

# Mean-reversion strategy

## Quantitative Finance (28E35600)

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# Strategy: Buy the losers

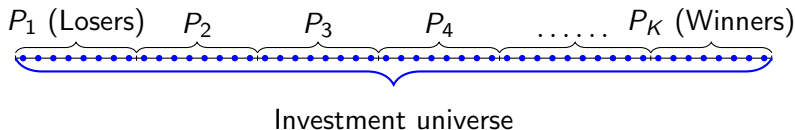
- The strategy I developed was motivated by empirical observation: stocks that have lost a lot of their value in the previous month tend to **mean-revert**
- The ideology of the strategy is converse to the commonly known quant strategy: **Buy winners, sell losers** (momentum)
  - This maybe the best explanation why the strategy seems to work!
- Other rationale for the strategy:
  - Investor overreaction
  - Buying losers is uncomfortable
  - **Crowding out of the converse strategy**

# Algorithm: Investment universe

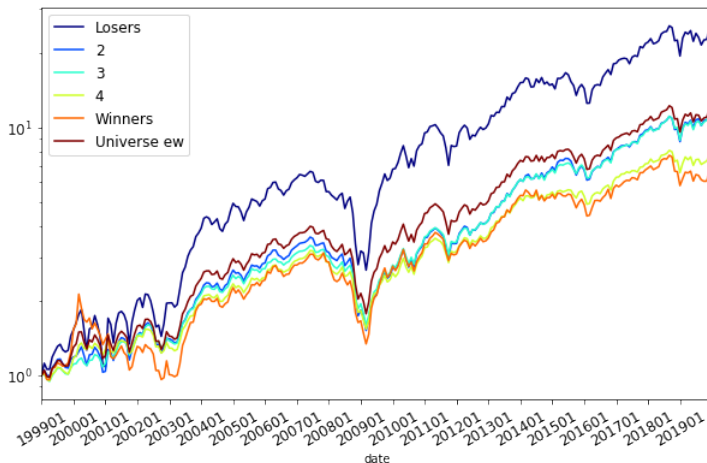
- I use CRSP Monthly Stock data (1999/01-2019/12). The data is retrieved from Wharton Research Data Services (WRDS).
- Factors (asset pricing model regressions) are from Kenneth French's webpage ([https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data\\_library.html](https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html)).
- The data is **filtered by market value (ME)** to ensure applicability for a significant asset manager. For each month the smallest 10% by lagged  $ME$  ( $ME_{t-1}$ ) is filtered out of the data.
- As a result of the adjustments and filtering we have restricted investment universe compared to whole CRSP dataset. In the sample period 1999/01-2019/11 this leads somewhat higher return for the "market portfolio" of the universe. Also the restricted universe is more volatile.

# Algorithm

- 1 Sort investment universe into  $K$  portfolios by lagged return  $RET_{t-1}$  (**in ascending order**)
  - Sorting is based on breakpoints (sample  $K$ -quantiles)
  - We have set of portfolios  $\{P_1, P_2, \dots, P_K\}$
  - $P_1$  is the portfolio (set of stocks) with the worst performance in the previous month (so called **losers**)
  - $P_K$  is the set of **winner** stocks
- 2 Buy portfolio  $P_1$  (losers)
  - The positions are **equally-weighted**
- 3 After month of holding, sell the portfolio and go back to 1. step

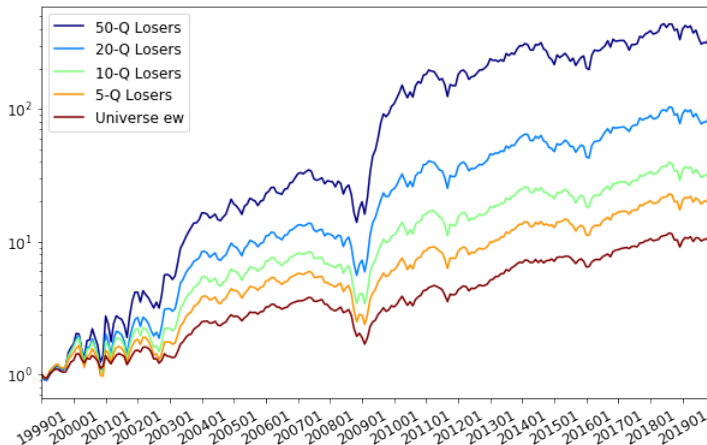


# Algorithm: 5-Quantile performance



**Figure:** Cumulative returns (log scale) of 5-Quantile mean reversion portfolios. 1-Quantile portfolio is named "Losers" (stocks with the worst performance in the last month). Similarly 5-Quantile portfolio is "Winners" (stocks with the best performance in the last month). Portfolios are rebalanced monthly and equally weighted. Portfolios are monitored from 1999/01 to 2019/12 using restricted CRSP data as the investment universe. *Universe ew* is the equally weighted market portfolio of the investment universe.

# Algorithm: K-Quantile loser performance



**Figure:** Cumulative returns (log scale) of K-Quantile partition loser portfolios,  $K = 5, 10, 20, 50$ . Portfolios are rebalanced monthly and equally weighted. *Universe ew* is the equally weighted market portfolio of the investment universe.

# Long-short strategies

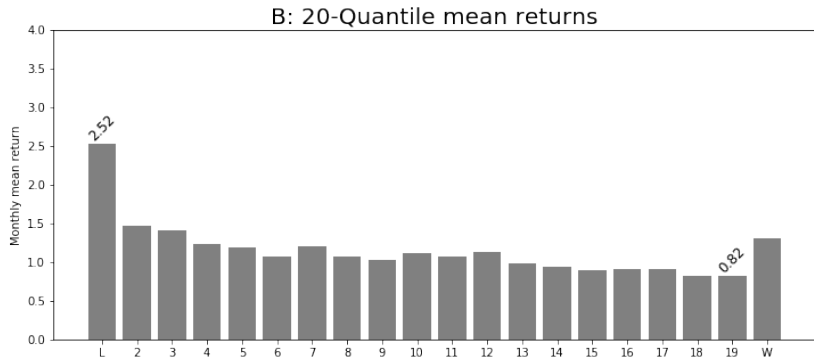
- Two long-short strategies are formed
  - 20-Quantile long-short:  $P_1 - P_{19}$
  - 50-Quantile long-short:  $P_1 - P_{47}$
- These motivated by the observation that the winner portfolio is not worst performing, but a **portfolio small distance behind the winner portfolio**
- As a general rule, a long-short strategy from  $K$ -Quantile mean-reversion portfolios could be formed as:

$$P_1 - \#(P_K)$$

$$\#(P_K) = \lceil K \cdot 0.95 \rceil$$

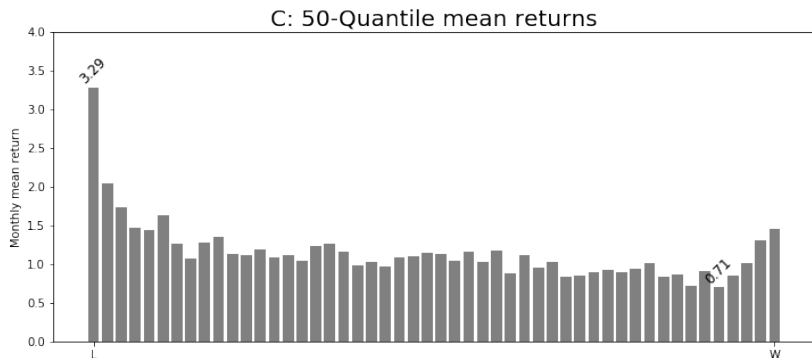


# Long-short strategies: Barplots



**Figure: Monthly mean returns of 20-Quantile mean-reversion portfolios.** Best returning portfolio (Losers) has monthly mean return of 2.52%. The worst returning portfolio (19th-quantile) has monthly mean return of 0.82%.

# Long-short strategies: Barplots



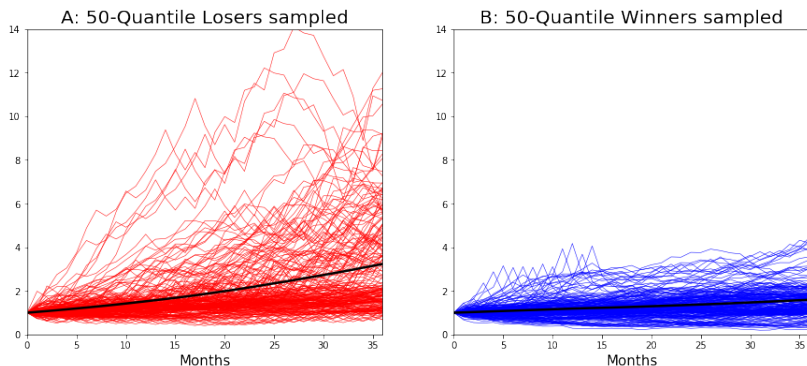
**Figure: Monthly mean returns of 50-Quantile mean-reversion portfolios.** Best returning portfolio (Losers) has monthly mean return of 3.29%. The worst returning portfolio (46th-quantile) has monthly mean return of 0.71%.

**Table: Periodic performance of selected  $K$ -Quantile mean-reversion portfolios.** The backtesting sample (21 years, 252 months) is partitioned into 7 3-year sub-periods. The monthly mean return (%) of portfolios for the periods.

Portfolio	Periods							FS
	'99-'01	'02-'04	'05-'07	'08-'10	'11-'13	'14-'16	'17-'19	'99-'19
50-Q Losers	6.86	5.24	1.11	6.57	1.74	0.62	0.87	<b>3.29</b>
20-Q Losers	4.87	4.30	0.63	4.40	1.57	0.77	1.11	<b>2.52</b>
50-Q Long-short	5.74	3.42	0.69	5.88	0.52	0.39	0.46	<b>2.44</b>
20-Q Long-short	3.83	2.59	0.20	3.61	0.19	0.64	0.86	<b>1.70</b>
Universe ew	1.54	1.90	0.55	1.03	1.49	0.67	0.91	<b>1.16</b>

- The results are **robust**
  - when restricting the investment universe to largest 70% by lagged market value ( $ME_{t-1}$ )
  - when using return data which **does not** include distribution to the shareholders ( $RETX$  instead of  $RET$ )

# Backtesting: sampled time serieses



**Figure: 50-Quantile Losers and Winners, time series sampled.** Time serieses of portfolio returns are sampled for all sub-time serieses of 36-month (3-year) periods. Black line indicates the average path.

# Risk analysis: metrics

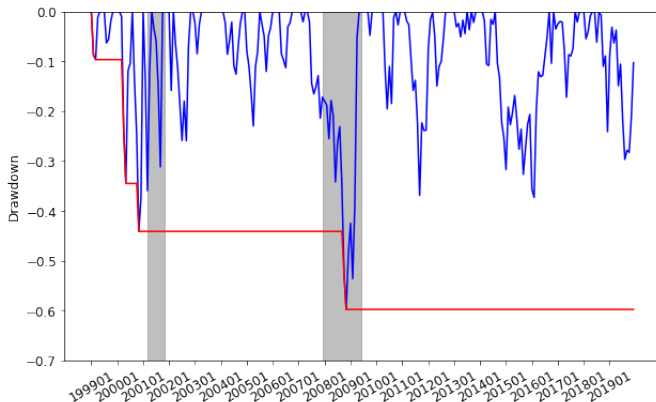
**Table: Risk metrics of the selected portfolios.** The metrics are calculated from the full backtesting sample (1999/01-2019/12) using monthly returns. See the report for further definitions of the metrics. **Blue** indicates maximum of all the portfolios studied. **Red** indicates minimum of all the portfolios studied.

Portfolio	Volatility	Semi-deviation	Sharpe ratio	MAR ratio	Sortino ratio	Max drawdown	min
50-Q Losers	13.58	6.13	0.231	6.17	0.536	-59.79	-27.29
20-Q Losers	11.68	5.99	0.203	4.71	0.421	-59.57	-26.40
50-Q Long-short	10.49	4.41	0.219	3.77	0.553	-47.60	-24.85
20-Q Long-short	8.51	3.93	0.183	2.34	0.433	-40.64	-20.69

**Table: Asset pricing monthly  $\alpha$ s of selected portfolios.** The regression are calculated from the full backtesting sample (1999/01-2019/12) using monthly returns. (\*\*\*) , (\*\*) and (\*) indicate statistical significance on levels 0.01, 0.05 and 0.1, respectively.

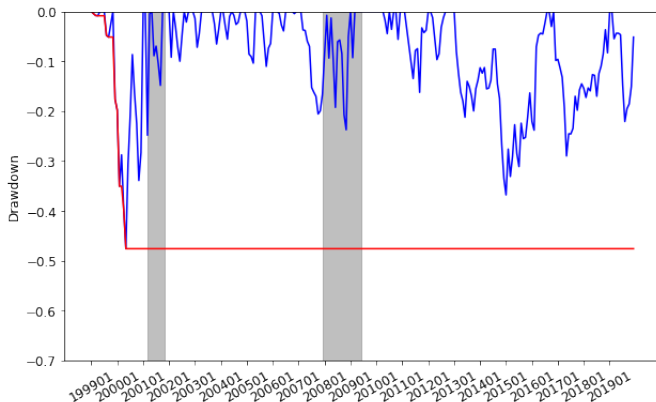
Portfolio	CAPM alpha %	FF-3 alpha %	CAR-4 alpha %	FF-5 alpha %
50-Q Losers	2.0 (***)	1.9 (***)	2.44 (***)	2.75 (***)
20-Q Losers	1.33 (***)	1.24 (***)	1.67 (***)	1.92 (***)
50-Q Long-short	1.81 (***)	1.82 (***)	2.34 (***)	2.51 (***)
20-Q Long-short	1.14 (**)	1.16 (**)	1.59 (***)	1.7 (***)

# Risk analysis: drawdown plots



**Figure: 50-Quantile Losers underwater drawdown plot.** Red line indicates the rolling-max drawdown. Shaded periods are recessions/economic downturns (Mar 2001- Nov 2001 and Dec 2007- June 2009).

# Risk analysis: drawdown plots



**Figure: 50-Quantile Long-short strategy underwater drawdown plot.** Red line indicates the rolling-max drawdown. Shaded periods are recessions/economic downturns (Mar 2001- Nov 2001 and Dec 2007- June 2009).



# Summary

- 50-Quantile Losers and 50-Quantile Long-short perform very well in the backtesting sample
  - 50-Quantile Losers grow by factor of **481.67** during 1999/01-2019/12 (28.04 when the universe is ME restricted to 70% largest)
  - 50-Quantile Long-short grow by factor of **138.25** (9.53)
- 50-Quantile Losers and 50-Quantile Long-short produce significant alpha w.r.t. all common asset pricing models in the full backtesting sample (1999/01-2019/12)
- In risk-return terms 50-Quantile Losers and 50-Quantile Long-short are best portfolios of the study