Debt Surplus Delta and the Cross Section of Stock Returns

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Abstract

This paper studies the asset pricing implications of Debt Surplus Delta (DSD), and its robustness in predicting returns in the cross-section of equities using the protocol proposed by Novy-Marx and Velikov (2023). A value-weighted long/short trading strategy based on DSD achieves an annualized gross (net) Sharpe ratio of 0.53 (0.44), and monthly average abnormal gross (net) return relative to the Fama and French (2015) five-factor model plus a momentum factor of 22 (20) bps/month with a t-statistic of 2.92 (2.75), respectively. Its gross monthly alpha relative to these six factors plus the six most closely related strategies from the factor zoo (Change in financial liabilities, Net debt financing, Investment to revenue, Book leverage (annual), Inventory Growth, Accruals) is 19 bps/month with a t-statistic of 2.65.

1 Introduction

The efficient market hypothesis suggests that asset prices should fully reflect all available information. However, a growing body of literature documents persistent patterns in stock returns that appear to contradict market efficiency (Hou et al., 2020). While many of these patterns stem from firms' operating activities and investment decisions, the role of corporate financing choices in driving expected returns remains incompletely understood (Baker and Wurgler, 2002). In particular, the dynamic relationship between firms' debt financing decisions and subsequent stock performance presents an important yet underexplored channel through which capital structure choices may affect asset prices.

Prior research has primarily focused on static measures of leverage (**?**) or aggregate changes in debt levels (Bradshaw et al., 2006). These approaches, however, fail to capture the nuanced information content embedded in firms' marginal financing decisions relative to their historical patterns. This gap is particularly notable given that deviations from established financing habits may signal meaningful changes in management's outlook or investment opportunities.

We propose that unexpected changes in debt financing behavior, which we term 'Debt Surplus Delta' (DSD), contain valuable information about future stock returns. Our hypothesis builds on the pecking order theory of capital structure (Myers and Majluf, 1984), which suggests that managers prefer debt financing over equity when they have positive private information. However, we argue that it is not the absolute level of debt issuance that matters, but rather its deviation from the firm's historical financing patterns.

The theoretical mechanism operates through two channels. First, following (Ross, 1977), managers with favorable private information may choose to increase leverage beyond typical levels to signal their confidence, as the additional debt service obligations would be unsustainable without strong future performance. Second, drawing on (Jensen and Meckling, 1976), unusual increases in leverage may indicate reduced agency costs through enhanced market discipline.

Importantly, our framework suggests that the predictive power of DSD should be particularly strong when the deviation from historical patterns is large. This follows from (?), who document that managers carefully consider their typical financing mix when making capital structure decisions. Therefore, significant departures from these patterns likely reflect meaningful new information rather than noise.

Our empirical analysis reveals that DSD strongly predicts future stock returns. A value-weighted long-short portfolio strategy based on DSD quintiles generates a monthly alpha of 22 basis points (t-statistic = 2.92) relative to the Fama-French six-factor model. The strategy achieves an annualized gross (net) Sharpe ratio of 0.53 (0.44), placing it in the top 5% of documented return predictors.

The predictive power of DSD remains robust after controlling for transaction costs and various methodological choices. The strategy's performance persists across different size groups, with the largest quintile of stocks generating a monthly alpha of 27 basis points (t-statistic = 3.06). This suggests that the DSD effect is not merely a small-stock phenomenon.

Most importantly, DSD continues to predict returns even after controlling for the six most closely related anomalies, including changes in financial liabilities and net debt financing. In spanning tests that include these related factors plus the Fama-French six factors, the DSD strategy maintains a significant alpha of 19 basis points per month (t-statistic = 2.65).

Our paper makes several important contributions to the literature on capital structure and asset pricing. First, we extend the work of (Bradshaw et al., 2006) by showing that it is not just the level of debt financing that matters, but its deviation from historical patterns. This provides new insights into how the dynamics of capital structure decisions affect expected returns.

Second, we contribute to the growing literature on investment-based asset pricing (Cochrane et al., 2023) by identifying a novel mechanism through which financing decisions reveal information about future investment opportunities and cash flows. Our findings suggest that unusual financing patterns serve as a powerful signal of future firm performance.

Finally, our results have important implications for both academic research and investment practice. For researchers, we demonstrate the importance of considering historical firm behavior when studying financing decisions. For practitioners, we document a new, implementable trading strategy that generates significant risk-adjusted returns even after accounting for transaction costs and that remains effective among large, liquid stocks.

2 Data

Our study investigates the predictive power of a financial signal derived from accounting data for cross-sectional returns, focusing specifically on the Debt Surplus Delta measure. We obtain accounting and financial data from COMPUSTAT, covering firm-level observations for publicly traded companies. To construct our signal, we use COMPUSTAT's item DLTIS for long-term debt issuance and CAPS for capitalization. Long-term debt issuance (DLTIS) represents the cash proceeds from issuance of long-term debt, while capitalization (CAPS) provides a measure of the firm's total market value, including both equity and debt components. The construction of the signal follows a difference-based approach, where we first calculate the change in DLTIS by subtracting its lagged value from the current value, and then scale this difference by the lagged value of CAPS for each firm in each year of our sample. This scaled difference captures the relative change in debt issuance relative to firm size, offering insight into the dynamics of a firm's financing decisions and capital structure changes. By focusing on this relationship, the signal aims to reflect aspects of debt management and financing policy in a manner that is both scalable and interpretable. We construct this measure using end-of-fiscal-year values for both DLTIS and CAPS to ensure consistency and comparability across firms and over time.

3 Signal diagnostics

Figure 1 plots descriptive statistics for the DSD signal. Panel A plots the time-series of the mean, median, and interquartile range for DSD. On average, the cross-sectional mean (median) DSD is -2.15 (-0.00) over the 1974 to 2023 sample, where the starting date is determined by the availability of the input DSD data. The signal's interquartile range spans -0.44 to 0.32. Panel B of Figure 1 plots the time-series of the coverage of the DSD signal for the CRSP universe. On average, the DSD signal is available for 5.72% of CRSP names, which on average make up 6.57% of total market capitalization.

4 Does DSD predict returns?

Table 1 reports the performance of portfolios constructed using a value-weighted, quintile sort on DSD using NYSE breaks. The first two lines of Panel A report monthly average excess returns for each of the five portfolios and for the long/short portfolio that buys the high DSD portfolio and sells the low DSD portfolio. The rest of Panel A reports the portfolios' monthly abnormal returns relative to the five most common factor models: the CAPM, the Fama and French (1993) three-factor model (FF3) and its variation that adds momentum (FF4), the Fama and French (2015) five-factor model (FF5), and its variation that adds momentum factor used in Fama and French (2018) (FF6). The table shows that the long/short DSD strategy earns an average return of 0.28% per month with a t-statistic of 3.74. The annualized Sharpe ratio of the strategy is 0.53. The alphas range from 0.22% to 0.31% per month and have t-statistics exceeding 2.92 everywhere. The lowest alpha is with respect to the FF6 factor model.

Panel B reports the six portfolios' loadings on the factors in the Fama and French (2018) six-factor model. The long/short strategy's most significant loading is 0.23, with a t-statistic of 4.58 on the CMA factor. Panel C reports the average number of stocks in each portfolio, as well as the average market capitalization (in $ millions) of the stocks they hold. In an average month, the five portfolios have at least 476 stocks and an average market capitalization of at least $1,584 million.

Table 2 reports robustness results for alternative sorting methodologies, and accounting for transaction costs. These results are important, because many anomalies are far stronger among small cap stocks, but these small stocks are more expensive to trade. Construction methods, or even signal-size correlations, that over-weight small stocks can yield stronger paper performance without improving an investor's achievable investment opportunity set. Panel A reports gross returns and alphas for the long/short strategies made using various different protfolio constructions. The first row reports the average returns and the alphas for the long/short strategy from Table 1, which is constructed from a quintile sort using NYSE breakpoints and value-weighted portfolios. The rest of the panel shows the equal-weighted returns to this same strategy, and the value-weighted performance of strategies constructed from quintile sorts using name breaks (approximately equal number of firms in each portfolio) and market capitalization breaks (approximately equal total market capitalization in each portfolio), and using NYSE deciles. The average return is lowest for the quintile sort using NYSE breakpoints and equal-weighted portfolios, and equals 23 bps/month with a t-statistics of 4.97. Out of the twenty-five alphas reported in Panel A, the t-statistics for twenty-five exceed two, and for nineteen exceed three.

Panel B reports for these same strategies the average monthly net returns and the generalized net alphas of Novy-Marx and Velikov (2016). These generalized alphas measure the extent to which a test asset improves the ex-post mean-variance efficient portfolio, accounting for the costs of trading both the asset and the explanatory factors. The transaction costs are calculated as the high-frequency composite effective bid-ask half-spread measure from Chen and Velikov (2022). The net average returns reported in the first column range between 1-23bps/month. The lowest return, (1 bps/month), is achieved from the quintile sort using NYSE breakpoints and equal-weighted portfolios, and has an associated t-statistic of 0.23. Out of the twenty-five construction-methodology-factor-model pairs reported in Panel B, the DSD trading strategy improves the achievable mean-variance efficient frontier spanned by the factor models in twenty-three cases, and significantly expands the achievable frontier in eighteen cases.

Table 3 provides direct tests for the role size plays in the DSD strategy performance. Panel A reports the average returns for the twenty-five portfolios constructed from a conditional double sort on size and DSD, as well as average returns and alphas for long/short trading DSD strategies within each size quintile. Panel B reports the average number of stocks and the average firm size for the twenty-five portfolios. Among the largest stocks (those with market capitalization greater than the 80^{th} NYSE percentile), the DSD strategy achieves an average return of 27 bps/month with a t-statistic of 3.06. Among these large cap stocks, the alphas for the DSD strategy relative to the five most common factor models range from 19 to 31 bps/month with t-statistics between 2.08 and 3.51.

5 How does DSD perform relative to the zoo?

Figure 2 puts the performance of DSD in context, showing the long/short strategy performance relative to other strategies in the "factor zoo." It shows Sharpe ratio histograms, both for gross and net returns (Panel A and B, respectively), for 212 documented anomalies in the zoo.[1] The vertical red line shows where the Sharpe ratio for the DSD strategy falls in the distribution. The DSD strategy's gross (net) Sharpe ratio of 0.53 (0.44) is greater than 95% (99%) of anomaly Sharpe ratios, respectively.

Figure 3 plots the growth of a $1 invested in these same 212 anomaly trading strategies (gray lines), and compares those with the growth of a $1 invested in the DSD strategy (red line).[2] Ignoring trading costs, a $1 invested in the DSD strategy would have yielded $3.94 which ranks the DSD strategy in the top 4% across the 212 anomalies. Accounting for trading costs, a $1 invested in the DSD strategy would have yielded $2.73 which ranks the DSD strategy in the top 3% across the 212 anomalies.

Figure 4 plots percentile ranks for the 212 anomaly trading strategies in terms of gross and Novy-Marx and Velikov (2016) net generalized alphas with respect to the CAPM, and the Fama-French three-, four-, five-, and six-factor models from Table 1, and indicates the ranking of the DSD relative to those. Panel A shows that the DSD strategy gross alphas fall between the 58 and 71 percentiles across the five factor models. Panel B shows that, accounting for trading costs, a large fraction of anomalies have not improved the investment opportunity set of an investor with access to the factor models over the 197406 to 202306 sample. For example, 45%

[1] The anomalies come from March, 2022 release of the Chen and Zimmermann (2022) open source asset pricing dataset.

[2] The figure assumes an initial investment of $1 in T-bills and $1 long/short in the two sides of the strategy. Returns are compounded each month, assuming, as in Detzel et al. (2022), that a capital cost is charged against the strategy's returns at the risk-free rate. This excess return corresponds more closely to the strategy's economic profitability.

(53%) of the 212 anomalies would not have improved the investment opportunity set for an investor having access to the Fama-French three-factor (six-factor) model. The DSD strategy has a positive net generalized alpha for five out of the five factor models. In these cases DSD ranks between the 79 and 87 percentiles in terms of how much it could have expanded the achievable investment frontier.

6 Does DSD add relative to related anomalies?

With so many anomalies, it is possible that any proposed, new cross-sectional predictor is just capturing some combination of known predictors. It is consequently natural to investigate to what extent the proposed predictor adds additional predictive power beyond the most closely related anomalies. Closely related anomalies are more likely to be formed on the basis of signals with higher absolute correlations. Figure 5 plots a name histogram of the correlations of DSD with 210 filtered anomaly signals.[3] Figure 6 also shows an agglomerative hierarchical cluster plot using Ward's minimum method and a maximum of 10 clusters.

A closely related anomaly is also more likely to price DSD or at least to weaken the power DSD has predicting the cross-section of returns. Figure 7 plots histograms of t-statistics for predictability tests of DSD conditioning on each of the 210 filtered anomaly signals one at a time. Panel A reports t-statistics on β_{DSD} from Fama-MacBeth regressions of the form $r_{i,t} = \alpha + \beta_{DSD} DSD_{i,t} + \beta_X X_{i,t} + \epsilon_{i,t}$, where X stands for one of the 210 filtered anomaly signals at a time. Panel B plots t-statistics on α from spanning tests of the form: $r_{DSD,t} = \alpha + \beta r_{X,t} + \epsilon_t$, where $r_{X,t}$ stands for the returns to one of the 210 filtered anomaly trading strategies at a time. The strategies employed in the spanning tests are constructed using quintile sorts, value-

[3] When performing tests at the underlying signal level (e.g., the correlations plotted in Figure 5), we filter the 212 anomalies to avoid small sample issues. For each anomaly, we calculate the common stock observations in an average month for which both the anomaly and the test signal are available. In the filtered anomaly set, we drop anomalies with fewer than 100 common stock observations in an average month.

weighting, and NYSE breakpoints. Panel C plots t-statistics on the average returns to strategies constructed by conditional double sorts. In each month, we sort stocks into quintiles based one of the 210 filtered anomaly signals. Then, within each quintile, we sort stocks into quintiles based on DSD. Stocks are finally grouped into five DSD portfolios by combining stocks within each anomaly sorting portfolio. The panel plots the t-statistics on the average returns of these conditional double-sorted DSD trading strategies conditioned on each of the 210 filtered anomalies.

Table 4 reports Fama-MacBeth cross-sectional regressions of returns on DSD and the six anomalies most closely-related to it. The six most-closely related anomalies are picked as those with the highest combined rank where the ranks are based on the absolute value of the Spearman correlations in Panel B of Figure 5 and the R^2 from the spanning tests in Figure 7, Panel B. Controlling for each of these signals at a time, the t-statistics on the DSD signal in these Fama-MacBeth regressions exceed 0.49, with the minimum t-statistic occurring when controlling for Net debt financing. Controlling for all six closely related anomalies, the t-statistic on DSD is 0.44.

Similarly, Table 5 reports results from spanning tests that regress returns to the DSD strategy onto the returns of the six most closely-related anomalies and the six Fama-French factors. Controlling for the six most-closely related anomalies individually, the DSD strategy earns alphas that range from 20-23bps/month. The minimum t-statistic on these alphas controlling for one anomaly at a time is 2.75, which is achieved when controlling for Net debt financing. Controlling for all six closely-related anomalies and the six Fama-French factors simultaneously, the DSD trading strategy achieves an alpha of 19bps/month with a t-statistic of 2.65.

7 Does DSD add relative to the whole zoo?

Finally, we can ask how much adding DSD to the entire factor zoo could improve investment performance. Figure 8 plots the growth of $1 invested in trading strategies that combine multiple anomalies following Chen and Velikov (2022). The combinations use either the 156 anomalies from the zoo that satisfy our inclusion criteria (blue lines) or these 156 anomalies augmented with the DSD signal.[4] We consider one different methods for combining signals.

Panel A shows results using "Average rank" as the combination method. This method sorts stocks on the basis of forecast excess returns, where these are calculated on the basis of their average cross-sectional percentile rank across return predictors, and the predictors are all signed so that higher ranks are associated with higher average returns. For this method, $1 investment in the 156-anomaly combination strategy grows to $935.00, while $1 investment in the combination strategy that includes DSD grows to $903.72.

8 Conclusion

This study provides compelling evidence for the effectiveness of Debt Surplus Delta (DSD) as a significant predictor of stock returns in the cross-section of equities. Our findings demonstrate that a value-weighted long/short trading strategy based on DSD generates economically and statistically significant returns, with an impressive annualized Sharpe ratio of 0.53 (0.44 net of transaction costs). The strategy's robustness is particularly noteworthy, maintaining significant abnormal returns even after controlling for the Fama-French five factors, momentum, and six closely related anomalies from the factor zoo.

[4]We filter the 207 Chen and Zimmermann (2022) anomalies and require for each anomaly the average month to have at least 40% of the cross-sectional observations available for market capitalization on CRSP in the period for which DSD is available.

The persistence of DSD's predictive power, evidenced by monthly abnormal returns of 22 basis points (20 bps net) with strong statistical significance (t-statistic of 2.92), suggests that this signal captures unique information about firm fundamentals that is not fully incorporated into stock prices. The signal's ability to generate alpha even after controlling for related factors (19 bps/month, t-statistic of 2.65) further validates its distinctive contribution to the existing literature on return predictability.

However, several limitations warrant consideration. First, our analysis focuses on U.S. equity markets, and the signal's effectiveness in international markets remains to be tested. Second, the study period may not fully capture the signal's behavior across different market regimes. Future research could explore the signal's performance in international markets, its interaction with other anomalies, and its effectiveness during various market conditions. Additionally, investigating the underlying economic mechanisms driving the DSD effect could provide valuable insights for both academics and practitioners.

In conclusion, our findings suggest that DSD represents a valuable addition to the quantitative investor's toolkit, offering meaningful predictive power for stock returns. The signal's robustness to various controls and transaction costs makes it particularly relevant for practical implementation in investment strategies.

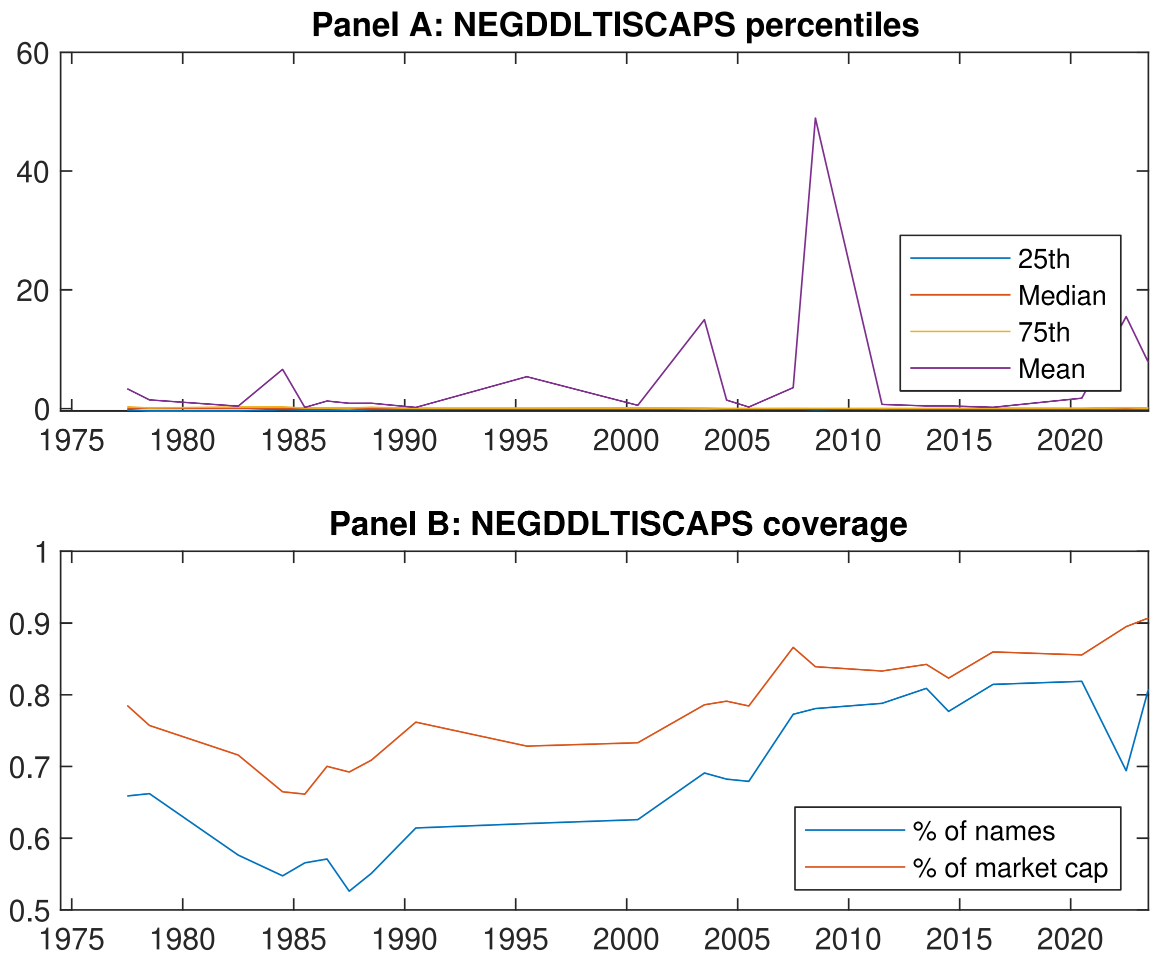

Figure 1: Times series of DSD percentiles and coverage.
This figure plots descriptive statistics for DSD. Panel A shows cross-sectional percentiles of DSD over the sample. Panel B plots the monthly coverage of DSD relative to the universe of CRSP stocks with available market capitalizations.

Table 1: Basic sort: VW, quintile, NYSE-breaks

This table reports average excess returns and alphas for portfolios sorted on DSD. At the end of each month, we sort stocks into five portfolios based on their signal using NYSE breakpoints. Panel A reports average value-weighted quintile portfolio (L,2,3,4,H) returns in excess of the risk-free rate, the long-short extreme quintile portfolio (H-L) return, and alphas with respect to the CAPM, Fama and French (1993) three-factor model, Fama and French (1993) three-factor model augmented with the Carhart (1997) momentum factor, Fama and French (2015) five-factor model, and the Fama and French (2015) five-factor model augmented with the Carhart (1997) momentum factor following Fama and French (2018). Panel B reports the factor loadings for the quintile portfolios and long-short extreme quintile portfolio in the Fama and French (2015) five-factor model. Panel C reports the average number of stocks and market capitalization of each portfolio. T-statistics are in brackets. The sample period is 197406 to 202306.

Panel A: Excess returns and alphas on DSD-sorted portfolios						
	(L)	(2)	(3)	(4)	(H)	(H-L)
r^e	0.62	0.67	0.65	0.72	0.90	0.28
	[3.11]	[3.41]	[3.04]	[3.85]	[4.65]	[3.74]
α_{CAPM}	-0.07	-0.02	-0.08	0.07	0.23	0.30
	[-1.22]	[-0.45]	[-1.16]	[1.41]	[4.40]	[4.02]
α_{FF3}	-0.11	-0.04	-0.01	0.06	0.20	0.31
	[-1.99]	[-0.97]	[-0.22]	[1.19]	[3.90]	[4.21]
α_{FF4}	-0.09	-0.01	0.07	0.05	0.15	0.24
	[-1.59]	[-0.34]	[1.07]	[1.07]	[3.01]	[3.31]
α_{FF5}	-0.17	-0.03	0.12	0.02	0.09	0.26
	[-3.08]	[-0.57]	[1.84]	[0.43]	[1.80]	[3.49]
α_{FF6}	-0.15	-0.01	0.16	0.02	0.07	0.22
	[-2.71]	[-0.18]	[2.66]	[0.44]	[1.34]	[2.92]
Panel B: Fama and French (2018) 6-factor model loadings for DSD-sorted portfolios						
β_{MKT}	1.04	1.02	0.99	0.97	1.03	-0.02
	[82.03]	[99.82]	[69.26]	[83.03]	[89.71]	[-0.96]
β_{SMB}	-0.00	-0.06	0.01	0.01	0.06	0.06
	[-0.20]	[-3.69]	[0.42]	[0.66]	[3.25]	[2.34]
β_{HML}	0.10	0.11	-0.14	-0.02	-0.02	-0.13
	[4.31]	[5.47]	[-5.10]	[-1.03]	[-0.95]	[-3.87]
β_{RMW}	0.17	0.02	-0.16	0.03	0.13	-0.04
	[6.74]	[0.98]	[-5.72]	[1.15]	[5.62]	[-1.26]
β_{CMA}	-0.00	-0.08	-0.20	0.11	0.22	0.23
	[-0.09]	[-2.79]	[-4.86]	[3.31]	[6.70]	[4.58]
β_{UMD}	-0.04	-0.03	-0.08	-0.00	0.04	0.08
	[-2.73]	[-2.98]	[-5.89]	[-0.09]	[3.54]	[4.42]
Panel C: Average number of firms (n) and market capitalization (me)						
n	491	564	1052	620	476	
me ($\$10^6$)	1652	2398	1828	2256	1584	

Table 2: Robustness to sorting methodology & trading costs
This table evaluates the robustness of the choices made in the DSD strategy construction methodology. In each panel, the first row shows results from a quintile, value-weighted sort using NYSE break points as employed in Table 1. Each of the subsequent rows deviates in one of the three choices at a time, and the choices are specified in the first three columns. For each strategy construction methodology, the table reports average excess returns and alphas with respect to the CAPM, Fama and French (1993) three-factor model, Fama and French (1993) three-factor model augmented with the Carhart (1997) momentum factor, Fama and French (2015) five-factor model, and the Fama and French (2015) five-factor model augmented with the Carhart (1997) momentum factor following Fama and French (2018). Panel A reports average returns and alphas with no adjustment for trading costs. Panel B reports net average returns and Novy-Marx and Velikov (2016) generalized alphas as prescribed by Detzel et al. (2022). T-statistics are in brackets. The sample period is 197406 to 202306.

Panel A: Gross Returns and Alphas								
Portfolios	Breaks	Weights	r^e	α_{CAPM}	α_{FF3}	α_{FF4}	α_{FF5}	α_{FF6}
Quintile	NYSE	VW	0.28	0.30	0.31	0.24	0.26	0.22
			[3.74]	[4.02]	[4.21]	[3.31]	[3.49]	[2.92]
Quintile	NYSE	EW	0.23	0.25	0.24	0.22	0.20	0.19
			[4.97]	[5.50]	[5.21]	[4.74]	[4.39]	[4.20]
Quintile	Name	VW	0.24	0.28	0.28	0.22	0.21	0.17
			[3.63]	[4.16]	[4.18]	[3.32]	[3.06]	[2.56]
Quintile	Cap	VW	0.23	0.26	0.27	0.22	0.22	0.19
			[3.24]	[3.65]	[3.84]	[3.04]	[3.11]	[2.63]
Decile	NYSE	VW	0.24	0.28	0.27	0.25	0.20	0.19
			[2.79]	[3.29]	[3.19]	[2.85]	[2.27]	[2.14]
Panel B: Net Returns and Novy-Marx and Velikov (2016) generalized alphas								
Portfolios	Breaks	Weights	r^e_{net}	α^*_{CAPM}	α^*_{FF3}	α^*_{FF4}	α^*_{FF5}	α^*_{FF6}
Quintile	NYSE	VW	0.23	0.26	0.27	0.24	0.23	0.20
			[3.07]	[3.52]	[3.66]	[3.21]	[3.07]	[2.75]
Quintile	NYSE	EW	0.01	0.04	0.02	0.02		
			[0.23]	[0.65]	[0.34]	[0.26]		
Quintile	Name	VW	0.20	0.25	0.25	0.22	0.18	0.16
			[2.92]	[3.63]	[3.63]	[3.20]	[2.68]	[2.38]
Quintile	Cap	VW	0.18	0.23	0.24	0.21	0.20	0.17
			[2.57]	[3.16]	[3.29]	[2.89]	[2.68]	[2.39]
Decile	NYSE	VW	0.19	0.24	0.23	0.21	0.16	0.15
			[2.20]	[2.73]	[2.65]	[2.47]	[1.81]	[1.70]

Table 3: Conditional sort on size and DSD

This table presents results for conditional double sorts on size and DSD. In each month, stocks are first sorted into quintiles based on size using NYSE breakpoints. Then, within each size quintile, stocks are further sorted based on DSD. Finally, they are grouped into twenty-five portfolios based on the intersection of the two sorts. Panel A presents the average returns to the 25 portfolios, as well as strategies that go long stocks with high DSD and short stocks with low DSD .Panel B documents the average number of firms and the average firm size for each portfolio. The sample period is 197406 to 202306.

Panel A: portfolio average returns and time-series regression results

	DSD Quintiles					DSD Strategies					
Size quintiles	(L)	(2)	(3)	(4)	(H)	r^e	α_{CAPM}	α_{FF3}	α_{FF4}	α_{FF5}	α_{FF6}
(1)	0.80	0.77	0.98	0.82	0.90	0.11	0.13	0.11	0.05	0.06	0.03
	[3.04]	[2.60]	[3.50]	[2.72]	[3.29]	[1.12]	[1.29]	[1.08]	[0.53]	[0.61]	[0.30]
(2)	0.83	0.92	0.83	0.94	0.90	0.07	0.11	0.08	0.06	0.06	0.05
	[3.21]	[3.46]	[3.18]	[3.56]	[3.63]	[0.92]	[1.41]	[1.10]	[0.83]	[0.73]	[0.58]
(3)	0.79	0.91	0.81	0.84	0.94	0.15	0.19	0.18	0.15	0.16	0.13
	[3.24]	[3.85]	[3.19]	[3.58]	[4.03]	[1.96]	[2.47]	[2.38]	[1.87]	[1.99]	[1.69]
(4)	0.72	0.92	0.86	0.81	0.85	0.13	0.14	0.13	0.10	0.10	0.08
	[3.28]	[4.19]	[3.75]	[3.68]	[3.96]	[1.67]	[1.88]	[1.72]	[1.33]	[1.20]	[0.98]
(5)	0.58	0.55	0.61	0.68	0.85	0.27	0.29	0.31	0.23	0.23	0.19
	[2.95]	[2.79]	[2.95]	[3.48]	[4.49]	[3.06]	[3.30]	[3.51]	[2.66]	[2.60]	[2.08]

Panel B: Portfolio average number of firms and market capitalization

	DSD Quintiles Average n					DSD Quintiles Average market capitalization ($\$10^6$)				
Size quintiles	(L)	(2)	(3)	(4)	(H)	(L)	(2)	(3)	(4)	(H)
(1)	363	362	363	362	361	36	29	30	29	34
(2)	99	98	99	98	99	56	55	54	56	56
(3)	69	69	69	69	69	96	98	93	95	96
(4)	58	58	58	58	58	209	212	203	210	207
(5)	53	53	53	53	53	1419	1758	1455	1726	1408

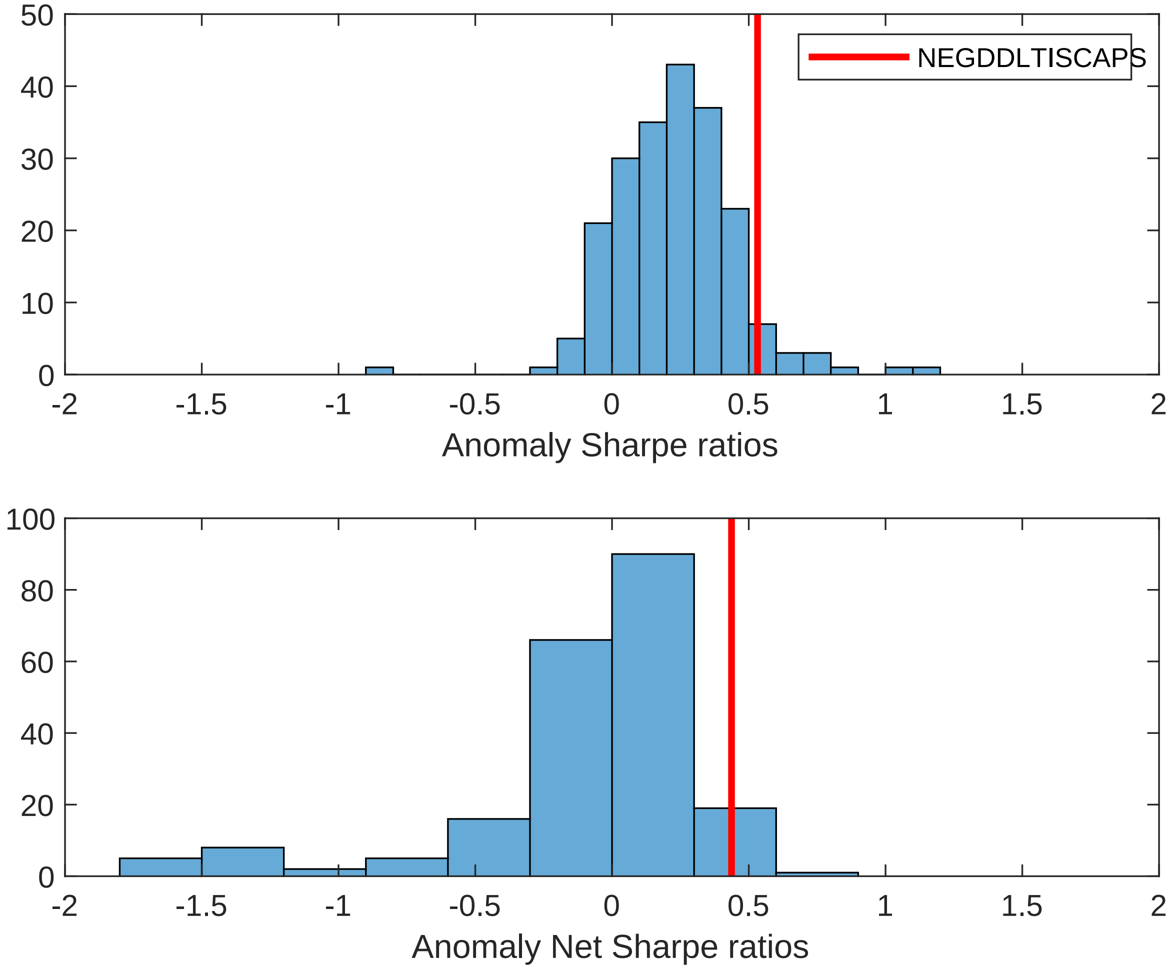

Figure 2: Distribution of Sharpe ratios.
This figure plots a histogram of Sharpe ratios for 212 anomalies, and compares the Sharpe ratio of the DSD with them (red vertical line). Panel A plots results for gross Sharpe ratios. Panel B plots results for net Sharpe ratios.

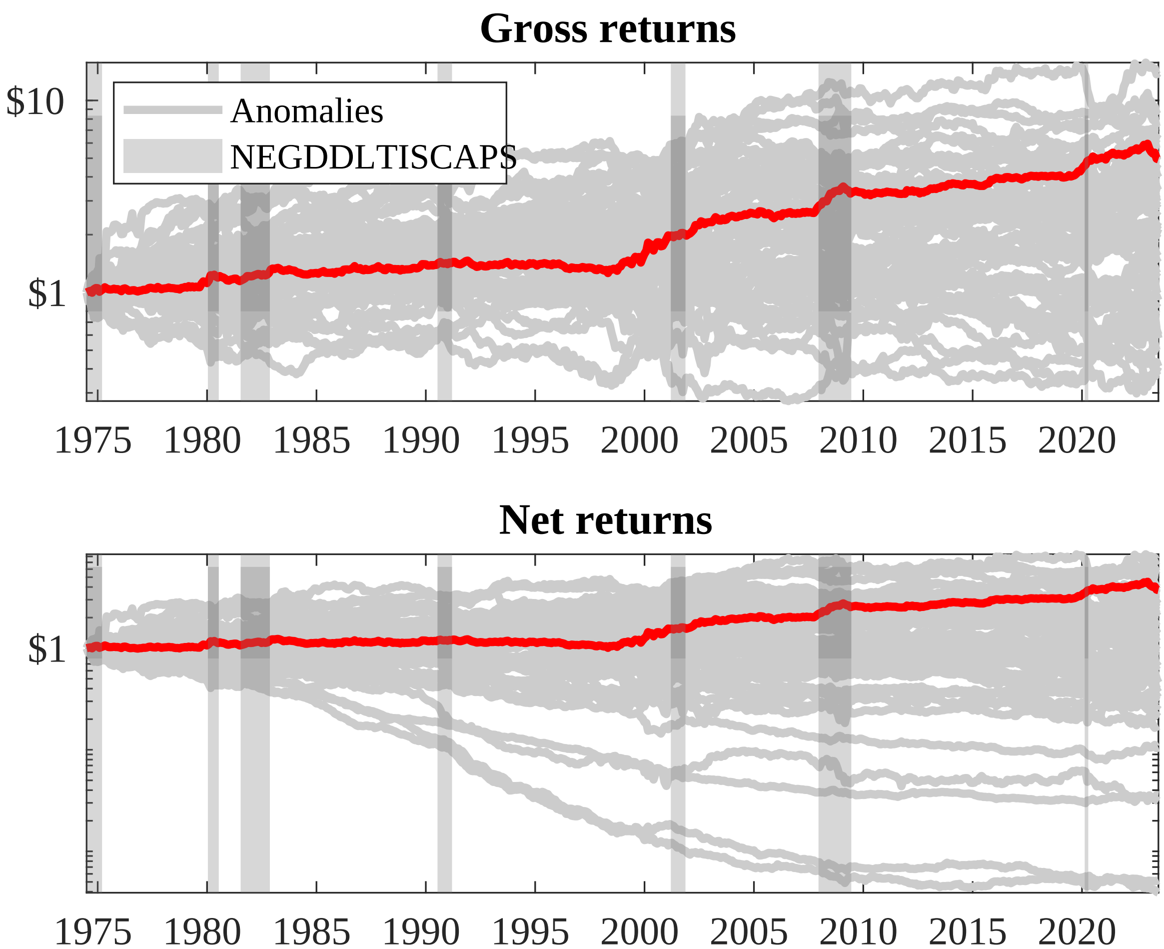

Figure 3: Dollar invested.
This figure plots the growth of a $1 invested in 212 anomaly trading strategies (gray lines), and compares those with the DSD trading strategy (red line). The strategies are constructed using value-weighted quintile sorts using NYSE breakpoints. Panel A plots results for gross strategy returns. Panel B plots results for net strtaegy returns.

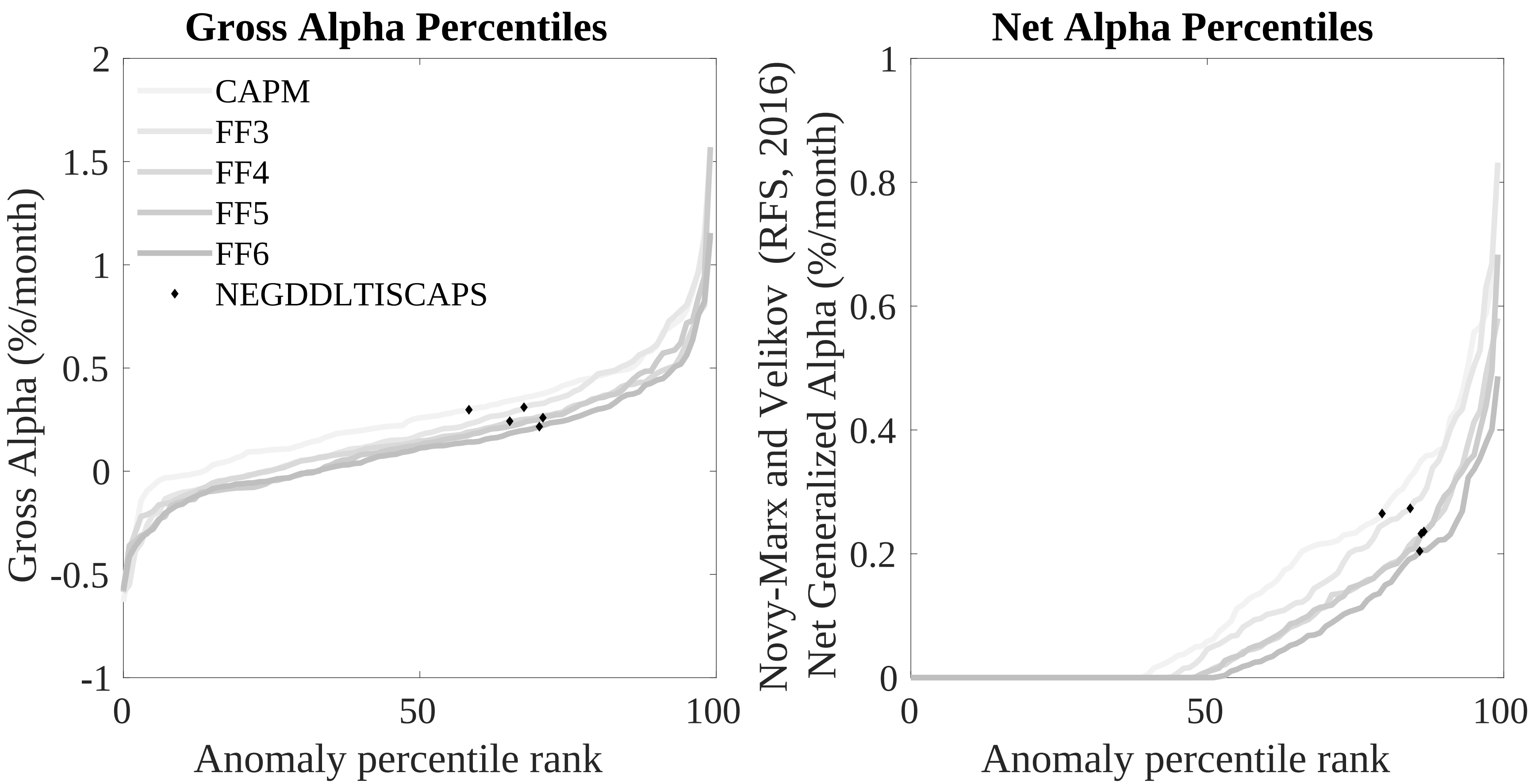

Figure 4: Gross and generalized net alpha percentiles of anomalies relative to factor models
This figure plots the percentile ranks for 212 anomaly trading strategies in terms of alphas (solid lines), and compares those with the DSD trading strategy alphas (diamonds). The strategies are constructed using value-weighted quintile sorts using NYSE breakpoints. The alphas include those with respect to the CAPM, Fama and French (1993) three-factor model, Fama and French (1993) three-factor model augmented with the Carhart (1997) momentum factor, Fama and French (2015) five-factor model, and the Fama and French (2015) five-factor model augmented with the Carhart (1997) momentum factor following Fama and French (2018). The left panel plots alphas with no adjustment for trading costs. The right panel plots Novy-Marx and Velikov (2016) net generalized alphas.

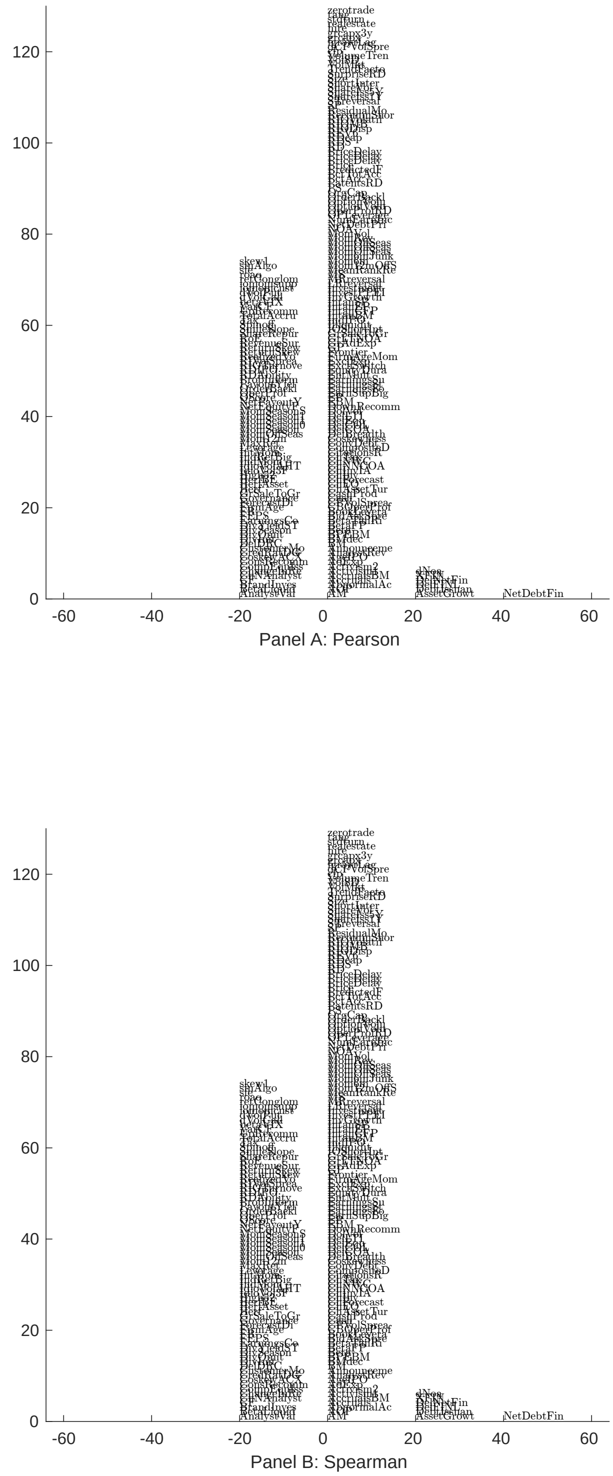

Figure 5: Distribution of correlations.
This figure plots a name histogram of correlations of 210 filtered anomaly signals with DSD. The correlations are pooled. Panel A plots Pearson correlations, while Panel B plots Spearman rank correlations.

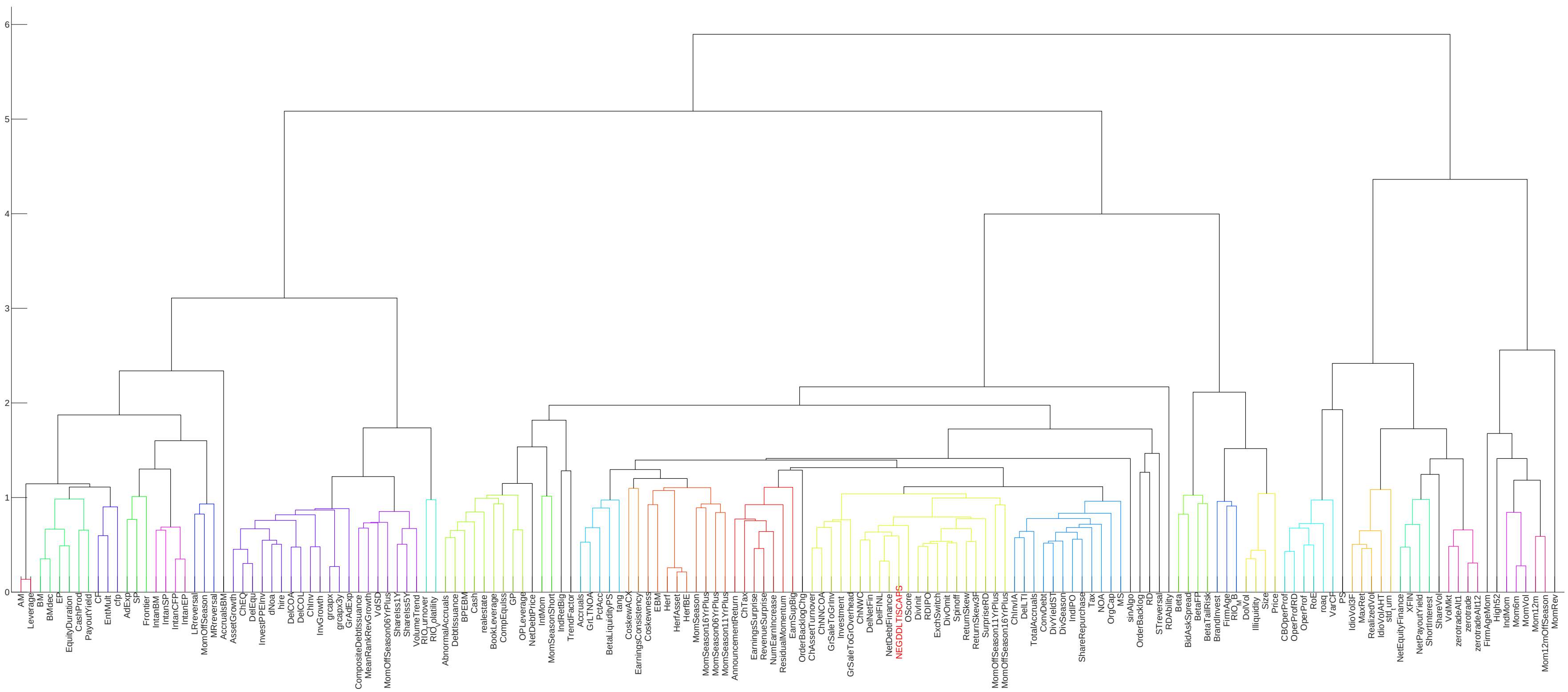

Figure 6: Agglomerative hierarchical cluster plot

This figure plots an agglomerative hierarchical cluster plot using Ward's minimum method and a maximum of 10 clusters.

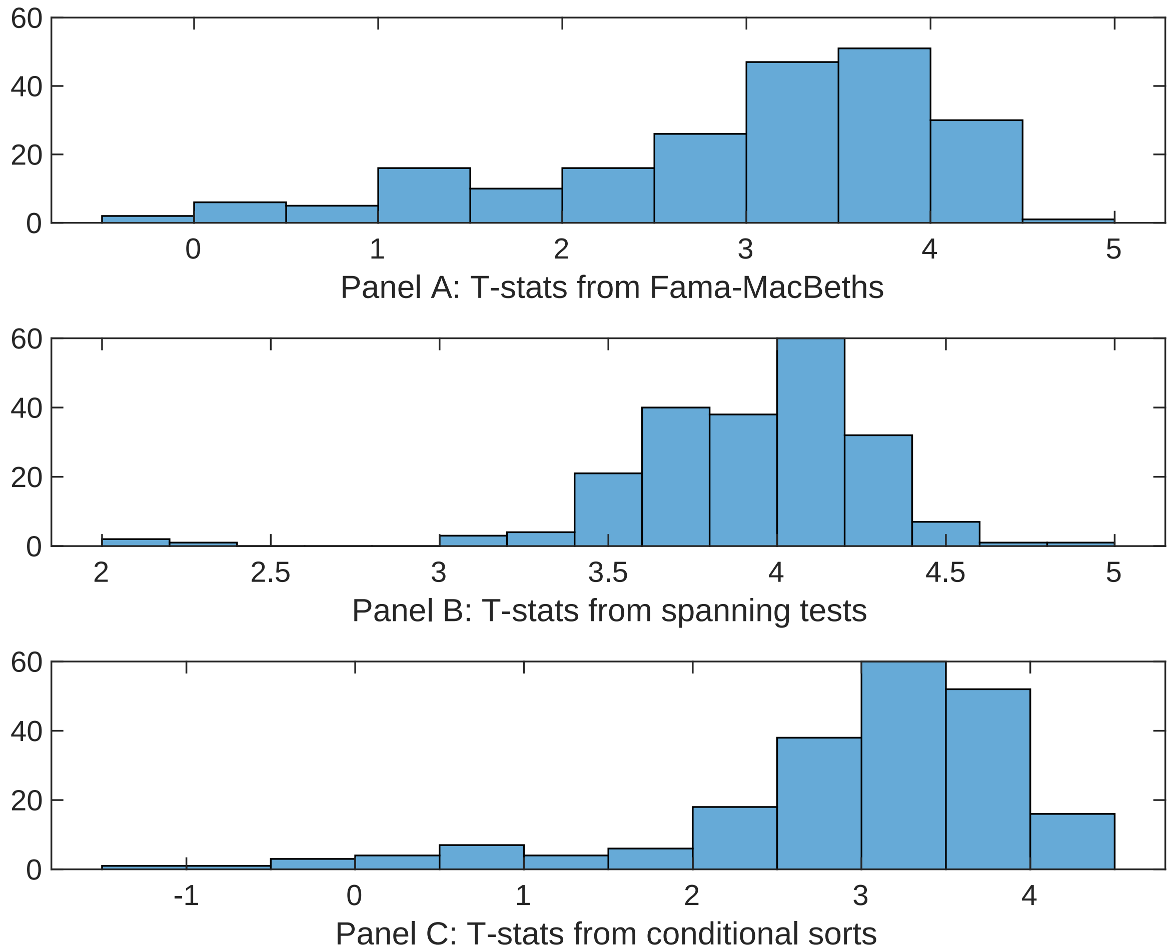

Figure 7: Distribution of t-stats on conditioning strategies
This figure plots histograms of t-statistics for predictability tests of DSD conditioning on each of the 210 filtered anomaly signals one at a time. Panel A reports t-statistics on β_{DSD} from Fama-MacBeth regressions of the form $r_{i,t} = \alpha + \beta_{DSD} DSD_{i,t} + \beta_X X_{i,t} + \epsilon_{i,t}$, where X stands for one of the 210 filtered anomaly signals at a time. Panel B plots t-statistics on α from spanning tests of the form: $r_{DSD,t} = \alpha + \beta r_{X,t} + \epsilon_t$, where $r_{X,t}$ stands for the returns to one of the 210 filtered anomaly trading strategies at a time. The strategies employed in the spanning tests are constructed using quintile sorts, value-weighting, and NYSE breakpoints. Panel C plots t-statistics on the average returns to strategies constructed by conditional double sorts. In each month, we sort stocks into quintiles based one of the 210 filtered anomaly signals at a time. Then, within each quintile, we sort stocks into quintiles based on DSD. Stocks are finally grouped into five DSD portfolios by combining stocks within each anomaly sorting portfolio. The panel plots the t-statistics on the average returns of these conditional double-sorted DSD trading strategies conditioned on each of the 210 filtered anomalies.

Table 4: Fama-MacBeths controlling for most closely related anomalies
This table presents Fama-MacBeth results of returns on DSD. and the six most closely related anomalies. The regressions take the following form: $r_{i,t} = \alpha + \beta_{DSD} DSD_{i,t} + \sum_{k=1}^{s} ix\beta_{X_k} X_{i,t}^{k} + \epsilon_{i,t}$. The six most closely related anomalies, X, are Change in financial liabilities, Net debt financing, Investment to revenue, Book leverage (annual), Inventory Growth, Accruals. These anomalies were picked as those with the highest combined rank where the ranks are based on the absolute value of the Spearman correlations in Panel B of Figure 5 and the R^2 from the spanning tests in Figure 7, Panel B. The sample period is 197406 to 202306.

Intercept	0.14	0.14	0.16	0.14	0.14	0.13	0.16
	[5.45]	[5.41]	[6.31]	[5.36]	[5.38]	[5.09]	[6.48]
DSD	0.34	0.27	0.15	0.19	0.17	0.18	0.31
	[0.59]	[0.49]	[3.06]	[3.66]	[2.46]	[3.42]	[0.44]
Anomaly 1	0.18						-0.37
	[9.34]						[-0.08]
Anomaly 2		0.21					0.14
		[8.80]					[2.79]
Anomaly 3			0.25				0.21
			[5.43]				[4.03]
Anomaly 4				0.13			0.49
				[1.43]			[0.42]
Anomaly 5					0.41		0.25
					[7.07]		[3.79]
Anomaly 6						0.14	0.74
						[4.42]	[1.88]
# months	588	588	588	588	588	588	588
$\bar{R}^2(\%)$	0	0	0	0	0	0	0

Table 5: Spanning tests controlling for most closely related anomalies
This table presents spanning tests results of regressing returns to the DSD trading strategy on trading strategies exploiting the six most closely related anomalies. The regressions take the following form: $r_t^{DSD} = \alpha + \sum_{k=1}^{6} \beta_{X_k} r_t^{X_k} + \sum_{j=1}^{6} \beta_{f_j} r_t^{f_j} + \epsilon_t$, where X_k indicates each of the six most-closely related anomalies and f_j indicates the six factors from the Fama and French (2015) five-factor model augmented with the Carhart (1997) momentum factor. The six most closely related anomalies, X, are Change in financial liabilities, Net debt financing, Investment to revenue, Book leverage (annual), Inventory Growth, Accruals. These anomalies were picked as those with the highest combined rank where the ranks are based on the absolute value of the Spearman correlations in Panel B of Figure 5 and the R^2 from the spanning tests in Figure 7, Panel B. The sample period is 197406 to 202306.

Intercept	0.21	0.21	0.22	0.20	0.23	0.21	0.19
	[2.90]	[2.91]	[2.93]	[2.75]	[3.04]	[2.82]	[2.65]
Anomaly 1	14.77						0.84
	[3.40]						[0.14]
Anomaly 2		14.95					14.87
		[3.59]					[2.66]
Anomaly 3			6.68				5.67
			[2.30]				[1.98]
Anomaly 4				11.70			13.89
				[4.31]			[4.43]
Anomaly 5					4.70		4.62
					[1.60]		[1.61]
Anomaly 6						4.71	-4.72
						[1.58]	[-1.40]
mkt	-1.63	-1.81	-2.00	-0.44	-1.93	-1.47	-0.81
	[-0.96]	[-1.07]	[-1.17]	[-0.26]	[-1.13]	[-0.85]	[-0.48]
smb	4.93	5.25	5.07	4.93	6.73	7.01	2.33
	[1.86]	[1.99]	[1.89]	[1.88]	[2.53]	[2.61]	[0.84]
hml	-11.55	-12.09	-11.75	-3.53	-12.45	-11.01	-2.70
	[-3.54]	[-3.72]	[-3.58]	[-0.93]	[-3.79]	[-3.26]	[-0.71]
rmw	-5.19	-5.28	-3.49	-1.04	-3.41	-2.59	-2.08
	[-1.53]	[-1.56]	[-1.03]	[-0.30]	[-1.00]	[-0.73]	[-0.59]
cma	17.06	18.15	21.32	21.85	17.79	20.40	14.66
	[3.32]	[3.60]	[4.30]	[4.46]	[3.17]	[4.03]	[2.58]
umd	6.10	6.30	6.62	7.43	7.09	7.25	5.21
	[3.46]	[3.61]	[3.75]	[4.36]	[4.06]	[4.18]	[2.93]
# months	588	588	588	588	588	588	588
$\bar{R}^2(\%)$	12	12	11	13	10	10	15

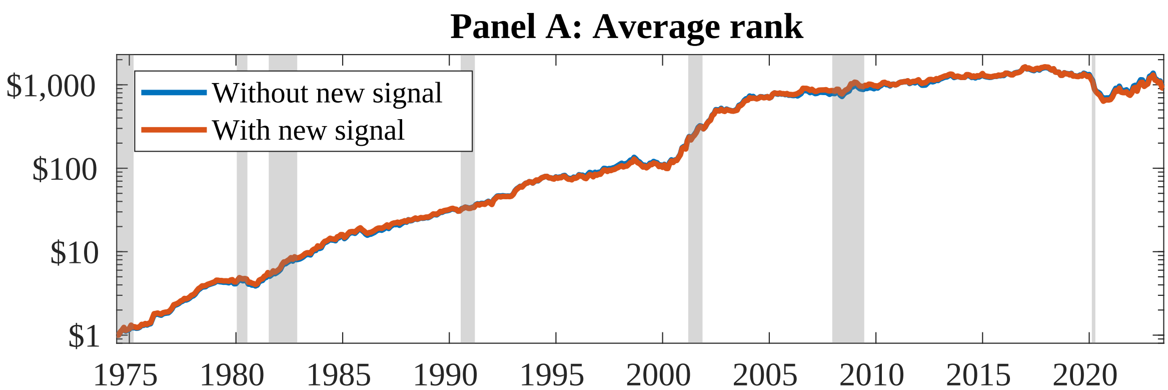

Figure 8: Combination strategy performance
This figure plots the growth of a $1 invested in trading strategies that combine multiple anomalies following Chen and Velikov (2022). In all panels, the blue solid lines indicate combination trading strategies that utilize 156 anomalies. The red solid lines indicate combination trading strategies that utilize the 156 anomalies as well as DSD. Panel A shows results using "Average rank" as the combination method. See Section 7 for details on the combination methods.

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