfolio returns on French's website.
  - Rows: DM correlation, KRF correlation.
  - Columns: Decile 1, Decile 2, Decile 3, Decile 4, Decile 5, Decile 6, Decile 7, Decile 8, Decile 9, Decile 10, WML

6. Has the momentum anomaly worked in the past few years? Show some empirical evidence.
  
7. Would you implement this trading strategy if you were running your own fund? What are the main implementation challenges to consider?