

Problem Set 3: Momentum

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Due on **Sunday May 11**. 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 Python code (py file) 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 Bruin Learn to submit your answers.

You should submit two files:

- .py **PS3_YourStudentID** (for example, PS3_012345678.py), with **all** code used in answering the questions written below
- .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)¹. Your output should be from 1927-2024.

- Suggested function: **PS3_Q1**
 - Input: dataframe **CRSP_Stocks**, with columns:

Variable Name	Variable type
PERMNO	integer
date	datetime
SHRCD	integer
EXCHCD	integer
RET	float
DLRET	float
PRC	float
SHROUT	integer

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

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

- Output: dataframe, 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	float	Firm's market value the previous month (in millions)
Ret	float	Firm's returns
Ranking_Ret	float	Firm's ranking returns (momentum signal)

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/moment/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 1927-2024.

- Suggested function: **PS3_Q2**

- Input: dataframe **CRSP_Stocks_Momentum**, the output of **PS3_Q1**
- Output: dataframe, with each row corresponding to a stock-year-month. Data table has columns Note: Returns should be formatted in decimal proportion (not percent).

Variable Name	Variable type	Variable description
Year	Integer	Year
Month	integer	Month
PERMNO	integer	
lag_Mkt_Cap	float	Firm's market value the previous month (in millions)
Ret	float	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
EXCHCD	integer	

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 1927-2024.

- Suggested function: **PS3_Q3**

- Inputs
 - * dataframe **CRSP_Stocks_Momentum_decile**, the output of **PS3_Q2**
 - * dataframe **FF_mkt** (as defined in **PS1_Q2**), with columns

Variable Name	Variable type
Year	integer
Month	integer
Market_minus_Rf	float
SMB	float
HML	float
Rf	float

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

- Output
 - * dataframe, 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	float	Decile (as defined by Daniel & Moskowitz (2016)) return
KRF_Ret	float	Decile (as defined by Kenneth R. French) return
Rf	float	Riskless rate

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

4. Recreate Table 1 from Daniel and Moskowitz (2016), but exclude the rows for α , $t(\alpha)$, β , and $sk(d)$, as well as the Market column. Ensure your version closely follows the original table's format and methods. Use the entire data sample for your statistics.

Additionally, calculate and include a new row at the bottom of your table showing the correlation between your portfolio returns and the decile-based breakpoints from Daniel and Moskowitz (2016), as well as the returns listed on Daniel's website.² Refer to the extra materials provided at the end of this assignment for an example on the table format and expected outcome.

- Suggested function: **PS3_Q4**

²http://www.kentdaniel.net/data/momentum/DM_data_2017_03.tar.gz. The file 'm_m_pt_tot.txt' contains the monthly Daniel and Moskowitz (2016) momentum portfolios to be used in this assignments. See http://www.kentdaniel.net/data/momentum/mom_data.pdf for more details.

- Input

- * dataframe **CRSP_Stocks_Momentum_returns**, the output of **PS3_Q3**
- * dataframe **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	float

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

- Output

- * 5×11 numeric matrix,/dataframe reproducing part of Table 1 in Daniel & Moskowitz (2016). Match the format and methodology to the extent possible.
 - Rows: $\bar{r} - \bar{r}_f$, σ , SR, $s\kappa(m)$, correlations.
 - Columns: Decile 1, Decile 2, Decile 3, Decile 4, Decile 5, Decile 6, Decile 7, Decile 8, Decile 9, Decile 10, WML

5. Recreate Table 1 from Daniel and Moskowitz (2016), but use NYSE breakpoints instead (i.e., Ken French portfolio breakpoints). Also, exclude the rows for α , $t(\alpha)$, β , and $sk(d)$, as well as the Market column. Ensure your version closely follows the original table's format and methods. Use the entire data sample for your statistics. Importantly, As in the previous question, calculate and include a new row at the bottom of your table showing the correlation between your portfolio returns and the momentum sorted portfolio listed on Ken French's website. Refer to the extra materials provided at the end of this assignment for an example on the table format and expected outcome.

- Suggested function: **PS3_Q5**

- Inputs

- * dataframe **CRSP_Stocks_Momentum_returns**, the output of **PS3_Q3** but using NYSE breakpoints
- * dataframe **KRF_returns** (momentum portfolio returns from French's website). Each row corresponds to a year-month-decile, with columns
 - Note: Returns should be formatted in decimal proportion (not percent).

Variable Name	Variable type
Year	integer
Month	integer
decile	integer
KRF_Ret	float

- Output

- * 5×11 numeric matrix/dataframe, 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: $\bar{r} - r_f$, σ , SR, $s\kappa(m)$, correlations.
 - 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 and discuss empirical evidence.

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

Additional Material

As a reference to guide your replication exercise, here are the replication tables obtained by the professor:

(Question 4) Summary statistics for Daniel and Moskowitz momentum portfolios:

	1	2	3	4	5	6	7	8	9	10	WML
Excess Return	-1.97	3.00	3.77	7.20	7.87	7.60	9.51	10.45	11.22	15.68	17.65
Volatility	36.98	30.01	25.73	22.80	21.03	19.88	19.06	18.63	19.80	23.50	30.42
Sharpe Ratio	-0.05	0.10	0.15	0.32	0.37	0.38	0.50	0.56	0.57	0.67	0.58
Skewness	0.08	-0.16	-0.21	0.09	-0.15	-0.25	-0.67	-0.55	-0.76	-0.78	-4.64
corr w/ original	0.9971	0.9974	0.9987	0.9987	0.9988	0.9991	0.9992	0.9994	0.9991	0.9987	0.9949

Replication sample from 01/31/1927 to 12/31/2024.

Original sample from 01/31/1927 to 12/31/2016 (for correlations).

(Question 5) Summary statistics for Ken French momentum portfolios:

	1	2	3	4	5	6	7	8	9	10	WML
Excess Return	1.26	5.61	6.33	7.56	7.61	8.32	9.04	10.15	10.77	14.90	13.64
Volatility	34.07	28.01	24.09	21.84	20.42	19.81	18.94	18.31	19.28	22.33	27.30
Sharpe Ratio	0.04	0.20	0.26	0.35	0.37	0.42	0.48	0.55	0.56	0.67	0.50
Skewness	0.13	-0.11	-0.17	0.09	-0.10	-0.28	-0.69	-0.53	-0.76	-0.88	-5.60
corr w/ original	0.9983	0.9983	0.9980	0.9981	0.9983	0.9982	0.9982	0.9988	0.9988	0.9992	0.9970

Sample from 01/31/1927 to 12/31/2024.