

Problem Set 3 Momentum

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Question 1

Before calculating the portfolio time series, 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:**

Following Ken French 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. **Sample Period:** Jan 1926 to Dec 2019

3. **Market Capitalization and Lag Market Cap calculation:**

market cap (in millions) = absolute value of price (PRC) * shares outstanding / 1000.

Lag Market cap is the one-month lag of the series we calculated. We also check the date to make sure we only include the true lags.

4. **Delisting return calculation:** In general holding period return = $(1+RET) * (1+DLRET) - 1$. If RET is missing, then holding period return will equal to DLRET. If DLRET is missing, then it will equal to RET.

5. **Portfolio weights:**

For value weighted portfolio, returns are weighted by lag market cap.

6. **Missing returns:**

Convert all values of "A", "B", "C", "-99", "-88", "-77", etc. to NA.

My method of dealing with missing data is slightly different from that of the paper. In the paper, missing data are filled, but in this exercise, we choose to omit those. Both produce similar results. More details will be explained in below Ranking Returns Calculation session.

7. **Ranking Returns Calculations**

Ranking returns are calculated by summing up month 1 to month 11 of the last 12 lags in log returns (holding period returns). Just like in the paper, we will make sure that there are enough lags (13 prices, 12 returns) for each observation, and that there are at least 8 months of data available among those 11 periods. If not, ranking return for that period will be NA.

However, if there are fewer than 11 but greater than 8 months available, we will ignore the missing months and move on to sum up 11 non-NA observations. Such handling is different from the paper, where only the non-NA observations within the 11 months are considered.

8. Output: 1927.01 to 2019.12

Year	Month	PERMNO	EXCHCD	lag_Mkt_Cap	Ret	Ranking_Ret
1986	7	10001	3	6.0331250	-0.010204	NA
1986	8	10001	3	5.9715625	0.072165	NA
1986	9	10001	3	6.4025000	-0.003077	NA
1986	10	10001	3	6.3176250	0.039216	NA
1986	11	10001	3	6.5653750	0.056604	NA
1986	12	10001	3	6.9370000	0.015000	NA
1987	1	10001	3	6.9370000	-0.035714	NA
1987	2	10001	3	6.6692500	-0.074074	0.196692037
1987	3	10001	3	6.1937500	0.036800	0.140122141
1987	4	10001	3	6.3176250	-0.039216	0.038273465
1987	5	10001	3	6.0698750	-0.071429	0.064560205
1987	6	10001	3	5.6363125	0.051429	0.034406920
1987	7	10001	3	5.8221250	0.021277	-0.026546363
1987	8	10001	3	5.9460000	0.083333	0.033860246
1987	9	10001	3	6.4415000	-0.022308	-0.014765918
1987	10	10001	3	6.2000000	0.020000	0.068358226
1987	11	10001	3	6.3240000	-0.029412	0.007331056

Question 2

1. Data Used:

Output data from question 1

2. DM Decile calculations

We calculate the DM Decile, from 1 to 10, based on the returns across all firms in each month. We would close the interval on the left, so any NA value generated, we know we need to put it in the 10th decile.

3. KRF Decile calculations

Similar to DM Decile, but we choose the break points only based on the stock listed on NYSE (EXCHCD=1).

4. Merging Data

For DM Decile, we cut the data using the entire output table from question 1. But for KRF Decile, we cut them using a copy of the question 1 table with only NYSE stocks. Then we merge 2 tables together because in R, it is more efficient that way.

After we merge the 2 tables, we will have lots of NA values in KRF Decile. We first order the table by year, month, and then ranking returns. Then all the NA's in will be in between non-NA deciles. Next, we can replace the NA's with the nearest prior non-NA decile. Last, if there is any NA left, we put it on Decile 1 because that is the only possible option for any NA left.

5. Sample Output

Period: 1927.1 to 2019.12

Year	Month	PERMNO	lag_Mkt_Cap	Ret	DM_decile	KRF_decile
1927	1	10583	0.1875000	0.100000	1	1
1927	1	14453	2.8600000	-0.125000	1	1
1927	1	15413	0.8391250	-0.285714	1	1
1927	1	12634	2.6775000	-0.105882	1	1
1927	1	10647	1.5281250	-0.202454	1	1
1927	1	13581	0.7125000	-0.157895	1	1
1927	1	11519	0.7350000	-0.020408	1	1
1927	1	13813	2.3250000	0.000000	1	1
1927	1	14330	0.9625000	0.227273	1	1
1927	1	12714	0.3135000	-0.090909	1	1

Question 3

1. **Data Used:**

Output table from question 2. F-F research data as described in PS1 Q2.

2. **Sample Period:**

1927.1 to 2019.12

3. **Calculations:**

DM_Ret = value weighted mean returns (total, not log) in each DM Decile for each month. Weight is lag market cap.

KRF_Ret = value weighted mean returns (total, not log) in each KRF Decile for each month. Weight is lag market cap.

Rf =monthly risk-free rates from FF_mkt

Decile=DM or KRF decile number

4. **Sample output**

	Year	Month	decile	DM_Ret	KRF_Ret	Rf
1	1927	1	1	-3.206760e-02	-3.206760e-02	0.0025
2	1927	1	2	-4.439395e-02	-4.439395e-02	0.0025
3	1927	1	3	2.605332e-02	2.605332e-02	0.0025
4	1927	1	4	1.282713e-03	1.282713e-03	0.0025
5	1927	1	5	-4.959444e-03	-4.959444e-03	0.0025
6	1927	1	6	6.218894e-03	6.218894e-03	0.0025
7	1927	1	7	6.931751e-03	6.931751e-03	0.0025
8	1927	1	8	4.338969e-03	4.338969e-03	0.0025
9	1927	1	9	-4.112331e-03	-4.112331e-03	0.0025
10	1927	1	10	-2.768648e-03	-2.768648e-03	0.0025
11	1927	2	1	7.035776e-02	7.035776e-02	0.0026

Question 4

1. Data Used:

Output table from question3

2. Sample period: 1927.01 to 2013.03

3. Calculations:

Annualized Excess Returns = arithmetic mean * 12

Annualized Volatility = monthly standard deviation * sqrt(12)

Sharp Ratio = annualized excess returns/annualized volatility

Skewness (SKm): use R functions skewness on log(returns+1), returns are not excess

WML Portfolio: Decile 10 returns minus Decile 1 returns; SKm =skewness(log(1+r_{WML}+r_f))

4. Comparing Results:

Replication

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	WML
r-rf	-2.82	2.54	2.87	6.43	7.11	7.15	9.18	10.35	11.36	15.51	18.33
SD	36.95	30.49	26.01	23.14	21.37	20.45	19.39	19.03	20.34	23.75	30.18
SR	-0.08	0.08	0.11	0.28	0.33	0.35	0.47	0.54	0.56	0.65	0.61
sk(m)	0.12	-0.08	-0.15	0.17	-0.20	-0.20	-0.51	-0.57	-0.78	-0.83	-5.11

Paper

Return statistic	Momentum decile portfolios										WML	Market
	1	2	3	4	5	6	7	8	9	10		
$\bar{r} - \bar{r}_f$	-2.5	2.9	2.9	6.4	7.1	7.1	9.2	10.4	11.3	15.3	17.9	7.7
σ	36.5	30.5	25.9	23.2	21.3	20.2	19.5	19.0	20.3	23.7	30.0	18.8
SR	-0.07	0.09	0.11	0.28	0.33	0.35	0.47	0.54	0.56	0.65	0.60	0.41
sk(m)	0.09	-0.05	-0.19	0.21	-0.13	-0.30	-0.55	-0.54	-0.76	-0.82	-4.70	-0.57

The overall results are consistent with those of the paper, with only minimal differences due to the two methodologies in handling missing data.

Question 5

1. **Data Used:** Output table from question3; DM returns data from his website; KRF returns data from French's webstie.
2. **Sample Period: 1927.01 to 2016.12**, this is because the DM returns data is up till 2016.12
3. **Data Cleaning:**
DM Returns: add Year and Month columns, delete other undesired ones.
KRF Returns: add Year and Month columns, delete other undesired ones.; make returns in decimal form, gather all decile columns into one column call "decile".
4. **Calculations:**
Correlation: use R function

5. Results:

	Decile 1	Decile 2	Decile 3	Decile 4	Decile 5	Decile 6	Decile 7	Decile 8	Decile 9	Decile 10	WML
DM Correlation	0.9971	0.9978	0.9987	0.9978	0.9977	0.9979	0.9986	0.9987	0.9987	0.9988	0.9951
KRF Correlation	0.9973	0.9979	0.9984	0.9974	0.9974	0.9971	0.9975	0.9982	0.9983	0.9989	0.9949

Question 6

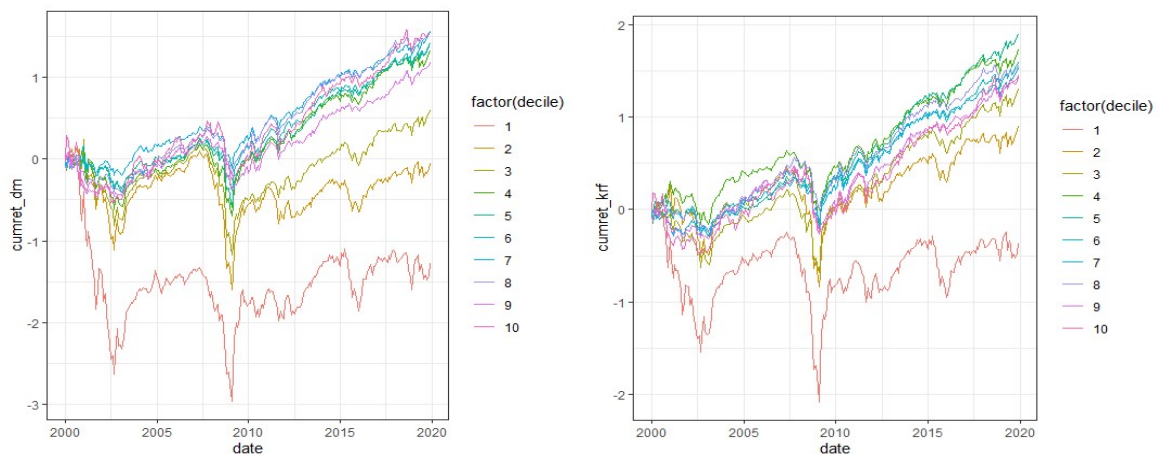
Has the momentum anomaly worked in the past few years? Show some empirical evidence.

1. **Data Used:** Output table from question3
2. **Sample Period:** 2000.01 to 2019.12
3. **Graphs and Results:**

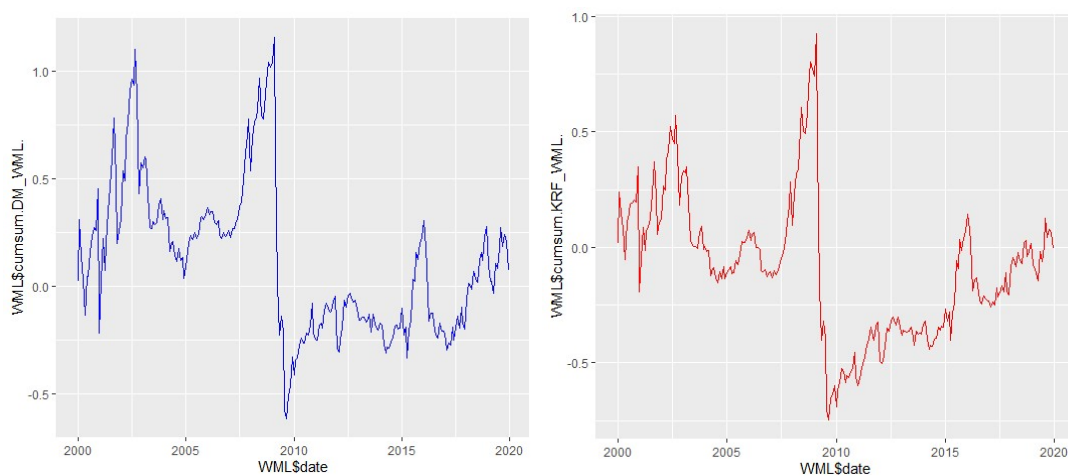
Below shows the numerical results using the DM method

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	WML
r-rf	-3.56	-0.22	0.60	4.35	3.39	3.59	4.57	4.42	1.53	5.62	9.18
SD	46.47	35.26	27.50	22.41	19.58	15.64	14.44	15.58	17.38	25.40	42.45
SR	-0.08	-0.01	0.02	0.19	0.17	0.23	0.32	0.28	0.09	0.22	0.22
sk(m)	0.09	-0.22	-0.43	-0.39	-0.63	-0.37	-0.74	-0.59	-0.84	-0.46	-2.05

Below shows the cumulative returns for each decile for both DM (left) and KRF:



And below shows the cum returns of the WML portfolios for both DM(left) and KRF:



As we can see from the above, the momentum strategy has not been Since 2008. This could be because the economy as a whole as been sluggish and financial markets have been volatile.

Question 7

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

I would implement this strategy, but not at the current time, amid the economic slow down and the Coronavirus pandemic. The main challenges are transaction costs for rebalancing and the risk exposed to the market.