Can Academic Research Generate New Anomalies?

Online Appendix

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A Betting against alpha and betting against beta strategies across size

Most long-short strategies that produce abnormal returns show decreasing performance as companies with low market capitalization values are removed from the sample (e.g., Fama and French 2008). In fact, the positive risk premiums generated by many factors disappear once small companies (or even micro cap companies) are removed from the sample. Therefore, it is important to study the performance of strategies for different levels of market cap.

Before performing the analysis separating companies by market capitalization, it is important to remember that the relationship between size and realized alpha, as well as that between size and realized beta, has an inverted U-shape form.[1] This means that there are small stocks at both extremes of the alpha and beta ranges. Thus, removing small stocks will negatively affect the BAA and BAB strategies' performance metrics.

Using the NYSE 30th and 70th percentile for market capitalization cutoff values, every December, I divide the dataset into three categories: (i) *30% Small*, which contains all firms whose market cap is equal to or below the 30th percentile; (ii) *40% Medium*, which contains all firms whose market cap is greater than the 30th percentile and lower than or equal to the 70th percentile; and (iii)

[1] See Table 4 in Section 4.3.1 and the corresponding discussion in the last paragraph of that section.

30% Big, which contains those firms with a market cap value greater than the 70th percentile. For each group, I construct the BAA and BAB strategies and run the same performance metrics as in the main body of the paper. As in the benchmark scenario, all strategies use a 12-month holding period.[2] Results are presented in Table A1.

[Insert Table A1 around here]

Sharpe Ratios decrease as the market capitalization value of the companies used to construct the strategies increases. However, an important desirable property is maintained: For both strategies, the Sharpe Ratio of the low portfolio surpasses that of the large one across all size groups. When looking at average returns, all strategies produce positive risk premiums across size groups too. In the case of the BAA strategy, the low portfolio generates higher average returns than the high portfolio across all size groups.

The CAPM cannot price the factors constructed with any set of market capitalization clusters, generating abnormal returns at the 1% level of significance or less across all groups. The only exception is the BAA strategy, which generates abnormal returns at the 5% level of significance or less when the 30% largest stocks are used. When controlling for the Carhart model, the results for the BAA strategy are quite similar to those obtained when controlling for the CAPM. The BAB factor presents a different scenario: It only generates statistically significant abnormal returns when small stocks are used. The BAA strategy loses some power when controlling for the Carhart model, generating statistically significant abnormal returns at the 1% level or less only for the small and medium groups, while for the group of large stocks the abnormal returns are significant at the 5% level. Finally, when I control for the FF6 or FF6+Rev model, the BAB factor only generates abnormal returns when small cap assets are used. The BAA strategy still generates statistically significant abnormal returns for the 40% Medium group, but no strategy generates significant abnormal returns for the 30% Big one.

Overall, I find that the analyzed strategies maintain some desirable properties across all size groups, like decreasing Sharpe Ratios across portfolios and positive risk premiums. As I include

[2] Results improve for the BAA strategy when using a 24-month holding period and for the BAB factor when using a 1-month holding period.

more factors in the empirical asset pricing model used to test the strategies, abnormal returns for strategies using only large stocks diminish and for the FF6 and FF6+Rev models disappear.

B Betting against alpha and betting against beta strategies for different holding periods

In this Section I analyze the performance of the different strategies when rebalancing them every 1-month, 6-month, 12-month (benchmark scenario), 24-month, and 48-month period. As in the main body of the paper, I use the same weights for every strategy, where I recalculate the weights at the end of each holding period using the formulas presented in Section 3.2.

Table B1 presents the performance metrics across holding period returns for the BAA and BAB strategies.

[Insert Table B1 around here]

The BAA strategy shows its best performance when rebalancing portfolios every 24 months. For the BAB factor, Sharpe Ratios and abnormal returns decrease when augmenting the holding period of the strategy. For this factor, the highest Sharpe Ratio, average returns, and abnormal returns are observed when the strategy is rebalanced monthly as suggested in Frazzini and Pedersen (FP, 2014).

C Betting against idiosyncratic and total volatility

In this Section I present the performance metrics of two more "betting against" strategies mentioned in Section 4.3.1: (i) Betting Against Total Volatility (BATV) and (ii) Betting Against Idiosyncratic Volatility (BAIV). These strategies are constructed using the same weight for the long and short portfolios already used for the BAA and BAB strategies. In the BATV strategy, assets are sorted according to their realized variance during the 60 months prior to the sorting date. In the BAIV strategy, assets are sorted according to their residual variance calculated from the CAPM regression using data from 60 months prior to the sorting date. Results are presented in Table C1 below.

[Insert Table C1 around here]

Finally, Table C2 presents the correlation coefficients between the BAA, BAB, BATV, and BAIV strategies reported in Section 4.3.1 in the main body of the paper.

[Insert Table C2 around here]

D Construction of the citations' indices

This Section describes the construction of the citation indices depicted in Figure 5 and Figure 6. The source data is extracted from Google Scholar search engine results using Harzing's (2007) program *Publish or Perish* version 6.27.6194. This program allowed me to create Excel spreadsheets with the yearly outcomes from the Google Scholar search engine. In my calculations I only kept those works having at least one citation in Google Scholar. Since Google Scholar limits the results of any search to the 1000 most cited papers, I stopped my search when the yearly results showed 1000 works with at least 1 citation. For the case when searching for the phrase "Capital Asset Pricing Model," this limit was reached in 2009. Therefore, I stopped in 2008.

To calculate the number of academic works containing the phrase "Capital Asset Pricing Model" presented in Figure 5, I searched this phrase yearly starting in 1950. However, focusing on just this phrase left out of the sample important works like Mossin (1966). This is because the name Capital Asset Pricing Model became popular by the end of the 1960s. For this reason, I added to the sample the results of searches for "Capital Asset Prices" between 1920 and 1975, while removing entries already obtained when searching for "Capital Asset Pricing Model" to avoid double counting.

I followed a similar procedure to calculate the number of academic works containing the phrase "Arbitrage Pricing Theory" and the phrase "Capital Asset Pricing Model" plus either the word "Anomaly" or "Anomalies." For these two searches, the limit of 1000 results with at least one citation in a year was never reached.

References

[1] Carhart M., 1997, On persistence in mutual fund performance, *Journal of Finance* 52, 57-82.

[2] Fama E. and K. French, 2008, Dissecting anomalies, *Journal of Finance* 63, 1653-1678.

[3] Fama E. and K. French, 2018, Choosing factors, *Journal of Financial Economics* 128, 234-252

[4] Frazzini A. and L. H. Pedersen, 2014, Betting against beta, *Journal of Financial Economics* 111, 1-25.

[5] Harzing A., 2007, Publish or Perish, available from http://www.harzing.com/pop.htm

[6] Mossin J., 1966, Equilibrium in a capital asset market, *Econometrica* 35, 768-783.

Online Appendix

Table A1: BAA and BAB for different ranges of market capitalization

This table presents the monthly performance metrics for the excess returns over the risk-free rate of the low portfolio, the excess returns over the risk-free rate of the high portfolio, and low minus high strategy used to construct Betting Against Alpha (BAA) and Betting Against Beta (BAB) strategies for sets containing assets grouped by their market capitalization value. These metrics are the monthly Sharpe Ratios; monthly Excess Returns over the one-month T-bill; and abnormal returns for the CAPM, Carhart (1997), Fama-French Six Factor (FF6, 2018), and FF6 plus reversal factors (FF6+Rev) models. The CAPM model contains only the Market factor. Carhart augments the CAPM with the SMB, HML, and MOM factors. FF6 augments the Carhart model with the RMW and CMA factors. FF6+Rev augments the FF6 model with the LTR and STR factors. The abnormal returns are estimated by OLS and their significance levels are calculated using heteroskedastic robust standard errors. The column Low (High) Alpha [Beta] shows the results for the portfolio containing assets with realized alphas [betas] below (above) the median alpha [beta] value. Alphas and betas used to assign assets to the low and high portfolios are estimated with OLS regressions using the CAPM model. I use 5-year data to calculate alphas and betas and rebalance the portfolios yearly, at the end of December. Additionally, at the moment of rebalancing, I use NYSE break points to create three sets of data: (i) 30% Small, which contains all firms whose market cap is equal to or below the 30th percentile; (ii) 40% Medium, which contains all firms whose market cap is greater than the 30th percentile and lower than or equal to the 70th percentile; and (iii) 30% Big, which contains those firms with a market cap value greater than the 70th percentile. I use monthly data corresponding to the period January 1968 – December 2015 to construct portfolios and factors for the period January 1973 – December 2015. Individual data on stock returns comes from the CRSP database, while the data for the CAPM, Carhart, FF6, and FF6+Rev models comes from Kenneth French's webpage.

	Betting Against Alpha			Betting Against Beta		
	Low	High	Low-High	Low	High	Low-High
	Sharpe Ratio					
30% Small	0.19	0.13	0.23	0.22	0.14	0.26
40% Medium	0.13	0.10	0.15	0.18	0.09	0.20
30% Big	0.13	0.09	0.14	0.17	0.08	0.19
	Average Returns					
30% Small	1.44%	0.80%	2.03%	0.94%	1.13%	0.85%
40% Medium	0.76%	0.59%	0.96%	0.67%	0.64%	0.70%
30% Big	0.64%	0.52%	0.82%	0.65%	0.51%	0.76%
	CAPM Alpha					
30% Small	0.88%***	0.26%**	1.47%***	0.61%***	0.42%**	0.81%***
40% Medium	0.21%*	-0.02%	0.46%***	0.32%***	-0.11%	0.64%***
30% Big	0.12%*	-0.07%	0.36%**	0.28%***	-0.19%**	0.64%***
	Carhart Alpha					
30% Small	0.82%***	0.17%*	1.55%***	0.44%***	0.48%**	0.51%***
40% Medium	0.13%**	-0.05%	0.40%***	0.10%*	0.00%	0.20%
30% Big	0.08%*	0.03%	0.28%**	0.10%*	0.03%	0.20%
	FF6 Alpha					
30% Small	0.87%***	0.16%*	1.76%***	0.39%***	0.56%***	0.41%***
40% Medium	0.08%	-0.07%	0.43%***	0.03%	0.03%	0.07%
30% Big	0.01%	0.04%	0.19%	0.00%	0.09%	-0.01%
	FF6+Rev Alpha					
30% Small	0.83%***	0.10%	1.72%***	0.35%***	0.52%***	0.35%***
40% Medium	0.05%	-0.09%	0.38%***	-0.02%	0.03%	-0.01%
30% Big	-0.01%	0.02%	0.18*	-0.02%	0.06%	-0.04%

* 10%, ** 5%, *** 1%

Table B1: BAA and BAB strategies constructed using different holding periods for the assets

This table presents the monthly performance metrics over different holding periods for the excess returns over the risk-free rate of the low portfolio, the excess returns over the risk-free rate of the high portfolio, and low minus high strategy used to construct Betting Against Alpha (BAA) and Betting Against Beta (BAB) strategies. These metrics are the monthly Sharpe Ratios; monthly Excess Returns over the one-month T-bill; and abnormal returns for the CAPM, Carhart (1997), Fama-French Six Factor (FF6, 2018), and FF6 plus reversal factors (FF6+Rev) models. The CAPM model contains only the Market factor. Carhart augments the CAPM with the SMB, HML, and MOM factors. FF6 augments the Carhart model with the RMW and CMA factors. FF6+Rev augments the FF6 model with the LTR and STR factors. The abnormal returns are estimated by OLS and their significance levels are calculated using heteroskedastic robust standard errors. The column Low (High) Alpha [Beta] shows the results for the portfolio containing assets with realized alphas [betas] below (above) the median alpha [beta] value. Alphas and betas to assign assets to the low and high portfolios are estimated with OLS regressions using the CAPM model. I use 5-year data to calculate alphas and betas and rebalance the portfolios using the following frequencies: 1, 6, 12, 24, and 48 months. I use monthly data corresponding to the period January 1968 – December 2015 to construct portfolios and low-high strategies for the period January 1973 – December 2015. Individual data on stock returns comes from the CRSP database, while the data for the CAPM, Carhart, FF6, and FF6+Rev models comes from Kenneth French's webpage.

	Betting Against Alpha			Betting Against Beta		
	Low Alpha	High Alpha	Low-High	Low Beta	High Beta	Low-High
Sharpe Ratio						
1 month	0.17	0.13	**0.18**	0.22	0.11	**0.28**
6 month	0.16	0.13	**0.18**	0.22	0.12	**0.27**
12 month	0.18	0.12	**0.22**	0.22	0.12	**0.26**
24 month	0.20	0.12	**0.24**	0.22	0.13	**0.24**
48 month	0.21	0.13	**0.25**	0.22	0.14	**0.23**
Average Returns						
1 month	1.10%	0.77%	**1.45%**	0.82%	0.87%	**0.87%**
6 month	1.07%	0.75%	**1.39%**	0.81%	0.89%	**0.80%**
12 month	1.15%	0.67%	**1.60%**	0.81%	0.90%	**0.79%**
24 month	1.25%	0.64%	**1.75%**	0.82%	0.96%	**0.70%**
48 month	1.23%	0.72%	**1.53%**	0.81%	1.01%	**0.66%**
CAPM Alpha						
1 month	0.55%***	0.19%**	**0.92%*** **	0.49%***	0.14%	**0.82%*** **
6 month	0.52%***	0.17%*	**0.88%*** **	0.48%***	0.16%	**0.75%*** **
12 month	0.60%***	0.10%	**1.10%*** **	0.47%***	0.18%	**0.73%*** **
24 month	0.69%***	0.08%	**1.22%*** **	0.47%***	0.25%***	**0.65%*** **
48 month	0.69%***	0.14%*	**1.06%*** **	0.46%***	0.31%**	**0.57%*** **
Carhart Alpha						
1 month	0.55%***	0.12%**	**1.08%*** **	0.31%***	0.25%***	**0.45%*** **
6 month	0.49%***	0.12%**	**0.95%*** **	0.30%***	0.26%***	**0.40%*** **
12 month	0.55%***	0.06%	**1.12%*** **	0.30%***	0.27%***	**0.40%*** **
24 month	0.61%***	0.07%	**1.16%*** **	0.29%***	0.33%***	**0.31%*** **
48 month	0.60%***	0.12%**	**1.04%*** **	0.29%***	0.37%***	**0.26%** **
FF6 Alpha						
1 month	0.56%***	0.14%**	**1.18%*** **	0.26%***	0.33%***	**0.35%*** **
6 month	0.49%***	0.12%*	**1.06%*** **	0.24%***	0.32%***	**0.29%*** **
12 month	0.55%***	0.05%	**1.24%*** **	0.24%***	0.32%***	**0.29%*** **
24 month	0.62%***	0.02%	**1.34%*** **	0.23%***	0.36%***	**0.21%** **
48 month	0.56%***	0.10%**	**1.11%*** **	0.25%***	0.39%***	**0.22%** **
FF6+Rev Alpha						
1 month	0.49%***	0.12%**	**1.08%*** **	0.23%***	0.28%***	**0.33%*** **
6 month	0.45%***	0.09%	**1.00%*** **	0.21%***	0.29%***	**0.24%** **
12 month	0.52%***	0.01%	**1.20%*** **	0.20%***	0.29%***	**0.23%** **
24 month	0.59%***	-0.02%	**1.31%*** **	0.19%***	0.34%***	**0.15%**
48 month	0.53%***	0.07%	**1.07%*** **	0.21%***	0.37%***	**0.15%**

* 10%, ** 5%, *** 1%

Table C1: Betting Against Total Volatility and Betting Against Idiosyncratic Volatility performance metrics

This table presents the monthly performance metrics for the excess returns over the risk free-rate of the low portfolio, the excess returns over the risk free-rate of the high portfolio, and the low minus high strategy used to construct the Betting Against Total Volatility and Betting Against Idiosyncratic Volatility factors. These metrics are the monthly Sharpe Ratios; monthly Excess Returns over the one-month T-bill; and abnormal returns for the CAPM, Carhart (1997), Fama-French Six Factor (FF6, 2018), and FF6 plus reversal factors (FF6+Rev) models. The CAPM model contains only the Market factor. Carhart augments the CAPM with the SMB, HML, and MOM factors. FF6 augments the Carhart model with the RMW and CMA factors. FF6+Rev augments the FF6 model with the LTR and STR factors. The abnormal returns are estimated by OLS and the t-statistics reported in parentheses are constructed using heteroskedastic robust standard errors. The variable Size corresponds to the market cap value of the portfolios in 2010 US dollars. The column Low (High) Volat shows the results for the portfolio containing assets with low (high) volatility calculated at the moment of rebalancing. Total volatility is calculated as the variance of an asset while idiosyncratic volatility is calculated as the residual variance from OLS regressions using the CAPM model. I use 5-year data to calculate the volatility measures and rebalance the portfolios yearly, at the end of December. I use monthly data corresponding to the period January 1968 – December 2015 to construct portfolios and factors for the period January 1973 – December 2015. Individual data on stock returns comes from the CRSP database, while the data for the CAPM, Carhart, FF6, and FF6+Rev models comes from Kenneth French’s webpage.

	Betting Against Total Volatility			Betting Against Idiosyncratic Volatility		
	Low Volat	High Volat	**Low - High**	Low Volat	High Volat	**Low - High**
Sharpe Ratio	0.19	0.14	**0.12**	0.19	0.14	**0.11**
Excess Return	0.68%	1.09%	**0.44%**	0.67%	1.10%	**0.43%**
CAPM alpha	0.34%	0.40%	**0.36%**	0.31%	0.44%	**0.30%**
	(4.45)	(1.96)	(2.19)	(4.19)	(2.15)	(1.86)
Carhart alpha	0.21%	0.44%	**0.11%**	0.20%	0.46%	**0.09%**
	(2.94)	(2.96)	(0.77)	(2.81)	(3.06)	(0.61)
FF6 alpha	0.11%	0.54%	**-0.12%**	0.09%	0.56%	**-0.14%**
	(1.58)	(3.63)	(-0.84)	(1.39)	(3.75)	(-1.05)
FF6+Rev alpha	0.07%	0.50%	**-0.16%**	0.06%	0.52%	**-0.18%**
	(1.11)	(3.57)	(-1.12)	(0.93)	(3.70)	(-1.30)

Table C2: Correlation between factors

This table presents the correlation coefficient between the Betting Against Alpha (BAA), Betting Against Beta (BAB), Betting Against Total Volatility (BATV), and Betting Against Idiosyncratic Volatility (BAIV) factors. The estimated alphas and betas used to construct the BAA and BAB factors come from OLS regressions using the CAPM. Total volatility is calculated as the variance of an asset, while idiosyncratic volatility is calculated as the residual variance from an OLS regression using the CAPM model. I use 5-year data to calculate alphas, betas, and the volatility measures. Portfolios are rebalanced yearly, at the end of December. I use monthly data corresponding to the period January 1968 – December 2015 to construct portfolios and factors for the period January 1973 – December 2015. Individual data on stock returns comes from the CRSP database, while the data for the CAPM comes from Kenneth French's webpage.

	BAA	BAB	BATV	BAIV
BAA	**1**			
BAB	0.21	**1**		
BATV	-0.19	0.56	**1**	
BAIV	-0.12	0.51	0.99	**1**