Exploring Alphabetic Bias in Value Stocks

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Abstract:

This paper investigates the existence of anomalous returns to sub-portfolios of value stocks based on alphabetical ticker symbol ordering. The bottom-up or fundamental research process many analysts use to appraise value stocks may indirectly encourage a bias related to the alphabetical order of the ticker symbols representing the potential investable universe. This bias should therefore produce different expected returns to value stocks throughout the ticker symbol alphabetic spectrum. It is found that for approximately the last fifteen years, stocks with ticker symbols early in the alphabet in general have statistically significant positive alpha within a rational framework. Further, stocks with ticker symbols late in the alphabet in general have statistically significant negative alpha within a rational framework. In contrast, this pattern disappears for the earlier time period, lending additional support to the finding due to the dependence of the effect on technological innovation.

Contents

1 Introduction

1.1 Motivations

This paper investigates whether the well documented and studied value factor, and in particular the returns to portfolios designed to have exposure to this factor, are further influenced by a behavioral anomaly known as alphabetic bias. While there is a fairly developed body of research about how alphabetic name ordering offers certain advantages (the phenomenon is particularly well documented in its existence in academia, see for instance [**Brogaard et. al. 2014**], [**Einav and Yariv 2006**], [**van Praag and van Praag 2008**], and [**Richardson 2010**]), the application has been limited in finance. This research finds its main inspiration from [**Jacobs and Hillert 2013**], who found that stocks with names early in the alphabet have approximately 5% to 15% higher trading activity and liquidity. The current literature seems to be lacking, however, in the application of this notion of alphabetic primacy, on the argument that it biases firm visibility, to the analysis of cross-sectional variation in stock returns. In particular, I investigate the effect of alphabetic ordering on the cross-sectional variation of value stocks. Given that value stocks are more conducive to traditional "deep dive" fundamental research, many value analysts begin by using stock screens (i.e. based on the typical higher-level value proxies such as price-to-earnings, price-to-book value, EV-to-cash-flow, dividend yield, etc.) to filter down their possible universe to something more reasonable to work with. From there, having filtered away all the names that they deem not to satisfy some necessary conditions for exposure to the value factor, they may start to run down the list (importantly, more than likely *alphabetically sorted*) with more thorough, bottom-up fundamental research. Therefore value-style stock tickers in particular that are near the top of the alphabet may receive more attention than those near the bottom, and thus value stocks may be particularly exposed to alphabetic bias due to this nuance in the research process.

1.2 Organization of Paper

The paper will be organized as follows. Section 2 will introduce the data set and will provide descriptive statistics for a number of important metrics on a full sample and yearly basis. Section 3 will introduce the methodology for forming portfolios based on the research hypothesis and will also describe the filtering of, and summarize the distributions of monthly returns for, the various portfolios formed. Section 4 tests the statistical performance of the portfolios in a rational framework using Fama-French type factor regressions. Section 5 concludes.

2 Data and Descriptive Statistics

The sample data was obtained from the CRSP/Compustat merged database, with price data coming specifically from the Security Monthly dataset and accounting data from the Fundamentals Quarterly dataset. How these data sets are merged and employed together will be made clear in the next section. The full sample spans the period from October 1997 through December 2019 (in particular, the data begins with fourth quarter accounting data from 1997. As will be explained in the methodology section, price data is not needed to start any portfolios until the end of December, 1997). Stocks with a market capitalization of less than $300MM are deleted from the dataset as being indicative of micro and nano-capitalizations. The metrics chosen to sort stocks with value exposure are price-to-book-value and price-to-earnings, and thus observations for which these metrics fall within the 1st and 99th percentiles are also deleted to remove the effect that these extreme outliers, perhaps even erroneous, have on the results. This is done initially on the entire dataset. Due to market cycles, regime changes, etc., additional outlier deletion is performed on a quarterly basis, as will be detailed further in the next section. Similarly, following [**Jegadeesh and Titman 2001**] and [**Zhang 2006**], filters will be employed to exclude low-price/penny stocks and recent IPOs, respectively, but again these are done on a quarter-by-quarter basis on the basis of forming realistic portfolios (that is, a pre-process blanket removal of stocks with prices below some cut-off will cause an obvious upward bias in performance).

Table I below provides descriptive statistics for the dataset, focusing on the two value proxies used, the price-to-book (P/B) ratio and price-to-earnings (P/E) ratio, along with market cap as a useful broad indicator of the typical firm making up the dataset. Panel A provides summary statistics for the entire sample period, while Panel B gives the summary statistics by year. Although the extremes of the ranges for the value metrics (Min and Max; recall that the 1st and 99th percentile were deleted from the data as a preliminary filter) are quite stable, Panel B highlights the fact that the quintiles (important for the formation of the portfolios which will be clarified in the net section) can have larger variations year-over-year due to market cycles, highlighting the rationale for applying an additional outlier filter on a quarterly basis.

Table I
Descriptive Statistics

Firm size (Market Cap) is in millions of United States Dollars. Price-to-earnings (P/E Ratio) is the end-of-quarter share price divided by the contemporaneous trailing 12 month diluted earnings-per-share. Price-to-book value (P/B Ratio) is the end of quarter share price divided by the contemporaneous book value of equity per common share outstanding. Stocks with a market capitalization of less than $300MM USD are excluded from the sample. The sample period is from October 1997 to December 2019.

Panel A: Full-Sample Descriptive Statistics

Variable	N	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
Market Cap	179,546	9,578	31,456	300	7549	1,851	5,852	1,287,643
P/E Ratio	179,546	30.09	36.07	3.06	14.22	19.86	30.34	377.40
P/B Ratio	179,546	3.18	2.84	0.39	1.50	2.28	3.71	23.29

Panel B: Descriptive Statistics by Year

Year	Variable	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
1997								
N=828	Market Cap	5,842	16,645	300	625	1,184	3,914	239,539
	P/E Ratio	31.62	32.18	4.58	16.47	22.55	32.62	328.57
	P/B Ratio	3.98	2.88	0.61	2.13	3.14	4.75	22.01
1998								
N=4849	Market Cap	5,949	19,534	300	567	1,106	3,470	348,106
	P/E Ratio	32.79	36.64	3.2	15.29	21.57	34.35	368.06
	P/B Ratio	3.86	3.18	0.4	1.82	2.83	4.66	23.23
1999								
N=6347	Market Cap	7,210	26,941	300	552	1,105	3,324	604,415
	P/E Ratio	34.04	41.37	3.08	13.6	20.75	35.74	376.56
	P/B Ratio	4.02	3.83	0.41	1.6	2.62	4.86	23.27
2000								
N=6494	Market Cap	8,102	30,559	300	605	1,268	3,666	571,614
	P/E Ratio	33.01	42.63	3.14	12.06	18.89	34.6	374.32
	P/B Ratio	4.01	3.82	0.39	1.55	2.61	4.95	23.25
2001								
N=6407	Market Cap	6,805	24,450	300	609	1,268	3,566	484,324
	P/E Ratio	31.36	37.12	3.17	14.03	20.2	32.32	373.67
	P/B Ratio	3.23	2.74	0.4	1.55	2.31	3.85	22.83
2002								
N=6300	Market Cap	6,087	20,455	300	616	1,273	3,622	371,982
	P/E Ratio	31.45	36.83	3.07	15.18	20.94	31.98	374.33
	P/B Ratio	2.94	2.42	0.39	1.51	2.19	3.45	23.15

Panel B: Descriptive Statistics by Year

Year	Variable	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
2003								
N=7076	Market Cap	6,396	20,672	300	644	1,379	3,821	311,755
	P/E Ratio	30.3	34.63	3.1	14.82	20.4	31.24	372.5
	P/B Ratio	2.97	2.42	0.39	1.52	2.18	3.53	22.52
2004								
N=9432	Market Cap	6,830	21,111	300	676	1,464	4,129	386,402
	P/E Ratio	30.18	33.82	3.06	15.52	20.7	30.42	371.8
	P/B Ratio	3.07	2.28	0.43	1.74	2.4	3.58	23.28
2005								
N=9822	Market Cap	7,177	21,386	300	686	1,512	4,481	395,371
	P/E Ratio	28.67	32.46	3.08	15.04	20.07	29.22	377.25
	P/B Ratio	3.16	2.44	0.4	1.74	2.41	3.67	23.1
2006								
N=10359	Market Cap	7,769	22,967	300	694	1,558	4,598	439,013
	P/E Ratio	29.04	32.84	3.07	15.18	20.09	29.49	373.63
	P/B Ratio	3.19	2.41	0.48	1.76	2.5	3.71	23.23
2007								
N=10028	Market Cap	8,917	26,525	300	717	1,683	5,230	505,713
	P/E Ratio	28.94	33.16	3.09	14.89	19.92	29.76	374.38
	P/B Ratio	3.26	2.61	0.43	1.69	2.47	3.85	22.69
2008								
N=8244	Market Cap	8,307	24,265	300	683	1,607	4,922	457,747
	P/E Ratio	24.9	31.7	3.09	11.96	16.65	24.79	371.18
	P/B Ratio	2.75	2.48	0.4	1.35	2.02	3.21	23.22
2009								
N=6679	Market Cap	8,097	22,871	300	698	1,660	4,811	335,973
	P/E Ratio	26.37	33.56	3.12	12.33	17.1	26.27	377.36
	P/B Ratio	2.59	2.43	0.4	1.26	1.89	2.95	23.23
2010								
N=8357	Market Cap	8,655	23,694	300	748	1,891	5,806	364,064
	P/E Ratio	27.83	34.14	3.1	13.24	18.16	28.09	371.75
	P/B Ratio	2.71	2.41	0.39	1.33	2.01	3.1	22.51
2011								
N=8566	Market Cap	9,237	25,616	300	817	2,055	6,402	414,432
	P/E Ratio	26.31	32.64	3.1	12.64	17.4	25.77	371
	P/B Ratio	2.76	2.48	0.39	1.31	2	3.22	23.25

Panel B: Descriptive Statistics by Year								
Year	Variable	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
2012								
N=8633	Market Cap	9,639	28,429	300	821	2,043	6,376	626,550
	P/E Ratio	27.18	34.86	3.09	12.95	17.73	26.1	376.67
	P/B Ratio	2.79	2.58	0.39	1.3	2.01	3.25	23.2
2013								
N=8905	Market Cap	10,748	29,488	300	928	2,397	7,312	500,681
	P/E Ratio	30.62	37.32	3.13	14.82	20.36	29.96	377.4
	P/B Ratio	3.13	2.8	0.4	1.44	2.27	3.67	23.23
2014								
N=9306	Market Cap	11,955	33,317	300	1,004	2,667	8,253	643,120
	P/E Ratio	31.73	36.81	3.07	15.79	21.32	31.33	376.8
	P/B Ratio	3.24	2.88	0.41	1.5	2.37	3.85	23.21
2015								
N=8952	Market Cap	11,890	34,409	300	979	2,543	8,114	717,000
	P/E Ratio	31.7	36.97	3.08	15.3	20.9	31.92	375.85
	P/B Ratio	3.27	3.05	0.39	1.44	2.3	3.94	23.29
2016								
N=8460	Market Cap	12,127	36,944	300	980	2,567	7,950	608,683
	P/E Ratio	31.85	36.94	3.11	15.41	21.4	31.84	376.6
	P/B Ratio	3.26	2.96	0.4	1.47	2.34	3.9	23.15
2017								
N=8828	Market Cap	14,038	44,511	301	1,088	2,946	9,150	859,968
	P/E Ratio	33.61	38.74	3.06	16.64	22.32	34.5	377
	P/B Ratio	3.39	3.07	0.39	1.55	2.38	4	23.23
2018								
N=8765	Market Cap	14,438	49,043	300	1,092	2,917	9,398	1,073,391
	P/E Ratio	31.09	39.48	3.07	13.16	19.74	31.64	371.62
	P/B Ratio	3.3	3.19	0.41	1.44	2.19	3.82	22.93
2019								
N=7909	Market Cap	16,681	59,839	300	1,196	3,212	10,430	1,287,643
	P/E Ratio	31.89	39.69	3.07	13.03	19.82	33.25	376.4
	P/B Ratio	3.36	3.36	0.4	1.34	2.19	3.94	23.24

3 Methodology, Portfolio Performance and Returns Analysis

This section assigns stocks to portfolios based on value-factor exposure and alphabetic sorting for insights about the average returns to the resulting groupings. Each quarter, a period-specific filter in addition to the full-sample filter already applied to the data is used. As noted in the previous section, this is due to the fact that market cycles, regime changes, etc., may materially change what constitutes an outlier from quarter to quarter. As these filters must to some degree be arbitrary in the cutoff level, a number of different options are considered, creating in a sense a robustness check on these choice variables. These filters are detailed below in Table II. After the filters have been applied, stocks in the first quintile of both the P/B and P/E ratios are gathered into an "Aggregate" value portfolio. This portfolio is then further broken down into four sub-portfolios, which are based on the alphabetic ordering of ticker symbols. One of these portfolios is formed of the first half of alphabetically-sorted ticker symbols. Another is formed of the first quarter of alphabetically-sorted ticker symbols. Another is formed of the last half of alphabetically-sorted ticker symbols. Finally, a portfolio is formed of the last quarter of alphabetically-sorted ticker symbols. Similar to the filtering process, it should be noted that the choice to first sort value-factors by quintile and then sort alphabetically by halves and quartiles is also to some degree arbitrary, however in this case the choice was driven by the desire to form largely diversified portfolios. Dropping either the value or alphabetical sorting to the decile level can at times result in highly concentrated portfolios (with the number of names in the portfolio less than approximately twenty). The portfolio is then held for the subsequent quarter. For example, the first portfolio is formed as of December 31st, 1997, and is held from this date until the next portfolio is formed on March 31st, 1998. Admittedly, this still presents some degree of look-ahead bias, as the quarter-end accounting data will be subject to some amount of lag in the reporting process. All portfolios are equally weighted, and rebalancing only happens at quarter end when a new portfolio is formed (of course, it is always possible that the new portfolio constituents are identical to those prior).

The results are given in Panels A - F below (with a dedicated panel for each filter). The t-statistics are adjusted for autocorrelation using the method of [**Wilks 1997**], and the significance is reported based on a one-tailed test, given that the results are directionally uniform in the sense that the front-alphabet ticker portfolios outperform the back-alphabet portfolios in all cases. Graphs of portfolio equity evolution and rolling average returns to the strategies are also given. I assert that the latter is supportive of the hypothesis that there is an alphabetic bias, particular one that is driven by a recent technological innovation (automated stock screeners). Given that it is reasonable to assume that the technology was either in its infancy, not easily available, or simply not widely used prior to the mid-2000s, the fact that the effect has gotten stronger and consistent in more recent periods strengthens the argument.

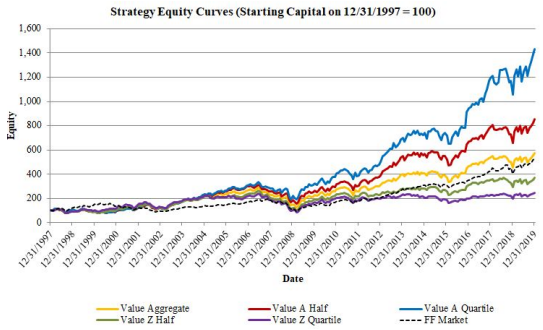
Table II
Portfolio Returns

Description of Portfolio Filters	
Filter	Description
1	No stock is allowed to *enter* the portfolio if the price is less that $5. Observations in the 1st and 99th percentile on the P/B and P/E ratios *within* each quarter are removed.
2	No stock is allowed to *enter* the portfolio if the price is less that $2. Observations in the 1st and 99th percentile on the P/B and P/E ratios *within* each quarter are removed.
3	No stock is allowed to *enter* the portfolio if the price is less that $5. Observations in the 2.5th and 97.5th percentile on the P/B and P/E ratios *within* each quarter are removed.
4	No stock is allowed to *enter* the portfolio if the price is less that $2. Observations in the 2.5th and 97.5th percentile on the P/B and P/E ratios *within* each quarter are removed.
5	No stock is allowed to *enter* the portfolio if the price is less that $5. Observations in the 5th and 95th percentile on the P/B and P/E ratios *within* each quarter are removed.
6	No stock is allowed to *enter* the portfolio if the price is less that $2. Observations in the 5th and 95th percentile on the P/B and P/E ratios *within* each quarter are removed.

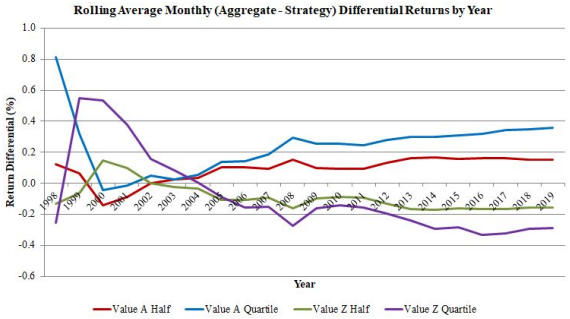
Panel A: Monthly Returns - Filter 1			
Portfolio	Description	Mean	Std. Dev.
Value Agg	This portfolio includes all stocks remaining after the filtering process.	0.646%	5.294%
Half A	After completing the filtering process, this portfolio includes the first half of stocks sorted alphabetically by ticker symbol.	0.799%	5.321%
Quart A	After completing the filtering process, this portfolio includes the first quartile of stocks sorted alphabetically by ticker symbol.	1.005%	5.505%
Half Z	After completing the filtering process, this portfolio includes the second half of stocks sorted alphabetically by ticker symbol.	0.490%	5.509%
Quart Z	After completing the filtering process, this portfolio includes the last quartile of stocks sorted alphabetically by ticker symbol.	0.359%	5.834%
(Quart A - Quart Z)		0.646% (1.197)	

Autocorrelation adjusted t statistic in parentheses

$^{*}\ p < 0.10, \quad ^{**}\ p < 0.05, \quad ^{***}\ p < 0.01$



(a) Equity Performance - Filter 1



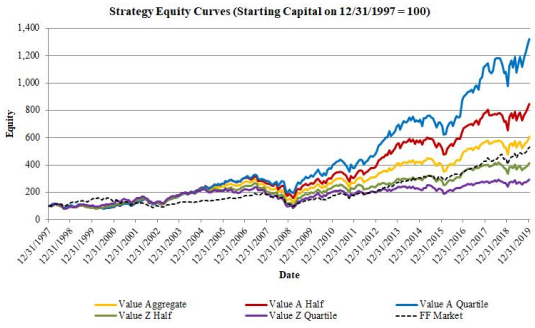
(b) Rolling Avg. Returns vs. Aggregate - Filter 1

Figure 1

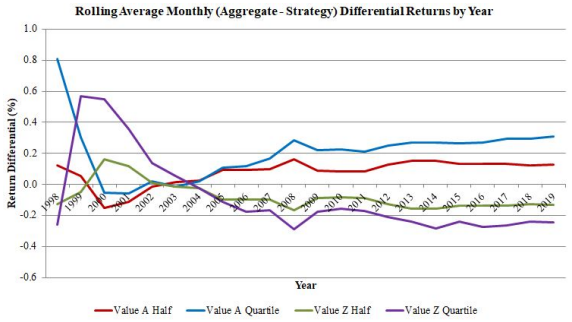
Panel B: Monthly Returns - Filter 2			
Portfolio	Description	Mean	Std. Dev.
Value Agg	This portfolio includes all stocks remaining after the filtering process.	0.668%	5.329%
Half A	After completing the filtering process, this portfolio includes the first half of stocks sorted alphabetically by ticker symbol.	0.796%	5.335%
Quart A	After completing the filtering process, this portfolio includes the first quartile of stocks sorted alphabetically by ticker symbol.	0.975%	5.509%
Half Z	After completing the filtering process, this portfolio includes the second half of stocks sorted alphabetically by ticker symbol.	0.538%	5.568%
Quart Z	After completing the filtering process, this portfolio includes the last quartile of stocks sorted alphabetically by ticker symbol.	0.425%	5.866%
(Quart A - Quart Z)		0.550% (1.012)	

Autocorrelation adjusted t statistic in parentheses

$^{*}\ p < 0.10, \quad ^{**}\ p < 0.05, \quad ^{***}\ p < 0.01$



(a) Equity Performance - Filter 2



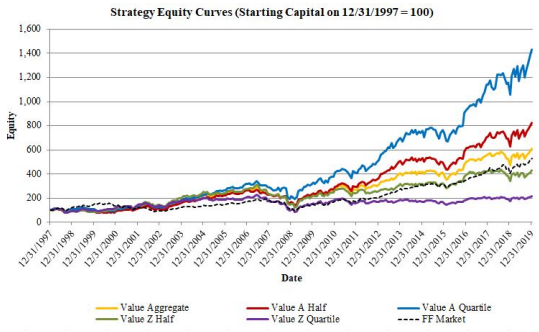
(b) Rolling Avg. Returns vs. Aggregate - Filter 2

Figure 2

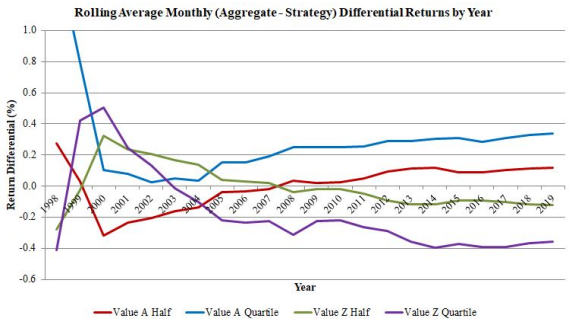
Panel C: Monthly Returns - Filter 3			
Portfolio	Description	Mean	Std. Dev.
Value Agg	This portfolio includes all stocks remaining after the filtering process.	0.661%	5.172%
Half A	After completing the filtering process, this portfolio includes the first half of stocks sorted alphabetically by ticker symbol.	0.779%	5.204%
Quart A	After completing the filtering process, this portfolio includes the first quartile of stocks sorted alphabetically by ticker symbol.	1.000%	5.391%
Half Z	After completing the filtering process, this portfolio includes the second half of stocks sorted alphabetically by ticker symbol.	0.541%	5.399%
Quart Z	After completing the filtering process, this portfolio includes the last quartile of stocks sorted alphabetically by ticker symbol.	0.303%	5.757%
(Quart A - Quart Z)		0.697% (1.351)*	

Autocorrelation adjusted t statistic in parentheses

$^{*}\ p < 0.10, \quad ^{**}\ p < 0.05, \quad ^{***}\ p < 0.01$



(a) Equity Performance - Filter 3



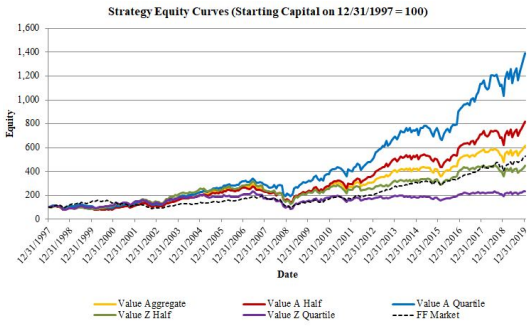
(b) Rolling Avg. Returns vs. Aggregate - Filter 3

Figure 3

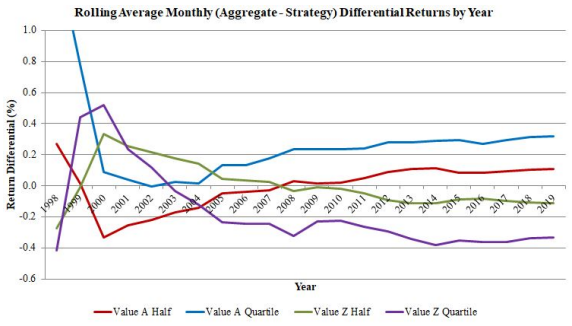
Panel D: Monthly Returns - Filter 4			
Portfolio	Description	Mean	Std. Dev.
Value Agg	This portfolio includes all stocks remaining after the filtering process.	0.668%	5.184%
Half A	After completing the filtering process, this portfolio includes the first half of stocks sorted alphabetically by ticker symbol.	0.776%	5.215%
Quart A	After completing the filtering process, this portfolio includes the first quartile of stocks sorted alphabetically by ticker symbol.	0.989%	5.388%
Half Z	After completing the filtering process, this portfolio includes the second half of stocks sorted alphabetically by ticker symbol.	0.558%	5.404%
Quart Z	After completing the filtering process, this portfolio includes the last quartile of stocks sorted alphabetically by ticker symbol.	0.334%	5.726%
(Quart A - Quart Z)		0.655% (1.271)	

Autocorrelation adjusted t statistic in parentheses

$^{*}\ p < 0.10, \quad ^{**}\ p < 0.05, \quad ^{***}\ p < 0.01$



(a) Equity Performance - Filter 4



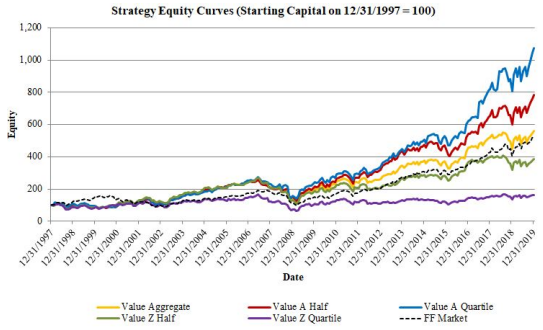
(b) Rolling Avg. Returns vs. Aggregate - Filter 4

Figure 4

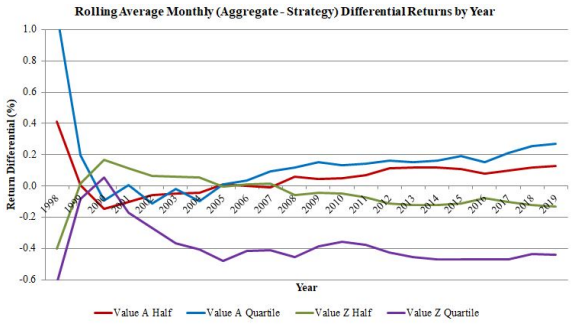
Panel E: Monthly Returns - Filter 5			
Portfolio	Description	Mean	Std. Dev.
Value Agg	This portfolio includes all stocks remaining after the filtering process.	0.629%	5.104%
Half A	After completing the filtering process, this portfolio includes the first half of stocks sorted alphabetically by ticker symbol.	0.757%	5.140%
Quart A	After completing the filtering process, this portfolio includes the first quartile of stocks sorted alphabetically by ticker symbol.	0.896%	5.472%
Half Z	After completing the filtering process, this portfolio includes the second half of stocks sorted alphabetically by ticker symbol.	0.496%	5.343%
Quart Z	After completing the filtering process, this portfolio includes the last quartile of stocks sorted alphabetically by ticker symbol.	0.190%	5.751%
(Quart A - Quart Z)		0.706% (1.321)*	

Autocorrelation adjusted t statistic in parentheses

$^{*}\ p < 0.10, \quad ^{**}\ p < 0.05, \quad ^{***}\ p < 0.01$



(a) Equity Performance - Filter 5



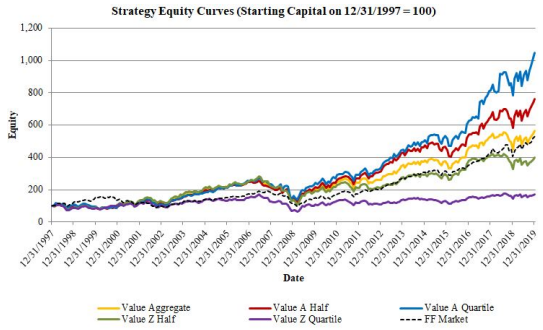
(b) Rolling Avg. Returns vs. Aggregate - Filter 5

Figure 5

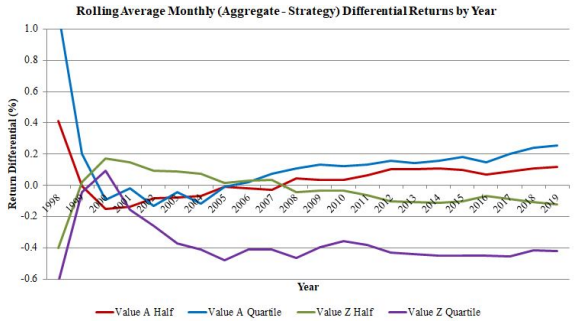
Panel F: Monthly Returns - Filter 6			
Portfolio	Description	Mean	Std. Dev.
Value Agg	This portfolio includes all stocks remaining after the filtering process.	0.630%	5.114%
Half A	After completing the filtering process, this portfolio includes the first half of stocks sorted alphabetically by ticker symbol.	0.747%	5.138%
Quart A	After completing the filtering process, this portfolio includes the first quartile of stocks sorted alphabetically by ticker symbol.	0.885%	5.453%
Half Z	After completing the filtering process, this portfolio includes the second half of stocks sorted alphabetically by ticker symbol.	0.510%	5.361%
Quart Z	After completing the filtering process, this portfolio includes the last quartile of stocks sorted alphabetically by ticker symbol.	0.207%	5.748%
(Quart A - Quart Z)		0.678% (1.269)	

Autocorrelation adjusted t statistic in parentheses

$^{*}\ p < 0.10, \quad ^{**}\ p < 0.05, \quad ^{***}\ p < 0.01$



(a) Equity Performance - Filter 6



(b) Rolling Avg. Returns vs. Aggregate - Filter 6

Figure 6

4 Five-Factor Model Results

This section examines whether the portfolio performance of the previous section can be explained using a rational approach, in similar spirit to [**Fama and French 1996**], where their seminal three-factor model was used to test some commonly documented Capital Asset Pricing Model (CAPM) anomalies. Here, the authors found that controlling for common risk exposures in a three-factor model largely removes the supposed anomalies, with the important exception of the continuation of short-term returns, better known as the momentum factor. Since the Fama-French three-factor model does not capture this momentum effect, the extension of ([**Carhart 1997**]) has become popular due to its inclusion of a momentum proxy (constructed as are the Fama-French factors from a long-short portfolio, here capturing the return differential between past winners and past losers as first introduced in [**Jegadeesh and Titman 1993**]). Further, in [**Fama and French 2015**], the authors extended their original three-factor model with two additional factors related to "quality," capturing premiums for profitability and investment activity. Preliminary research showed that a five-factor model that effectively extends the four-factor model of [**Carhart 1997**] with the profitability factor of [**Fama and French 2015**] was the best in terms of explanatory power for the aggregate, full-sample portfolios considered herein, and therefore this model was adopted for the subsequent analysis. The investment factor from [**Fama and French 2015**] turned out to be redundant with the value premium (and the correlation of the two series is > 0.6 for the sample period, the highest absolute pair-wise correlation among any of the factors), and never showed statistical significance. Thus, for our purposes, if the five-factor model can capture the cross-sectional variation in stock returns, then the intercept from the following regression should be statistically indistinguishable from zero,

$$R_{it} - R_{ft} = \alpha + \beta_{i1}(R_{Mt} - R_{ft}) + \beta_{i2}\text{SMB}_t + \beta_{i3}\text{HML}_t + \beta_{i4}\text{UMD}_t + \beta_{i5}\text{RMW}_t + \varepsilon_{it}, \quad (4.1)$$

where $R_{it} - R_{ft}$ is the return of portfolio i in excess of the risk-free rate in month t, $R_{Mt} - R_{ft}$ is the excess return of the market cap-weighted portfolio, SMB is the return differential between portfolios of small and large stocks and represents a size premium, HML is the return differential between portfolios of stocks with high book-to-market ratios and low book-to-market ratios and represents a value premium, UMD is the return difference between portfolios of past winners and past losers and represents a momentum premium, and RMW is the return difference between portfolios of firms with robust (high) and weak (low) operating profitability and represents a quality premium.

Tables III - VIII below report the regression results for the portfolios as defined by

their filters above, and importantly segregated between different period ranges. That is, each table includes a full sample regression (December 1997 - December 2019), and additional regressions for the periods of December 2004 - December 2019, December 2009 - December 2019, and December 1997 - December 2004. The results for the aggregate portfolios and additionally the factor loadings on $R_{Mt} - R_{ft}$, SMB, HML, UMD, and RMW are all as expected. All aggregate portfolios are fully explained by the five-factor model, with all intercepts being statistically indistinguishable from zero and most factor loadings being significant at the 1% level. Untabulated results show that the adjusted R^2 is around 0.95 for all of the aggregate portfolios. As shown, factor loadings for $R_{Mt} - R_{ft}$ are greater than 0.9 for all portfolios, reflecting diversification and broad exposure. The loadings on SMB are all positive, reflecting both the simple reality that we have included all stocks with market caps greater than $300MM and that many value stocks are so because of recent financial distress, which in a properly functioning market should naturally result in a reduced market capitalization. The loading on HML is of course positive for all portfolios by design (although still a nice confirmation that the filtering and sorting algorithms were properly implemented). The loading on UMD is further negative for all portfolios, consistent with the typical empirical observation that the value and momentum factors are negatively correlated. Finally, the loading on RMW is positive for most portfolios. This is the only result that may cause some confusion initially, as one of the justifications for the existence of a value premium is compensation for taking on the equity risk of firms experiencing financial distress, a trait typically not associated with robust profitability. However, the result makes sense in light of the inclusion of the P/E ratio in the value-sorting process in addition to the traditional P/B ratio, the denominator of which will naturally drive a positive relationship with this factor.

For the full sample period, there is in general a lack of evidence in favor of rejecting the null hypothesis that the intercept is indistinguishable from zero. Only for the A-Quartile portfolio under the first four filters and the Z-Quartile portfolio under the sixth filter can we reject the null hypothesis, and these are only at the 10% and 5% levels of significance, respectively. Even still, the average monthly alpha of approximately 0.25% (maximum 0.29%) for the A-Quartile portfolios and -0.25% (minimum -0.50%) for the Z-Quartile portfolios has an economic significance that may nevertheless be enticing in practice. The more recent time periods, that is December 2004 - December 2019 and December 2009 - December 2019, tell a different story. For these periods, most of the quartile portfolios have statistically significant alpha at the 5% level, with the A-Quartile portfolios showing positive monthly alpha typically greater than 2% and the Z-Quartile portfolios showing negative monthly alpha typically less than -2%. By contrast, the early sub-period of December 1997 - December 2004 does not have a statistically significant alpha at any level for any portfolio. As explained in the previous section, I assert that the fact that the effect has gotten stronger and more statistically significant in more recent periods is supportive of the anomalous nature of the results.

Table IIIa: Five-Factor Regression Results - Filter 1

	Full Sample (December 1997- December 2019)				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.042	0.109	0.291	−0.195	−0.256
	(−0.364)	(0.875)	(1.936)*	(−1.303)	(−1.242)
Mkt - Rf	0.947	0.932	0.949	0.964	0.943
	(26.417)***	(22.543)***	(18.74)***	(22.657)***	(14.97)***
SMB	0.509	0.518	0.523	0.498	0.422
	(11.924)***	(10.284)***	(8.515)***	(10.119)***	(6.329)***
HML	0.45	0.49	0.472	0.406	0.302
	(6.916)***	(7.889)***	(6.225)***	(4.915)***	(2.537)***
UMD	−0.257	−0.253	−0.255	−0.261	−0.322
	(−9.994)***	(−9.574)***	(−7.687)***	(−7.937)***	(−6.719)***
RMW	0.398	0.418	0.47	0.376	0.32
	(6.929)***	(6.315)***	(5.502)***	(5.849)***	(3.705)***
Observations	264				
	December 2004- December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.115	0.122	0.394	−0.357	−0.587
	(−0.905)	(0.862)	(2.347)**	(−2.162)**	(−2.477)**
Mkt - Rf	0.946	0.908	0.924	0.988	1.03
	(21.655)***	(17.083)***	(16.246)***	(19.189)***	(12.785)***
SMB	0.422	0.458	0.557	0.38	0.247
	(7.992)***	(6.713)***	(6.627)***	(5.734)***	(2.497)**
HML	0.183	0.278	0.232	0.081	−0.054
	(1.991)**	(3.125)***	(2.246)**	(0.677)	(−0.288)
UMD	−0.296	−0.266	−0.236	−0.328	−0.36
	(−7.904)***	(−7.186)***	(−5.61)***	(−6.022)***	(−4.42)***
RMW	0.125	0.147	0.142	0.099	0.022
	(1.427)	(1.379)	(1.228)	(1.006)	(0.16)
Observations	180				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table IIIb: Five-Factor Regression Results - Filter 1

	December 2009- December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.068	0.124	0.395	−0.268	−0.52
	(−0.547)	(0.999)	(2.586)**	(−1.656)	(−2.46)**
Mkt - Rf	0.968	1.001	1.014	0.934	0.954
	(24.345)***	(23.12)***	(23.174)***	(21.407)***	(15.865)***
SMB	0.355	0.31	0.406	0.401	0.241
	(6.113)***	(4.325)***	(4.361)***	(6.071)***	(2.259)**
HML	0.26	0.352	0.384	0.167	0.065
	(4.223)***	(6.096)***	(4.688)***	(2.092)**	(0.625)
UMD	−0.273	−0.228	−0.231	−0.318	−0.321
	(−6.046)***	(−4.507)***	(−4.154)***	(−6.451)***	(−4.893)***
RMW	−0.027	−0.053	−0.104	0	−0.036
	(−0.335)	(−0.587)	(−0.848)	(−0.003)	(−0.253)
Observations	120				
	December 1997- December 2004				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	0.053	0.06	0.136	0.047	0.31
	(0.27)	(0.266)	(0.461)	(0.18)	(0.964)
Mkt - Rf	1.006	1.016	0.992	0.996	0.897
	(20.08)***	(14.467)***	(10.028)***	(19.587)***	(11.365)***
SMB	0.598	0.614	0.56	0.582	0.522
	(9.363)***	(8.401)***	(6.048)***	(7.657)***	(5.508)***
HML	0.667	0.662	0.644	0.673	0.603
	(10.619)***	(8.582)***	(6.098)***	(7.711)***	(6.325)***
UMD	−0.252	−0.259	−0.28	−0.244	−0.348
	(−9.623)***	(−8.312)***	(−7.311)***	(−7.438)***	(−8.276)***
RMW	0.394	0.465	0.471	0.32	0.208
	(4.396)***	(4.284)***	(3.43)***	(3.405)***	(1.654)
Observations	84				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table IVa: Five-Factor Regression Results - Filter 2

	Full Sample (December 1997 - December 2019)				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.017	0.104	0.258	−0.14	−0.175
	(−0.147)	(0.84)	(1.715)*	(−0.921)	(−0.851)
Mkt - Rf	0.95	0.934	0.951	0.967	0.939
	(26.635)***	(22.815)***	(18.82)***	(23.029)***	(15.493)***
SMB	0.507	0.523	0.525	0.49	0.406
	(11.828)***	(10.449)***	(8.589)***	(9.825)***	(6.055)***
HML	0.451	0.496	0.474	0.403	0.311
	(6.94)***	(7.944)***	(6.196)***	(4.996)***	(2.767)***
UMD	−0.265	−0.255	−0.255	−0.275	−0.338
	(−10.104)***	(−9.634)***	(−7.648)***	(−8.135)***	(−7.514)***
RMW	0.396	0.421	0.476	0.369	0.301
	(6.838)***	(6.353)***	(5.58)***	(5.649)***	(3.496)***
Observations	264				
	December 2004 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.092	0.106	0.345	−0.293	−0.47
	(−0.719)	(0.749)	(2.051)**	(−1.749)*	(−1.999)**
Mkt - Rf	0.949	0.911	0.927	0.989	1.026
	(21.932)***	(17.372)***	(16.276)***	(19.971)***	(13.672)***
SMB	0.404	0.461	0.555	0.345	0.198
	(7.484)***	(6.875)***	(6.629)***	(4.916)***	(1.948)*
HML	0.18	0.281	0.24	0.074	−0.037
	(2.034)**	(3.167)***	(2.281)**	(0.667)	(−0.217)
UMD	−0.314	−0.27	−0.236	−0.359	−0.398
	(−8.435)***	(−7.332)***	(−5.466)***	(−6.575)***	(−5.292)***
RMW	0.109	0.154	0.165	0.062	−0.018
	(1.218)	(1.431)	(1.421)	(0.596)	(−0.128)
Observations	180				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table IVb: Five-Factor Regression Results - Filter 2

	December 2009 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.041	0.097	0.328	−0.183	−0.348
	(−0.331)	(0.794)	(2.194)**	(−1.116)	(−1.541)
Mkt - Rf	0.968	1.006	1.022	0.93	0.944
	(24.899)***	(23.972)***	(23.732)***	(21.629)***	(16.134)***
SMB	0.331	0.31	0.399	0.352	0.17
	(5.726)***	(4.504)***	(4.349)***	(5.225)***	(1.435)
HML	0.258	0.355	0.403	0.162	0.074
	(4.294)***	(6.29)***	(5.083)***	(2.054)**	(0.725)
UMD	−0.293	−0.238	−0.233	−0.348	−0.381
	(−6.659)***	(−4.853)***	(−4.304)***	(−7.161)***	(−4.992)***
RMW	−0.062	−0.052	−0.08	−0.07	−0.127
	(−0.788)	(−0.583)	(−0.669)	(−0.692)	(−0.826)
Observations	120				
	December 1997 - December 2004				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	0.078	0.076	0.13	0.08	0.314
	(0.396)	(0.337)	(0.439)	(0.308)	(0.961)
Mkt - Rf	1.012	1.018	0.994	1.007	0.895
	(20.863)***	(14.483)***	(10.022)***	(20.054)***	(11.076)***
SMB	0.603	0.617	0.562	0.589	0.518
	(9.367)***	(8.431)***	(6.051)***	(7.625)***	(5.302)***
HML	0.665	0.669	0.643	0.661	0.587
	(10.058)***	(8.691)***	(6.1)***	(7.153)***	(6.023)***
UMD	−0.253	−0.259	−0.28	−0.246	−0.345
	(−9.236)***	(−8.291)***	(−7.31)***	(−7.201)***	(−8.161)***
RMW	0.402	0.464	0.474	0.338	0.219
	(4.441)***	(4.267)***	(3.451)***	(3.466)***	(1.695)*
Observations	84				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table Va: Five-Factor Regression Results - Filter 3

	Full Sample (December 1997 - December 2019)				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.042	0.064	0.273	−0.149	−0.324
	(−0.383)	(0.533)	(1.803)*	(−1.009)	(−1.583)
Mkt - Rf	0.94	0.939	0.96	0.94	0.915
	(26.774)***	(23.914)***	(18.638)***	(21.047)***	(14.444)***
SMB	0.522	0.513	0.482	0.531	0.482
	(12.172)***	(9.424)***	(7.408)***	(11.375)***	(7.461)***
HML	0.428	0.448	0.405	0.406	0.287
	(6.835)***	(7.989)***	(5.572)***	(4.628)***	(2.387)**
UMD	−0.238	−0.229	−0.236	−0.249	−0.324
	(−9.308)***	(−8.702)***	(−7.53)***	(−7.409)***	(−7.204)***
RMW	0.441	0.472	0.506	0.407	0.382
	(7.899)***	(6.968)***	(5.421)***	(6.386)***	(4.348)***
Observations	264				
	December 2004 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.099	0.147	0.397	−0.348	−0.624
	(−0.808)	(1.128)	(2.337)**	(−2.04)**	(−2.547)**
Mkt - Rf	0.94	0.918	0.92	0.962	1.019
	(21.973)***	(19.364)***	(14.82)***	(16.872)***	(12.102)***
SMB	0.44	0.469	0.555	0.411	0.28
	(8.22)***	(7.395)***	(6.672)***	(5.797)***	(2.857)***
HML	0.195	0.277	0.192	0.108	−0.033
	(2.078)**	(3.638)***	(1.994)**	(0.777)	(−0.167)
UMD	−0.256	−0.214	−0.222	−0.3	−0.354
	(−6.726)***	(−6.793)***	(−6.357)***	(−5.216)***	(−4.397)***
RMW	0.164	0.204	0.137	0.121	0.085
	(1.929)*	(1.975)**	(1.202)	(1.196)	(0.558)
Observations	180				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table Vb: Five-Factor Regression Results - Filter 3

	December 2009 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.058	0.145	0.388	−0.27	−0.639
	(−0.504)	(1.241)	(2.488)**	(−1.75)*	(−2.812)***
Mkt - Rf	0.969	0.995	0.991	0.942	0.993
	(26.861)***	(26.573)***	(21.758)***	(21.292)***	(15.479)***
SMB	0.522	0.513	0.482	0.531	0.482
	(6.507)***	(5.688)***	(4.322)***	(5.212)***	(2.033)**
HML	0.387	0.38	0.392	0.394	0.21
	(4.636)***	(6.057)***	(4.174)***	(2.868)***	(1.081)
UMD	−0.219	−0.174	−0.21	−0.264	−0.241
	(−4.535)***	(−3.691)***	(−4.146)***	(−4.568)***	(−3.593)***
RMW	0.015	0.01	−0.126	0.018	0.021
	(0.209)	(0.12)	(−1.156)	(0.176)	(0.12)
Observations	120				
	December 1997 - December 2004				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	0.05	−0.101	0.158	0.204	0.2
	(0.255)	(−0.424)	(0.547)	(0.851)	(0.674)
Mkt - Rf	0.985	1.004	0.993	0.967	0.827
	(19.362)***	(14.601)***	(11.817)***	(18.717)***	(12.366)***
SMB	0.608	0.604	0.485	0.613	0.577
	(9.929)***	(7.626)***	(5.021)***	(9.52)***	(6.689)***
HML	0.599	0.575	0.497	0.626	0.513
	(9.202)***	(6.614)***	(4.432)***	(7.907)***	(5.306)***
UMD	−0.247	−0.253	−0.25	−0.243	−0.354
	(−9.337)***	(−7.092)***	(−5.97)***	(−8.439)***	(−9.171)***
RMW	0.459	0.534	0.541	0.378	0.291
	(5.364)***	(4.767)***	(3.819)***	(4.718)***	(2.696)***
Observations	84				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table VIa: Five-Factor Regression Results - Filter 4

	Full Sample (December 1997 - December 2019)				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.036	0.061	0.26	−0.134	−0.289
	(−0.33)	(0.508)	(1.719)*	(−0.916)	(−1.422)
Mkt - Rf	0.943	0.939	0.96	0.946	0.913
	(26.82)***	(24.098)***	(18.755)***	(21.559)***	(14.549)***
SMB	0.522	0.518	0.485	0.527	0.473
	(12.126)***	(9.604)***	(7.499)***	(11.163)***	(7.253)***
HML	0.425	0.454	0.407	0.395	0.283
	(6.847)***	(8.038)***	(5.577)***	(4.664)***	(2.425)**
UMD	−0.24	−0.231	−0.235	−0.249	−0.322
	(−9.259)***	(−8.738)***	(−7.445)***	(−7.486)***	(−7.235)***
RMW	0.44	0.473	0.509	0.406	0.375
	(7.872)***	(6.959)***	(5.445)***	(6.361)***	(4.283)***
Observations	264				
	December 2004 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.098	0.138	0.378	−0.337	−0.575
	(−0.81)	(1.072)	(2.233)**	(−2.016)**	(−2.381)**
Mkt - Rf	0.945	0.918	0.919	0.972	1.022
	(22.019)***	(19.632)***	(14.886)***	(17.459)***	(12.38)***
SMB	0.432	0.475	0.561	0.39	0.258
	(8.142)***	(7.677)***	(6.872)***	(5.54)***	(2.622)***
HML	0.195	0.281	0.199	0.104	−0.028
	(2.145)**	(3.701)***	(2.052)**	(0.801)	(−0.147)
UMD	−0.256	−0.218	−0.219	−0.295	−0.346
	(−6.885)***	(−6.913)***	(−6.063)***	(−5.393)***	(−4.442)***
RMW	0.152	0.204	0.15	0.097	0.057
	(1.774)*	(1.964)*	(1.309)	(0.954)	(0.378)
Observations	180				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table VIb: Five-Factor Regression Results - Filter 4

	December 2009 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.056	0.139	0.369	−0.257	−0.581
	(−0.497)	(1.213)	(2.403)**	(−1.669)*	(−2.56)**
Mkt - Rf	0.971	0.996	0.993	0.945	0.993
	(27.782)***	(27.452)***	(22.509)***	(21.756)***	(15.803)***
SMB	0.377	0.387	0.399	0.367	0.189
	(6.384)***	(6.141)***	(4.577)***	(4.756)***	(1.781)*
HML	0.286	0.344	0.35	0.227	0.105
	(4.602)***	(6.341)***	(4.569)***	(2.702)***	(1.014)
UMD	−0.22	−0.182	−0.204	−0.258	−0.232
	(−4.506)***	(−3.965)***	(−4.064)***	(−4.394)***	(−3.379)***
RMW	−0.011	0.003	−0.11	−0.028	−0.022
	(−0.165)	(0.036)	(−0.997)	(−0.274)	(−0.122)
Observations	120				
	December 1997 - December 2004				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	0.07	−0.091	0.158	0.233	0.214
	(0.363)	(−0.38)	(0.547)	(0.984)	(0.711)
Mkt - Rf	0.987	1.002	0.993	0.973	0.816
	(19.865)***	(14.569)***	(11.817)***	(19.598)***	(11.818)***
SMB	0.615	0.606	0.485	0.624	0.58
	(10.013)***	(7.653)***	(5.021)***	(9.763)***	(6.68)***
HML	0.591	0.579	0.497	0.605	0.496
	(8.728)***	(6.625)***	(4.432)***	(7.248)***	(5.181)***
UMD	−0.252	−0.253	−0.25	−0.251	−0.359
	(−9.073)***	(−7.043)***	(−5.97)***	(−8.189)***	(−9.384)***
RMW	0.467	0.533	0.541	0.398	0.3
	(5.414)***	(4.74)***	(3.819)***	(4.889)***	(2.707)***
Observations	84				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table VIIa: Five-Factor Regression Results - Filter 5

	Full Sample (December 1997 - December 2019)				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.081	0.057	0.177	−0.224	−0.497
	(−0.782)	(0.452)	(1.091)	(−1.674)	(−2.632)
Mkt - Rf	0.945	0.935	0.971	0.957	0.97
	(31.761)***	(22.441)***	(18.948)***	(29.265)***	(19.804)***
SMB	0.506	0.471	0.447	0.541	0.486
	(12.744)***	(9.443)***	(7.145)***	(11.195)***	(7.119)***
HML	0.456	0.45	0.415	0.459	0.385
	(9.316)***	(7.915)***	(5.869)***	(7.869)***	(4.892)***
UMD	−0.208	−0.207	−0.23	−0.207	−0.251
	(−9.393)***	(−8.262)***	(−7.76)***	(−7.197)***	(−5.826)***
RMW	0.42	0.428	0.469	0.41	0.371
	(7.54)***	(6.453)***	(5.459)***	(6.113)***	(3.81)***
Observations	264				
	December 2004 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.075	0.169	0.402	−0.33	−0.568
	(−0.631)	(1.087)	(1.928)*	(−2.248)**	(−2.769)***
Mkt - Rf	0.929	0.902	0.932	0.958	0.988
	(24.009)***	(15.462)***	(13.78)***	(24.272)***	(17.707)***
SMB	0.464	0.485	0.504	0.441	0.358
	(8.216)***	(6.568)***	(5.31)***	(6.03)***	(3.773)***
HML	0.241	0.267	0.157	0.209	0.114
	(3.521)***	(3.292)***	(1.742)*	(2.506)**	(1.044)
UMD	−0.223	−0.193	−0.216	−0.253	−0.289
	(−7.154)***	(−5.556)***	(−6.206)***	(−5.787)***	(−4.571)***
RMW	0.17	0.108	−0.03	0.23	0.141
	(1.816)*	(0.862)	(−0.21)	(2.378)**	(1.009)
Observations	180				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table VIIb: Five-Factor Regression Results - Filter 5

	December 2009 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.008	0.229	0.423	−0.258	−0.581
	(−0.067)	(1.537)	(1.9)*	(−1.586)	(−2.529)**
Mkt - Rf	0.959	0.95	0.945	0.97	1.017
	(26.993)***	(25.232)***	(20.211)***	(21.101)***	(14.755)***
SMB	0.438	0.415	0.441	0.462	0.243
	(7.152)***	(5.556)***	(3.982)***	(5.425)***	(2.456)**
HML	0.317	0.308	0.228	0.326	0.209
	(5.133)***	(5.072)***	(2.535)**	(3.815)***	(1.825)*
UMD	−0.18	−0.119	−0.154	−0.242	−0.265
	(−3.851)***	(−2.493)**	(−2.935)***	(−4.029)***	(−3.532)***
RMW	0.066	−0.085	−0.191	0.22	0.1
	(0.854)	(−0.826)	(−1.314)	(2.206)**	(0.719)
Observations	120				
	December 1997 - December 2004				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.106	−0.097	−0.134	−0.109	−0.472
	(−0.591)	(−0.475)	(−0.532)	(−0.44)	(−1.318)
Mkt - Rf	1.003	0.986	1.011	1.024	1.022
	(26.43)***	(18.771)***	(14.876)***	(20.855)***	(12.82)***
SMB	0.573	0.52	0.484	0.626	0.598
	(10.07)***	(7.417)***	(5.645)***	(9.114)***	(6.235)***
HML	0.617	0.552	0.548	0.685	0.647
	(10.816)***	(6.841)***	(5.323)***	(9.224)***	(6.935)***
UMD	−0.21	−0.226	−0.249	−0.194	−0.251
	(−8.132)***	(−6.602)***	(−6.738)***	(−6.183)***	(−4.687)***
RMW	0.435	0.485	0.531	0.382	0.34
	(5.917)***	(5.379)***	(5.051)***	(3.907)***	(2.381)**
Observations	84				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table VIIIa: Five-Factor Regression Results - Filter 6

	Full Sample (December 1997 - December 2019)				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.076	0.05	0.168	−0.207	−0.481
	(−0.729)	(0.4)	(1.043)	(−1.536)	(−2.571)**
Mkt - Rf	0.944	0.931	0.966	0.959	0.973
	(30.486)***	(22.4)***	(18.893)***	(29.284)***	(20.256)***
SMB	0.506	0.472	0.451	0.541	0.485
	(12.813)***	(9.553)***	(7.269)***	(11.22)***	(7.109)***
HML	0.45	0.451	0.413	0.447	0.381
	(9.017)***	(7.847)***	(5.827)***	(7.708)***	(5.003)***
UMD	−0.212	−0.21	−0.233	−0.213	−0.25
	(−9.555)***	(−8.385)***	(−7.809)***	(−7.558)***	(−6.321)***
RMW	0.415	0.426	0.472	0.404	0.369
	(7.371)***	(6.408)***	(5.496)***	(5.859)***	(3.759)***
Observations	264				
	December 2004 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.084	0.158	0.384	−0.336	−0.556
	(−0.705)	(1.016)	(1.861)*	(−2.318)**	(−2.754)***
Mkt - Rf	0.932	0.898	0.925	0.968	1
	(23.14)***	(15.438)***	(13.741)***	(25.275)***	(19.033)***
SMB	0.457	0.484	0.509	0.426	0.346
	(8.205)***	(6.616)***	(5.502)***	(5.927)***	(3.662)***
HML	0.232	0.265	0.154	0.194	0.106
	(3.39)***	(3.241)***	(1.732)*	(2.373)**	(1.007)
UMD	−0.226	−0.199	−0.22	−0.253	−0.284
	(−7.406)***	(−5.757)***	(−6.292)***	(−5.942)***	(−4.824)***
RMW	0.153	0.098	−0.023	0.206	0.109
	(1.615)	(0.783)	(−0.163)	(2.096)**	(0.791)
Observations	180				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table VIIIb: Five-Factor Regression Results - Filter 6

	December 2009 - December 2019				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.019	0.214	0.409	−0.26	−0.545
	(−0.151)	(1.433)	(1.857)*	(−1.586)	(−2.388)**
Mkt - Rf	0.958	0.949	0.941	0.968	1.014
	(27.27)***	(25.513)***	(20.285)***	(21.101)***	(15.19)***
SMB	0.429	0.409	0.444	0.448	0.244
	(7.063)***	(5.512)***	(4.171)***	(5.337)***	(2.485)**
HML	0.307	0.311	0.23	0.302	0.193
	(5.01)***	(5.183)***	(2.649)***	(3.544)***	(1.723)*
UMD	−0.191	−0.136	−0.166	−0.246	−0.273
	(−4.076)***	(−2.823)***	(−3.181)***	(−4.148)***	(−3.786)***
RMW	0.04	−0.105	−0.187	0.186	0.066
	(0.512)	(−1.021)	(−1.291)	(1.816)*	(0.459)
Observations	120				
	December 1997 - December 2004				
	Value Agg	Half A	Quart A	Half Z	Quart Z
Alpha	−0.071	−0.091	−0.124	−0.042	−0.437
	(−0.391)	(−0.453)	(−0.494)	(−0.169)	(−1.217)
Mkt - Rf	0.999	0.984	1.008	1.017	1.009
	(26.191)***	(18.8)***	(14.872)***	(20.152)***	(12.199)***
SMB	0.578	0.522	0.487	0.635	0.603
	(10.169)***	(7.492)***	(5.678)***	(9.171)***	(6.217)***
HML	0.612	0.552	0.547	0.675	0.634
	(10.327)***	(6.859)***	(5.326)***	(8.967)***	(6.821)***
UMD	−0.218	−0.227	−0.251	−0.209	−0.257
	(−8.173)***	(−6.718)***	(−6.789)***	(−6.455)***	(−5.288)***
RMW	0.434	0.486	0.533	0.38	0.344
	(5.784)***	(5.384)***	(5.064)***	(3.743)***	(2.34)**
Observations	84				

Robust t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusion

This paper examined the existence of a possible anomaly in value stocks in which there is a statistically abnormal performance between stocks with tickers near the front of the alphabet and stocks with tickers near the end of the alphabet. It was found that in general stocks with ticker symbols near the front of the alphabet have higher average monthly returns than stocks with tickers near the end of the alphabet, with the difference ranging from between 0.55% and 0.71% for the time period and portfolio settings considered. Under a rational framework, the results also showed a generally significant positive alpha for front-alphabet portfolios and generally significant negative alpha for back-alphabet portfolios, with a differential in excess of 4%, in the last fifteen years. Prior to this period, it was typically possible to entirely explain the portfolio returns by using a factor model, supporting the argument that the anomaly is driven by an indirect effect of a technological innovation on the research process. One particularly necessary area of further research will be to replicate this entire process for growth stocks. As the hypothesis was formed specifically in relation to an observation about the value-investor-style research process, growth portfolios would offer an important control on the methodology and results.

References

[1] Brogaard, J., Engelberg, J., Parsons, C. A., 2014. Networks and Productivity: Causal Evidence from Editor Rotations. *Journal of Financial Economics*. 111:251-270.

[2] Carhart, M. M., 1997. On Persistence in Mutual Fund Performance. *The Journal of Finance*. 52 (1):57-82.

[3] Chen, N., Zhang, F., 1998. Risk and Return of Value Stocks. *The Journal of Business*. 71 (4):501-535.

[4] Einav, L., Yariv, L., 2006. What's in a Surname? The Effects of Surname Initials on Academic Success. *Journal of Economic Perspectives*. 20:175-187.

[5] Fama, E. F., French, K. R., 1996. Multifactor Explanations of Asset Pricing Anomalies. *The Journal of Finance*. 51 (1):55-84.

[6] Fama, E. F., French, K. R., 2015. A Five-Factor Asset Pricing Model. *Journal of Financial Economics*. 116:1-22.

[7] Jacobs, H., Hillert, A., 2013. The Power of Primacy: Alphabetic Bias, Investor Recognition, and Market Outcomes. *SSRN Electronic Journal*.

[8] Jegadeesh, N., Titman, S., 1993. Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *The Journal of Finance*. 48 (1):65-91.

[9] Jegadeesh, N., Titman, S., 2001. Profitability of Momentum Strategies: An Evaluation of Alternative Explanations. *The Journal of Finance*. 56 (2):699-720.

[10] Richardson, M. L., 2010. Alphabetic Bias in the Selection of Reviewers for the American Journal of Roentgenology. *American Journal of Roentgenology*. 191:213-216.

[11] van Praag, C. M., van Praag, B. M., 2008. The Benefits of Being Economics Professor A (Rather Than Z). *Economica*. 75:782-796.

[12] Wilks, D. S., 1997. Resampling Hypothesis Tests for Autocorrelated Fields. *Journal of Climate*. 10:65-82.

[13] Zhang, L., 2005. The Value Premium. *The Journal of Finance*. 60 (1):67-103.

[14] Zhang, X. F., 2006. Information Uncertainty and Stock Returns. *The Journal of Finance*. 61 (1):105-137.

Appendices

A MatLab Code

```
%% Import fundamentals data
clear;
clc;

% Setup the Import Options
opts = spreadsheetImportOptions("NumVariables", 23);

% Specify sheet and range
opts.Sheet = "WRDS";
opts.DataRange = "A2:W552358";

% Specify column names and types
opts.VariableNames = ["StandardandPoorsIdentifier", "DataDate", "FiscalYear", "FiscalQuarter"...
, "IndustryFormat", "LevelofConsolidationCompanyInterimDescriptor", "PopulationSource"...
, "DataFormat", "TickerSymbol", "CUSIP", "CompanyName", "ISOCurrencyCode"...
, "CalendarDataYearandQuarter", "FiscalDataYearandQuarter", "CommonOrdinaryEquityTotal"...
, "CommonSharesOutstanding", "EPS", "OperatingActivitiesNetCashFlow", "ActiveInactiveStatusMarker"...
, "BPS", "OCFPS", "SharePrice", "MarketCap"];
opts.VariableTypes = ["double", "double", "double", "double", "categorical", "categorical", "categorical"...
, "categorical", "categorical", "double", "categorical", "categorical", "categorical", "categorical"...
, "double", "double", "double", "double", "categorical", "double", "double", "double", "double"];
opts = setvaropts(opts, [5, 6, 7, 8, 9, 11, 12, 13, 14, 19], "EmptyFieldRule", "auto");

% Import the data
MSC515Fundamentals19952019 = readtable("C:\Users\Zack\Documents\MATLAB\MSC515Fundamentals19972019.xlsx"...
, opts, "UseExcel", false);

% Clear temporary variables
clear opts

%% Import price data. This is split into 3 files due to excel limitations

%                1995   1999
opts = spreadsheetImportOptions("NumVariables", 26);

% Specify sheet and range
```

```
opts.Sheet = "WRDS";
opts.DataRange = "A2:Z421885";

% Specify column names and types
opts.VariableNames = ["StandardandPoorsIdentifier", "PrimaryLinkMarker", "SecuritylevelIdentifier"...
, "LinkTypeCodd", "HistoricalCRSPPERMNOLinktoCOMPUSTATRecord", "HistoricalCRSPPERMCOLinktoCOMPUSTATRecord"...
, "FirstEffectiveDateofLink", "LastEffectiveDateofLink", "IssueIDSecurityMonthlyDescriptor"...
, "DataDateSecurityMonthly", "TickerSymbol", "CUSIP", "CompanyName", "PriceCloseMonthly"...
, "SPHoldingsValueGrowthIndicator", "ccmbegdt", "Quarter", "Month", "LastMonthofQuarter"...
, "FirstMonthofQuarter", "YearLMoQ", "YearFMoQ", "YearFMNQ", "FundamentalsQuarter", "LastMofFundQ"...
, "StartingPrice"];
opts.VariableTypes = ["double", "categorical", "double", "categorical", "double", "double", "double"...
, "categorical", "double", "double", "string", "double", "string", "double", "string", "double"...
, "categorical", "double", "double", "double", "string", "string", "string", "categorical", "string"...
, "double"];
opts = setvaropts(opts, [11, 13, 15, 21, 22, 23, 25], "WhitespaceRule", "preserve");
opts = setvaropts(opts, [2, 4, 8, 11, 13, 15, 17, 21, 22, 23, 24, 25], "EmptyFieldRule", "auto");

% Import the data
MSC515Prices19951999 = readtable("C:\Users\Zack\Documents\MATLAB\MSC515Prices19951999.xlsx", opts...
, "UseExcel", false);

% Clear temporary variables
clear opts

% Remove entries where the "starting price" would be a useless 0
boolTemp1 = MSC515Prices19951999.FundamentalsQuarter ...
~= '1995Q3';
boolTemp2 = MSC515Prices19951999.StartingPrice ...
== 0;
boolComb = [boolTemp1 boolTemp2];
removeIndexes = false(length(boolComb), 1);
for i = 1:length(boolComb)
if (boolComb(i, 1) == true && boolComb(i, 2) == true)
removeIndexes(i, 1) = true;
end
end
MSC515Prices19951999(removeIndexes, :) = [];

%                   1999    2009
opts = spreadsheetImportOptions("NumVariables", 26);

```

```
% Specify sheet and range
opts.Sheet = "WRDS";
opts.DataRange = "A2:Z819432";

% Specify column names and types
opts.VariableNames = ["StandardandPoorsIdentifier", "PrimaryLinkMarker", "SecuritylevelIdentifier"...
, "LinkTypeCodd", "HistoricalCRSPPERMNOLinktoCOMPUSTATRecord", "HistoricalCRSPPERMCOLinktoCOMPUSTATRecord"...
, "FirstEffectiveDateofLink", "LastEffectiveDateofLink", "IssueIDSecurityMonthlyDescriptor"...
, "DataDateSecurityMonthly", "TickerSymbol", "CUSIP", "CompanyName", "PriceCloseMonthly"...
, "SPHoldingsValueGrowthIndicator", "ccmbegdt", "Quarter", "Month", "LastMonthofQuarter"...
, "FirstMonthofQuarter", "YearLMoQ", "YearFMoQ", "YearFMNQ", "FundamentalsQuarter", "LastMofFundQ"...
, "StartingPrice"];
opts.VariableTypes = ["double", "categorical", "double", "categorical", "double", "double", "double"...
, "categorical", "double", "double", "string", "double", "string", "double", "string", "double"...
, "categorical", "double", "double", "double", "string", "string", "string", "categorical", "string"...
, "double"];
opts = setvaropts(opts, [11, 13, 15, 21, 22, 23, 25], "WhitespaceRule", "preserve");
opts = setvaropts(opts, [2, 4, 8, 11, 13, 15, 17, 21, 22, 23, 24, 25], "EmptyFieldRule", "auto");

% Import the data
MSC515Prices19992009 = readtable("C:\Users\Zack\Documents\MATLAB\MSC515Prices19992009.xlsx", opts...
, "UseExcel", false);

% Clear temporary variables
clear opts

% Remove entries where the "starting price" would be a useless 0
boolTemp1 = MSC515Prices19992009.FundamentalsQuarter ...
~= '1999Q2';
boolTemp2 = MSC515Prices19992009.StartingPrice ...
== 0;
boolComb = [boolTemp1 boolTemp2];
removeIndexes = false(length(boolComb), 1);
for i = 1:length(boolComb)
if (boolComb(i, 1) == true && boolComb(i, 2) == true)
removeIndexes(i, 1) = true;
end
end
MSC515Prices19992009(removeIndexes, :) = [];

%                2009    2019
opts = spreadsheetImportOptions("NumVariables", 26);
```

```
121
122 % Specify sheet and range
123 opts.Sheet = "WRDS";
124 opts.DataRange = "A2:Z671321";
125
126 % Specify column names and types
127 opts.VariableNames = ["StandardandPoorsIdentifier", "PrimaryLinkMarker", "SecuritylevelIdentifier"...
128 , "LinkTypeCodd", "HistoricalCRSPPERMNOLinktoCOMPUSTATRecord", "HistoricalCRSPPERMCOLinktoCOMPUSTATRecord"...
129 , "FirstEffectiveDateofLink", "LastEffectiveDateofLink", "IssueIDSecurityMonthlyDescriptor"...
130 , "DataDateSecurityMonthly", "TickerSymbol", "CUSIP", "CompanyName", "PriceCloseMonthly"...
131 , "SPHoldingsValueGrowthIndicator", "ccmbegdt", "Quarter", "Month", "LastMonthofQuarter"...
132 , "FirstMonthofQuarter", "YearLMoQ", "YearFMoQ", "YearFMNQ", "FundamentalsQuarter", "LastMofFundQ"...
133 , "StartingPrice"];
134 opts.VariableTypes = ["double", "categorical", "double", "categorical", "double", "double", "double"...
135 , "categorical", "double", "double", "string", "double", "string", "double", "string", "double"...
136 , "categorical", "double", "double", "double", "string", "string", "string", "categorical", "string"...
137 , "double"];
138 opts = setvaropts(opts, [11, 13, 15, 21, 22, 23, 25], "WhitespaceRule", "preserve");
139 opts = setvaropts(opts, [2, 4, 8, 11, 13, 15, 17, 21, 22, 23, 24, 25], "EmptyFieldRule", "auto");
140
141 % Import the data
142 MSC515Prices20092019 = readtable("C:\Users\Zack\Documents\MATLAB\MSC515Prices20092019.xlsx", opts...
143 , "UseExcel", false);
144
145 % Clear temporary variables
146 clear opts
147
148 % Remove entries where the "starting price" would be a useless 0
149 boolTemp1 = MSC515Prices20092019.FundamentalsQuarter ...
150 ~= '2009Q2';
151 boolTemp2 = MSC515Prices20092019.StartingPrice ...
152 == 0;
153 boolComb = [boolTemp1 boolTemp2];
154 removeIndexes = false(length(boolComb), 1);
155 for i = 1:length(boolComb)
156 if (boolComb(i, 1) == true && boolComb(i, 2) == true)
157 removeIndexes(i, 1) = true;
158 end
159 end
160 MSC515Prices20092019(removeIndexes, :) = [];
161
162 % Bring the split price data together
```

```
MSC515Prices19952019 = [MSC515Prices19951999; MSC515Prices19992009; MSC515Prices20092019];

%% Organize the fundamental ticker data
dataQuarter = unique(MSC515Fundamentals19952019.CalendarDataYearandQuarter);
MSC515Fundamentals19952019 = fillmissing(MSC515Fundamentals19952019,'constant',0,'DataVariables', @isnumeric);

%    Some filtering  %
% Berkshire share count and price creates erroneous market caps?
MSC515Fundamentals19952019(MSC515Fundamentals19952019.CompanyName == "BERKSHIRE HATHAWAY", :) = [];
% Remove negative BPS and EPS. These aren't necessarily "bad," but
% will probably cause instability
MSC515Fundamentals19952019(MSC515Fundamentals19952019.BPS <= 0, :) = [];
MSC515Fundamentals19952019(MSC515Fundamentals19952019.EPS <= 0, :) = [];
% Remove time independent outliers (contemporaneous or time dependent outliers will also be
% removed when the portfolios are actually formed)
pBPS = prctile(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.BPS, [1 99]);
pEPS = prctile(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.EPS, [1 99]);
pOCFPS = prctile(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.OCFPS, [1 99]);
MSC515Fundamentals19952019(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.BPS ...
<= pBPS(1), :) = [];
MSC515Fundamentals19952019(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.BPS ...
>= pBPS(2), :) = [];
MSC515Fundamentals19952019(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.OCFPS ...
<= pOCFPS(1), :) = [];
MSC515Fundamentals19952019(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.OCFPS ...
>= pOCFPS(2), :) = [];
MSC515Fundamentals19952019(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.EPS ...
<= pEPS(1), :) = [];
MSC515Fundamentals19952019(MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.EPS ...
>= pEPS(2), :) = [];
%                           %

%   Filter out micro and nano capitalizations
MSC515Fundamentals19952019(MSC515Fundamentals19952019.MarketCap < 300000000, :) = [];
%
PERatio = MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.EPS;
PBRatio = MSC515Fundamentals19952019.SharePrice./MSC515Fundamentals19952019.BPS;
MSC515Fundamentals19952019 = [MSC515Fundamentals19952019 array2table(PERatio) array2table(PBRatio)];
calendarYear = MSC515Fundamentals19952019.CalendarDataYearandQuarter;
for i = 1:length(calendarYear)
tempVal = calendarYear(i, 1);
calendarYear(i, 1) = extractBetween(string(tempVal), 1, 4);
```

```
205 end
206 MSC515Fundamentals19952019 = [MSC515Fundamentals19952019 array2table(calendarYear)];
207
208 %    Summary Statistics of Fundamental Data  %
209 % Total
210 statArrayTotal = grpstats(MSC515Fundamentals19952019,[],{'mean','std','min'...
211 ,@(x) prctile(x,25),@(x) prctile(x,75),'median','max'},...
212 'DataVars',{'MarketCap','PERatio','PBRatio'});
213 % By Year
214 statArrayYear = grpstats(MSC515Fundamentals19952019,'calendarYear',{'mean','std','min'...
215 ,@(x) prctile(x,25),@(x) prctile(x,75),'median','max'},...
216 'DataVars',{'MarketCap','PERatio','PBRatio'});
217 %                                          %
218
219 % Loop through and store the firm identifiers that satisfy the
220 % quartiles for each data quarter
221 identifierStoreLower = cell(length(dataQuarter), 1);
222 for i = 1:length(identifierStoreLower)
223 identifierStoreLower{i, 1} = [];
224 dataTemp =  MSC515Fundamentals19952019(MSC515Fundamentals19952019.CalendarDataYearandQuarter ...
225 == dataQuarter(i, 1), :);
226 % Remove contemporaneous outliers
227 pBPS = prctile(dataTemp.SharePrice./dataTemp.BPS, [1 99]);
228 pEPS = prctile(dataTemp.SharePrice./dataTemp.EPS, [1 99]);
229 pOCFPS = prctile(dataTemp.SharePrice./dataTemp.OCFPS, [1 99]);
230 dataTemp(dataTemp.SharePrice./dataTemp.BPS ...
231 <= pBPS(1), :) = [];
232 dataTemp(dataTemp.SharePrice./dataTemp.BPS ...
233 >= pBPS(2), :) = [];
234 dataTemp(dataTemp.SharePrice./dataTemp.OCFPS ...
235 <= pOCFPS(1), :) = [];
236 dataTemp(dataTemp.SharePrice./dataTemp.OCFPS ...
237 >= pOCFPS(2), :) = [];
238 dataTemp(dataTemp.SharePrice./dataTemp.EPS ...
239 <= pEPS(1), :) = [];
240 dataTemp(dataTemp.SharePrice./dataTemp.EPS ...
241 >= pEPS(2), :) = [];
242 % Get the upper and lower percentiles of the cleaned current universe of data
243 pBPS = prctile(dataTemp.SharePrice./dataTemp.BPS, [20 80]);
244 pEPS = prctile(dataTemp.SharePrice./dataTemp.EPS, [20 80]);
245 pOCFPS = prctile(dataTemp.SharePrice./dataTemp.OCFPS, [20 80]);
246 for j = 1:height(dataTemp)
```

```
247 if (dataTemp.SharePrice(j)/dataTemp.BPS(j) <= pBPS(1) && ...
248 dataTemp.SharePrice(j)/dataTemp.EPS(j) <= pEPS(1))
249 identifierStoreLower{i, 1} = [identifierStoreLower{i, 1}; dataTemp.StandardandPoorsIdentifier(j)];
250 end
251 end
252 identifierStoreLower{i, 1} = unique(identifierStoreLower{i, 1});
253 end
254
255 % Split these upper and lower quintiles in alphabetical halfs. Note
256 % that this already assumes the data came in alphabetical order!
257 outlierVal = 0;
258 identifierStoreLowerA = cell(length(dataQuarter), 1);
259 identifierStoreLowerZ = cell(length(dataQuarter), 1);
260 for i = 1:length(identifierStoreLowerA)
261 identifierStoreLowerTemp = identifierStoreLower{i, 1};
262 if (mod(length(identifierStoreLowerTemp), 2) == 0)
263 outlierCount = ceil(length(identifierStoreLowerTemp) * outlierVal / 100);
264 identifierStoreLowerA{i, 1} = identifierStoreLowerTemp((1 + outlierCount):(length(identifierStoreLowerTemp) / 2), :);
265 identifierStoreLowerZ{i, 1} = ...
266 identifierStoreLowerTemp((length(identifierStoreLowerTemp) / 2 + 1):(end - outlierCount), :);
267 else
268 identifierStoreLowerA{i, 1} = ...
269 identifierStoreLowerTemp((1 + outlierCount):round(length(identifierStoreLowerTemp) / 2), :);
270 identifierStoreLowerZ{i, 1} = ...
271 identifierStoreLowerTemp((round(length(identifierStoreLowerTemp) / 2) + 1):(end - outlierCount), :);
272 end
273 end
274 % Split these upper and lower quintiles in alphabetical quarters. Note
275 % that this already assumes the data came in alphabetical order!
276 identifierStoreLowerQA = cell(length(dataQuarter), 1);
277 identifierStoreLowerQZ = cell(length(dataQuarter), 1);
278 for i = 1:length(identifierStoreLowerQA)
279 identifierStoreLowerTemp = identifierStoreLower{i, 1};
280 if (mod(length(identifierStoreLowerTemp), 4) == 0)
281 outlierCount = ceil(length(identifierStoreLowerTemp) * outlierVal / 100);
282 identifierStoreLowerQA{i, 1} = identifierStoreLowerTemp((1 + outlierCount)...
283 :(length(identifierStoreLowerTemp) / 4), :);
284 identifierStoreLowerQZ{i, 1} = ...
285 identifierStoreLowerTemp(end (length(identifierStoreLowerTemp) / 4):(end - outlierCount), :);
286 else
287 identifierStoreLowerQA{i, 1} = ...
288 identifierStoreLowerTemp((1 + outlierCount):round(length(identifierStoreLowerTemp) / 4), :);
```

```
identifierStoreLowerQZ{i, 1} = ...
identifierStoreLowerTemp(end (round(length(identifierStoreLowerTemp) / 4)):(end    outlierCount), :);
end
end

%% Run the portfolios

% Value Aggregate
% Gather the quarter by quarter pricing data needed
portfolioDataStoreLower = cell(length(dataQuarter)    1, 1);
pennyStockFilter = 5; % No stocks allowed to ENTER portfolio less than this price
for i = 1:(length(dataQuarter)    1)
dataTemp =  MSC515Prices19952019(MSC515Prices19952019.FundamentalsQuarter ...
== dataQuarter(i, 1), :);
dataTemp2 =  MSC515Fundamentals19952019(MSC515Fundamentals19952019.CalendarDataYearandQuarter ...
== dataQuarter(i, 1), :);
identifierStoreLowerTemp = identifierStoreLower{i};
for j = 1:length(identifierStoreLowerTemp)
tickerDataTemp = [];
for z = 1:height(dataTemp)
if (dataTemp.StandardandPoorsIdentifier(z) == identifierStoreLowerTemp(j) ...
&& dataTemp.StartingPrice(z) > pennyStockFilter && ...
years(datetime(num2str(dataTemp.DataDateSecurityMonthly(z)), 'InputFormat', 'yyyyMMdd') ...
  datetime(num2str(dataTemp.FirstEffectiveDateofLink(z)), 'InputFormat', 'yyyyMMdd')) ...
> 1) % Exclude starting penny stocks and near IPOs
for zz = 1:height(dataTemp2)
if (dataTemp2.StandardandPoorsIdentifier(zz) == identifierStoreLowerTemp(j))
tickerDataTemp = [tickerDataTemp; [dataTemp.DataDateSecurityMonthly(z) ...
dataTemp.PriceCloseMonthly(z) dataTemp.StartingPrice(z) ...
dataTemp2.CommonSharesOutstanding(zz)]];
end
end
end
end
if (~isempty(tickerDataTemp))
portfolioDataStoreLower{i} = [portfolioDataStoreLower{i}; {unique(tickerDataTemp, 'rows')}];
end
end
end
% Simulate the portfolio
capitalLower = 100;
equityLower = [];
```

```
equityLower = [equityLower; capitalLower];
for i = 1:length(portfolioDataStoreLower)
weightTemp =  equityLower(end)/length(portfolioDataStoreLower{i});
portfoliosTemp = zeros(length(portfolioDataStoreLower{i}), 1);
for jj = 1:3 % 3 Months per quarter
for j = 1:length(portfolioDataStoreLower{i})
if (jj == 1)
if ((portfolioDataStoreLower{i}{j}(1, 2) ...
/portfolioDataStoreLower{i}{j}(1, 3)) > 5)
portfoliosTemp(j) = portfoliosTemp(j);
else
portfoliosTemp(j) = weightTemp * portfolioDataStoreLower{i}{j}(1, 2) ...
/portfolioDataStoreLower{i}{j}(1, 3);
end
else
if (size(portfolioDataStoreLower{i}{j}, 1) < 3) % Assume total loss
portfoliosTemp(j) = 0;
elseif (isnan(portfolioDataStoreLower{i}{j}(jj, 2)) ...
|| portfolioDataStoreLower{i}{j}(jj, 2) ...
/portfolioDataStoreLower{i}{j}(jj - 1, 2) > 5) % What is NAN?
portfoliosTemp(j) = portfoliosTemp(j);
elseif (portfolioDataStoreLower{i}{j}(jj, 4) >= ...
1.95 * portfolioDataStoreLower{i}{j}(jj - 1, 4) ...
|| portfolioDataStoreLower{i}{j}(jj, 4) <= ...
0.55 * portfolioDataStoreLower{i}{j}(jj - 1, 4)) % Stock splits
portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLower{i}{j}(jj, 2) ...
/(portfolioDataStoreLower{i}{j}(jj - 1, 2) /...
portfolioDataStoreLower{i}{j}(jj, 4)/portfolioDataStoreLower{i}{j}(jj - 1, 4));
else
portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLower{i}{j}(jj, 2) ...
/portfolioDataStoreLower{i}{j}(jj - 1, 2);
end
end
end
capitalLower = sum(portfoliosTemp);
equityLower = [equityLower; capitalLower];
end
end

% Value Half A
% Gather the quarter by quarter pricing data needed
portfolioDataStoreLowerA = cell(length(dataQuarter) - 1, 1);
```

```
for i = 1:(length(dataQuarter)    1)
dataTemp =  MSC515Prices19952019(MSC515Prices19952019.FundamentalsQuarter ...
== dataQuarter(i, 1), :);
dataTemp2 =  MSC515Fundamentals19952019(MSC515Fundamentals19952019.CalendarDataYearandQuarter ...
== dataQuarter(i, 1), :);
identifierStoreLowerATemp = identifierStoreLowerA{i};
for j = 1:length(identifierStoreLowerATemp)
tickerDataTemp = [];
for z = 1:height(dataTemp)
if (dataTemp.StandardandPoorsIdentifier(z) == identifierStoreLowerATemp(j) ...
&& dataTemp.StartingPrice(z) > pennyStockFilter && ...
years(datetime(num2str(dataTemp.DataDateSecurityMonthly(z)), 'InputFormat', 'yyyyMMdd') ...
  datetime(num2str(dataTemp.FirstEffectiveDateofLink(z)), 'InputFormat', 'yyyyMMdd')) ...
> 1) % Exclude starting penny stocks and near IPOs
for zz = 1:height(dataTemp2)
if (dataTemp2.StandardandPoorsIdentifier(zz) == identifierStoreLowerATemp(j))
tickerDataTemp = [tickerDataTemp; [dataTemp.DataDateSecurityMonthly(z) ...
dataTemp.PriceCloseMonthly(z) dataTemp.StartingPrice(z) ...
dataTemp2.CommonSharesOutstanding(zz)]];
end
end
end
end
if (~isempty(tickerDataTemp))
portfolioDataStoreLowerA{i} = [portfolioDataStoreLowerA{i}; {unique(tickerDataTemp, 'rows')}];
end
end
end
% Simulate the portfolio
capitalLowerA = 100;
equityLowerA = [];
equityLowerA = [equityLowerA; capitalLowerA];
for i = 1:length(portfolioDataStoreLowerA)
weightTemp =  equityLowerA(end)/length(portfolioDataStoreLowerA{i});
portfoliosTemp = zeros(length(portfolioDataStoreLowerA{i}), 1);
for jj = 1:3 % 3 Months per quarter
for j = 1:length(portfolioDataStoreLowerA{i})
if (jj == 1)
if ((portfolioDataStoreLowerA{i}{j}(1, 2) ...
/portfolioDataStoreLowerA{i}{j}(1, 3)) > 5)
portfoliosTemp(j) = portfoliosTemp(j);
else
```

```
portfoliosTemp(j) = weightTemp * portfolioDataStoreLowerA{i}{j}(1, 2) ...
/portfolioDataStoreLowerA{i}{j}(1, 3);
end
else
if (size(portfolioDataStoreLowerA{i}{j}, 1) < 3) % Assume total loss
portfoliosTemp(j) = 0;
elseif (isnan(portfolioDataStoreLowerA{i}{j}(jj, 2)) ...
|| portfolioDataStoreLowerA{i}{j}(jj, 2) ...
/portfolioDataStoreLowerA{i}{j}(jj    1, 2) > 5) % What is NAN?
portfoliosTemp(j) = portfoliosTemp(j);
elseif (portfolioDataStoreLowerA{i}{j}(jj, 4) >= ...
1.95 * portfolioDataStoreLowerA{i}{j}(jj    1, 4) ...
|| portfolioDataStoreLowerA{i}{j}(jj, 4) <= ...
0.55 * portfolioDataStoreLowerA{i}{j}(jj    1, 4)) % Stock splits
portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLowerA{i}{j}(jj, 2) ...
/(portfolioDataStoreLowerA{i}{j}(jj    1, 2) /...
portfolioDataStoreLowerA{i}{j}(jj, 4)/portfolioDataStoreLowerA{i}{j}(jj    1, 4));
else
portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLowerA{i}{j}(jj, 2) ...
/portfolioDataStoreLowerA{i}{j}(jj    1, 2);
end
end
end
capitalLowerA = sum(portfoliosTemp);
equityLowerA = [equityLowerA; capitalLowerA];
end
end

% Value Quartile A
% Gather the quarter by quarter pricing data needed
portfolioDataStoreLowerQA = cell(length(dataQuarter)    1, 1);
for i = 1:(length(dataQuarter)    1)
dataTemp =  MSC515Prices19952019(MSC515Prices19952019.FundamentalsQuarter ...
== dataQuarter(i, 1), :);
dataTemp2 =  MSC515Fundamentals19952019(MSC515Fundamentals19952019.CalendarDataYearandQuarter ...
== dataQuarter(i, 1), :);
identifierStoreLowerQATemp = identifierStoreLowerQA{i};
for j = 1:length(identifierStoreLowerQATemp)
tickerDataTemp = [];
for z = 1:height(dataTemp)
if (dataTemp.StandardandPoorsIdentifier(z) == identifierStoreLowerQATemp(j) ...
&& dataTemp.StartingPrice(z) > pennyStockFilter && ...
```

```
457  years(datetime(num2str(dataTemp.DataDateSecurityMonthly(z)), 'InputFormat', 'yyyyMMdd') ...
458    datetime(num2str(dataTemp.FirstEffectiveDateofLink(z)), 'InputFormat', 'yyyyMMdd')) ...
459  > 1) % Exclude starting penny stocks and near IPOs
460  for zz = 1:height(dataTemp2)
461  if (dataTemp2.StandardandPoorsIdentifier(zz) == identifierStoreLowerQATemp(j))
462  tickerDataTemp = [tickerDataTemp; [dataTemp.DataDateSecurityMonthly(z) ...
463  dataTemp.PriceCloseMonthly(z) dataTemp.StartingPrice(z) ...
464  dataTemp2.CommonSharesOutstanding(zz)]];
465  end
466  end
467  end
468  end
469  if (~isempty(tickerDataTemp))
470  portfolioDataStoreLowerQA{i} = [portfolioDataStoreLowerQA{i}; {unique(tickerDataTemp, 'rows')}];
471  end
472  end
473  end
474  % Simulate the portfolio
475  capitalLowerQA = 100;
476  equityLowerQA = [];
477  equityLowerQA = [equityLowerQA; capitalLowerQA];
478  for i = 1:length(portfolioDataStoreLowerQA)
479  weightTemp =  equityLowerQA(end)/length(portfolioDataStoreLowerQA{i});
480  portfoliosTemp = zeros(length(portfolioDataStoreLowerQA{i}), 1);
481  for jj = 1:3 % 3 Months per quarter
482  for j = 1:length(portfolioDataStoreLowerQA{i})
483  if (jj == 1)
484  if ((portfolioDataStoreLowerQA{i}{j}(1, 2) ...
485  /portfolioDataStoreLowerQA{i}{j}(1, 3)) > 5)
486  portfoliosTemp(j) = portfoliosTemp(j);
487  else
488  portfoliosTemp(j) = weightTemp * portfolioDataStoreLowerQA{i}{j}(1, 2) ...
489  /portfolioDataStoreLowerQA{i}{j}(1, 3);
490  end
491  else
492  if (size(portfolioDataStoreLowerQA{i}{j}, 1) < 3) % Assume total loss
493  portfoliosTemp(j) = 0;
494  elseif (isnan(portfolioDataStoreLowerQA{i}{j}(jj, 2)) ...
495  || portfolioDataStoreLowerQA{i}{j}(jj, 2) ...
496  /portfolioDataStoreLowerQA{i}{j}(jj    1, 2) > 5) % What is NAN?
497  portfoliosTemp(j) = portfoliosTemp(j);
498  elseif (portfolioDataStoreLowerQA{i}{j}(jj, 4) >= ...
```

```
1.95 * portfolioDataStoreLowerQA{i}{j}(jj    1, 4) ...
|| portfolioDataStoreLowerQA{i}{j}(jj, 4) <= ...
0.55 * portfolioDataStoreLowerQA{i}{j}(jj    1, 4)) % Stock splits
portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLowerQA{i}{j}(jj, 2) ...
/(portfolioDataStoreLowerQA{i}{j}(jj    1, 2) /...
portfolioDataStoreLowerQA{i}{j}(jj, 4)/portfolioDataStoreLowerQA{i}{j}(jj    1, 4));
else
portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLowerQA{i}{j}(jj, 2) ...
/portfolioDataStoreLowerQA{i}{j}(jj    1, 2);
end
end
end
capitalLowerQA = sum(portfoliosTemp);
equityLowerQA = [equityLowerQA; capitalLowerQA];
end
end

% Value Half Z
% Gather the quarter by quarter pricing data needed
portfolioDataStoreLowerZ = cell(length(dataQuarter)    1, 1);
for i = 1:(length(dataQuarter)    1)
dataTemp =  MSC515Prices19952019(MSC515Prices19952019.FundamentalsQuarter ...
== dataQuarter(i, 1), :);
dataTemp2 =  MSC515Fundamentals19952019(MSC515Fundamentals19952019.CalendarDataYearandQuarter ...
== dataQuarter(i, 1), :);
identifierStoreLowerZTemp = identifierStoreLowerZ{i};
for j = 1:length(identifierStoreLowerZTemp)
tickerDataTemp = [];
for z = 1:height(dataTemp)
if (dataTemp.StandardandPoorsIdentifier(z) == identifierStoreLowerZTemp(j) ...
&& dataTemp.StartingPrice(z) > pennyStockFilter && ...
years(datetime(num2str(dataTemp.DataDateSecurityMonthly(z)), 'InputFormat', 'yyyyMMdd') ...
  datetime(num2str(dataTemp.FirstEffectiveDateofLink(z)), 'InputFormat', 'yyyyMMdd')) ...
> 1) % Exclude starting penny stocks and near IPOs
for zz = 1:height(dataTemp2)
if (dataTemp2.StandardandPoorsIdentifier(zz) == identifierStoreLowerZTemp(j))
tickerDataTemp = [tickerDataTemp; [dataTemp.DataDateSecurityMonthly(z) ...
dataTemp.PriceCloseMonthly(z) dataTemp.StartingPrice(z) ...
dataTemp2.CommonSharesOutstanding(zz)]];
end
end
end
```

```
end
if (~isempty(tickerDataTemp))
portfolioDataStoreLowerZ{i} = [portfolioDataStoreLowerZ{i}; {unique(tickerDataTemp, 'rows')}];
end
end
end
% Simulate the portfolio
capitalLowerZ = 100;
equityLowerZ = [];
equityLowerZ = [equityLowerZ; capitalLowerZ];
for i = 1:length(portfolioDataStoreLowerZ)
weightTemp =  equityLowerZ(end)/length(portfolioDataStoreLowerZ{i});
portfoliosTemp = zeros(length(portfolioDataStoreLowerZ{i}), 1);
for jj = 1:3 % 3 Months per quarter
for j = 1:length(portfolioDataStoreLowerZ{i})
if (jj == 1)
if ((portfolioDataStoreLowerZ{i}{j}(1, 2) ...
/portfolioDataStoreLowerZ{i}{j}(1, 3)) > 5)
portfoliosTemp(j) = portfoliosTemp(j);
else
portfoliosTemp(j) = weightTemp * portfolioDataStoreLowerZ{i}{j}(1, 2) ...
/portfolioDataStoreLowerZ{i}{j}(1, 3);
end
else
if (size(portfolioDataStoreLowerZ{i}{j}, 1) < 3) % Assume total loss
portfoliosTemp(j) = 0;
elseif (isnan(portfolioDataStoreLowerZ{i}{j}(jj, 2)) ...
|| portfolioDataStoreLowerZ{i}{j}(jj, 2) ...
/portfolioDataStoreLowerZ{i}{j}(jj    1, 2) > 5) % What is NAN?
portfoliosTemp(j) = portfoliosTemp(j);
elseif (portfolioDataStoreLowerZ{i}{j}(jj, 4) >= ...
1.95 * portfolioDataStoreLowerZ{i}{j}(jj    1, 4) ...
|| portfolioDataStoreLowerZ{i}{j}(jj, 4) <= ...
0.55 * portfolioDataStoreLowerZ{i}{j}(jj    1, 4)) % Stock splits
portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLowerZ{i}{j}(jj, 2) ...
/(portfolioDataStoreLowerZ{i}{j}(jj    1, 2) /...
portfolioDataStoreLowerZ{i}{j}(jj, 4)/portfolioDataStoreLowerZ{i}{j}(jj    1, 4));
else
portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLowerZ{i}{j}(jj, 2) ...
/portfolioDataStoreLowerZ{i}{j}(jj    1, 2);
end
end
```

```
end
capitalLowerZ = sum(portfoliosTemp);
equityLowerZ = [equityLowerZ; capitalLowerZ];
end
end

% Value Quartile Z
% Gather the quarter by quarter pricing data needed
portfolioDataStoreLowerQZ = cell(length(dataQuarter)   1, 1);
for i = 1:(length(dataQuarter)   1)
dataTemp =  MSC515Prices19952019(MSC515Prices19952019.FundamentalsQuarter ...
== dataQuarter(i, 1), :);
dataTemp2 =  MSC515Fundamentals19952019(MSC515Fundamentals19952019.CalendarDataYearandQuarter ...
== dataQuarter(i, 1), :);
identifierStoreLowerQZTemp = identifierStoreLowerQZ{i};
for j = 1:length(identifierStoreLowerQZTemp)
tickerDataTemp = [];
for z = 1:height(dataTemp)
if (dataTemp.StandardandPoorsIdentifier(z) == identifierStoreLowerQZTemp(j) ...
&& dataTemp.StartingPrice(z) > pennyStockFilter && ...
years(datetime(num2str(dataTemp.DataDateSecurityMonthly(z)), 'InputFormat', 'yyyyMMdd') ...
  datetime(num2str(dataTemp.FirstEffectiveDateofLink(z)), 'InputFormat', 'yyyyMMdd')) ...
> 1) % Exclude starting penny stocks and near IPOs
for zz = 1:height(dataTemp2)
if (dataTemp2.StandardandPoorsIdentifier(zz) == identifierStoreLowerQZTemp(j))
tickerDataTemp = [tickerDataTemp; [dataTemp.DataDateSecurityMonthly(z) ...
dataTemp.PriceCloseMonthly(z) dataTemp.StartingPrice(z) ...
dataTemp2.CommonSharesOutstanding(zz)]];
end
end
end
end
if (~isempty(tickerDataTemp))
portfolioDataStoreLowerQZ{i} = [portfolioDataStoreLowerQZ{i}; {unique(tickerDataTemp, 'rows')}];
end
end
end
% Simulate the portfolio
capitalLowerQZ = 100;
equityLowerQZ = [];
equityLowerQZ = [equityLowerQZ; capitalLowerQZ];
for i = 1:length(portfolioDataStoreLowerQZ)
```

```
625 weightTemp =  equityLowerQZ(end)/length(portfolioDataStoreLowerQZ{i});
626 portfoliosTemp = zeros(length(portfolioDataStoreLowerQZ{i}), 1);
627 for jj = 1:3 % 3 Months per quarter
628 for j = 1:length(portfolioDataStoreLowerQZ{i})
629 if (jj == 1)
630 if ((portfolioDataStoreLowerQZ{i}{j}(1, 2) ...
631 /portfolioDataStoreLowerQZ{i}{j}(1, 3)) > 5)
632 portfoliosTemp(j) = portfoliosTemp(j);
633 else
634 portfoliosTemp(j) = weightTemp * portfolioDataStoreLowerQZ{i}{j}(1, 2) ...
635 /portfolioDataStoreLowerQZ{i}{j}(1, 3);
636 end
637 else
638 if (size(portfolioDataStoreLowerQZ{i}{j}, 1) < 3) % Assume total loss
639 portfoliosTemp(j) = 0;
640 elseif (isnan(portfolioDataStoreLowerQZ{i}{j}(jj, 2)) ...
641 || portfolioDataStoreLowerQZ{i}{j}(jj, 2) ...
642 /portfolioDataStoreLowerQZ{i}{j}(jj   1, 2) > 5) % What is NAN?
643 portfoliosTemp(j) = portfoliosTemp(j);
644 elseif (portfolioDataStoreLowerQZ{i}{j}(jj, 4) >= ...
645 1.95 * portfolioDataStoreLowerQZ{i}{j}(jj   1, 4) ...
646 || portfolioDataStoreLowerQZ{i}{j}(jj, 4) <= ...
647 0.55 * portfolioDataStoreLowerQZ{i}{j}(jj   1, 4)) % Stock splits
648 portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLowerQZ{i}{j}(jj, 2) ...
649 /(portfolioDataStoreLowerQZ{i}{j}(jj   1, 2) /...
650 portfolioDataStoreLowerQZ{i}{j}(jj, 4)/portfolioDataStoreLowerQZ{i}{j}(jj   1, 4));
651 else
652 portfoliosTemp(j) = portfoliosTemp(j) * portfolioDataStoreLowerQZ{i}{j}(jj, 2) ...
653 /portfolioDataStoreLowerQZ{i}{j}(jj   1, 2);
654 end
655 end
656 end
657 capitalLowerQZ = sum(portfoliosTemp);
658 equityLowerQZ = [equityLowerQZ; capitalLowerQZ];
659 end
660 end
```