

Appendix to Zoom in on Momentum¹

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Abstract

This appendix supplements tables and figures to Zoom in on Momentum.

JEL classification: G11; G12

Keywords: Momentum; Monotonicity; Cross-section

[Table A1](#)—which contains average returns for 10 momentum,⁴ size, book-to-market, operating profitability, investment, earnings/price, cashflow/price, dividend yield, short-term reversal, long-term reversal, accruals, market beta, net share issues, variance, and residual variance portfolios from Professor Kenneth R. French’s website⁵—indicates that momentum portfolios achieve both stronger long-short profitability and return monotonicity than other anomaly portfolios. It also provides the portfolios’ average long-short returns and Patton–Timmermann (2010) monotonicity-relation (MR) test statistics. The test’s null (alternative) hypothesis is a flat or weakly decreasing (a strictly increasing) pattern.

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⁴ The results of 10 equal-weighted momentum portfolios are also provided.

⁵ https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

The MR statistic (0.14%) and the average long-short return (14.0%) are greatest for the momentum portfolios. In detail, the average returns of the fourth and the fifth momentum portfolio exhibit the least difference⁶. The p -value of this difference rejects the null hypothesis of a flat or weakly decreasing pattern at the 0.1% level.⁷ In contrast with the momentum portfolios though, other anomaly portfolios, reveal a trade-off between the long-short return and the MR statistic. For example, the residual variance portfolios show a strong long-short return (7.4%) but a weak MR statistic (−1.83%). The accruals portfolios indicate a strong MR statistic (−0.38%) but a weak long-short return (4.4%). Therefore, the cross-section of momentum returns appears more informative than those of other anomaly returns.⁸

Table A2 extends Table A1, which only examines 14 anomalies from Professor French’s website, by reporting the long-short performance and return monotonicity of 10 or fewer portfolios sorted by 185 anomalies from Professor Hou, Xue, and Zhang’s website.⁹

Table A3, extending Table 2 in the main document, which only displays WML_n’s factor regression results, exhibits the mean absolute alphas and Gibbons–Ross–Shanken (1989) statistics of 10, 25, 50, 100 portfolios, respectively, sorted by momentum. Similarly, Table A4 reexamines factor regressions in Table 2 in the main document, *i.e.*, regresses WML₁₀ on Mkt_RF, SMB₁₀, HML₁₀, RMW₁₀, and CMA₁₀, and then WML₂₅ on Mkt_RF, SMB₂₅, HML₂₅, RMW₂₅, and CMA₂₅, and so on.

⁶ $MR = \min_{i=2,\dots,N} \hat{\Delta}_i$, where $\hat{\Delta}_i = \hat{\mu}_i - \hat{\mu}_{i-1}$ (Patton and Timmermann, 2010).

⁷ The non-tabulated MR statistics from the 20, 25, and 50 momentum portfolios are −0.80% ($p=0.007$), −0.99% (0.005), and −2.75% (0.179), respectively.

⁸ The non-tabulated MR statistic from the July-to-June momentum portfolios is −0.31% (0.015).

⁹ <https://global-q.org/testingportfolios.html>.

[Table A5](#) reexamines spanning regressions in Table 3 in the main document with three different types of factor momentum strategies: the Leippold–Yang (2021) 12-month (LY_{12}) factor momentum and the Arnott–Kalesnik–Linnainmaa (2023) one- (AKL_1) and six-month (AKL_6) factor momentum.

[Tables A6](#), [A7](#), and [A8](#) supplement Table 5 in the main document, which only shows the factor regression results of recent and intermediate horizon past performance WML_{ns} (Novy-Marx, 2012), presenting their summary statistics (As Table 1 in the main document does), spanning regression results (Table 3), and market timing regression results (Table 4), respectively.

Similarly, [Table A10](#) shows the factor regression results of residual momentum (Blitz, Huij, and Martens, 2011) WML_{ns} , and [Tables A9](#), [A11](#), and [A12](#) supplement Table A10 presenting their summary statistics, spanning regression results, and market timing regression results, respectively.

[Table A13](#) provides the spanning regression results of 5×5 and 5×10 two-way portfolios sorted by both momentum and each of other four anomalies, namely size, book-to-market, operating profitability, and investment.

[Tables A14](#), [A15](#), [A16](#), and [A17](#) inspect if the difference between the performance of the more- and fewer-portfolio momentum factors is robust to industry momentum (Moskowitz and Grinblatt, 1999), portfolio momentum (Lewellen, 2002), and macromomentum (Bhojraj and Swaminathan, 2006).

[Figure A1](#) corresponds to Figure 3 in the main document, which cross-sectionally investigates the performance of 10, 25, 50, and 100 value-weighted portfolios sorted by

momentum, but instead considers their equal-weighted counterparts. Similarly, [Figure A3](#) instead explores value-weighted portfolios sorted by residual momentum.

[Figure A2](#), supplementing Table A5, illustrates the spanning alphas of WML_n s on the Leippold–Yang (2021) 12-month (LY_{12}) factor momentum and the Arnott–Kalesnik–Linnainmaa (2023) one- (AKL_1) and six-month (AKL_6) factor momentum as the functions of the number of portfolios.

[Figure A4](#), following Daniel and Moskowitz (2016), shades bear-down and bear-up markets on Figure 4 in the main document, which contains the cumulative returns of WML_n s and $vWML_n$ s, to study the influence of momentum crashes. In turn, [Figure A5](#) plots the time-varying betas of these WML_n s and $vWML_n$ s in the bear markets. Similarly, [Figure A6](#) includes the cumulative returns of recent and intermediate horizon past performance momentum, and [Figure A7](#) does those of residual momentum.

[Figure A8](#), mapping to Figure 5 in the main document, which only considers conventional one-year momentum, illustrates the long-short average returns and Fama–French (2018) alphas of recent past performance ($t-6, t-2$), intermediate horizon past performance ($t-12, t-7$), and less-biased ($t-11, t-3$) momentum (Gong, Liu, and Liu, 2015) as the functions of the number of portfolios. Similarly, [Figures A9](#) and [A10](#) do those of residual and alpha (Hühn and Scholz, 2018; Zaremba, Umutlu, and Karathanasopoulos, 2019) momentum, respectively. In turn, [Figure A11](#) considers their Hou–Mo–Xue–Zhang (2020) and Daniel–Hirshleifer–Sun (2020) alphas.

[Figure A12](#), in addition to Figure 6 in the main document, which only considers the long-short average returns and Fama–French (2018) alphas, depicts the Hou–Mo–Xue–Zhang (2020) and Daniel–Hirshleifer–Sun (2020) alphas of the size (SMB), book-to-market (HML),

operating profitability (RMW), and investment (CMA) strategies as the functions of the number of portfolios. In addition to these four anomalies, [Figures A13](#) and [A14](#) delve into 49 anomalies in Kozak (2020) and 128 anomalies in Chen and Zimmermann (2022), respectively.

[Figure A15](#) reports the average returns and monotonicity-relation statistics (Patton and Timmermann, 2010) of 5×5 two-way portfolios sorted by both momentum and each of other four anomalies, namely size, book-to-market, operating profitability, and investment.

[Figure A16](#) presents the 10-year postholding period cumulative returns (Jegadeesh and Titman, 2001) of full, recent, and intermediate horizon past performance WML_ns. In turn, [Figure A17](#) scrutinizes the influence of past momentum performance (PMP) quintiles (Ali, Daniel, and Hirshleifer, 2017) on these cumulative returns, the two standard error bands of which are shown in [Figure A18](#).

References

- Arnott, Robert D., Vitali Kalesnik, and Juhani T. Linnainmaa (2023). Factor momentum. *Review of Financial Studies* 36 (8), 3034–3070.
- Ali, Usman, Kent Daniel, and David Hirshleifer (2017). One brief shining moment(um): past momentum performance and momentum reversals. Working paper. <https://ssrn.com/abstract=2956493>.
- Bhojraj, Sanjeev and Bhaskaran Swaminathan (2006). Macromomentum: returns predictability in international equity indices. *Journal of Business* 79 (1), 429–451.
- Blitz, David, Joop Huij, and Martin Martens (2011). Residual momentum. *Journal of Empirical Finance* 18 (3), 506–521.
- Campbell, John Y. and Samuel B. Thompson (2008). Predicting excess stock returns out of sample: can anything beat the historical average? *Review of Financial Studies* 21 (4), 1509–1531.
- Chen, Andrew Y. and Tom Zimmermann (2022). Open source cross-sectional asset pricing. *Critical Finance Review* 11 (2), 207–264.
- Daniel, Kent, David Hirshleifer, and Lin Sun (2020). Short- and long-horizon behavioral factors. *Review of Financial Studies* 33 (4), 1673–1736.
- Daniel, Kent and Tobias J. Moskowitz (2016). Momentum crashes. *Journal of Financial Economics* 122 (2), 221–247.
- Fama, Eugene F. and Kenneth R. French (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* 33 (1), 3–56.
- Fama, Eugene F. and Kenneth R. French (2018). Choosing factors. *Journal of Financial Economics* 128 (2), 234–252.

- Gibbons, Michael R., Stephen A. Ross, and Jay Shanken (1989). A test of the efficiency of a given portfolio. *Econometrica* 57 (5), 1121–1152.
- Gong, Qiang, Ming Liu, and Qianqiu Liu (2015). Momentum is really short-term momentum. *Journal of Banking & Finance* 50, 169–182.
- Goyal, Amit and Sunil Wahal (2016). Is momentum an echo? *Journal of Financial and Quantitative Analysis* 50 (6), 1237–1267.
- Hou, Kewei, Haitao Mo, Chen Xue, and Lu Zhang (2021). An augmented q-factor model with expected growth. *Review of Finance* 25 (1), 1–41.
- Hou, Kewei, Chen Xue, and Lu Zhang (2020). Replicating anomalies. *Review of Financial Studies* 33 (5), 2019–2133.
- Hühn, Hannah Lea and Hendrik Scholz (2018). Alpha momentum and price momentum. *International Journal of Financial Studies* 6 (2), 49.
- Jegadeesh, Narasimhan and Sheridan Titman (2001). Profitability of momentum strategies: an evaluation of alternative explanations. *Journal of Finance* 56 (2), 699–720.
- Kozak, Serhiy (2020). Kernel trick for the cross-section. Working paper. <https://ssrn.com/abstract=3307895>.
- Leippold, Markus and Hanlin Yang (2021). The anatomy of factor momentum. Working paper. <https://ssrn.com/abstract=3517888>.
- Lewellen, Jonathan (2002). Momentum and autocorrelation in stock returns. *Review of Financial Studies* 15 (2), 533–564.
- Moreira, Alan and Tyler Muir (2017). Volatility-managed portfolios. *Journal of Finance* 72 (4), 1611–1644.
- Moskowitz, Tobias J. and Mark Grinblatt (1999). Do industries explain momentum? *Journal of Finance* 54 (4), 1249–1290.
- Novy-Marx, Robert (2012). Is momentum really momentum? *Journal of Financial Economics* 103 (3), 429–453.
- Patton, Andrew J. and Allan Timmermann (2010). Monotonicity in asset returns: new tests with applications to the term structure, the CAPM, and portfolio sorts. *Journal of Financial Economics* 98 (3), 605–625.
- Zaremba, Adam, Mehmet Umutlu, and Andreas Karathanasopoulos (2019). Alpha momentum and alpha reversal in country and industry equity indexes. *Journal of Empirical Finance* 53, 144–161.

Table A1. Monotonicity tests.

The table shows Patton–Timmermann (2010) monotonicity test results based on 10 value-weighted portfolios formed on momentum (Pr_12_2), size (ME), book-to-market (BE-ME), operating profitability (OP), investment (INV), earnings/price (E-P), cashflow/price (CF-P), dividend yield (D-P), short-term reversal (Pr_1_0), long-term reversal (Pr_60_13), accruals (AC), market beta (BETA), net share issues (NI), variance (VAR), and residual variance (RESVAR). The portfolios are from Professor Kenneth R. French's website. Asterisks (daggers) indicate equal-weighted (reverse-ordered) portfolios. Each column begins in the starting month and ends in December 2019. Return averages (Lo, P2-P9, Hi), high-minus-low averages (HML), and monotonicity-relation statistics (MR) are annualized. The *t*-statistics are in parenthesis, and *p*-values are in brackets. The test's null (alternative) hypothesis is a flat or weakly decreasing (a strictly increasing) pattern.

| Portfolio | Pr_12_2 | Pr_12_2* | ME† | BE-ME | OP | INV† | E-P | CF-P |
|-----------|---------|----------|-----------|---------|---------|---------|---------|---------|
| Starting | 192701 | 192701 | 192607 | 192607 | 196307 | 196307 | 195107 | 195106 |
| Low | 4.0 | 11.3 | 10.7 | 10.5 | 9.1 | 8.8 | 11.1 | 10.9 |
| P2 | 8.4 | 13.1 | 12.1 | 11.9 | 9.6 | 12.0 | 10.2 | 11.6 |
| P3 | 9.1 | 13.4 | 12.9 | 11.4 | 10.1 | 11.0 | 11.8 | 11.1 |
| P4 | 10.6 | 14.6 | 13.2 | 11.4 | 10.7 | 11.9 | 11.5 | 11.9 |
| P5 | 10.8 | 14.6 | 14.1 | 12.2 | 12.0 | 11.4 | 11.9 | 12.5 |
| P6 | 11.5 | 15.9 | 13.9 | 12.7 | 11.0 | 11.5 | 13.5 | 12.0 |
| P7 | 12.2 | 16.0 | 14.4 | 11.9 | 10.6 | 11.7 | 14.1 | 13.3 |
| P8 | 13.4 | 17.1 | 14.9 | 14.4 | 12.4 | 12.5 | 14.7 | 13.7 |
| P9 | 14.4 | 18.9 | 14.9 | 15.8 | 12.8 | 13.9 | 15.6 | 14.6 |
| High | 18.0 | 21.2 | 16.3 | 15.9 | 12.0 | 13.6 | 16.3 | 15.9 |
| HML | 14.0 | 9.9 | 5.6 | 5.5 | 2.9 | 4.7 | 5.2 | 5.1 |
| | (5.0) | (3.6) | (2.1) | (2.4) | (1.6) | (3.2) | (3.1) | (3.0) |
| MR | 0.14 | -0.01 | -0.23 | -0.82 | -0.97 | -1.02 | -0.82 | -0.48 |
| | [0.001] | [0.005] | [0.075] | [0.192] | [0.196] | [0.270] | [0.158] | [0.028] |
| Portfolio | D-P | Pr_1_0† | Pr_60_13† | AC† | BETA | NI† | VAR† | RESVAR† |
| Starting | 192707 | 192602 | 193101 | 196307 | 196307 | 196307 | 196307 | 196307 |
| Low | 10.5 | 6.0 | 10.9 | 8.9 | 11.3 | 6.4 | 4.7 | 4.0 |
| P2 | 11.4 | 9.8 | 11.0 | 10.3 | 10.9 | 8.2 | 11.6 | 11.6 |
| P3 | 10.9 | 10.9 | 12.7 | 11.7 | 11.7 | 10.1 | 13.6 | 14.2 |
| P4 | 12.3 | 11.6 | 12.4 | 11.4 | 12.8 | 11.2 | 13.7 | 12.4 |
| P5 | 10.6 | 11.9 | 12.1 | 11.0 | 11.3 | 12.7 | 13.1 | 13.9 |
| P6 | 11.7 | 12.5 | 13.0 | 11.5 | 12.3 | 13.1 | 12.1 | 12.7 |
| P7 | 12.7 | 12.3 | 12.6 | 11.6 | 11.0 | 12.1 | 11.7 | 12.3 |
| P8 | 12.9 | 13.6 | 14.3 | 12.0 | 12.7 | 10.7 | 11.8 | 11.2 |
| P9 | 12.6 | 14.0 | 14.6 | 13.1 | 12.1 | 10.7 | 12.0 | 11.9 |
| High | 12.2 | 16.3 | 16.6 | 13.3 | 12.1 | 11.5 | 10.5 | 11.4 |
| HML | 1.7 | 10.3 | 5.7 | 4.4 | 0.8 | 5.2 | 5.8 | 7.4 |
| | (0.9) | (4.9) | (2.4) | (3.4) | (0.3) | (3.5) | (1.6) | (2.3) |
| MR | -1.66 | -0.20 | -0.38 | -0.38 | -1.47 | -1.43 | -1.56 | -1.83 |
| | [0.796] | [0.006] | [0.027] | [0.001] | [0.575] | [0.281] | [0.577] | [0.729] |

Table A2. Monotonicity tests: other anomaly portfolios.

The table shows Patton–Timmermann (2010) monotonicity test results based on value-weighted portfolios formed on 185 anomalies (Hou *et al.*, 2021, Hou, Xue, and Zhang, 2020). The portfolios are from Professors Kewei Hou, Chen Xue, and Lu Zhang’s website. Asterisks mean reverse-ordered portfolios. Each anomaly shows the number of portfolios, the starting month, the high-minus-low average (HML) and its *t*-statistic, and the monotonicity-relation statistic (MR) and its bootstrap *p*-value. The ending month is December 2019. HMLs and MRs are annualized. Anomalies are sorted by HML, the *t*-statistics are in parentheses, and bootstrap *p*-values are in brackets. The test’s null (alternative) hypothesis is a flat or weakly decreasing (a strictly increasing) pattern.

| Anomaly | N portfolios | Starting | HML | t-statistic | MR | p-value |
|--|--------------|----------|-------|-------------|-------|---------|
| prior 11-month returns, 1-month holding period | 10 | 196701 | 13.77 | (4.1) | -0.20 | [0.002] |
| quarterly R&D expense-to-market, 1-month holding period | 10 | 199001 | 13.02 | (3.2) | -3.28 | [0.422] |
| expected growth, 1-month holding period | 10 | 196701 | 12.64 | (6.8) | 0.25 | [0.000] |
| changes in analyst earnings forecasts, 1-month holding period | 10 | 197603 | 11.35 | (4.7) | -1.10 | [0.035] |
| seasonality, average return across months t-72, t-84, t-96, t-108, and t-120 | 10 | 196701 | 9.90 | (5.2) | -1.38 | [0.284] |
| expected growth, 6-month holding period | 10 | 196701 | 9.89 | (5.6) | 0.46 | [0.000] |
| quarterly R&D expense-to-market, 12-month holding period | 10 | 199001 | 9.84 | (3.0) | -1.09 | [0.112] |
| quarterly earnings-to-price, 1-month holding period | 10 | 196701 | 9.74 | (4.6) | -0.82 | [0.058] |
| prior 6-month returns, 6-month holding period | 10 | 196701 | 9.65 | (3.8) | -0.68 | [0.320] |
| quarterly R&D expense-to-market, 6-month holding period | 10 | 199001 | 9.41 | (2.6) | -1.67 | [0.236] |
| prior 11-month returns, 6-month holding period | 10 | 196701 | 9.38 | (3.3) | -0.31 | [0.069] |
| customer momentum, 1-month holding period | 5 | 197907 | 9.20 | (3.8) | -0.09 | [0.010] |
| R&D expense-to-market | 10 | 197607 | 9.16 | (3.3) | -0.82 | [0.020] |
| quarterly operating profits-to-lagged assets, 1-month holding period | 10 | 197601 | 9.15 | (4.1) | -0.82 | [0.051] |
| revisions in analyst earnings forecasts, 1-month holding period | 10 | 197607 | 8.92 | (3.3) | -1.29 | [0.177] |
| 4-quarter changes in return on equity, 1-month holding period | 10 | 196701 | 8.87 | (5.6) | -0.57 | [0.014] |
| customer industries momentum, 1-month holding period | 10 | 196701 | 8.76 | (3.5) | -2.50 | [0.475] |
| cumulative abnormal returns around earnings announcement dates, 1-month holding period | 10 | 197201 | 8.65 | (5.4) | -1.23 | [0.222] |
| supplier industries momentum, 1-month holding period | 10 | 196701 | 8.53 | (3.4) | -0.96 | [0.020] |
| seasonality, average return across months t-24, t-36, t-48, and t-60 | 10 | 196701 | 8.52 | (4.7) | -1.12 | [0.184] |
| expected growth, 12-month holding period | 10 | 196701 | 8.40 | (5.0) | 0.06 | [0.000] |
| quarterly assets turnover, 1-month holding period | 10 | 197201 | 8.08 | (4.1) | -2.78 | [0.818] |
| operating cash flow-to-assets | 10 | 196701 | 8.01 | (4.2) | -1.18 | [0.244] |
| return on equity, 1-month holding period | 10 | 196701 | 8.00 | (3.4) | -1.07 | [0.186] |
| failure probability, 6-month holding period* | 10 | 197601 | 7.96 | (2.3) | -0.28 | [0.040] |
| quarterly return on net operating assets, 1-month holding period | 10 | 197601 | 7.80 | (3.2) | -1.03 | [0.163] |
| net stock issues* | 10 | 196701 | 7.79 | (5.4) | -3.02 | [0.950] |
| industry momentum, 1-month holding period | 9 | 196701 | 7.72 | (2.7) | 0.04 | [0.000] |
| quarterly operating profits-to-lagged book equity, 1-month holding period | 10 | 197201 | 7.65 | (3.3) | -1.12 | [0.166] |
| seasonality, average return across months t-132, t-144, t-156, t-168, and t-180 | 10 | 196701 | 7.54 | (4.5) | -2.61 | [0.875] |
| prior 6-month returns, 1-month holding period | 10 | 196701 | 7.43 | (2.3) | -1.12 | [0.254] |
| industry momentum, 12-month holding period | 9 | 196701 | 7.33 | (3.6) | -0.58 | [0.330] |
| industry lead-lag effect in prior returns, 1-month holding period | 9 | 196701 | 7.33 | (3.1) | -0.78 | [0.048] |

Table A2. *Continued.* Monotonicity tests: other anomaly portfolios.

| Anomaly | N portfolios | Starting | HML | t-statistic | MR | p-value |
|---|--------------|----------|------|-------------|-------|---------|
| industry momentum, 6-month holding period | 9 | 196701 | 7.25 | (3.0) | -0.59 | [0.223] |
| net payout yield | 10 | 197207 | 7.21 | (3.6) | -0.28 | [0.001] |
| earnings predictability* | 10 | 196701 | 7.16 | (3.6) | -2.19 | [0.766] |
| organizational capital-to-assets | 10 | 196701 | 7.14 | (3.4) | -1.49 | [0.451] |
| cash-based operating profits-to-lagged assets | 10 | 196701 | 7.11 | (3.9) | -0.65 | [0.043] |
| quarterly assets turnover, 6-month holding period | 10 | 197201 | 7.05 | (3.7) | -1.65 | [0.604] |
| quarterly enterprise multiple, 1-month holding period* | 10 | 197601 | 7.03 | (3.2) | -0.58 | [0.020] |
| advertising expense-to-market | 10 | 197307 | 7.00 | (2.6) | -1.35 | [0.126] |
| 11-month residual momentum, 1-month holding period | 10 | 196701 | 6.97 | (3.8) | -1.17 | [0.278] |
| industry lead-lag effect in earnings surprises, 1-month holding period | 9 | 196701 | 6.90 | (3.6) | -1.70 | [0.496] |
| 52-week high, 6-month holding period | 10 | 196701 | 6.88 | (2.2) | -0.47 | [0.245] |
| seasonality, return in month t-12 | 10 | 196701 | 6.86 | (3.2) | -0.91 | [0.123] |
| seasonality, average return from month t-11 to t-1 | 10 | 196701 | 6.85 | (2.0) | -1.73 | [0.576] |
| quarterly gross profits-to-lagged assets, 1-month holding period | 10 | 197601 | 6.72 | (4.1) | -0.89 | [0.084] |
| return on assets, 1-month holding period | 10 | 197201 | 6.71 | (2.8) | -1.11 | [0.151] |
| composite equity issuance* | 10 | 196701 | 6.68 | (3.6) | -1.40 | [0.353] |
| quarterly operating profits-to-lagged assets, 6-month holding period | 10 | 197601 | 6.62 | (3.3) | -0.49 | [0.026] |
| seasonality, average return across months t-192, t-204, t-216, t-228, and t-240 | 10 | 196701 | 6.59 | (3.6) | -1.67 | [0.313] |
| operating cash flow-to-price | 10 | 197207 | 6.54 | (2.7) | -0.49 | [0.015] |
| percent discretionary accruals* | 10 | 196701 | 6.51 | (4.7) | -0.82 | [0.046] |
| 4-quarter changes in return on assets, 1-month holding period | 10 | 197301 | 6.44 | (3.6) | -0.45 | [0.002] |
| prior 6-month returns, 12-month holding period | 10 | 196701 | 6.38 | (3.1) | -0.24 | [0.096] |
| changes in analyst earnings forecasts, 6-month holding period | 10 | 197603 | 6.36 | (3.5) | -0.48 | [0.047] |
| idiosyncratic volatility estimated from the Fama-French 3-factor model, 1-month holding period* | 10 | 196701 | 6.35 | (1.9) | -1.92 | [0.778] |
| industry-adjusted organizational capital-to-assets | 10 | 196701 | 6.31 | (4.3) | -0.50 | [0.005] |
| quarterly sales-to-price, 1-month holding period | 10 | 196701 | 6.13 | (2.4) | -0.88 | [0.122] |
| quarterly cash-based operating profits-to-lagged assets, 1-month holding period | 10 | 197601 | 6.12 | (3.5) | -1.20 | [0.158] |
| quarterly operating profits-to-lagged assets, 12-month holding period | 10 | 197601 | 6.11 | (3.2) | -0.54 | [0.079] |
| quarterly operating leverage, 1-month holding period | 10 | 197301 | 6.10 | (3.1) | -1.63 | [0.361] |
| quarterly earnings-to-price, 6-month holding period | 10 | 196701 | 6.08 | (3.1) | -0.34 | [0.036] |
| quarterly operating leverage, 12-month holding period | 10 | 197301 | 6.06 | (3.3) | -0.87 | [0.127] |
| segment momentum, 1-month holding period | 10 | 197707 | 6.04 | (2.2) | -1.07 | [0.031] |
| quarterly operating cash flow-to-price, 1-month holding period | 10 | 198501 | 5.98 | (2.0) | -0.94 | [0.059] |
| idiosyncratic volatility estimated from the q-factor model, 1-month holding period* | 10 | 196702 | 5.97 | (1.8) | -2.27 | [0.889] |
| quarterly operating leverage, 6-month holding period | 10 | 197301 | 5.97 | (3.1) | -1.24 | [0.267] |
| quarterly assets turnover, 12-month holding period | 10 | 197201 | 5.93 | (3.2) | -1.35 | [0.533] |
| quarterly cash flow-to-price, 1-month holding period | 10 | 196701 | 5.91 | (2.5) | -1.40 | [0.276] |
| quarterly capital turnover, 1-month holding period | 10 | 197201 | 5.83 | (3.0) | -1.27 | [0.174] |

Table A2. Continued. Monotonicity tests: other anomaly portfolios.

| Anomaly | N portfolios | Starting | HML | t-statistic | MR | p-value |
|--|--------------|----------|------|-------------|-------|---------|
| quarterly R&D expense-to-sales, 12-month holding period | 10 | 199001 | 5.79 | (2.0) | -1.61 | [0.129] |
| quarterly asset liquidity, 6-month holding period | 10 | 197601 | 5.78 | (2.8) | -0.10 | [0.001] |
| quarterly R&D expense-to-sales, 6-month holding period | 10 | 199001 | 5.74 | (2.0) | -1.53 | [0.076] |
| quarterly cash-based operating profits-to-lagged assets, 6-month holding period | 10 | 197601 | 5.71 | (3.9) | -0.16 | [0.000] |
| quarterly fundamental score, 6-month holding period | 7 | 198501 | 5.69 | (2.5) | -1.24 | [0.524] |
| quarterly sales-to-price, 6-month holding period | 10 | 196701 | 5.68 | (2.4) | -0.45 | [0.058] |
| quarterly asset liquidity, 1-month holding period | 10 | 197601 | 5.66 | (2.6) | -1.04 | [0.182] |
| quarterly cash-based operating profits-to-lagged assets, 12-month holding period | 10 | 197601 | 5.65 | (4.2) | -0.20 | [0.004] |
| operating profits-to-assets | 10 | 196701 | 5.60 | (2.8) | -1.53 | [0.426] |
| net operating assets* | 10 | 196701 | 5.59 | (3.9) | -3.14 | [0.962] |
| changes in net operating assets* | 10 | 196701 | 5.58 | (3.7) | -1.76 | [0.680] |
| quarterly fundamental score, 1-month holding period | 7 | 198501 | 5.54 | (2.0) | -0.97 | [0.190] |
| changes in net non-cash working capital* | 10 | 196701 | 5.53 | (3.7) | -0.81 | [0.075] |
| 11-month residual momentum, 6-month holding period | 10 | 196701 | 5.49 | (3.6) | -0.23 | [0.039] |
| 52-week high, 12-month holding period | 10 | 196701 | 5.46 | (2.0) | -0.04 | [0.031] |
| quarterly capital turnover, 6-month holding period | 10 | 197201 | 5.44 | (2.9) | -1.90 | [0.694] |
| revisions in analyst earnings forecasts, 6-month holding period | 10 | 197607 | 5.37 | (2.3) | -0.78 | [0.121] |
| operating leverage | 10 | 196701 | 5.35 | (3.1) | -1.26 | [0.210] |
| R&D capital-to-assets | 10 | 198007 | 5.34 | (2.0) | -2.41 | [0.518] |
| 6-month residual momentum, 6-month holding period | 10 | 196701 | 5.29 | (3.9) | -0.41 | [0.171] |
| prior 11-month returns, 12-month holding period | 10 | 196701 | 5.25 | (2.2) | -0.29 | [0.098] |
| quarterly sales-to-price, 12-month holding period | 10 | 196701 | 5.22 | (2.4) | -0.34 | [0.034] |
| seasonality, average return from month t-120 to t-61 except for months t-72, t-84, t-96, t-108, and t-120* | 10 | 196701 | 5.21 | (2.5) | -1.30 | [0.272] |
| quarterly return on net operating assets, 6-month holding period | 10 | 197601 | 5.19 | (2.3) | -0.36 | [0.012] |
| discretionary accruals* | 10 | 196701 | 5.16 | (3.6) | -1.12 | [0.199] |
| changes in PPE and inventory scaled by lagged assets* | 10 | 196701 | 5.12 | (3.5) | -1.64 | [0.625] |
| standard unexpected earnings, 1-month holding period | 10 | 196701 | 5.12 | (3.2) | -1.61 | [0.542] |
| percent operating accruals* | 10 | 196701 | 5.06 | (3.5) | -0.62 | [0.017] |
| quarterly operating profits-to-lagged book equity, 6-month holding period | 10 | 197201 | 5.04 | (2.3) | -0.99 | [0.247] |
| enterprise multiple* | 10 | 196701 | 4.99 | (2.5) | -0.17 | [0.001] |
| quarterly O-score, 1-month holding period* | 10 | 197601 | 4.99 | (2.1) | -1.29 | [0.306] |
| return on equity, 6-month holding period | 10 | 196701 | 4.93 | (2.2) | -1.18 | [0.532] |
| quarterly capital turnover, 12-month holding period | 10 | 197201 | 4.91 | (2.7) | -1.34 | [0.482] |
| percent total accruals* | 10 | 196701 | 4.87 | (3.2) | -1.25 | [0.242] |
| assets turnover | 10 | 196701 | 4.87 | (2.5) | -0.69 | [0.036] |
| investment growth* | 10 | 196701 | 4.86 | (3.6) | -1.40 | [0.370] |
| total volatility, 1-month holding period* | 10 | 196701 | 4.82 | (1.3) | -1.89 | [0.706] |
| gross profits-to-assets | 10 | 196701 | 4.80 | (3.1) | -0.46 | [0.003] |

Table A2. Continued. Monotonicity tests: other anomaly portfolios.

| Anomaly | N portfolios | Starting | HML | t-statistic | MR | p-value |
|---|--------------|----------|------|-------------|-------|---------|
| sales-to-price | 10 | 196701 | 4.79 | (2.2) | -0.33 | [0.006] |
| quarterly asset liquidity, 12-month holding period | 10 | 197601 | 4.75 | (2.4) | -0.29 | [0.013] |
| quarterly investment-to-assets (asset growth), 6-month holding period* | 10 | 197301 | 4.72 | (2.6) | -0.57 | [0.050] |
| inventory changes* | 10 | 196701 | 4.66 | (3.1) | -0.98 | [0.100] |
| seasonality, average return from month t-60 to t-13 except for months t-24, t-36, t-48, and t-60* | 10 | 196701 | 4.66 | (1.9) | -1.13 | [0.220] |
| industry-adjusted real estate ratio | 10 | 197007 | 4.62 | (2.6) | -0.99 | [0.039] |
| quarterly gross profits-to-lagged assets, 6-month holding period | 10 | 197601 | 4.61 | (3.0) | -0.62 | [0.038] |
| quarterly cash flow-to-price, 6-month holding period | 10 | 196701 | 4.61 | (2.2) | -0.27 | [0.017] |
| book-to-market equity | 10 | 196701 | 4.56 | (2.1) | -0.83 | [0.120] |
| revenue surprises, 1-month holding period | 10 | 196701 | 4.52 | (2.8) | -1.94 | [0.751] |
| systematic volatility, 1-month holding period* | 10 | 198602 | 4.46 | (1.7) | -1.85 | [0.506] |
| 4-quarter changes in return on equity, 6-month holding period | 10 | 196701 | 4.46 | (3.4) | -0.59 | [0.066] |
| payout yield | 10 | 197207 | 4.45 | (2.0) | -0.68 | [0.026] |
| quarterly investment-to-assets (asset growth), 12-month holding period* | 10 | 197301 | 4.42 | (2.6) | -0.46 | [0.054] |
| quarterly earnings-to-price, 12-month holding period | 10 | 196701 | 4.32 | (2.4) | -0.37 | [0.075] |
| changes in non-current operating assets* | 10 | 196701 | 4.31 | (3.1) | -0.88 | [0.079] |
| changes in net non-current operating assets* | 10 | 196701 | 4.27 | (3.2) | -1.25 | [0.296] |
| quarterly fundamental score, 12-month holding period | 7 | 198501 | 4.23 | (2.0) | -0.73 | [0.306] |
| 6-month residual momentum, 12-month holding period | 10 | 196701 | 4.23 | (3.8) | -0.19 | [0.067] |
| investment-to-assets (asset growth)* | 10 | 196701 | 4.23 | (2.5) | -0.72 | [0.062] |
| cumulative abnormal returns around earnings announcement dates, 6-month holding period | 10 | 197201 | 4.19 | (3.8) | -0.36 | [0.010] |
| quarterly gross profits-to-lagged assets, 12-month holding period | 10 | 197601 | 4.10 | (2.7) | -0.32 | [0.003] |
| quarterly book-to-market equity, 12-month holding period | 10 | 196701 | 4.09 | (1.8) | -0.35 | [0.048] |
| capital turnover | 10 | 196701 | 4.08 | (2.3) | -2.65 | [0.840] |
| analyst-based intrinsic value-to-market | 10 | 197607 | 4.07 | (1.7) | -2.91 | [0.856] |
| industry lead-lag effect in prior returns, 12-month holding period | 9 | 196701 | 4.04 | (4.2) | 0.03 | [0.000] |
| dollar trading volume, 12-month holding period* | 10 | 196701 | 4.03 | (2.1) | -0.25 | [0.078] |
| industry lead-lag effect in prior returns, 6-month holding period | 9 | 196701 | 4.03 | (3.3) | -0.18 | [0.006] |
| earnings-to-price | 10 | 196701 | 4.02 | (1.8) | -1.76 | [0.670] |
| inventory growth* | 10 | 196701 | 3.92 | (2.7) | -2.62 | [0.915] |
| intangible return* | 10 | 196701 | 3.91 | (1.7) | -1.48 | [0.443] |
| quarterly sales growth, 1-month holding period | 10 | 196701 | 3.90 | (2.0) | -1.73 | [0.647] |
| the number of quarters with consecutive earnings increase, 1-month holding period | 9 | 196901 | 3.85 | (2.9) | -1.20 | [0.168] |
| equity duration* | 10 | 196701 | 3.82 | (1.8) | -1.65 | [0.579] |
| cash flow-to-price | 10 | 196701 | 3.78 | (1.7) | -1.07 | [0.221] |
| quarterly enterprise multiple, 12-month holding period* | 10 | 197601 | 3.74 | (1.9) | -0.80 | [0.368] |
| earnings timeliness | 10 | 196701 | 3.73 | (2.5) | -0.71 | [0.018] |
| changes in analyst earnings forecasts, 12-month holding period | 10 | 197603 | 3.68 | (2.5) | -0.37 | [0.034] |

Table A2. Continued. Monotonicity tests: other anomaly portfolios.

| Anomaly | N portfolios | Starting | HML | t-statistic | MR | p-value |
|--|--------------|----------|------|-------------|-------|---------|
| 11-month residual momentum, 12-month holding period | 10 | 196701 | 3.67 | (2.8) | -0.38 | [0.281] |
| book-to-June-end market equity | 10 | 196701 | 3.63 | (1.6) | -0.62 | [0.052] |
| customer industries momentum, 6-month holding period | 10 | 196701 | 3.61 | (3.0) | -1.41 | [0.722] |
| quarterly cash flow-to-price, 12-month holding period | 10 | 196701 | 3.61 | (1.8) | -0.10 | [0.013] |
| changes in book equity* | 10 | 196701 | 3.59 | (2.1) | -0.65 | [0.035] |
| quarterly enterprise multiple, 6-month holding period* | 10 | 197601 | 3.57 | (1.7) | -0.83 | [0.242] |
| idiosyncratic skewness estimated from the Fama-French 3-factor model, 1-month holding period | 10 | 196701 | 3.55 | (3.1) | -1.57 | [0.580] |
| 2-year investment growth* | 10 | 196701 | 3.51 | (2.4) | -1.62 | [0.467] |
| short-term reversal* | 10 | 196701 | 3.47 | (1.4) | -1.99 | [0.781] |
| long-term reversal, 6-month holding period* | 10 | 196701 | 3.39 | (1.5) | -0.69 | [0.192] |
| changes in long-term net operating assets* | 10 | 196701 | 3.38 | (2.2) | -0.95 | [0.106] |
| percent changes in investment relative to industry* | 10 | 196701 | 3.36 | (2.6) | -0.65 | [0.026] |
| 4-quarter changes in return on assets, 6-month holding period | 10 | 197301 | 3.34 | (2.2) | -1.79 | [0.790] |
| operating accruals* | 10 | 196701 | 3.34 | (2.3) | -1.24 | [0.320] |
| customer industries momentum, 12-month holding period | 10 | 196701 | 3.32 | (3.4) | -0.96 | [0.714] |
| Roe-based intrinsic value-to-market | 10 | 196701 | 3.22 | (1.5) | -1.83 | [0.655] |
| enterprise book-to-price | 10 | 196701 | 3.19 | (1.4) | -0.79 | [0.058] |
| industry concentration in sales* | 10 | 196701 | 3.18 | (1.9) | -2.54 | [0.508] |
| long-term reversal, 1-month holding period* | 10 | 196701 | 3.16 | (1.3) | -0.56 | [0.026] |
| long-term reversal, 12-month holding period* | 10 | 196701 | 3.15 | (1.5) | -0.28 | [0.050] |
| operating profits-to-book equity | 10 | 196701 | 3.12 | (1.5) | -1.35 | [0.401] |
| changes in net financial assets | 10 | 196701 | 3.08 | (2.3) | -1.73 | [0.601] |
| 4-quarter changes in return on equity, 12-month holding period | 10 | 196701 | 3.03 | (2.7) | -0.37 | [0.032] |
| changes in current operating assets* | 10 | 196701 | 3.00 | (1.9) | -1.20 | [0.221] |
| changes in financial liabilities* | 10 | 196701 | 2.97 | (2.4) | -1.13 | [0.233] |
| abnormal corporate investment* | 10 | 196701 | 2.94 | (2.0) | -1.48 | [0.418] |
| cumulative abnormal returns around earnings announcement dates, 12-month holding period | 10 | 197201 | 2.89 | (3.3) | -0.39 | [0.039] |
| idiosyncratic skewness estimated from the q-factor model, 1-month holding period | 10 | 196702 | 2.79 | (2.5) | -1.92 | [0.817] |
| total accruals* | 10 | 196701 | 2.69 | (1.8) | -0.71 | [0.040] |
| dividend yield | 10 | 196701 | 2.68 | (1.0) | -1.11 | [0.233] |
| net debt financing* | 10 | 197207 | 2.61 | (1.9) | -0.74 | [0.027] |
| effective tax rate | 10 | 196701 | 2.51 | (2.0) | -1.60 | [0.446] |
| quarterly tax income-to-book income, 12-month holding period | 10 | 196701 | 2.41 | (2.1) | -1.57 | [0.816] |
| the market equity* | 10 | 196701 | 1.96 | (0.8) | -0.63 | [0.196] |
| segment momentum, 12-month holding period | 10 | 197707 | 1.90 | (2.2) | -0.20 | [0.004] |
| standard unexpected earnings, 6-month holding period | 10 | 196701 | 1.85 | (1.3) | -1.88 | [0.945] |
| customer momentum, 12-month holding period | 5 | 197907 | 1.73 | (2.1) | -0.71 | [0.436] |
| market beta, 1-month holding period | 10 | 196701 | 0.14 | (0.0) | -0.69 | [0.100] |

Table A3. Number of momentum portfolios and performance of factor models.

The table shows the mean absolute alphas (MA α) and the Gibbons–Ross–Shanken (1989) F -statistics of the 10, 25, 50, and 100 momentum portfolios, respectively. Each panel shows the covered months. Alphas are annualized. p -values are in brackets.

| N | 10 | 25 | 50 | 100 |
|--|---------|---------|---------|---------|
| CAPM (192701–201912) | | | | |
| MA α | 3.87 | 4.06 | 4.10 | 4.11 |
| GRS F | 6.66 | 3.89 | 2.49 | 1.96 |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Fama–French (1993) three-factor model (192701–201912) | | | | |
| MA α | 4.54 | 4.74 | 4.81 | 4.79 |
| GRS F | 8.17 | 4.54 | 2.72 | 2.03 |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Fama–French (2018) five-factor model (196307–201912) | | | | |
| MA α | 3.39 | 3.58 | 3.70 | 3.72 |
| GRS F | 4.85 | 2.74 | 2.16 | 1.81 |
| | [0.000] | [0.000] | [0.000] | [0.000] |
| Hou–Mo–Xue–Zhang (2020) five-factor model (196701–201912) | | | | |
| MA α | 1.35 | 1.39 | 1.64 | 1.85 |
| GRS F | 1.69 | 1.26 | 1.40 | 1.26 |
| | [0.080] | [0.177] | [0.040] | [0.059] |
| Stambaugh–Yuan (2017) four-factor model (196301–201612) | | | | |
| MA α | 1.26 | 1.42 | 1.75 | 1.98 |
| GRS F | 2.34 | 1.84 | 1.83 | 1.61 |
| | [0.010] | [0.008] | [0.001] | [0.001] |
| Daniel–Hirshleifer–Sun (2020) three-factor model (197207–201812) | | | | |
| MA α | 1.50 | 1.57 | 1.73 | 2.01 |
| GRS F | 2.66 | 1.63 | 1.45 | 1.33 |
| | [0.003] | [0.028] | [0.028] | [0.028] |

Table A4. Zoom in on others: factor regressions.

This table shows time-series regression results of the form $y_t = \alpha + \beta'x_t + \varepsilon_t$, where y is the winner-minus-loser (WML_n) return based on 10, 25, 50, or 100 momentum portfolios, and x is the Fama–French (2015) five factors based on 10, 25, 50, or 100 corresponding portfolios: the market (Mkt_RF), small-minus-big (SMB_n), high-minus-low (HML_n), robust-minus-weak (RMW_n), and conservative-minus-aggressive (CMA_n) factors. Except Mkt_RF , factors in the first column are two-way sorted and from Professor Kenneth R. French’s website, and those in the other columns are one-way sorted and based on CRSP. The data span July 1963 to December 2019. t -statistics are in parentheses, and alphas are annualized.

| | French | WML ₁₀ | WML ₂₅ | WML ₅₀ | WML ₁₀₀ |
|-----------|------------------|-------------------|-------------------|-------------------|--------------------|
| α | 8.72 (3.44) | 17.47 (5.47) | 28.24 (7.73) | 35.42 (7.20) | 37.78 (5.69) |
| Mkt_RF | -0.15 (-1.96) | -0.00 (-1.75) | -0.00 (-1.79) | -0.00 (-1.58) | -0.00 (-1.12) |
| SMB_n | 0.05 (0.47) | 0.03 (0.17) | -0.20 (-0.95) | -0.29 (-1.16) | -0.39 (-1.51) |
| HML_n | -0.52 (-3.20) | -0.39 (-2.44) | -0.32 (-2.16) | -0.16 (-1.18) | -0.28 (-1.74) |
| RMW_n | 0.22 (0.87) | 0.12 (0.73) | -0.04 (-0.22) | 0.22 (1.14) | 0.14 (0.70) |
| CMA_n | 0.33 (1.32) | 0.24 (1.19) | 0.18 (0.82) | -0.08 (-0.40) | -0.02 (-0.13) |
| R^2 | 9.49 | 7.55 | 8.39 | 8.08 | 8.59 |

Table A5. Factor momentum: spanning regressions.

This table shows time-series regression results of the form $y_t = \alpha + \beta x_t + \varepsilon_t$, where y is either the simple or the volatility-managed winner-minus-loser (WML_n) return based on 10, 25, 50, or 100 momentum portfolios, and x is one or more factor momentum strategies—the Leippold–Yang (2021) 12-month (LY_{12}) factor momentum and the Arnott–Kalesnik–Linnainmaa (2023) one- (AKL_1) and six-month (AKL_6) factor momentum—based on 210 US equity factors. The 210 factors are from Professor Markus Leippold’s website (<https://osf.io/6sxc8>). The first four columns regress simple WML_n s on simple factor momentum, and the last four columns regress volatility-managed WML_n s on volatility-managed factor momentum. Similar to Moreira and Muir (2017), volatility-managed factor momentum scales non-managed factor momentum by the inverse of its conditional variance proxied by the previous year’s realized variance. The data span July 1966 to December 2018. t -statistics are in parentheses, and alphas are annualized.

| | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
|---|---------------------------|------------|------------|-------------|---------------------------------------|-------------|-------------|--------------|
| | WML_{10} | WML_{25} | WML_{50} | WML_{100} | $vWML_{10}$ | $vWML_{25}$ | $vWML_{50}$ | $vWML_{100}$ |
| <i>Panel A. Leippold–Yang (2021) 12-month factor momentum (LY_{12})</i> | | | | | | | | |
| α | 9.07 | 17.37 | 23.22 | 25.50 | 15.15 | 25.34 | 34.41 | 41.20 |
| | (2.80) | (4.48) | (4.19) | (3.22) | (3.91) | (5.17) | (5.13) | (4.85) |
| (v) LY_{12} | 3.92 | 4.57 | 4.97 | 5.01 | 2.92 | 3.14 | 3.13 | 3.66 |
| | (7.51) | (7.12) | (6.10) | (5.11) | (9.49) | (10.00) | (8.40) | (7.52) |
| R^2 | 42.50 | 34.93 | 27.78 | 16.29 | 23.51 | 16.42 | 11.03 | 8.67 |
| <i>Panel B. Arnott–Kalesnik–Linnainmaa (2023) one-month factor momentum (AKL_1)</i> | | | | | | | | |
| α | 14.10 | 23.29 | 30.82 | 34.02 | 17.09 | 27.23 | 36.49 | 44.17 |
| | (5.05) | (6.66) | (6.71) | (5.37) | (4.40) | (5.58) | (5.43) | (4.87) |
| (v) AKL_1 | 0.14 | 0.16 | 0.08 | 0.00 | 0.27 | 0.30 | 0.29 | 0.30 |
| | (1.18) | (1.19) | (0.42) | (0.01) | (3.18) | (2.66) | (2.02) | (1.70) |
| R^2 | 0.84 | 0.65 | 0.10 | 0.00 | 3.03 | 2.32 | 1.43 | 0.88 |
| <i>Panel C. Arnott–Kalesnik–Linnainmaa (2023) six-month factor momentum (AKL_6)</i> | | | | | | | | |
| α | 10.71 | 19.25 | 26.23 | 29.08 | 14.34 | 23.93 | 34.10 | 39.53 |
| | (3.38) | (4.97) | (5.37) | (4.34) | (3.67) | (5.14) | (5.03) | (4.71) |
| (v) AKL_6 | 1.38 | 1.62 | 1.50 | 1.36 | 1.63 | 1.88 | 1.61 | 2.20 |
| | (2.82) | (2.86) | (2.33) | (1.68) | (4.32) | (3.45) | (2.56) | (2.58) |
| R^2 | 5.53 | 4.59 | 2.64 | 1.26 | 7.65 | 6.18 | 3.06 | 3.28 |
| <i>Panel D. All three types of factor momentum (LY_{12}, AKL_1, and AKL_6)</i> | | | | | | | | |
| α | 10.18 | 18.68 | 26.43 | 29.91 | 12.24 | 21.55 | 31.78 | 37.43 |
| | (4.06) | (5.70) | (5.99) | (4.80) | (3.47) | (4.66) | (4.74) | (4.32) |
| (v) LY_{12} | 4.18 | 4.87 | 5.47 | 5.62 | 2.65 | 2.76 | 2.92 | 3.25 |
| | (6.80) | (6.56) | (5.80) | (4.62) | (9.27) | (7.98) | (7.69) | (6.41) |
| (v) AKL_1 | 0.05 | 0.05 | -0.03 | -0.10 | 0.13 | 0.15 | 0.14 | 0.12 |
| | (0.45) | (0.43) | (-0.20) | (-0.44) | (1.94) | (1.55) | (1.07) | (0.78) |
| (v) AKL_6 | -0.59 | -0.67 | -1.00 | -1.16 | 0.37 | 0.57 | 0.23 | 0.68 |
| | (-1.25) | (-1.26) | (-1.57) | (-1.37) | (0.96) | (0.96) | (0.35) | (0.75) |
| R^2 | 43.29 | 35.55 | 28.76 | 17.18 | 24.61 | 17.51 | 11.44 | 9.09 |

Table A6. Term structure of momentum: summary statistics.

The table shows summary statistics for $WML_n^{6,2}$ (top-left four columns), $vWML_n^{6,2}$ (top-right), $WML_n^{12,7}$ (bottom-left), and $vWML_n^{12,7}$ (bottom-right), where $WML^{6,2}$ and $WML^{12,7}$ are the simple WML strategies based on recent (five months from $t-6$ to $t-2$) and intermediate horizon (six months from $t-12$ to $t-7$) past performance, respectively (Novy-Marx, 2012; Goyal and Wahal 2015), and $vWML^{6,2}$ and $vWML^{12,7}$ are their volatility-managed counterparts, respectively (Moreira and Muir, 2017). The data span July 1926 ($WML^{6,2}$), August 1926 ($vWML^{6,2}$), January 1927 ($WML^{12,7}$), and February 1927 ($vWML^{12,7}$) to December 2019, respectively. Average returns, standard deviations, and Sharpe ratios are annualized.

| | | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
|---------------------------|--------|---------------------------|------------|------------|-------------|---------------------------------------|-------------|-------------|--------------|
| | | WML_{10} | WML_{25} | WML_{50} | WML_{100} | $vWML_{10}$ | $vWML_{25}$ | $vWML_{50}$ | $vWML_{100}$ |
| (6,2) winner-minus-loser | Mean | 8.62 | 15.82 | 19.98 | 23.51 | 23.37 | 31.03 | 38.11 | 47.12 |
| | St dev | 24.73 | 31.45 | 38.06 | 48.63 | 24.74 | 31.46 | 38.08 | 48.66 |
| | Sharpe | 0.35 | 0.50 | 0.52 | 0.48 | 0.94 | 0.99 | 1.00 | 0.97 |
| | Skew | -2.34 | -2.08 | -1.65 | -2.15 | 1.88 | 1.91 | 1.73 | 1.78 |
| | Kurt | 16.60 | 21.28 | 18.11 | 19.51 | 9.79 | 12.28 | 12.90 | 11.81 |
| | Min | -67.19 | -98.89 | -105.86 | -123.49 | -23.25 | -38.84 | -68.81 | -71.57 |
| | Q1 | -1.93 | -2.23 | -2.71 | -3.31 | -1.29 | -1.47 | -1.69 | -2.09 |
| | Med | 1.15 | 1.84 | 2.32 | 2.55 | 0.80 | 1.15 | 1.33 | 1.61 |
| | Q3 | 4.16 | 5.60 | 6.66 | 8.41 | 4.07 | 5.01 | 6.00 | 7.37 |
| | Max | 28.56 | 61.90 | 79.53 | 94.72 | 58.98 | 86.16 | 101.04 | 126.82 |
| (12,7) winner-minus-loser | Mean | 13.03 | 21.59 | 23.48 | 27.06 | 20.69 | 30.45 | 31.95 | 32.01 |
| | St dev | 23.47 | 28.86 | 32.96 | 42.84 | 23.48 | 28.87 | 32.97 | 42.86 |
| | Sharpe | 0.56 | 0.75 | 0.71 | 0.63 | 0.88 | 1.05 | 0.97 | 0.75 |
| | Skew | -3.97 | -2.60 | -2.38 | -3.28 | 0.93 | 0.82 | 0.68 | 3.02 |
| | Kurt | 49.97 | 30.02 | 26.97 | 46.34 | 7.54 | 4.00 | 10.31 | 36.53 |
| | Min | -95.46 | -99.37 | -102.74 | -177.35 | -34.81 | -36.65 | -54.28 | -70.82 |
| | Q1 | -1.65 | -1.90 | -2.04 | -2.89 | -1.32 | -1.31 | -1.22 | -1.82 |
| | Med | 1.35 | 1.93 | 2.41 | 2.55 | 0.95 | 1.31 | 1.50 | 1.30 |
| | Q3 | 4.19 | 5.54 | 6.65 | 7.60 | 3.94 | 5.74 | 5.84 | 6.33 |
| | Max | 24.88 | 33.84 | 54.78 | 79.76 | 53.34 | 44.60 | 81.12 | 164.00 |

Table A7. Term structure of momentum: spanning regressions.

This table shows spanning regression results of the more-portfolio momentum factors on their fewer-portfolio counterparts (top) and of the volatility-managed momentum factors on their simple counterparts (bottom). The top panel regresses the more-portfolio simple (left)/volatility-managed (right) recent (top)/intermediate horizon (bottom) past performance momentum factors on their fewer-portfolio counterparts, respectively (Novy-Marx, 2012; Goyal and Wahal, 2015). The bottom panel regresses the volatility-managed recent (left)/intermediate horizon (right) factors on their simple counterparts, respectively (Moreira and Muir, 2017). The data span July 1926 (WML^{6,2}), August 1926 (vWML^{6,2}), January 1927 (WML^{12,7}), and February 1927 (vWML^{12,7}) to December 2019, respectively. The *t*-statistics are in parentheses, and alphas are annualized.

| | | Simple WML | | | Volatility-managed WML | | |
|--------------------------|---------------------------|-------------------|-------------------|--------------------|------------------------|--------------------|---------------------|
| | | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| (6,2) winner-minus-loser | α | 6.25 (3.91) | 2.99 (1.63) | 1.95 (0.72) | 9.55 (4.09) | 8.87 (3.45) | 12.34 (3.36) |
| | WML ₁₀ | 1.11 (59.78) | | | 0.92 (35.02) | | |
| | WML ₂₅ | | 1.07 (64.39) | | | 0.94 (41.47) | |
| | WML ₅₀ | | | 1.08 (52.72) | | | 0.91 (34.13) |
| | R ² | 76.13 | 78.73 | 71.27 | 52.29 | 60.58 | 51.00 |
| | (12,7) winner-minus-loser | α | 7.30 (5.32) | 1.66 (1.02) | 4.24 (1.41) | 11.49 (5.57) | 4.95 (2.20) |
| WML ₁₀ | | 1.10 (65.81) | | | 0.92 (37.28) | | |
| WML ₂₅ | | | 1.01 (63.49) | | | 0.89 (41.14) | |
| WML ₅₀ | | | | 0.97 (37.57) | | | 0.96 (36.33) |
| R ² | | 79.54 | 78.35 | 55.89 | 55.53 | 60.32 | 54.26 |

| (6,2) winner-minus-loser | | | | | (12,7) winner-minus-loser | | | |
|--------------------------|--------------------|--------------------|--------------------|---------------------|---------------------------|--------------------|--------------------|---------------------|
| | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| α | 19.08 (8.55) | 22.44 (8.12) | 26.89 (8.14) | 35.17 (8.03) | 14.18 (6.64) | 18.95 (7.31) | 20.19 (6.68) | 18.79 (4.77) |
| WML _n | 0.50 (19.27) | 0.54 (21.66) | 0.56 (22.59) | 0.51 (19.72) | 0.50 (19.34) | 0.53 (21.03) | 0.50 (19.36) | 0.49 (18.72) |
| R ² | 24.92 | 29.53 | 31.32 | 25.79 | 25.15 | 28.44 | 25.19 | 23.95 |

Table A8. Term structure of momentum: market timing regressions.

This table shows Daniel and Moskowitz's (2016) market timing regression results of the following form.

$$y_t = \alpha + [\beta_0 + I_{t-1}^B(\beta_B + I_t^U\beta_{BU})]R_{Mt}^e + \varepsilon_t,$$

where y is one of the simple (left)/volatility-managed (right) recent (top)/intermediate horizon (bottom) past performance winner-minus-lose returns based on 10, 25, 50, or 100 momentum portfolios, I^B is a bear-market indicator that equals 1 if the trailing two-year cumulative market return is negative and 0 otherwise, I^U is an up-market indicator that equals 1 if the contemporaneous excess market return is positive and 0 otherwise, and R_{Mt}^e is the excess market return. The data span July 1926 (WML^{6,2}), August 1926 (vWML^{6,2}), January 1927 (WML^{12,7}), and February 1927 (vWML^{12,7}) to December 2019, respectively. The t -statistics are in parentheses, and alphas are annualized.

| | | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
|---------------------------|----------------|---------------------------|-------------------|-------------------|--------------------|---------------------------------------|--------------------|--------------------|---------------------|
| | | WML ₁₀ | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| (6,2) winner-minus-loser | α | 15.34 (6.49) | 21.41 (6.65) | 25.28 (6.23) | 31.61 (6.15) | 26.35 (9.60) | 34.82 (9.97) | 43.78 (10.37) | 52.07 (9.61) |
| | Mkt_RF | -0.11 (-2.34) | -0.04 (-0.67) | -0.09 (-1.15) | -0.04 (-0.38) | -0.05 (-0.90) | -0.02 (-0.31) | -0.07 (-0.86) | 0.00 (-0.00) |
| | Bear | -0.30 (-3.11) | -0.44 (-3.36) | -0.36 (-2.18) | -0.39 (-1.87) | 0.14 (1.27) | 0.10 (0.69) | 0.25 (1.44) | 0.19 (0.87) |
| | BearUp | -0.84 (-7.69) | -0.69 (-4.69) | -0.54 (-2.90) | -1.02 (-4.33) | -0.38 (-3.01) | -0.46 (-2.85) | -0.66 (-3.41) | -0.61 (-2.43) |
| | Sum | -1.25 (-1.25) | -1.18 (-13.04) | -1.00 (-8.74) | -1.46 (-10.08) | -0.29 (-3.71) | -0.38 (-3.87) | -0.49 (-4.08) | -0.41 (-2.71) |
| | R ² | 26.30 | 15.09 | 7.64 | 9.13 | 1.35 | 1.37 | 1.63 | 0.74 |
| (12,7) winner-minus-loser | α | 15.05 (6.41) | 22.94 (7.92) | 25.33 (7.48) | 29.40 (6.43) | 21.20 (8.13) | 32.05 (10.02) | 33.67 (9.18) | 34.77 (7.29) |
| | Mkt_RF | 0.11 (2.22) | 0.14 (2.45) | 0.13 (1.88) | 0.10 (1.08) | 0.05 (0.88) | 0.10 (1.52) | 0.08 (1.11) | 0.09 (0.93) |
| | Bear | -0.69 (-7.17) | -0.95 (-7.98) | -0.90 (-6.45) | -0.83 (-4.43) | -0.11 (-1.01) | -0.09 (-0.71) | -0.03 (-0.18) | 0.01 (0.05) |
| | BearUp | -0.32 (-2.92) | -0.23 (-1.70) | -0.29 (-1.84) | -0.26 (-1.22) | -0.11 (-0.95) | -0.27 (-1.83) | -0.27 (-1.59) | -0.41 (-1.85) |
| | Sum | -0.90 (-13.62) | -1.03 (-12.63) | -1.05 (-11.04) | -0.99 (-7.68) | -0.18 (-2.39) | -0.26 (-2.94) | -0.21 (-2.06) | -0.31 (-2.28) |
| | R ² | 18.70 | 17.92 | 13.78 | 7.18 | 0.65 | 1.01 | 0.52 | 0.59 |

Table A9. Residual momentum: summary statistics.

This table, like Table 2, shows summary statistics for simple (left)/volatility-managed (right) WML_ns based on 10/25/50/100 value-weighted residual momentum portfolios (Blitz, Huij, and Martens, 2011) based on full (top)/recent/intermediate horizon (bottom) past performance. Average returns, standard deviations, and Sharpe ratios are annualized.

| | | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
|---------------------------|--------|---------------------------|-------------------|-------------------|--------------------|---------------------------------------|--------------------|--------------------|---------------------|
| | | WML ₁₀ | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| Mean | | 8.59 | 9.69 | 10.91 | 11.92 | 8.69 | 11.10 | 11.57 | 13.88 |
| St dev | | 12.55 | 16.80 | 18.87 | 24.17 | 12.56 | 16.78 | 18.88 | 24.17 |
| Sharpe | | 0.68 | 0.58 | 0.58 | 0.49 | 0.69 | 0.66 | 0.61 | 0.57 |
| Skew | | -0.38 | -0.93 | -0.57 | -2.17 | 1.76 | 1.06 | 0.26 | 0.17 |
| Kurt | | 7.09 | 15.60 | 5.97 | 24.63 | 15.07 | 7.51 | 4.88 | 9.22 |
| Min | | -20.98 | -47.51 | -41.57 | -85.42 | -15.85 | -17.77 | -30.90 | -59.67 |
| Q1 | | -1.20 | -1.43 | -1.93 | -2.41 | -0.86 | -1.16 | -1.55 | -1.89 |
| Med | | 0.66 | 0.83 | 0.97 | 0.95 | 0.40 | 0.57 | 0.69 | 0.53 |
| Q3 | | 2.66 | 3.14 | 4.03 | 4.62 | 1.95 | 2.66 | 3.28 | 3.75 |
| Max | | 26.97 | 38.62 | 23.61 | 24.97 | 39.21 | 36.72 | 28.95 | 40.45 |
| | | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
| | | WML ₁₀ | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| (6,2) winner-minus-loser | Mean | 1.04 | 1.78 | 1.78 | 1.15 | 1.93 | 2.91 | 4.71 | 6.37 |
| | St dev | 12.98 | 14.80 | 18.39 | 21.51 | 12.97 | 14.81 | 18.39 | 21.51 |
| | Sharpe | 0.08 | 0.12 | 0.10 | 0.05 | 0.15 | 0.20 | 0.26 | 0.30 |
| | Skew | -2.27 | -0.56 | -0.84 | -0.81 | -0.12 | 0.32 | 0.51 | 0.39 |
| | Kurt | 23.49 | 5.89 | 6.82 | 5.02 | 4.50 | 6.48 | 4.79 | 3.24 |
| | Min | -42.99 | -31.17 | -38.19 | -43.24 | -22.86 | -23.67 | -21.33 | -26.79 |
| | Q1 | -1.54 | -1.91 | -2.31 | -2.75 | -1.43 | -1.65 | -2.08 | -2.39 |
| | Med | 0.15 | 0.18 | 0.33 | 0.46 | 0.11 | 0.12 | 0.25 | 0.30 |
| | Q3 | 2.00 | 2.48 | 2.89 | 3.45 | 1.84 | 2.05 | 2.48 | 3.20 |
| | Max | 15.11 | 20.04 | 29.41 | 27.40 | 19.49 | 28.68 | 30.21 | 34.65 |
| (12,7) winner-minus-loser | Mean | 7.91 | 10.47 | 11.01 | 14.12 | 7.48 | 8.45 | 8.42 | 9.33 |
| | St dev | 11.28 | 14.79 | 17.08 | 22.57 | 11.27 | 14.74 | 17.06 | 22.59 |
| | Sharpe | 0.70 | 0.71 | 0.65 | 0.63 | 0.66 | 0.57 | 0.49 | 0.41 |
| | Skew | 0.84 | 0.70 | 0.70 | 2.06 | 1.12 | 0.34 | 0.62 | -0.54 |
| | Kurt | 5.97 | 6.81 | 4.75 | 20.33 | 6.23 | 7.65 | 7.09 | 14.85 |
| | Min | -13.10 | -18.60 | -16.28 | -22.77 | -13.47 | -26.42 | -28.43 | -66.06 |
| | Q1 | -1.12 | -1.48 | -1.86 | -2.16 | -0.90 | -1.17 | -1.37 | -1.69 |
| | Med | 0.57 | 0.67 | 0.83 | 1.03 | 0.33 | 0.41 | 0.46 | 0.60 |
| | Q3 | 2.31 | 3.17 | 3.46 | 4.14 | 1.79 | 2.28 | 2.53 | 3.25 |
| | Max | 23.64 | 33.64 | 33.33 | 77.26 | 21.50 | 29.35 | 33.76 | 45.02 |

Table A10. Residual momentum: factor regressions.

This table shows time-series regression results of the form $y_t = \alpha + \beta'x_t + \varepsilon_t$, where y is one of the simple/volatility-managed WML returns based on 10/25/50/100 residual momentum portfolios (Blitz, Huij, and Martens, 2011) based on full (Panels A and B)/recent/intermediate horizon (Panels C and D) past performance, and x is either Hou–Mo–Xue–Zhang (2020) five factors (Panels A and C) or Daniel–Hirshleifer–Sun (2020) three-factors (Panels B and D). Each panel shows the covered months. Alphas are annualized.

| | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
|--|---------------------------|-------------------|-------------------|--------------------|---------------------------------------|--------------------|--------------------|---------------------|
| | WML ₁₀ | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| <i>Panel A. Hou–Mo–Xue–Zhang (2020) five-factor model (196701-201912)</i> | | | | | | | | |
| α | 2.34 | 3.67 | 7.26 | 10.79 | 2.93 | 3.58 | 5.22 | 9.65 |
| | (1.25) | (1.52) | (2.43) | (3.12) | (1.39) | (1.29) | (1.62) | (2.32) |
| R_MKT | 0.03 | 0.02 | 0.01 | -0.08 | 0.10 | 0.10 | 0.10 | 0.02 |
| | (0.76) | (0.38) | (0.16) | (-1.17) | (2.64) | (1.91) | (1.69) | (0.29) |
| R_ME | 0.12 | 0.10 | 0.08 | 0.06 | 0.08 | 0.11 | 0.09 | 0.03 |
| | (2.45) | (1.68) | (1.08) | (0.70) | (1.50) | (1.52) | (1.13) | (0.30) |
| R_IA | 0.05 | 0.16 | 0.05 | 0.02 | 0.10 | 0.14 | 0.08 | 0.09 |
| | (0.68) | (1.54) | (0.36) | (0.17) | (1.09) | (1.18) | (0.58) | (0.50) |
| R_ROE | 0.28 | 0.36 | 0.37 | 0.62 | 0.10 | 0.12 | 0.11 | 0.25 |
| | (4.37) | (4.42) | (3.66) | (5.25) | (1.35) | (1.33) | (0.99) | (1.80) |
| R_EG | 0.33 | 0.28 | 0.20 | 0.18 | 0.44 | 0.54 | 0.51 | 0.28 |
| | (3.53) | (2.31) | (1.32) | (1.07) | (4.14) | (3.91) | (3.18) | (1.36) |
| R ² | 8.95 | 7.50 | 4.06 | 7.95 | 5.10 | 4.75 | 2.92 | 1.76 |
| <i>Panel B. Daniel–Hirshleifer–Sun (2020) three-factor model (197207-201812)</i> | | | | | | | | |
| α | 1.82 | 2.85 | 4.20 | 7.52 | 2.65 | 3.80 | 4.79 | 5.53 |
| | (0.97) | (1.16) | (1.40) | (2.15) | (1.26) | (1.37) | (1.49) | (1.34) |
| Mkt_RF | 0.04 | 0.04 | 0.05 | -0.03 | 0.12 | 0.11 | 0.13 | 0.12 |
| | (19.01) | (15.11) | (14.95) | (15.12) | (12.90) | (10.26) | (8.81) | (6.68) |
| PEAD | 0.69 | 0.71 | 0.87 | 1.02 | 0.53 | 0.55 | 0.55 | 0.53 |
| | (9.10) | (7.23) | (7.15) | (7.23) | (6.17) | (4.91) | (4.22) | (3.19) |
| FIN | 0.14 | 0.18 | 0.17 | 0.18 | 0.19 | 0.20 | 0.21 | 0.26 |
| | (3.28) | (3.22) | (2.43) | (2.22) | (3.91) | (3.11) | (2.86) | (2.77) |
| R ² | 14.03 | 9.97 | 9.06 | 9.89 | 8.18 | 5.29 | 4.13 | 2.85 |

Table A10. Continued. Residual momentum: factor regressions.

| | | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
|---|---------------------------|---------------------------|-------------------|-------------------|--------------------|---------------------------------------|--------------------|--------------------|---------------------|
| | | WML ₁₀ | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| <i>Panel C. Hou-Mo-Xue-Zhang (2020)</i> five-factor model (196701-201912) | (6,2) winner-minus-loser | α | -3.37 (-1.86) | -4.51 (-2.01) | -4.50 (-1.69) | -5.54 (-1.77) | -2.75 (-1.25) | -1.52 (-0.59) | 1.31 (0.42) |
| | | R_MKT | -0.01 (-0.42) | -0.03 (-0.61) | 0.02 (0.32) | -0.03 (-0.57) | 0.03 (0.71) | -0.01 (-0.15) | 0.00 (0.02) |
| | | R_ME | 0.11 (2.33) | 0.10 (1.77) | 0.09 (1.38) | 0.10 (1.20) | 0.05 (0.84) | 0.02 (0.36) | -0.01 (-0.12) |
| | | R_IA | 0.16 (2.10) | 0.29 (3.04) | 0.29 (2.59) | 0.29 (2.23) | 0.07 (0.77) | 0.11 (0.99) | 0.08 (0.64) |
| | | R_ROE | 0.18 (2.95) | 0.39 (5.18) | 0.36 (3.93) | 0.63 (5.96) | 0.05 (0.70) | 0.11 (1.28) | 0.10 (0.94) |
| | | R_EG | 0.22 (2.43) | 0.15 (1.31) | 0.24 (1.79) | 0.19 (1.24) | 0.28 (2.56) | 0.13 (0.98) | 0.11 (0.70) |
| | | R ² | 6.21 | 9.48 | 6.70 | 10.42 | 2.11 | 1.28 | 0.69 |
| | | | | | | | | | 1.29 |
| | (12,7) winner-minus-loser | α | 5.33 (3.16) | 8.54 (3.90) | 8.64 (3.31) | 10.25 (3.22) | 4.49 (2.33) | 5.92 (2.31) | 5.77 (1.88) |
| | | R_MKT | 0.06 (1.83) | 0.05 (1.13) | 0.07 (1.36) | 0.09 (1.49) | 0.12 (3.33) | 0.16 (3.28) | 0.18 (3.12) |
| | | R_ME | -0.01 (-0.26) | -0.03 (-0.56) | -0.09 (-1.34) | -0.11 (-1.42) | -0.02 (-0.38) | -0.01 (-0.12) | -0.05 (-0.58) |
| | | R_IA | -0.15 (-2.17) | -0.18 (-1.90) | -0.30 (-2.73) | -0.31 (-2.28) | -0.04 (-0.44) | -0.09 (-0.87) | -0.22 (-1.69) |
| | | R_ROE | 0.18 (3.15) | 0.27 (3.63) | 0.23 (2.61) | 0.34 (3.12) | 0.14 (2.21) | 0.17 (1.99) | 0.16 (1.56) |
| | | R_EG | 0.22 (2.55) | 0.18 (1.69) | 0.36 (2.75) | 0.30 (1.87) | 0.31 (3.18) | 0.44 (3.44) | 0.58 (3.78) |
| | | R ² | 5.65 | 5.32 | 6.14 | 5.55 | 5.03 | 5.06 | 5.42 |
| | | | | | | | | | 3.02 |
| <i>Panel D. Daniel-Hirshleifer-Sun (2020)</i> three-factor model (197207-201812) | (6,2) winner-minus-loser | α | -4.20 (-2.31) | -5.98 (-2.65) | -4.11 (-1.51) | -7.70 (-2.38) | -2.76 (-1.24) | -3.01 (-1.20) | 1.73 (0.55) |
| | | Mkt_RF | 0.03 (14.33) | 0.04 (13.98) | 0.06 (10.31) | 0.03 (11.69) | 0.06 (6.35) | 0.03 (6.93) | 0.03 (3.72) |
| | | PEAD | 0.50 (6.86) | 0.61 (6.69) | 0.54 (4.93) | 0.73 (5.59) | 0.27 (3.04) | 0.34 (3.32) | 0.23 (1.78) |
| | | FIN | 0.18 (4.45) | 0.31 (6.01) | 0.27 (4.42) | 0.37 (5.02) | 0.13 (2.58) | 0.16 (2.88) | 0.13 (1.87) |
| | | R ² | 10.76 | 13.07 | 7.19 | 9.75 | 2.55 | 3.37 | 1.16 |
| | | | | | | | | | 2.09 |
| | (12,7) winner-minus-loser | α | 6.47 (3.64) | 8.10 (3.52) | 7.89 (2.87) | 9.32 (2.79) | 5.99 (3.03) | 7.54 (2.81) | 8.49 (2.62) |
| | | Mkt_RF | 0.05 (9.57) | 0.04 (10.13) | 0.06 (10.25) | 0.09 (7.59) | 0.12 (8.73) | 0.13 (7.11) | 0.15 (5.89) |
| | | PEAD | 0.33 (4.58) | 0.45 (4.85) | 0.54 (4.90) | 0.49 (3.63) | 0.33 (4.18) | 0.37 (3.40) | 0.37 (2.82) |
| | | FIN | 0.02 (0.40) | 0.02 (0.48) | 0.06 (0.97) | 0.10 (1.38) | 0.10 (2.20) | 0.10 (1.64) | 0.10 (1.31) |
| | | R ² | 3.82 | 4.08 | 4.20 | 2.55 | 4.25 | 2.82 | 2.12 |
| | | | | | | | | | 1.17 |

Table A11. Residual momentum: spanning regressions.

This table, like Table 4, shows time-series regression results of the form $y_t = \alpha + \beta'x_t + \varepsilon_t$, where y is one of the simple/volatility-managed WML return based on 25, 50, or 100 residual momentum portfolios, and x is the corresponding WML return based on 10, 25, 50, or 100 residual momentum portfolios. Panels D and E relate WMLs based on 11-month simple and residual returns. The t -statistics are in parentheses, and alphas are annualized.

| <i>Panel A. Simple winner-minus-loser</i> | | | | | | | | | | |
|--|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|--|----------------------------------|----------------------------------|----------------------------------|-----------------------------------|---------------------|
| | WML ₂₅ | WML ₅₀ | WML ₅₀ | WML ₁₀₀ | WML ₁₀₀ | WML ₁₀₀ | | | | |
| α | 0.24 | 2.02 | 1.95 | 2.59 | 2.58 | 1.07 | | | | |
| | (0.23) | (1.37) | (1.77) | (1.21) | (1.36) | (1.60) | | | | |
| WML ₁₀ | 1.10 | 1.03 | | 1.09 | | | | | | |
| | (47.51) | (31.22) | | (22.50) | | | | | | |
| WML ₂₅ | | | 0.92 | | 0.96 | | | | | |
| | | | (47.70) | | (33.51) | | | | | |
| WML ₅₀ | | | | | | 0.99 | | | | |
| | | | | | | (44.36) | | | | |
| R ² | 67.55 | 47.35 | 67.73 | 31.83 | 44.97 | 60.35 | | | | |
| <i>Panel B. Volatility-managed winner-minus-loser</i> | | | | | | | | | | |
| | vWML ₂₅ | vWML ₅₀ | vWML ₅₀ | vWML ₁₀₀ | vWML ₁₀₀ | vWML ₁₀₀ | | | | |
| α | 2.81 | 4.01 | 2.35 | 6.31 | 5.59 | 3.56 | | | | |
| | (2.23) | (2.42) | (2.94) | (1.73) | (1.81) | (2.16) | | | | |
| vWML ₁₀ | 0.95 | 0.87 | | 0.87 | | | | | | |
| | (33.56) | (23.36) | | (16.71) | | | | | | |
| vWML ₂₅ | | | 0.83 | | 0.75 | | | | | |
| | | | (36.02) | | (19.96) | | | | | |
| vWML ₅₀ | | | | | | 0.89 | | | | |
| | | | | | | (32.03) | | | | |
| R ² | 50.99 | 33.51 | 54.51 | 20.49 | 26.90 | 48.65 | | | | |
| <i>Panel C. Volatility-managed winner-minus-loser by simple winner-minus-loser</i> | | | | | | | | | | |
| | vWML ₁₀ | vWML ₂₅ | vWML ₂₅ | vWML ₅₀ | vWML ₅₀ | vWML ₅₀ | vWML ₁₀₀ | vWML ₁₀₀ | vWML ₁₀₀ | vWML ₁₀₀ |
| α | 2.89 | 4.96 | 4.87 | 5.61 | 5.72 | 4.01 | 7.70 | 8.25 | 6.69 | 6.23 |
| | (2.83) | (2.64) | (2.95) | (2.23) | (2.37) | (2.76) | (1.67) | (1.70) | (1.81) | (2.04) |
| WML ₁₀ | 0.68 | 0.72 | | 0.69 | | | 0.72 | | | |
| | (42.59) | (25.39) | | (21.50) | | | (16.07) | | | |
| WML ₂₅ | | | 0.65 | | 0.61 | | | 0.59 | | |
| | | | (35.99) | | (25.99) | | | (18.70) | | |
| WML ₅₀ | | | | | | 0.69 | | | 0.66 | |
| | | | | | | (40.77) | | | (26.79) | |
| WML ₁₀₀ | | | | | | | | | | 0.65 |
| | | | | | | | | | | (38.48) |
| R ² | 45.64 | 28.69 | 42.27 | 21.33 | 29.37 | 48.06 | 14.03 | 16.68 | 26.59 | 41.71 |
| <i>Panel D. y = WML^{residual}</i> | | | | | <i>Panel E. y = WML^{simple}</i> | | | | | |
| | WML ₁₀ ^{res} | WML ₂₅ ^{res} | WML ₅₀ ^{res} | WML ₁₀₀ ^{res} | | WML ₁₀ ^{sim} | WML ₂₅ ^{sim} | WML ₅₀ ^{sim} | WML ₁₀₀ ^{sim} | |
| α | 4.99 | 4.42 | 5.67 | 6.15 | α | 3.54 | 11.65 | 18.11 | 24.21 | |
| | (4.51) | (2.85) | (3.08) | (2.56) | | (1.47) | (3.60) | (4.43) | (4.75) | |
| WML _n ^{sim} | 0.26 | 0.24 | 0.19 | 0.17 | WML _n ^{res} | 1.21 | 1.05 | 0.93 | 0.79 | |
| | (22.20) | (19.20) | (15.00) | (13.01) | | (22.20) | (19.20) | (15.00) | (13.01) | |
| R ² | 31.25 | 25.37 | 17.19 | 13.50 | R ² | 31.25 | 25.37 | 17.19 | 13.50 | |

Table A11. *Continued.* Residual momentum: spanning regressions.
Panel F. Pairwise simple/volatility-managed WMLs, recent/intermediate horizon

| | | Simple WML | | | Volatility-managed WML | | |
|---------------------------|-------------------|-------------------|-------------------|--------------------|------------------------|--------------------|---------------------|
| | | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| (6,2) winner-minus-loser | α | 0.84 (0.88) | 0.08 (0.06) | -0.40 (-0.27) | 1.48 (1.24) | 2.23 (1.58) | 3.13 (1.71) |
| | WML ₁₀ | 0.90 (42.66) | | | 0.74 (28.01) | | |
| | WML ₂₅ | | 0.96 (39.63) | | | 0.85 (31.01) | |
| | WML ₅₀ | | | 0.88 (37.24) | | | 0.69 (24.02) |
| | R ² | 62.68 | 59.16 | 56.13 | 42.01 | 47.03 | 34.76 |
| (12,7) winner-minus-loser | α | 2.08 (2.23) | 1.31 (1.20) | 3.26 (2.03) | 2.20 (1.81) | 1.33 (1.06) | 1.57 (0.91) |
| | WML ₁₀ | 1.06 (45.31) | | | 0.84 (27.37) | | |
| | WML ₂₅ | | 0.93 (44.23) | | | 0.84 (34.63) | |
| | WML ₅₀ | | | 0.99 (36.84) | | | 0.92 (31.93) |
| | R ² | 65.45 | 64.35 | 55.60 | 40.89 | 52.55 | 48.50 |

Panel G. Volatility-managed by simple WMLns, recent/intermediate horizon

| (6,2) winner-minus-loser | | | | | (12,7) winner-minus-loser | | | |
|--------------------------|--------------------|--------------------|--------------------|---------------------|---------------------------|--------------------|--------------------|---------------------|
| | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| α | 1.30 (1.25) | 1.71 (1.48) | 3.47 (2.44) | 5.54 (3.38) | 2.02 (2.29) | 1.65 (1.36) | 0.81 (0.61) | 0.34 (0.18) |
| WML _n | 0.65 (28.41) | 0.67 (29.80) | 0.68 (30.38) | 0.69 (31.32) | 0.68 (30.88) | 0.64 (27.56) | 0.68 (30.90) | 0.64 (27.14) |
| R ² | 42.70 | 45.05 | 46.02 | 47.52 | 46.82 | 41.22 | 46.86 | 40.48 |

| | | Panel H. $y = \text{WML}^{\text{residual}}$ | | | | Panel I. $y = \text{WML}^{\text{simple}}$ | | | |
|------------|---------------------------------|---|----------------------------------|----------------------------------|-----------------------------------|---|----------------------------------|----------------------------------|-----------------------------------|
| | | WML ₁₀ ^{res} | WML ₂₅ ^{res} | WML ₅₀ ^{res} | WML ₁₀₀ ^{res} | WML ₁₀ ^{sim} | WML ₂₅ ^{sim} | WML ₅₀ ^{sim} | WML ₁₀₀ ^{sim} |
| (6,2) WML | α | -1.35 (-1.24) | -1.60 (-1.15) | -1.47 (-0.80) | -1.49 (-0.67) | α | 6.39 (3.06) | 13.75 (4.67) | 18.83 (4.98) |
| | WML _n ^{sim} | 0.32 (25.02) | 0.22 (17.28) | 0.16 (11.75) | 0.11 (8.52) | WML _n ^{res} | 1.16 (25.02) | 0.99 (17.28) | 0.70 (11.75) |
| | R ² | 36.61 | 21.60 | 11.29 | 6.28 | R ² | 36.61 | 21.60 | 11.29 |
| | | | | | | | | | |
| (12,7) WML | α | 6.54 (5.60) | 8.11 (5.24) | 9.16 (5.06) | 13.79 (5.72) | α | 8.49 (3.46) | 15.89 (5.30) | 19.56 (5.61) |
| | WML _n ^{sim} | 0.11 (7.88) | 0.12 (7.56) | 0.08 (5.22) | 0.01 (0.78) | WML _n ^{res} | 0.49 (7.88) | 0.43 (7.56) | 0.30 (5.22) |
| | R ² | 5.42 | 5.01 | 2.46 | 0.06 | R ² | 5.42 | 5.01 | 2.46 |
| | | | | | | | | | |

Table A12. Residual momentum: market timing regressions.

This table, like Table 5, shows Daniel and Moskowitz's (2016) market timing regression results of the following form.

$$y_t = \alpha + [\beta_0 + I_{t-1}^B(\beta_B + I_t^U\beta_{BU})]R_{Mt}^e + \varepsilon_t,$$

where y is one of the simple/volatility-managed full/recent/intermediate horizon past performance winner-minus-lose returns based on 10, 25, 50, or 100 residual momentum portfolios, I^B is a bear-market indicator, and I^U is an up-market indicator. The t -statistics are in parentheses, and alphas are annualized.

| | | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
|----------------|--|---------------------------|-------------------|-------------------|--------------------|---------------------------------------|--------------------|--------------------|---------------------|
| | | WML ₁₀ | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| α | | 9.30 | 10.94 | 11.61 | 15.18 | 9.30 | 12.05 | 11.98 | 14.77 |
| | | (6.99) | (6.17) | (5.74) | (6.02) | (6.68) | (6.47) | (5.71) | (5.50) |
| Mkt_RF | | 0.00 | 0.03 | 0.07 | 0.06 | 0.03 | 0.02 | 0.04 | 0.04 |
| | | (0.02) | (0.81) | (1.68) | (1.19) | (1.16) | (0.56) | (0.90) | (0.72) |
| Bear | | -0.27 | -0.35 | -0.41 | -0.42 | -0.04 | -0.03 | -0.09 | -0.07 |
| | | (-4.98) | (-4.89) | (-4.91) | (-4.05) | (-0.63) | (-0.39) | (-1.00) | (-0.59) |
| BearUp | | -0.05 | -0.15 | -0.10 | -0.45 | -0.11 | -0.15 | -0.08 | -0.15 |
| | | (-0.88) | (-1.79) | (-1.09) | (-3.87) | (-1.78) | (-1.75) | (-0.86) | (-1.24) |
| Sum | | -0.32 | -0.47 | -0.44 | -0.80 | -0.12 | -0.16 | -0.13 | -0.18 |
| | | (-1.43) | (-2.92) | (-1.77) | (-6.32) | (-2.91) | (-2.85) | (-1.40) | (-2.03) |
| R ² | | 9.56 | 10.22 | 7.64 | 12.33 | 0.96 | 0.88 | 0.58 | 0.59 |

| | | Simple winner-minus-loser | | | | Volatility-managed winner-minus-loser | | | |
|---------------------------|----------------|---------------------------|-------------------|-------------------|--------------------|---------------------------------------|--------------------|--------------------|---------------------|
| | | WML ₁₀ | WML ₂₅ | WML ₅₀ | WML ₁₀₀ | vWML ₁₀ | vWML ₂₅ | vWML ₅₀ | vWML ₁₀₀ |
| (6,2) winner-minus-loser | α | 4.31 | 3.59 | 4.37 | 3.90 | 2.82 | 3.65 | 5.78 | 7.47 |
| | | (3.28) | (2.29) | (2.24) | (1.70) | (1.97) | (2.22) | (2.83) | (3.13) |
| | Mkt_RF | -0.05 | -0.09 | -0.07 | -0.04 | -0.04 | -0.04 | -0.04 | -0.05 |
| | | (-1.85) | (-2.78) | (-1.88) | (-0.83) | (-1.29) | (-1.16) | (-0.85) | (-1.02) |
| | Bear | -0.10 | -0.18 | -0.19 | -0.26 | -0.01 | -0.01 | 0.02 | -0.02 |
| | | (-1.85) | (-2.74) | (-2.33) | (-2.75) | (-0.23) | (-0.08) | (0.24) | (-0.18) |
| | BearUp | -0.39 | -0.13 | -0.25 | -0.30 | -0.08 | -0.06 | -0.12 | -0.10 |
| | | (-6.43) | (-1.82) | (-2.82) | (-2.85) | (-1.26) | (-0.83) | (-1.25) | (-0.91) |
| | Sum | -0.53 | -0.39 | -0.51 | -0.59 | -0.13 | -0.11 | -0.13 | -0.17 |
| | | (-14.55) | (-8.98) | (-9.36) | (-9.27) | (-3.33) | (-2.31) | (-2.29) | (-2.48) |
| | R ² | 17.50 | 9.64 | 9.14 | 8.74 | 1.28 | 0.67 | 0.55 | 0.73 |
| (12,7) winner-minus-loser | α | 5.16 | 6.65 | 7.69 | 8.47 | 7.19 | 7.94 | 8.14 | 9.03 |
| | | (4.21) | (4.14) | (4.10) | (3.50) | (5.73) | (4.84) | (4.29) | (3.59) |
| | Mkt_RF | 0.04 | 0.06 | 0.08 | 0.06 | 0.03 | 0.08 | 0.06 | 0.06 |
| | | (1.77) | (1.85) | (2.14) | (1.29) | (1.29) | (2.28) | (1.58) | (1.15) |
| | Bear | -0.20 | -0.34 | -0.28 | -0.19 | -0.05 | -0.11 | -0.08 | -0.02 |
| | | (-4.00) | (-5.16) | (-3.70) | (-1.90) | (-0.89) | (-1.64) | (-1.00) | (-0.19) |
| | BearUp | 0.37 | 0.53 | 0.43 | 0.75 | 0.01 | 0.01 | -0.01 | -0.02 |
| | | (6.62) | (7.17) | (4.97) | (6.80) | (0.25) | (0.17) | (-0.12) | (-0.13) |
| | Sum | 0.21 | 0.25 | 0.22 | 0.63 | 0.00 | -0.02 | -0.03 | 0.02 |
| | | (6.26) | (5.52) | (4.27) | (9.27) | (0.05) | (-0.48) | (-0.51) | (0.34) |
| | R ² | 4.64 | 4.85 | 2.72 | 7.52 | 0.16 | 0.53 | 0.26 | 0.15 |

Table A13. Two-way portfolios: spanning regressions.

This table shows time-series regression results of the form $y_t = \alpha + \beta'x_t + \varepsilon_t$, where y is either the simple (left five columns) or the volatility-managed (right five columns) WML return based on 5×10 two-way momentum portfolios, and x is the corresponding WML return based on 5×5 two-way momentum portfolios. Panels A, B, C, and D relate size, book-to-market, operating profitability, and investment, respectively, to momentum. Panels E, F, G, and H relate each vWML to its WML. Each panel shows the covered months. Δ CER is a certainty equivalent return difference. (Campbell and Thompson, 2008; Cederburg *et al.*, 2020), the t -statistics are in parentheses, and alphas are annualized.

| | WML ₁₀ | | | | | vWML ₁₀ | | | | |
|--|-------------------|---------|---------|---------|---------|--------------------|---------|---------|---------|---------|
| Panel A. Size (192701-201912) | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| α | 2.73 | 1.82 | 2.28 | 3.06 | 2.44 | 4.02 | 3.83 | 6.56 | 3.02 | 8.62 |
| | (2.31) | (1.79) | (1.81) | (2.50) | (1.30) | (3.70) | (2.49) | (3.79) | (1.61) | (3.29) |
| (v)WML ₅ | 1.15 | 1.18 | 1.25 | 1.16 | 1.19 | 1.17 | 1.08 | 1.17 | 1.04 | 0.94 |
| | (76.32) | (86.08) | (80.50) | (78.91) | (49.35) | (88.70) | (53.95) | (56.52) | (47.42) | (28.53) |
| R ² | 85.17 | 87.96 | 86.47 | 86.06 | 71.37 | 88.59 | 74.18 | 75.92 | 69.11 | 46.01 |
| Δ CER | 1.05 | 0.64 | 0.66 | 1.16 | 0.01 | 3.02 | -0.22 | 2.85 | -1.31 | 1.90 |
| Panel B. Book-to-market (192701-201912) | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| α | 6.06 | 8.15 | 2.93 | 3.27 | 3.39 | 8.13 | 11.33 | 8.24 | 6.46 | 10.59 |
| | (3.28) | (4.19) | (1.79) | (1.96) | (1.83) | (3.75) | (4.99) | (3.83) | (2.94) | (4.10) |
| (v)WML ₅ | 0.96 | 1.01 | 1.10 | 1.13 | 1.12 | 0.86 | 0.89 | 0.92 | 0.97 | 0.88 |
| | (46.43) | (40.41) | (51.42) | (54.73) | (53.34) | (36.47) | (30.78) | (32.85) | (35.84) | (31.12) |
| R ² | 66.16 | 59.44 | 70.36 | 72.89 | 71.92 | 54.87 | 45.98 | 49.22 | 53.57 | 46.66 |
| Δ CER | 1.84 | 3.06 | 0.56 | 0.68 | 0.89 | 1.95 | 4.41 | 2.47 | 1.17 | 2.86 |
| Panel C. Operating profitability (195107-201912) | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| α | 5.25 | 4.81 | 1.70 | 3.61 | 4.15 | 12.47 | 6.56 | 6.35 | 4.73 | 7.21 |
| | (3.26) | (2.85) | (0.84) | (2.11) | (2.36) | (4.82) | (2.85) | (2.44) | (2.15) | (3.61) |
| (v)WML ₅ | 1.10 | 1.12 | 1.14 | 1.10 | 1.14 | 0.60 | 0.96 | 0.93 | 0.96 | 1.08 |
| | (49.76) | (49.70) | (39.02) | (44.79) | (44.85) | (21.68) | (31.35) | (25.18) | (30.70) | (37.81) |
| R ² | 75.12 | 75.08 | 65.00 | 71.03 | 71.06 | 36.46 | 54.55 | 43.63 | 53.59 | 63.63 |
| Δ CER | 2.65 | 1.88 | -0.93 | 1.03 | 1.27 | 1.82 | 1.58 | -1.05 | -0.09 | 3.23 |
| Panel D. Investment (195207-201912) | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| α | 0.14 | 5.86 | 21.01 | 1.43 | 1.72 | 6.86 | 9.99 | 17.02 | 7.26 | 2.61 |
| | (0.09) | (1.92) | (3.25) | (0.81) | (1.28) | (2.88) | (2.44) | (2.73) | (3.04) | (1.52) |
| (v)WML ₅ | 1.19 | 1.18 | 1.15 | 1.09 | 1.12 | 0.94 | 0.42 | 1.37 | 0.88 | 1.05 |
| | (52.92) | (26.60) | (12.60) | (42.81) | (57.81) | (27.65) | (7.15) | (15.64) | (25.56) | (43.00) |
| R ² | 77.65 | 46.68 | 16.42 | 69.40 | 80.53 | 48.75 | 5.96 | 23.27 | 44.74 | 69.61 |
| Δ CER | -0.69 | 0.87 | 2.39 | -0.32 | -0.32 | 0.79 | -2.49 | 0.76 | 1.78 | -3.02 |

Table A13. Continued. Two-way portfolios: spanning regressions.

| vWML ₅ | | | | | | vWML ₁₀ | | | | |
|--|------------------|-----------------|-----------------|-----------------|-----------------|--------------------|-----------------|-----------------|-----------------|-----------------|
| Panel E. Size (192701-201912) | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| α | 28.67 (10.26) | 19.41 (7.88) | 25.66 (8.63) | 16.48 (5.95) | 17.49 (6.10) | 22.01 (9.78) | 16.57 (8.17) | 17.83 (7.99) | 15.81 (6.93) | 11.33 (5.54) |
| WML ₅₍₁₀₎ | 0.42 (14.79) | 0.54 (20.64) | 0.50 (18.19) | 0.55 (20.62) | 0.57 (21.60) | 0.41 (14.25) | 0.49 (18.06) | 0.49 (17.66) | 0.49 (17.82) | 0.56 (21.30) |
| R ² | 17.77 | 29.60 | 24.63 | 29.73 | 32.82 | 16.69 | 24.35 | 23.53 | 23.87 | 31.05 |
| Δ CER | 19.30 | 13.41 | 12.78 | 9.59 | 5.88 | 21.26 | 12.55 | 14.97 | 7.12 | 7.78 |
| Panel F. Book-to-market (192701-201912) | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| α | 17.92 (6.82) | 14.29 (5.67) | 12.80 (5.28) | 13.09 (5.07) | 16.36 (5.56) | 16.12 (6.94) | 9.28 (4.85) | 7.82 (4.19) | 9.33 (4.85) | 10.04 (4.52) |
| WML ₅₍₁₀₎ | 0.56 (22.43) | 0.57 (23.42) | 0.59 (24.48) | 0.59 (24.55) | 0.55 (21.74) | 0.51 (19.61) | 0.57 (23.06) | 0.58 (23.81) | 0.61 (25.50) | 0.57 (22.92) |
| R ² | 31.51 | 33.02 | 35.00 | 35.13 | 29.93 | 25.71 | 32.32 | 33.75 | 36.87 | 32.07 |
| Δ CER | 8.63 | 4.25 | 3.17 | 4.09 | 3.70 | 8.74 | 5.60 | 5.07 | 4.58 | 5.66 |
| Panel G. Operating profitability (195107-201912) | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| α | 12.47 (4.82) | 10.32 (3.84) | 11.50 (4.42) | 9.18 (3.99) | 10.93 (4.81) | 9.98 (4.92) | 7.89 (3.89) | 7.67 (4.44) | 8.12 (4.68) | 7.04 (4.06) |
| WML ₅₍₁₀₎ | 0.60 (21.68) | 0.61 (22.20) | 0.65 (24.39) | 0.70 (27.64) | 0.72 (30.00) | 0.60 (21.52) | 0.63 (23.02) | 0.70 (28.14) | 0.70 (28.21) | 0.70 (27.69) |
| R ² | 36.46 | 37.58 | 42.08 | 48.35 | 52.42 | 36.11 | 39.29 | 49.16 | 49.29 | 48.35 |
| Δ CER | 5.79 | 3.63 | 4.87 | 5.06 | 3.79 | 4.96 | 3.34 | 4.75 | 3.94 | 5.74 |
| Panel H. Investment (195207-201912) | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| α | 14.27 (5.56) | 7.73 (2.22) | 19.21 (2.93) | 9.41 (4.13) | 13.00 (5.72) | 8.75 (4.98) | 7.53 (4.24) | 5.58 (3.01) | 5.44 (3.04) | 11.63 (6.53) |
| WML ₅₍₁₀₎ | 0.62 (22.57) | 0.56 (19.03) | 0.39 (12.15) | 0.70 (27.81) | 0.66 (25.04) | 0.69 (27.01) | 0.68 (26.37) | 0.67 (25.66) | 0.68 (26.29) | 0.68 (26.09) |
| R ² | 38.79 | 30.98 | 15.46 | 48.94 | 43.72 | 47.49 | 46.29 | 44.92 | 46.14 | 45.75 |
| Δ CER | 6.02 | 4.20 | 2.28 | 2.26 | 10.96 | 7.50 | 0.83 | 0.65 | 4.36 | 8.27 |

Table A14. Industry momentum.

The table shows summary statistics and time-series regression results for 5 and 10 value-weighted momentum portfolios, respectively, based on 30 industry portfolios. Following Moskowitz and Grinblatt (1999), the momentum portfolios based on the 30 industry portfolios sort the industry portfolios on their past six-month returns. The regression results are based on either the market factor or Fama–French (1993) three factors. The data are from Professor Kenneth R. French's website and span January 1927 to December 2019. Average returns, standard deviations, Sharpe ratios, and alphas are annualized, and the t -statistics are in parentheses.

| 5 and 10 momentum portfolios, respectively, from 30 industry portfolios (Moskowitz and Grinblatt, 1999) | | | | | | | | | | | | | | | | | | |
|---|--------|--------|--------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------------|---------------------------------|
| | 1 | 2 | 3 | 4 | 5 | WML ₅ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | WML ₁₀ | W ₁₀ -W ₅ |
| Mean | 8.92 | 9.51 | 13.06 | 14.17 | 13.40 | 4.48 | 8.32 | 9.73 | 9.26 | 10.08 | 12.28 | 13.25 | 13.56 | 13.94 | 13.26 | 14.95 | 6.62 | 2.14 |
| St Dev | 22.75 | 20.70 | 19.55 | 18.63 | 19.14 | 15.91 | 24.98 | 22.17 | 21.97 | 20.90 | 21.14 | 20.02 | 19.59 | 19.88 | 19.10 | 21.24 | 20.20 | 11.23 |
| Sharpe | 0.25 | 0.30 | 0.50 | 0.58 | 0.53 | 0.28 | 0.20 | 0.29 | 0.27 | 0.33 | 0.43 | 0.50 | 0.52 | 0.54 | 0.52 | 0.55 | 0.33 | 0.19 |
| Skew | 0.88 | 0.95 | 0.28 | -0.05 | -0.31 | -0.97 | 0.70 | 0.80 | 1.02 | 0.49 | 0.78 | 0.11 | 0.19 | 0.02 | -0.16 | -0.27 | -0.63 | 0.04 |
| Kurt | 11.49 | 13.65 | 8.85 | 5.99 | 3.26 | 7.18 | 9.81 | 10.72 | 12.82 | 9.28 | 13.56 | 6.81 | 6.68 | 8.16 | 3.16 | 3.99 | 6.03 | 2.64 |
| Min | -29.55 | -29.18 | -31.55 | -31.84 | -26.19 | -35.46 | -34.80 | -28.88 | -26.47 | -35.71 | -34.17 | -29.80 | -31.77 | -31.96 | -23.53 | -30.18 | -40.75 | -17.01 |
| Q1 | -2.35 | -1.90 | -1.60 | -1.70 | -1.74 | -1.88 | -2.85 | -2.44 | -2.06 | -1.90 | -1.72 | -1.76 | -1.83 | -1.62 | -1.87 | -1.89 | -2.31 | -1.33 |
| Med | 0.94 | 1.01 | 1.41 | 1.53 | 1.30 | 0.60 | 0.83 | 0.89 | 0.81 | 1.14 | 1.26 | 1.20 | 1.34 | 1.61 | 1.31 | 1.46 | 0.70 | 0.13 |
| Q3 | 3.96 | 3.56 | 3.98 | 4.25 | 4.43 | 2.97 | 4.08 | 4.06 | 3.76 | 3.70 | 3.98 | 4.16 | 4.12 | 4.43 | 4.28 | 4.89 | 3.66 | 1.73 |
| Max | 54.82 | 60.82 | 46.09 | 35.52 | 33.60 | 21.60 | 57.99 | 59.42 | 64.44 | 48.76 | 58.93 | 44.71 | 44.73 | 44.84 | 32.58 | 39.92 | 28.03 | 14.77 |
| α | -3.31 | -2.05 | 1.84 | 3.34 | 2.70 | 6.00 | -4.21 | -2.15 | -2.54 | -1.28 | 0.72 | 2.18 | 2.64 | 2.96 | 2.77 | 3.94 | 8.16 | 2.15 |
| | (-3.4) | (-2.5) | (2.7) | (5.0) | (3.1) | (3.7) | (-3.2) | (-2.1) | (-2.5) | (-1.3) | (0.8) | (2.4) | (3.0) | (3.2) | (2.9) | (3.3) | (3.9) | (1.8) |
| Mkt_RF | 1.12 | 1.04 | 1.00 | 0.95 | 0.93 | -0.19 | 1.16 | 1.08 | 1.07 | 1.02 | 1.04 | 0.98 | 0.96 | 0.97 | 0.91 | 0.97 | -0.19 | 0.00 |
| | (74.1) | (82.6) | (94.0) | (92.0) | (68.9) | (-7.6) | (56.1) | (68.5) | (68.4) | (67.6) | (72.6) | (70.2) | (70.9) | (68.4) | (60.4) | (52.5) | (-6.0) | (-0.1) |
| R ² | 83.14 | 85.98 | 88.80 | 88.36 | 80.98 | 4.93 | 73.88 | 80.83 | 80.76 | 80.41 | 82.56 | 81.56 | 81.84 | 80.77 | 76.61 | 71.21 | 3.10 | 0.00 |
| α | -3.57 | -2.35 | 1.49 | 3.35 | 2.81 | 6.38 | -4.80 | -2.30 | -2.88 | -1.69 | 0.32 | 1.80 | 2.55 | 2.88 | 2.91 | 3.95 | 8.75 | 2.37 |
| | (-3.7) | (-2.9) | (2.2) | (5.0) | (3.2) | (3.9) | (-3.7) | (-2.3) | (-2.9) | (-1.8) | (0.4) | (2.0) | (2.9) | (3.2) | (3.0) | (3.3) | (4.2) | (2.0) |
| Mkt_RF | 1.11 | 1.02 | 0.98 | 0.96 | 0.93 | -0.17 | 1.11 | 1.08 | 1.05 | 0.98 | 1.01 | 0.96 | 0.96 | 0.98 | 0.91 | 0.96 | -0.15 | 0.03 |
| | (67.7) | (75.8) | (87.3) | (86.7) | (63.9) | (-6.5) | (50.4) | (63.3) | (62.4) | (61.4) | (66.3) | (64.6) | (65.5) | (64.2) | (56.1) | (48.1) | (-4.2) | (1.4) |
| SMB | 0.05 | 0.03 | 0.00 | -0.07 | 0.06 | 0.01 | 0.19 | -0.02 | 0.05 | 0.10 | 0.06 | 0.00 | -0.01 | -0.08 | 0.05 | 0.08 | -0.11 | -0.13 |
| | (1.7) | (1.3) | (0.1) | (-3.9) | (2.5) | (0.3) | (5.2) | (-0.7) | (1.9) | (3.7) | (2.6) | (0.2) | (-0.5) | (-3.1) | (1.8) | (2.3) | (-2.0) | (-3.9) |
| HML | 0.07 | 0.09 | 0.11 | 0.02 | -0.05 | -0.13 | 0.14 | 0.05 | 0.10 | 0.11 | 0.11 | 0.12 | 0.03 | 0.05 | -0.06 | -0.02 | -0.16 | -0.04 |
| | (3.0) | (4.6) | (6.9) | (1.1) | (-2.6) | (-3.2) | (4.3) | (2.2) | (4.0) | (4.6) | (5.0) | (5.5) | (1.5) | (2.0) | (-2.5) | (-0.8) | (-3.2) | (-1.2) |
| R ² | 83.33 | 86.26 | 89.26 | 88.53 | 81.19 | 5.80 | 74.97 | 80.91 | 81.10 | 81.03 | 83.06 | 82.06 | 81.88 | 80.99 | 76.80 | 71.36 | 4.37 | 1.55 |

Table A15. Portfolio momentum: 5×5 size and book-to-market and 5×5 operating profitability and investment portfolios.

The table shows summary statistics and time-series regression results for 5 and 10 value-weighted momentum portfolios, respectively, based on 5×5 size and book-to-market portfolios (Panel A) and 5×5 operating profitability and investment portfolios (Panel B), respectively. Following Lewellen (2002), the momentum portfolios based on the 5×5 portfolios sort the portfolios on their past 12-month returns. The regression results are based on either the market factor, Fama–French three (1993) factors, or Fama–French six (2018) factors. The data are from Professor Kenneth R. French’s website. Each panel shows the covered months. Average returns, standard deviations, Sharpe ratios, and alphas are annualized, and the *t*-statistics are in parentheses.

| Panel A. 5 and 10 momentum portfolios, respectively, from 5×5 size and book-to-market portfolios (192707–201912) (Lewellen, 2002) | | | | | | | | | | | | | | | | | | |
|---|--------|--------|--------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------------|---------------------------------|
| | 1 | 2 | 3 | 4 | 5 | WML ₅ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | WML ₁₀ | W ₁₀ –W ₅ |
| Mean | 9.38 | 11.59 | 13.54 | 15.03 | 15.29 | 5.91 | 8.76 | 11.01 | 11.57 | 12.31 | 13.59 | 14.01 | 15.33 | 14.92 | 15.02 | 16.41 | 7.65 | 1.74 |
| St Dev | 24.48 | 22.47 | 21.53 | 21.36 | 22.95 | 16.25 | 27.59 | 24.30 | 23.87 | 22.86 | 21.77 | 23.30 | 22.85 | 21.74 | 23.84 | 23.86 | 18.82 | 10.88 |
| Sharpe | 0.25 | 0.37 | 0.48 | 0.55 | 0.52 | 0.36 | 0.20 | 0.32 | 0.35 | 0.40 | 0.47 | 0.46 | 0.53 | 0.54 | 0.49 | 0.55 | 0.41 | 0.16 |
| Skew | 1.21 | 1.35 | 0.26 | 0.73 | 1.11 | -1.43 | 1.89 | 1.24 | 1.51 | 1.33 | 0.17 | 1.18 | 1.10 | 0.58 | 1.68 | 0.97 | -1.32 | -10.74 |
| Kurt | 17.02 | 17.34 | 8.66 | 10.33 | 14.12 | 29.55 | 20.28 | 17.62 | 18.63 | 16.19 | 6.75 | 17.65 | 13.14 | 9.37 | 20.59 | 11.40 | 17.37 | 245.49 |
| Min | -37.65 | -32.11 | -33.45 | -27.68 | -28.64 | -60.08 | -33.82 | -39.44 | -32.79 | -31.34 | -33.84 | -33.07 | -30.75 | -27.54 | -29.63 | -28.59 | -54.37 | -71.42 |
| Q1 | -2.09 | -1.92 | -1.76 | -1.89 | -1.79 | -1.60 | -2.47 | -2.12 | -2.06 | -2.00 | -1.81 | -1.79 | -1.98 | -1.91 | -1.91 | -1.66 | -1.62 | -0.63 |
| Med | 1.03 | 1.27 | 1.44 | 1.56 | 1.52 | 0.59 | 0.89 | 1.16 | 1.18 | 1.22 | 1.46 | 1.53 | 1.36 | 1.59 | 1.54 | 1.47 | 0.80 | 0.12 |
| Q3 | 3.93 | 4.01 | 4.30 | 4.38 | 4.41 | 2.56 | 3.93 | 4.05 | 4.00 | 4.19 | 4.24 | 4.18 | 4.64 | 4.35 | 4.48 | 4.75 | 3.20 | 1.02 |
| Max | 72.87 | 64.20 | 49.13 | 55.49 | 67.25 | 33.33 | 81.97 | 74.38 | 64.31 | 64.01 | 42.78 | 69.46 | 59.07 | 56.36 | 72.21 | 62.73 | 36.64 | 13.35 |
| α | -3.33 | -0.75 | 1.54 | 3.20 | 3.13 | 6.46 | -4.75 | -1.61 | -1.11 | -0.04 | 1.64 | 1.41 | 3.10 | 3.09 | 2.76 | 4.08 | 8.83 | 2.37 |
| | (-3.0) | (-0.9) | (2.1) | (4.1) | (3.1) | (3.8) | (-3.3) | (-1.4) | (-1.1) | (-0.0) | (2.0) | (1.6) | (3.2) | (3.5) | (2.3) | (3.5) | (4.5) | (2.1) |
| Mkt_RF | 1.19 | 1.14 | 1.10 | 1.08 | 1.12 | -0.07 | 1.29 | 1.18 | 1.19 | 1.15 | 1.09 | 1.18 | 1.13 | 1.08 | 1.13 | 1.14 | -0.15 | -0.08 |
| | (69.4) | (94.0) | (99.5) | (88.3) | (71.0) | (-2.7) | (58.1) | (68.4) | (78.9) | (83.3) | (84.9) | (88.3) | (76.0) | (78.2) | (62.0) | (64.0) | (-5.0) | (-4.6) |
| R ² | 81.31 | 88.86 | 89.93 | 87.57 | 81.97 | 0.63 | 75.28 | 80.86 | 84.88 | 86.22 | 86.67 | 87.56 | 83.91 | 84.65 | 77.62 | 78.73 | 2.17 | 1.86 |
| α | -4.28 | -1.69 | 0.75 | 2.35 | 2.06 | 6.34 | -6.22 | -2.60 | -2.25 | -1.25 | 0.72 | 0.23 | 1.87 | 2.29 | 1.40 | 2.78 | 9.00 | 2.66 |
| | (-4.1) | (-2.5) | (1.2) | (3.6) | (2.4) | (3.8) | (-4.9) | (-2.5) | (-2.6) | (-1.8) | (1.0) | (0.3) | (2.6) | (3.0) | (1.5) | (2.9) | (4.6) | (2.4) |
| Mkt_RF | 1.12 | 1.07 | 1.04 | 0.99 | 1.00 | -0.12 | 1.16 | 1.10 | 1.10 | 1.03 | 1.01 | 1.08 | 1.00 | 0.98 | 0.98 | 1.01 | -0.15 | -0.03 |
| | (64.3) | (93.4) | (97.9) | (89.8) | (71.2) | (-4.2) | (54.2) | (63.5) | (76.9) | (87.9) | (83.8) | (92.2) | (82.5) | (77.8) | (64.1) | (63.3) | (-4.6) | (-1.7) |
| SMB | 0.17 | 0.16 | 0.18 | 0.32 | 0.45 | 0.29 | 0.43 | 0.22 | 0.22 | 0.35 | 0.27 | 0.28 | 0.47 | 0.39 | 0.59 | 0.48 | 0.05 | -0.24 |
| | (5.8) | (8.6) | (10.5) | (18.0) | (19.7) | (6.3) | (12.2) | (7.9) | (9.6) | (17.9) | (13.8) | (14.8) | (23.8) | (18.9) | (23.6) | (18.4) | (1.0) | (-7.8) |
| HML | 0.27 | 0.27 | 0.21 | 0.19 | 0.22 | -0.04 | 0.37 | 0.27 | 0.31 | 0.30 | 0.23 | 0.31 | 0.27 | 0.15 | 0.28 | 0.30 | -0.07 | -0.03 |
| | (10.5) | (16.0) | (13.6) | (11.9) | (10.9) | (-1.1) | (11.7) | (10.6) | (15.1) | (17.5) | (13.1) | (18.2) | (15.4) | (8.2) | (12.7) | (12.7) | (-1.5) | (-1.0) |
| R ² | 83.56 | 91.51 | 92.15 | 91.38 | 87.80 | 4.09 | 80.58 | 83.58 | 88.39 | 91.37 | 90.08 | 91.85 | 90.88 | 89.04 | 86.66 | 85.58 | 2.43 | 7.13 |

Table A15. Continued. Portfolio momentum: 5×5 size and book-to-market and 5×5 operating profitability and investment portfolios.

| Panel B. 5 and 10 momentum portfolios, respectively, from 5x5 operating profitability and investment portfolios (196407–201912) | | | | | | | | | | | | | | | | | | | |
|---|---------|---------|--------|--------|--------|------------------|---------|---------|--------|--------|--------|--------|--------|--------|--------|--------|-------------------|---------------------------------|--|
| | 1 | 2 | 3 | 4 | 5 | WML ₅ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | WML ₁₀ | W ₁₀ -W ₅ | |
| Mean | 8.98 | 10.89 | 10.73 | 11.73 | 13.68 | 4.70 | 8.09 | 9.76 | 10.90 | 11.29 | 10.78 | 11.15 | 11.56 | 12.08 | 14.05 | 13.92 | 5.83 | 1.13 | |
| St Dev | 17.72 | 15.84 | 15.29 | 15.46 | 16.00 | 10.16 | 18.61 | 17.57 | 16.36 | 16.22 | 15.45 | 15.73 | 15.54 | 16.16 | 16.14 | 16.92 | 12.01 | 5.68 | |
| Sharpe | 0.25 | 0.40 | 0.40 | 0.46 | 0.57 | 0.46 | 0.19 | 0.30 | 0.39 | 0.41 | 0.40 | 0.42 | 0.45 | 0.47 | 0.59 | 0.55 | 0.49 | 0.20 | |
| Skew | -0.42 | -0.55 | -0.36 | -0.45 | -0.52 | 0.18 | -0.38 | -0.33 | -0.49 | -0.59 | -0.33 | -0.42 | -0.46 | -0.41 | -0.53 | -0.42 | 0.35 | 0.58 | |
| Kurt | 2.46 | 2.43 | 1.25 | 2.62 | 2.02 | 4.19 | 1.92 | 3.05 | 2.19 | 2.58 | 1.48 | 1.42 | 2.45 | 2.87 | 2.88 | 1.50 | 3.88 | 3.30 | |
| Min | -22.37 | -23.25 | -19.61 | -22.96 | -23.93 | -13.19 | -23.91 | -25.03 | -23.95 | -26.07 | -18.12 | -22.75 | -22.20 | -24.21 | -27.28 | -21.47 | -12.51 | -6.36 | |
| Q1 | -1.94 | -1.51 | -1.49 | -1.53 | -1.60 | -1.06 | -2.31 | -1.86 | -1.56 | -1.72 | -1.53 | -1.80 | -1.39 | -1.71 | -1.60 | -1.73 | -1.37 | -0.77 | |
| Med | 0.92 | 1.18 | 1.19 | 1.15 | 1.43 | 0.45 | 0.91 | 0.99 | 1.01 | 1.09 | 1.12 | 1.20 | 1.23 | 1.30 | 1.48 | 1.44 | 0.53 | -0.02 | |
| Q3 | 3.56 | 3.69 | 3.60 | 3.60 | 4.15 | 1.81 | 3.71 | 3.45 | 3.78 | 3.76 | 3.51 | 3.73 | 3.70 | 3.95 | 3.93 | 4.25 | 2.37 | 0.92 | |
| Max | 20.26 | 16.36 | 16.88 | 19.16 | 15.79 | 17.21 | 20.66 | 23.39 | 16.74 | 15.85 | 19.11 | 14.24 | 18.66 | 21.64 | 17.38 | 16.39 | 20.77 | 9.24 | |
| α | -2.48 | -0.05 | 0.07 | 0.97 | 2.85 | 5.32 | -3.58 | -1.49 | -0.04 | 0.34 | 0.15 | 0.43 | 0.87 | 1.23 | 3.27 | 2.96 | 6.54 | 1.22 | |
| | (-3.0) | (-0.1) | (0.1) | (1.8) | (4.0) | (3.9) | (-3.7) | (-1.6) | (-0.1) | (0.5) | (0.2) | (0.6) | (1.3) | (1.6) | (4.0) | (3.2) | (4.1) | (1.6) | |
| Mkt_RF | 1.09 | 1.00 | 0.96 | 0.98 | 0.99 | -0.10 | 1.12 | 1.05 | 1.00 | 1.01 | 0.95 | 0.97 | 0.97 | 0.99 | 0.98 | 1.01 | -0.11 | -0.01 | |
| | (69.6) | (102.3) | (91.9) | (96.4) | (73.9) | (-3.9) | (61.2) | (59.6) | (70.8) | (78.7) | (74.7) | (73.3) | (79.6) | (70.3) | (64.2) | (57.6) | (-3.7) | (-0.9) | |
| R ² | 87.93 | 94.04 | 92.71 | 93.33 | 89.15 | 2.19 | 84.95 | 84.24 | 88.30 | 90.32 | 89.37 | 88.99 | 90.52 | 88.16 | 86.11 | 83.32 | 2.02 | 0.13 | |
| α | 1.00 | -0.12 | -0.58 | -0.96 | 0.34 | -0.66 | -0.38 | 1.91 | 0.12 | -0.03 | -0.30 | -0.63 | -0.95 | -1.00 | 0.47 | 0.45 | 0.83 | 1.49 | |
| | (1.4) | (-0.2) | (-1.0) | (-1.8) | (0.5) | (-0.6) | (-0.4) | (2.1) | (0.2) | (-0.0) | (-0.4) | (-0.9) | (-1.5) | (-1.3) | (0.6) | (0.5) | (0.6) | (1.9) | |
| Mkt_RF | 1.01 | 1.02 | 1.00 | 1.02 | 1.03 | 0.02 | 1.04 | 0.97 | 1.02 | 1.03 | 0.99 | 1.00 | 1.02 | 1.04 | 1.04 | 1.03 | -0.01 | -0.03 | |
| | (67.6) | (99.7) | (86.1) | (95.4) | (78.8) | (0.9) | (59.0) | (53.2) | (65.5) | (72.3) | (69.4) | (67.8) | (77.0) | (68.0) | (64.6) | (59.7) | (-0.5) | (-2.2) | |
| SMB | -0.01 | -0.02 | -0.04 | 0.03 | 0.06 | 0.07 | 0.05 | -0.01 | -0.01 | 0.01 | -0.06 | 0.01 | 0.03 | 0.06 | 0.04 | 0.11 | 0.06 | -0.01 | |
| | (-0.3) | (-1.2) | (-2.3) | (2.0) | (3.6) | (2.2) | (2.1) | (-0.4) | (-0.5) | (0.5) | (-2.8) | (0.3) | (1.5) | (2.7) | (1.9) | (4.8) | (1.6) | (-0.4) | |
| HML | 0.00 | 0.06 | 0.06 | 0.06 | -0.01 | -0.01 | 0.02 | -0.03 | 0.05 | 0.07 | 0.03 | 0.09 | 0.07 | 0.05 | 0.00 | -0.01 | -0.04 | -0.02 | |
| | (0.2) | (2.8) | (2.4) | (2.7) | (-0.3) | (-0.3) | (0.7) | (-0.8) | (1.7) | (2.6) | (1.0) | (3.1) | (2.6) | (1.8) | (-0.0) | (-0.4) | (-0.7) | (-0.7) | |
| RMW | -0.09 | 0.12 | 0.10 | 0.07 | -0.02 | 0.07 | -0.05 | -0.12 | 0.07 | 0.13 | 0.08 | 0.12 | 0.09 | 0.03 | 0.08 | -0.12 | -0.07 | -0.14 | |
| | (-3.2) | (5.9) | (4.4) | (3.6) | (-0.8) | (1.7) | (-1.4) | (-3.5) | (2.4) | (4.8) | (3.0) | (4.1) | (3.7) | (1.0) | (2.6) | (-3.5) | (-1.3) | (-4.7) | |
| CMA | -0.19 | 0.04 | 0.06 | 0.12 | 0.14 | 0.33 | -0.12 | -0.18 | 0.08 | 0.02 | 0.10 | 0.05 | 0.16 | 0.14 | 0.24 | 0.11 | 0.23 | -0.10 | |
| | (-4.4) | (1.4) | (1.8) | (4.1) | (3.8) | (5.0) | (-2.3) | (-3.5) | (1.7) | (0.4) | (2.5) | (1.1) | (4.2) | (3.2) | (5.3) | (2.3) | (2.9) | (-2.1) | |
| UMD | -0.14 | -0.05 | -0.01 | 0.05 | 0.11 | 0.25 | -0.16 | -0.12 | -0.06 | -0.03 | -0.02 | 0.00 | 0.02 | 0.07 | 0.08 | 0.14 | 0.30 | 0.05 | |
| | (-16.0) | (-8.1) | (-1.7) | (7.7) | (15.2) | (18.8) | (-15.8) | (-11.2) | (-6.6) | (-4.1) | (-2.6) | (-0.2) | (3.2) | (7.8) | (8.7) | (14.0) | (18.8) | (5.4) | |
| R ² | 91.86 | 95.15 | 93.38 | 94.45 | 92.34 | 40.12 | 89.56 | 87.50 | 89.55 | 91.16 | 90.15 | 89.76 | 91.66 | 89.73 | 88.42 | 87.98 | 38.52 | 9.14 | |

Table A16. Macromomentum: 21 international equity indices.

The table shows summary statistics and time-series regression results for 3 and 7 value-weighted momentum portfolios, respectively, based on 21 international equity indices. Following Bhojraj and Swaminathan (2006), the momentum portfolios based on the 21 equity indices sort the indices on their past 12-month returns. The regression results are based on either the market factor or Fama–French three (1993) factors. The data are from AQR Capital Management’s website and span January 1987 to December 2019. Average returns, standard deviations, Sharpe ratios, and alphas are annualized, and the *t*-statistics are in parentheses.

| 3 and 7 momentum portfolios, respectively, from 21 international equity indices (Bhojraj and Swaminathan, 2006) | | | | | | | | | | | | | |
|---|---------|---------|---------|------------------|---------|---------|---------|---------|---------|---------|---------|------------------|--------------------------------|
| | 1 | 2 | 3 | WML ₃ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | WML ₇ | W ₇ –W ₃ |
| Mean | 7.01 | 10.17 | 11.48 | 4.47 | 8.01 | 8.36 | 10.29 | 12.17 | 10.49 | 10.50 | 18.74 | 10.73 | 6.26 |
| St Dev | 17.95 | 16.22 | 18.45 | 14.80 | 22.79 | 18.00 | 17.56 | 16.91 | 17.34 | 19.58 | 25.77 | 25.96 | 22.07 |
| Sharpe | 0.22 | 0.44 | 0.46 | 0.30 | 0.22 | 0.30 | 0.41 | 0.54 | 0.43 | 0.38 | 0.61 | 0.41 | 0.28 |
| Skew | -0.32 | -0.86 | -0.57 | 0.67 | 0.20 | -0.62 | -0.67 | -0.51 | -0.53 | -1.46 | -0.22 | 0.09 | -0.09 |
| Kurt | 2.09 | 2.21 | 2.77 | 2.99 | 2.05 | 3.32 | 3.22 | 1.56 | 2.19 | 9.03 | 4.59 | 2.15 | 4.13 |
| Min | -25.99 | -22.75 | -26.55 | -14.57 | -22.43 | -29.98 | -26.70 | -22.28 | -21.98 | -42.45 | -42.45 | -30.95 | -30.12 |
| Q1 | -2.62 | -1.69 | -1.82 | -2.30 | -2.79 | -1.94 | -2.09 | -1.94 | -1.70 | -1.99 | -2.43 | -3.54 | -2.57 |
| Med | 0.92 | 1.60 | 1.46 | 0.08 | 0.87 | 0.92 | 1.21 | 1.46 | 1.21 | 1.26 | 1.73 | 0.47 | 0.67 |
| Q3 | 3.65 | 3.79 | 3.91 | 2.71 | 4.08 | 3.81 | 3.99 | 3.95 | 3.62 | 4.18 | 5.91 | 5.08 | 3.79 |
| Max | 15.68 | 14.50 | 22.81 | 22.01 | 27.25 | 14.77 | 16.53 | 14.56 | 19.68 | 19.16 | 35.87 | 29.26 | 31.64 |
| α | 0.78 | 4.43 | 5.54 | 4.76 | 1.24 | 2.45 | 4.38 | 6.74 | 4.67 | 4.44 | 12.68 | 11.44 | 6.68 |
| | (0.56) | (3.84) | (3.08) | (1.83) | (0.48) | (1.46) | (2.87) | (4.06) | (3.07) | (2.15) | (3.53) | (2.52) | (1.73) |
| MKT | 1.06 | 0.97 | 1.01 | -0.05 | 1.15 | 1.00 | 1.00 | 0.92 | 0.99 | 1.03 | 1.03 | -0.12 | -0.07 |
| | (39.88) | (44.70) | (29.66) | (-0.99) | (23.68) | (31.69) | (34.87) | (29.39) | (34.35) | (26.34) | (15.17) | (-1.40) | (-0.97) |
| R ² | 80.15 | 83.53 | 69.06 | 0.25 | 58.74 | 71.83 | 75.53 | 68.67 | 74.97 | 63.77 | 36.88 | 0.49 | 0.24 |
| α | 0.94 | 4.08 | 5.01 | 4.07 | 0.49 | 2.05 | 3.75 | 6.04 | 4.48 | 3.97 | 12.65 | 12.16 | 8.08 |
| | (0.66) | (3.50) | (2.78) | (1.56) | (0.19) | (1.21) | (2.45) | (3.63) | (2.91) | (1.93) | (3.53) | (2.66) | (2.08) |
| MKT | 1.06 | 0.98 | 1.01 | -0.04 | 1.16 | 1.02 | 1.02 | 0.94 | 0.99 | 1.02 | 0.99 | -0.17 | -0.13 |
| | (38.24) | (43.50) | (28.88) | (-0.86) | (23.16) | (31.04) | (34.30) | (29.05) | (33.13) | (25.57) | (14.26) | (-1.91) | (-1.67) |
| SMB | -0.04 | 0.02 | 0.17 | 0.21 | 0.08 | -0.09 | 0.03 | 0.02 | 0.01 | 0.31 | 0.52 | 0.44 | 0.23 |
| | (-0.70) | (0.32) | (2.14) | (1.87) | (0.72) | (-1.15) | (0.44) | (0.30) | (0.09) | (3.51) | (3.32) | (2.20) | (1.34) |
| HML | -0.05 | 0.10 | 0.18 | 0.22 | 0.22 | 0.09 | 0.17 | 0.19 | 0.05 | 0.19 | 0.11 | -0.11 | -0.34 |
| | (-0.88) | (2.13) | (2.44) | (2.17) | (2.12) | (1.36) | (2.85) | (2.93) | (0.87) | (2.31) | (0.75) | (-0.61) | (-2.17) |
| R ² | 80.21 | 83.72 | 69.80 | 2.10 | 59.23 | 72.08 | 76.03 | 69.35 | 75.02 | 65.21 | 38.63 | 1.88 | 2.04 |

Table A17. Portfolio momentum in Europe, Japan, and Asia Pacific ex Japan: 5×5 size and book-to-market and 2×4×4 size, operating profitability, and investment portfolios. The table shows summary statistics and time-series regression results for 5 and 10 value-weighted momentum portfolios, respectively, based on 5×5 size and book-to-market portfolios and 2×4×4 size, operating profitability, and investment portfolios in Europe (Japan; Asia Pacific ex Japan) in Panels A and B (C and D; E and F), respectively. Following Lewellen (2002), the momentum portfolios based on the portfolios sort the portfolios on their past 12-month returns. The regression results are based on either the market factor or Fama–French three (1993) factors. The data are from Professor Kenneth R. French’s website. The data span July 1991 to December 2019. Average returns, standard deviations, Sharpe ratios, and alphas are annualized, and the *t*-statistics are in parentheses.

| <i>Panel A.</i> 5 and 10 momentum portfolios, respectively, from European 5×5 size and book-to-market portfolios | | | | | | | | | | | | | | | | | | |
|--|--------|--------|--------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------------|---------------------------------|
| | 1 | 2 | 3 | 4 | 5 | WML ₅ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | WML ₁₀ | W ₁₀ –W ₅ |
| Mean | 6.52 | 7.76 | 9.87 | 10.47 | 13.10 | 6.59 | 6.48 | 6.00 | 6.60 | 8.17 | 9.61 | 10.68 | 10.31 | 10.19 | 11.81 | 14.54 | 8.06 | 1.48 |
| St Dev | 19.05 | 17.28 | 16.85 | 17.31 | 16.77 | 11.06 | 19.50 | 18.41 | 17.95 | 17.23 | 16.97 | 17.27 | 17.00 | 17.47 | 17.01 | 17.37 | 12.21 | 5.94 |
| Sharpe | 0.21 | 0.31 | 0.44 | 0.46 | 0.63 | 0.60 | 0.21 | 0.19 | 0.23 | 0.33 | 0.42 | 0.48 | 0.46 | 0.44 | 0.55 | 0.70 | 0.66 | 0.25 |
| Skew | -0.48 | -0.83 | -0.71 | -0.64 | -0.52 | -0.09 | -0.46 | -0.63 | -0.83 | -0.81 | -0.69 | -0.71 | -0.88 | -0.58 | -0.49 | -0.55 | -0.25 | 0.17 |
| Kurt | 2.99 | 3.13 | 2.87 | 2.09 | 1.55 | 3.59 | 3.18 | 2.78 | 3.03 | 3.12 | 2.76 | 2.62 | 4.85 | 1.32 | 1.42 | 1.53 | 2.70 | 15.61 |
| Min | -27.04 | -26.43 | -24.87 | -23.91 | -19.13 | -13.65 | -27.26 | -26.60 | -26.73 | -26.05 | -24.56 | -25.03 | -30.17 | -19.74 | -19.35 | -18.98 | -15.64 | -12.40 |
| Q1 | -2.26 | -2.01 | -1.83 | -1.93 | -1.69 | -1.10 | -2.43 | -2.28 | -2.15 | -1.89 | -1.80 | -1.81 | -1.64 | -1.84 | -1.77 | -1.44 | -1.21 | -0.47 |
| Med | 0.92 | 0.93 | 0.90 | 1.27 | 1.48 | 0.47 | 0.84 | 0.86 | 0.83 | 0.86 | 0.85 | 0.87 | 1.38 | 1.23 | 1.26 | 1.65 | 0.60 | 0.10 |
| Q3 | 3.72 | 4.00 | 4.07 | 4.24 | 4.10 | 2.25 | 3.84 | 3.70 | 3.90 | 3.90 | 3.90 | 4.19 | 3.62 | 4.10 | 4.12 | 4.33 | 2.57 | 0.70 |
| Max | 23.33 | 15.16 | 16.10 | 16.54 | 16.34 | 14.46 | 24.56 | 17.29 | 14.53 | 16.29 | 15.81 | 16.34 | 17.13 | 16.08 | 16.33 | 16.35 | 13.38 | 10.61 |
| α | -3.30 | -1.49 | 0.71 | 1.16 | 4.21 | 7.51 | -3.42 | -3.52 | -2.81 | -1.00 | 0.48 | 1.49 | 1.22 | 0.95 | 2.86 | 5.62 | 9.04 | 1.53 |
| | (-2.6) | (-1.5) | (0.9) | (1.3) | (3.7) | (3.7) | (-2.4) | (-2.8) | (-2.4) | (-0.9) | (0.5) | (1.4) | (1.2) | (0.9) | (2.4) | (4.0) | (4.0) | (1.4) |
| Mkt_RF | 1.08 | 1.00 | 0.99 | 1.01 | 0.95 | -0.14 | 1.09 | 1.04 | 1.02 | 0.99 | 0.98 | 0.99 | 0.98 | 1.00 | 0.96 | 0.95 | -0.14 | -0.01 |
| | (49.9) | (58.7) | (68.6) | (63.8) | (47.4) | (-3.8) | (45.1) | (47.2) | (51.0) | (53.3) | (59.0) | (54.3) | (54.0) | (51.7) | (45.8) | (38.8) | (-3.6) | (-0.4) |
| R ² | 87.99 | 91.02 | 93.26 | 92.30 | 86.84 | 4.09 | 85.68 | 86.75 | 88.45 | 89.32 | 91.10 | 89.65 | 89.55 | 88.73 | 86.07 | 81.58 | 3.75 | 0.04 |
| α | -3.53 | -1.95 | 0.44 | 0.94 | 4.18 | 7.70 | -3.89 | -3.66 | -3.24 | -1.49 | 0.03 | 1.10 | 0.82 | 0.76 | 2.70 | 5.64 | 9.53 | 1.82 |
| | (-2.8) | (-2.2) | (0.6) | (1.2) | (3.9) | (3.8) | (-2.9) | (-2.9) | (-3.1) | (-1.5) | (0.0) | (1.2) | (1.0) | (0.8) | (2.4) | (4.4) | (4.2) | (1.6) |
| Mkt_RF | 1.08 | 1.01 | 1.00 | 1.03 | 0.97 | -0.11 | 1.10 | 1.05 | 1.04 | 1.00 | 1.00 | 1.01 | 1.00 | 1.03 | 0.98 | 0.99 | -0.11 | 0.00 |
| | (48.9) | (62.8) | (77.3) | (71.5) | (50.6) | (-3.1) | (46.0) | (46.9) | (56.2) | (58.5) | (66.7) | (64.1) | (65.7) | (60.0) | (49.4) | (43.4) | (-2.8) | (-0.0) |
| SMB | 0.11 | 0.27 | 0.29 | 0.31 | 0.29 | 0.19 | 0.27 | 0.17 | 0.36 | 0.32 | 0.33 | 0.41 | 0.43 | 0.40 | 0.33 | 0.42 | 0.15 | -0.03 |
| | (2.2) | (7.6) | (10.2) | (9.9) | (7.1) | (2.4) | (5.2) | (3.4) | (9.0) | (8.8) | (10.1) | (11.8) | (13.0) | (10.9) | (7.8) | (8.6) | (1.8) | (-0.8) |
| HML | 0.06 | 0.11 | 0.04 | 0.02 | -0.05 | -0.10 | 0.11 | 0.02 | 0.08 | 0.11 | 0.09 | 0.06 | 0.06 | -0.01 | -0.01 | -0.09 | -0.20 | -0.10 |
| | (1.4) | (3.4) | (1.5) | (0.7) | (-1.2) | (-1.5) | (2.4) | (0.4) | (2.2) | (3.2) | (3.2) | (1.8) | (1.9) | (-0.3) | (-0.2) | (-2.0) | (-2.5) | (-2.4) |
| R ² | 88.22 | 92.52 | 94.85 | 94.02 | 88.61 | 6.38 | 86.91 | 87.20 | 90.75 | 91.47 | 93.29 | 92.70 | 93.04 | 91.66 | 88.19 | 85.09 | 6.54 | 1.92 |

Table A17. Continued. Portfolio momentum in Europe, Japan, and Asia Pacific ex Japan: 5×5 size and book-to-market and 2×4×4 size, operating profitability, and investment portfolios.

| <i>Panel B. 4 and 8 momentum portfolios, respectively, from European 2×4×4 size, operating profitability, and investment portfolios</i> | | | | | | | | | | | | | | | | |
|---|--------|--------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|------------------|--------------------------------|--|
| | 1 | 2 | 3 | 4 | WML ₄ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | WML ₈ | W ₈ -W ₄ | |
| Mean | 6.16 | 8.81 | 9.88 | 11.37 | 5.21 | 5.71 | 6.45 | 7.41 | 10.11 | 9.48 | 10.81 | 10.29 | 12.98 | 7.27 | 2.06 | |
| St Dev | 19.16 | 17.31 | 16.47 | 16.50 | 9.83 | 19.90 | 19.08 | 18.10 | 17.09 | 16.35 | 16.95 | 16.85 | 17.05 | 12.36 | 6.10 | |
| Sharpe | 0.19 | 0.37 | 0.45 | 0.54 | 0.53 | 0.16 | 0.21 | 0.27 | 0.45 | 0.43 | 0.49 | 0.46 | 0.62 | 0.59 | 0.34 | |
| Skew | -0.74 | -0.46 | -0.64 | -0.52 | 0.03 | -0.60 | -0.95 | -0.39 | -0.44 | -0.57 | -0.63 | -0.70 | -0.36 | 0.07 | 0.44 | |
| Kurt | 3.46 | 2.10 | 1.69 | 1.78 | 3.34 | 2.99 | 4.39 | 2.65 | 1.28 | 1.53 | 1.88 | 1.77 | 1.64 | 2.90 | 2.89 | |
| Min | -29.61 | -23.23 | -21.10 | -20.65 | -11.49 | -29.31 | -30.41 | -25.43 | -20.40 | -20.29 | -21.88 | -20.47 | -20.75 | -12.96 | -5.58 | |
| Q1 | -2.37 | -2.44 | -1.77 | -1.74 | -0.94 | -2.51 | -2.22 | -2.42 | -2.25 | -1.70 | -1.66 | -1.56 | -1.64 | -1.44 | -0.66 | |
| Med | 0.95 | 0.91 | 1.03 | 1.19 | 0.39 | 0.82 | 1.07 | 0.82 | 1.07 | 0.90 | 1.07 | 1.06 | 1.46 | 0.64 | 0.17 | |
| Q3 | 3.97 | 3.81 | 3.78 | 4.15 | 1.83 | 4.02 | 3.85 | 3.84 | 3.94 | 3.86 | 3.85 | 3.95 | 4.19 | 2.57 | 1.02 | |
| Max | 19.41 | 18.57 | 12.39 | 16.38 | 13.53 | 20.97 | 20.03 | 20.76 | 16.24 | 12.86 | 15.44 | 14.63 | 18.80 | 16.08 | 8.49 | |
| α | -3.80 | -0.64 | 0.78 | 2.40 | 6.19 | -4.26 | -3.43 | -2.21 | 0.91 | 0.54 | 1.62 | 1.28 | 4.00 | 8.26 | 2.06 | |
| | (-3.4) | (-1.0) | (1.2) | (2.7) | (3.4) | (-2.8) | (-2.9) | (-2.4) | (1.0) | (0.6) | (1.9) | (1.2) | (3.3) | (3.6) | (1.8) | |
| Mkt_RF | 1.10 | 1.03 | 0.98 | 0.96 | -0.14 | 1.11 | 1.09 | 1.06 | 0.99 | 0.95 | 0.99 | 0.96 | 0.96 | -0.15 | 0.00 | |
| | (56.3) | (90.8) | (90.3) | (61.9) | (-4.6) | (42.2) | (52.8) | (64.8) | (61.5) | (66.3) | (66.3) | (52.5) | (45.9) | (-3.7) | (-0.1) | |
| R ² | 90.33 | 96.04 | 96.00 | 91.86 | 5.91 | 83.96 | 89.12 | 92.50 | 91.76 | 92.81 | 92.81 | 89.01 | 86.10 | 3.81 | 0.00 | |
| α | -4.16 | -0.96 | 0.63 | 2.60 | 6.76 | -4.74 | -3.99 | -2.69 | 0.51 | 0.39 | 1.35 | 1.30 | 3.86 | 8.60 | 1.85 | |
| | (-3.7) | (-1.5) | (1.0) | (3.0) | (3.8) | (-3.2) | (-3.4) | (-2.9) | (0.6) | (0.5) | (1.6) | (1.2) | (3.3) | (3.7) | (1.6) | |
| Mkt_RF | 1.10 | 1.03 | 0.98 | 0.98 | -0.13 | 1.11 | 1.09 | 1.05 | 0.99 | 0.96 | 0.99 | 0.98 | 0.98 | -0.13 | -0.01 | |
| | (55.2) | (90.5) | (88.4) | (63.1) | (-3.9) | (42.0) | (52.4) | (64.7) | (61.4) | (65.5) | (65.3) | (52.8) | (47.4) | (-3.2) | (-0.3) | |
| SMB | 0.10 | 0.08 | 0.06 | 0.11 | 0.00 | 0.22 | 0.14 | 0.12 | 0.14 | 0.11 | 0.10 | 0.15 | 0.24 | 0.03 | 0.02 | |
| | (2.4) | (3.2) | (2.4) | (3.1) | (0.0) | (3.7) | (3.1) | (3.4) | (3.8) | (3.3) | (3.0) | (3.6) | (5.3) | (0.3) | (0.5) | |
| HML | 0.08 | 0.08 | 0.03 | -0.12 | -0.20 | 0.07 | 0.13 | 0.11 | 0.08 | 0.00 | 0.05 | -0.07 | -0.06 | -0.13 | 0.06 | |
| | (2.1) | (3.5) | (1.2) | (-3.8) | (-3.1) | (1.4) | (3.2) | (3.4) | (2.5) | (0.1) | (1.7) | (-2.0) | (-1.5) | (-1.6) | (1.6) | |
| R ² | 90.61 | 96.29 | 96.09 | 92.39 | 8.57 | 84.68 | 89.74 | 93.00 | 92.25 | 93.04 | 93.06 | 89.52 | 87.23 | 4.58 | 0.85 | |

Table A17. Continued. Portfolio momentum in Europe, Japan, and Asia Pacific ex Japan: 5×5 size and book-to-market and 2×4×4 size, operating profitability, and investment portfolios.

| Panel C. 5 and 10 momentum portfolios, respectively, from Japanese 5×5 size and book-to-market portfolios | | | | | | | | | | | | | | | | | | | |
|---|--------|--------|--------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------------|---------------------------------|--|
| | 1 | 2 | 3 | 4 | 5 | WML ₅ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | WML ₁₀ | W ₁₀ -W ₅ | |
| Mean | 2.38 | 3.08 | 3.43 | 5.63 | 5.96 | 3.58 | 0.98 | 3.58 | 2.26 | 4.42 | 3.74 | 4.02 | 5.70 | 6.37 | 8.30 | 6.01 | 5.04 | 1.45 | |
| St Dev | 22.03 | 20.11 | 20.43 | 19.92 | 19.63 | 14.01 | 22.96 | 21.68 | 20.73 | 20.28 | 20.96 | 20.64 | 20.39 | 19.73 | 19.80 | 20.84 | 16.77 | 7.34 | |
| Sharpe | 0.00 | 0.03 | 0.05 | 0.16 | 0.18 | 0.26 | -0.06 | 0.05 | -0.01 | 0.10 | 0.06 | 0.08 | 0.16 | 0.20 | 0.29 | 0.17 | 0.30 | 0.20 | |
| Skew | 0.15 | 0.24 | 0.25 | 0.36 | 0.38 | 0.02 | 0.16 | 0.14 | 0.25 | 0.19 | 0.36 | 0.27 | 0.26 | 0.52 | 0.40 | 0.69 | 0.28 | 0.50 | |
| Kurt | 1.02 | 1.04 | 1.24 | 1.38 | 1.39 | 2.56 | 1.16 | 0.72 | 1.02 | 0.95 | 1.39 | 1.29 | 1.61 | 1.25 | 1.00 | 3.13 | 3.50 | 9.87 | |
| Min | -18.04 | -18.02 | -18.31 | -18.21 | -16.32 | -16.62 | -19.55 | -17.50 | -18.87 | -17.17 | -18.00 | -18.41 | -20.28 | -15.17 | -15.07 | -16.93 | -19.38 | -12.73 | |
| Q1 | -3.30 | -3.20 | -3.24 | -2.68 | -3.20 | -1.66 | -3.99 | -3.48 | -3.39 | -3.41 | -3.17 | -2.96 | -2.75 | -2.67 | -3.16 | -3.14 | -1.85 | -0.73 | |
| Med | 0.66 | 0.22 | 0.34 | 0.53 | 0.83 | 0.19 | 0.36 | 0.67 | 0.21 | 0.77 | 0.37 | 0.62 | 0.41 | 0.40 | 0.68 | 0.67 | 0.25 | -0.01 | |
| Q3 | 3.78 | 3.53 | 3.55 | 3.46 | 3.51 | 2.36 | 3.69 | 3.81 | 3.36 | 3.55 | 3.75 | 3.49 | 3.66 | 3.57 | 3.56 | 3.70 | 2.89 | 0.93 | |
| Max | 25.50 | 24.37 | 20.45 | 20.14 | 25.63 | 14.95 | 27.11 | 24.08 | 24.48 | 24.21 | 20.87 | 20.16 | 21.71 | 21.02 | 23.91 | 28.81 | 23.60 | 11.71 | |
| α | -1.88 | -1.04 | -0.73 | 1.51 | 1.89 | 3.77 | -3.31 | -0.65 | -1.90 | 0.32 | -0.46 | -0.12 | 1.56 | 2.29 | 4.24 | 1.93 | 5.25 | 1.47 | |
| | (-1.1) | (-0.7) | (-0.5) | (1.1) | (1.3) | (1.5) | (-1.7) | (-0.4) | (-1.2) | (0.2) | (-0.3) | (-0.1) | (1.0) | (1.5) | (2.7) | (1.0) | (1.7) | (1.1) | |
| Mkt_RF | 1.09 | 1.00 | 1.03 | 1.01 | 0.97 | -0.12 | 1.10 | 1.07 | 1.02 | 0.99 | 1.05 | 1.02 | 1.01 | 0.98 | 0.97 | 0.98 | -0.13 | -0.01 | |
| | (42.0) | (44.3) | (48.8) | (48.8) | (42.7) | (-2.9) | (36.4) | (41.6) | (41.5) | (39.4) | (46.2) | (41.3) | (43.2) | (42.2) | (39.3) | (32.5) | (-2.6) | (-0.5) | |
| R ² | 83.82 | 85.21 | 87.49 | 87.49 | 84.29 | 2.34 | 79.55 | 83.56 | 83.52 | 82.00 | 86.26 | 83.38 | 84.59 | 83.95 | 81.99 | 75.66 | 1.97 | 0.08 | |
| α | -2.45 | -1.90 | -1.54 | 0.87 | 1.88 | 4.33 | -3.83 | -1.39 | -2.69 | -0.80 | -1.57 | -1.04 | 1.04 | 1.48 | 3.81 | 2.11 | 5.94 | 1.61 | |
| | (-1.7) | (-1.6) | (-1.4) | (0.7) | (1.4) | (1.7) | (-2.2) | (-1.0) | (-2.0) | (-0.6) | (-1.4) | (-0.9) | (0.8) | (1.2) | (2.7) | (1.2) | (1.9) | (1.2) | |
| Mkt_RF | 1.07 | 1.00 | 1.02 | 1.00 | 0.95 | -0.12 | 1.09 | 1.06 | 1.01 | 0.98 | 1.05 | 1.00 | 1.00 | 0.97 | 0.95 | 0.94 | -0.14 | -0.02 | |
| | (45.8) | (51.5) | (58.7) | (54.2) | (43.8) | (-2.9) | (39.0) | (47.7) | (48.6) | (49.3) | (57.8) | (52.1) | (47.2) | (48.0) | (42.3) | (33.8) | (-2.9) | (-1.0) | |
| SMB | 0.38 | 0.37 | 0.38 | 0.30 | 0.25 | -0.13 | 0.43 | 0.43 | 0.43 | 0.47 | 0.41 | 0.49 | 0.34 | 0.36 | 0.35 | 0.39 | -0.05 | 0.08 | |
| | (9.6) | (11.2) | (12.7) | (9.6) | (6.8) | (-1.9) | (9.1) | (11.5) | (12.1) | (13.8) | (13.1) | (14.9) | (9.5) | (10.4) | (9.1) | (8.1) | (-0.5) | (2.3) | |
| HML | 0.10 | 0.19 | 0.17 | 0.13 | -0.03 | -0.14 | 0.08 | 0.15 | 0.16 | 0.25 | 0.25 | 0.19 | 0.10 | 0.17 | 0.07 | -0.10 | -0.19 | -0.05 | |
| | (2.4) | (5.3) | (5.3) | (3.9) | (-0.8) | (-1.8) | (1.6) | (3.6) | (4.1) | (6.7) | (7.5) | (5.2) | (2.4) | (4.7) | (1.7) | (-2.0) | (-2.0) | (-1.2) | |
| R ² | 87.37 | 89.69 | 91.87 | 90.43 | 86.24 | 4.13 | 83.59 | 88.38 | 88.79 | 89.19 | 91.63 | 90.29 | 87.94 | 88.29 | 85.60 | 79.88 | 3.22 | 2.13 | |

Table A17. Continued. Portfolio momentum in Europe, Japan, and Asia Pacific ex Japan: 5×5 size and book-to-market and 2×4×4 size, operating profitability, and investment portfolios.

| <i>Panel D. 4 and 8 momentum portfolios, respectively, from Japanese 2×4×4 size, operating profitability, and investment portfolios</i> | | | | | | | | | | | | | | | | |
|---|--------|--------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|------------------|--------------------------------|--|
| | 1 | 2 | 3 | 4 | WML ₄ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | WML ₈ | W ₈ -W ₄ | |
| Mean | 3.01 | 2.89 | 4.92 | 6.30 | 3.29 | 4.34 | 2.28 | 4.07 | 2.13 | 6.87 | 3.69 | 7.68 | 6.07 | 1.73 | -1.56 | |
| St Dev | 22.15 | 20.25 | 18.65 | 19.37 | 13.05 | 23.46 | 21.78 | 20.26 | 20.58 | 19.14 | 19.11 | 19.87 | 20.31 | 16.33 | 6.97 | |
| Sharpe | 0.02 | 0.02 | 0.13 | 0.20 | 0.25 | 0.08 | -0.01 | 0.08 | -0.02 | 0.23 | 0.06 | 0.26 | 0.18 | 0.11 | -0.22 | |
| Skew | 0.46 | 0.23 | 0.14 | 0.43 | 0.17 | 0.50 | 0.39 | 0.23 | 0.18 | 0.31 | 0.06 | 0.46 | 0.45 | 0.09 | 0.28 | |
| Kurt | 2.37 | 1.48 | 0.45 | 1.66 | 5.30 | 2.57 | 2.11 | 1.25 | 1.31 | 0.69 | 0.26 | 1.47 | 1.82 | 5.58 | 2.57 | |
| Min | -19.67 | -19.49 | -16.11 | -18.32 | -20.02 | -21.60 | -18.48 | -16.80 | -20.24 | -15.30 | -16.74 | -15.91 | -18.89 | -25.85 | -7.84 | |
| Q1 | -3.57 | -2.79 | -3.19 | -2.68 | -1.48 | -3.33 | -3.31 | -3.15 | -3.05 | -3.18 | -3.41 | -2.95 | -3.02 | -2.12 | -1.26 | |
| Med | 0.36 | 0.15 | 0.53 | 0.59 | 0.13 | 0.35 | 0.41 | 0.38 | 0.17 | 0.66 | 0.47 | 0.74 | 0.69 | 0.03 | -0.13 | |
| Q3 | 3.39 | 3.68 | 3.55 | 3.37 | 1.69 | 3.63 | 3.66 | 3.53 | 3.30 | 3.78 | 3.66 | 3.78 | 3.30 | 2.08 | 0.80 | |
| Max | 28.10 | 23.57 | 16.57 | 25.13 | 16.32 | 32.09 | 26.94 | 24.56 | 22.40 | 18.93 | 15.44 | 24.02 | 26.71 | 20.61 | 8.48 | |
| α | -1.29 | -1.28 | 0.87 | 2.21 | 3.50 | -0.01 | -1.97 | -0.05 | -2.04 | 2.83 | -0.37 | 3.55 | 1.98 | 1.99 | -1.51 | |
| | (-0.8) | (-1.0) | (0.8) | (1.8) | (1.5) | (-0.0) | (-1.2) | (-0.0) | (-1.5) | (2.1) | (-0.3) | (2.8) | (1.2) | (0.7) | (-1.2) | |
| Mkt_RF | 1.11 | 1.03 | 0.96 | 0.98 | -0.12 | 1.14 | 1.08 | 1.00 | 1.03 | 0.96 | 0.96 | 1.01 | 0.99 | -0.15 | -0.03 | |
| | (45.9) | (52.1) | (58.9) | (52.0) | (-3.3) | (38.3) | (43.6) | (42.5) | (47.2) | (45.5) | (48.2) | (51.1) | (38.3) | (-3.3) | (-1.5) | |
| R ² | 86.11 | 88.87 | 91.08 | 88.84 | 3.10 | 81.22 | 84.85 | 84.18 | 86.78 | 85.87 | 87.23 | 88.47 | 81.15 | 3.05 | 0.63 | |
| α | -2.11 | -2.12 | 0.03 | 2.40 | 4.51 | -0.89 | -3.05 | -0.84 | -2.96 | 1.85 | -1.28 | 3.05 | 2.59 | 3.48 | -1.03 | |
| | (-1.4) | (-1.8) | (0.0) | (2.0) | (1.9) | (-0.5) | (-2.1) | (-0.6) | (-2.4) | (1.5) | (-1.1) | (2.5) | (1.6) | (1.2) | (-0.8) | |
| Mkt_RF | 1.11 | 1.03 | 0.97 | 0.97 | -0.14 | 1.14 | 1.09 | 1.01 | 1.03 | 0.96 | 0.97 | 1.01 | 0.96 | -0.18 | -0.04 | |
| | (47.9) | (56.6) | (65.0) | (51.3) | (-3.8) | (40.1) | (46.7) | (44.1) | (52.7) | (50.6) | (51.8) | (52.6) | (38.1) | (-3.8) | (-1.9) | |
| SMB | 0.21 | 0.22 | 0.15 | 0.10 | -0.11 | 0.31 | 0.21 | 0.18 | 0.30 | 0.26 | 0.16 | 0.18 | 0.14 | -0.17 | -0.06 | |
| | (5.3) | (7.1) | (6.1) | (3.0) | (-1.8) | (6.4) | (5.2) | (4.6) | (8.9) | (8.0) | (5.1) | (5.6) | (3.3) | (-2.1) | (-1.6) | |
| HML | 0.15 | 0.15 | 0.17 | -0.09 | -0.24 | 0.13 | 0.22 | 0.15 | 0.14 | 0.17 | 0.19 | 0.07 | -0.22 | -0.35 | -0.11 | |
| | (3.5) | (4.4) | (6.3) | (-2.5) | (-3.4) | (2.4) | (5.1) | (3.5) | (3.9) | (4.9) | (5.5) | (1.9) | (-4.8) | (-4.1) | (-3.0) | |
| R ² | 87.69 | 90.89 | 92.84 | 89.30 | 7.42 | 83.63 | 87.05 | 85.73 | 89.83 | 88.97 | 89.17 | 89.60 | 82.75 | 9.09 | 4.12 | |

Table A17. Continued. Portfolio momentum in Europe, Japan, and Asia Pacific ex Japan: 5×5 size and book-to-market and 2×4×4 size, operating profitability, and investment portfolios.

| Panel E. 5 and 10 momentum portfolios, respectively, from Asia Pacific ex Japan 5×5 size and book-to-market portfolios | | | | | | | | | | | | | | | | | | |
|--|--------|--------|--------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------------|---------------------------------|
| | 1 | 2 | 3 | 4 | 5 | WML ₅ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | WML ₁₀ | W ₁₀ -W ₅ |
| Mean | 9.37 | 10.15 | 9.71 | 11.07 | 13.41 | 4.04 | 8.33 | 9.41 | 8.56 | 10.01 | 10.29 | 9.63 | 10.51 | 11.06 | 14.09 | 12.48 | 4.14 | 0.11 |
| St Dev | 23.42 | 22.18 | 21.55 | 21.21 | 21.46 | 13.75 | 23.45 | 23.72 | 22.58 | 21.86 | 22.24 | 21.95 | 22.16 | 21.24 | 22.13 | 21.60 | 14.80 | 7.92 |
| Sharpe | 0.30 | 0.35 | 0.34 | 0.41 | 0.51 | 0.29 | 0.25 | 0.29 | 0.27 | 0.35 | 0.35 | 0.33 | 0.36 | 0.40 | 0.53 | 0.46 | 0.28 | 0.01 |
| Skew | 0.33 | -0.37 | -0.26 | -0.45 | -0.66 | -0.80 | 0.29 | 0.36 | -0.41 | -0.52 | -0.11 | -0.41 | -0.16 | -0.75 | -0.64 | -0.79 | -0.78 | 0.10 |
| Kurt | 6.21 | 3.82 | 2.88 | 3.38 | 2.15 | 6.92 | 4.84 | 7.22 | 3.84 | 3.65 | 3.81 | 2.45 | 3.85 | 2.71 | 2.38 | 2.64 | 7.64 | 3.14 |
| Min | -33.71 | -32.58 | -26.01 | -29.71 | -24.28 | -23.20 | -32.59 | -34.79 | -33.98 | -31.46 | -30.54 | -26.93 | -28.25 | -30.74 | -26.78 | -28.47 | -23.69 | -10.57 |
| Q1 | -2.32 | -1.93 | -2.19 | -2.41 | -1.79 | -1.68 | -2.36 | -2.33 | -2.21 | -1.78 | -2.06 | -2.50 | -2.37 | -2.22 | -1.65 | -1.76 | -1.69 | -1.04 |
| Med | 0.82 | 0.96 | 1.20 | 1.22 | 1.32 | 0.34 | 0.76 | 0.92 | 0.71 | 1.31 | 1.01 | 1.56 | 1.32 | 1.02 | 1.46 | 1.15 | 0.71 | -0.04 |
| Q3 | 3.94 | 3.57 | 4.05 | 4.19 | 4.87 | 2.52 | 3.93 | 3.61 | 3.87 | 3.95 | 3.75 | 4.24 | 3.96 | 4.34 | 4.87 | 4.91 | 2.66 | 0.97 |
| Max | 39.45 | 26.00 | 26.61 | 28.44 | 17.96 | 17.90 | 34.95 | 42.37 | 24.80 | 26.79 | 30.33 | 24.61 | 32.47 | 18.20 | 18.65 | 17.72 | 24.01 | 8.92 |
| α | -2.13 | -1.13 | -1.44 | 0.05 | 2.66 | 4.79 | -3.05 | -2.11 | -2.77 | -0.95 | -0.86 | -1.60 | -0.73 | 0.21 | 3.13 | 1.89 | 4.94 | 0.15 |
| | (-1.2) | (-0.8) | (-1.3) | (0.0) | (1.7) | (1.9) | (-1.6) | (-1.1) | (-1.9) | (-0.6) | (-0.6) | (-1.3) | (-0.5) | (0.2) | (1.9) | (1.0) | (1.8) | (0.1) |
| Mkt_RF | 1.08 | 1.05 | 1.04 | 1.02 | 0.99 | -0.09 | 1.06 | 1.08 | 1.06 | 1.01 | 1.04 | 1.05 | 1.05 | 1.00 | 1.01 | 0.97 | -0.10 | -0.01 |
| | (43.7) | (55.1) | (64.9) | (65.0) | (43.7) | (-2.4) | (39.8) | (40.8) | (49.5) | (45.6) | (47.6) | (57.6) | (53.5) | (51.9) | (42.2) | (37.4) | (-2.4) | (-0.2) |
| R ² | 84.88 | 89.94 | 92.53 | 92.56 | 84.86 | 1.71 | 82.35 | 83.01 | 87.82 | 85.94 | 86.95 | 90.70 | 89.40 | 88.78 | 83.95 | 80.44 | 1.66 | 0.02 |
| α | -2.75 | -0.34 | -1.11 | 0.28 | 2.53 | 5.28 | -2.54 | -2.94 | -1.83 | 0.42 | -0.62 | -0.82 | -0.30 | 0.65 | 2.96 | 2.00 | 4.54 | -0.74 |
| | (-1.7) | (-0.3) | (-1.1) | (0.3) | (1.7) | (2.0) | (-1.4) | (-1.7) | (-1.3) | (0.3) | (-0.5) | (-0.7) | (-0.2) | (0.5) | (1.9) | (1.2) | (1.6) | (-0.5) |
| Mkt_RF | 1.07 | 1.06 | 1.03 | 1.02 | 0.98 | -0.09 | 1.06 | 1.06 | 1.06 | 1.02 | 1.03 | 1.05 | 1.05 | 1.00 | 1.00 | 0.96 | -0.10 | -0.01 |
| | (46.2) | (56.9) | (69.6) | (67.4) | (47.4) | (-2.3) | (42.5) | (43.6) | (52.1) | (50.2) | (53.3) | (62.9) | (56.3) | (56.3) | (45.2) | (41.4) | (-2.5) | (-0.7) |
| SMB | 0.27 | 0.19 | 0.22 | 0.17 | 0.32 | 0.05 | 0.37 | 0.30 | 0.26 | 0.34 | 0.36 | 0.28 | 0.24 | 0.29 | 0.32 | 0.41 | 0.04 | 0.00 |
| | (6.1) | (5.2) | (7.7) | (5.7) | (7.9) | (0.6) | (7.5) | (6.3) | (6.4) | (8.7) | (9.6) | (8.6) | (6.6) | (8.4) | (7.3) | (9.0) | (0.6) | (-0.1) |
| HML | 0.22 | -0.03 | 0.06 | 0.05 | 0.17 | -0.05 | 0.10 | 0.27 | -0.02 | -0.04 | 0.14 | 0.01 | 0.05 | 0.07 | 0.18 | 0.18 | 0.08 | 0.13 |
| | (5.0) | (-0.8) | (2.0) | (1.6) | (4.3) | (-0.7) | (2.0) | (5.7) | (-0.5) | (-1.1) | (3.6) | (0.5) | (1.4) | (2.1) | (4.1) | (4.0) | (1.1) | (3.2) |
| R ² | 87.12 | 90.72 | 93.67 | 93.25 | 87.70 | 2.00 | 84.96 | 85.89 | 89.17 | 88.56 | 89.96 | 92.37 | 90.65 | 90.76 | 86.59 | 84.68 | 2.05 | 3.06 |

Table A17. Continued. Portfolio momentum in Europe, Japan, and Asia Pacific ex Japan: 5×5 size and book-to-market and 2×4×4 size, operating profitability, and investment portfolios.

| <i>Panel F.</i> 4 and 8 momentum portfolios, respectively, from Asia Pacific ex Japan 2×4×4 size, operating profitability, and investment portfolios | | | | | | | | | | | | | | | | |
|--|--------|--------|--------|--------|------------------|--------|--------|--------|--------|--------|--------|--------|--------|------------------|--------------------------------|--|
| | 1 | 2 | 3 | 4 | WML ₄ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | WML ₈ | W ₈ -W ₄ | |
| Mean | 6.54 | 10.11 | 13.23 | 10.35 | 3.81 | 3.29 | 7.99 | 10.34 | 10.72 | 14.35 | 11.53 | 11.95 | 9.40 | 6.11 | 2.30 | |
| St Dev | 24.22 | 21.65 | 21.64 | 20.42 | 14.34 | 24.43 | 24.70 | 23.77 | 21.70 | 22.00 | 22.31 | 20.95 | 21.11 | 16.53 | 9.45 | |
| Sharpe | 0.17 | 0.35 | 0.50 | 0.39 | 0.27 | 0.03 | 0.22 | 0.33 | 0.38 | 0.54 | 0.41 | 0.45 | 0.33 | 0.37 | 0.24 | |
| Skew | -0.14 | -0.39 | -0.08 | -0.41 | -0.61 | -0.13 | 0.06 | -0.33 | -0.33 | -0.01 | -0.17 | -0.23 | -0.71 | -0.74 | 0.52 | |
| Kurt | 3.26 | 3.20 | 2.85 | 2.51 | 5.91 | 2.67 | 4.20 | 3.81 | 2.72 | 1.73 | 4.06 | 2.39 | 2.78 | 5.81 | 4.00 | |
| Min | -27.95 | -26.90 | -26.32 | -24.84 | -21.59 | -25.98 | -29.68 | -33.73 | -25.65 | -24.18 | -27.26 | -24.32 | -25.15 | -26.87 | -9.91 | |
| Q1 | -2.78 | -1.95 | -2.19 | -1.80 | -1.49 | -3.20 | -3.12 | -2.30 | -2.00 | -2.22 | -2.07 | -1.80 | -1.81 | -1.81 | -1.34 | |
| Med | 0.97 | 1.15 | 1.36 | 1.22 | 0.36 | 0.54 | 0.81 | 1.43 | 1.23 | 1.30 | 1.22 | 1.17 | 1.14 | 0.71 | 0.16 | |
| Q3 | 3.80 | 3.82 | 4.70 | 4.06 | 2.25 | 3.75 | 4.02 | 4.22 | 4.06 | 4.66 | 4.43 | 4.32 | 4.21 | 3.00 | 1.70 | |
| Max | 28.61 | 25.17 | 30.07 | 26.42 | 21.13 | 29.75 | 31.66 | 28.57 | 23.14 | 23.42 | 35.10 | 27.94 | 22.85 | 22.04 | 16.44 | |
| α | -5.33 | -1.07 | 2.05 | -0.09 | 5.24 | -8.33 | -3.93 | -1.44 | -0.31 | 3.26 | 0.43 | 1.46 | -0.93 | 7.39 | 2.15 | |
| | (-3.1) | (-0.9) | (1.8) | (-0.1) | (2.0) | (-4.0) | (-2.1) | (-0.9) | (-0.2) | (2.2) | (0.3) | (0.9) | (-0.5) | (2.4) | (1.2) | |
| Mkt_RF | 1.12 | 1.04 | 1.04 | 0.95 | -0.17 | 1.09 | 1.13 | 1.11 | 1.02 | 1.03 | 1.03 | 0.96 | 0.94 | -0.15 | 0.02 | |
| | (45.5) | (63.4) | (64.6) | (47.3) | (-4.5) | (36.8) | (41.4) | (48.6) | (51.5) | (48.8) | (44.4) | (41.8) | (35.9) | (-3.5) | (0.7) | |
| R ² | 85.91 | 92.19 | 92.47 | 86.79 | 5.69 | 79.97 | 83.43 | 87.42 | 88.63 | 87.52 | 85.27 | 83.70 | 79.15 | 3.44 | 0.14 | |
| α | -5.30 | -0.60 | 1.47 | -0.06 | 5.24 | -8.09 | -3.92 | -1.00 | -0.04 | 2.81 | -0.19 | 1.07 | -0.74 | 7.35 | 2.11 | |
| | (-3.1) | (-0.5) | (1.3) | (-0.0) | (2.0) | (-4.0) | (-2.1) | (-0.6) | (-0.0) | (1.9) | (-0.1) | (0.7) | (-0.4) | (2.4) | (1.2) | |
| Mkt_RF | 1.12 | 1.04 | 1.03 | 0.95 | -0.17 | 1.09 | 1.13 | 1.11 | 1.02 | 1.02 | 1.02 | 0.95 | 0.94 | -0.15 | 0.02 | |
| | (45.7) | (63.4) | (65.0) | (47.3) | (-4.5) | (37.8) | (41.6) | (49.8) | (51.2) | (48.5) | (46.3) | (42.2) | (36.2) | (-3.4) | (0.7) | |
| SMB | 0.16 | 0.06 | 0.06 | 0.11 | -0.04 | 0.28 | 0.19 | 0.21 | 0.05 | 0.06 | 0.24 | 0.16 | 0.18 | -0.10 | -0.06 | |
| | (3.2) | (1.7) | (2.0) | (2.9) | (-0.6) | (4.9) | (3.5) | (4.8) | (1.4) | (1.4) | (5.4) | (3.5) | (3.6) | (-1.1) | (-1.1) | |
| HML | 0.03 | -0.06 | 0.10 | 0.02 | -0.01 | 0.03 | 0.04 | -0.02 | -0.03 | 0.08 | 0.15 | 0.09 | 0.01 | -0.02 | -0.01 | |
| | (0.7) | (-1.8) | (3.3) | (0.6) | (-0.1) | (0.5) | (0.8) | (-0.4) | (-0.7) | (2.0) | (3.4) | (2.1) | (0.2) | (-0.2) | (-0.1) | |
| R ² | 86.37 | 92.33 | 92.81 | 87.13 | 5.79 | 81.37 | 84.06 | 88.22 | 88.70 | 87.76 | 86.97 | 84.53 | 79.93 | 3.83 | 0.52 | |

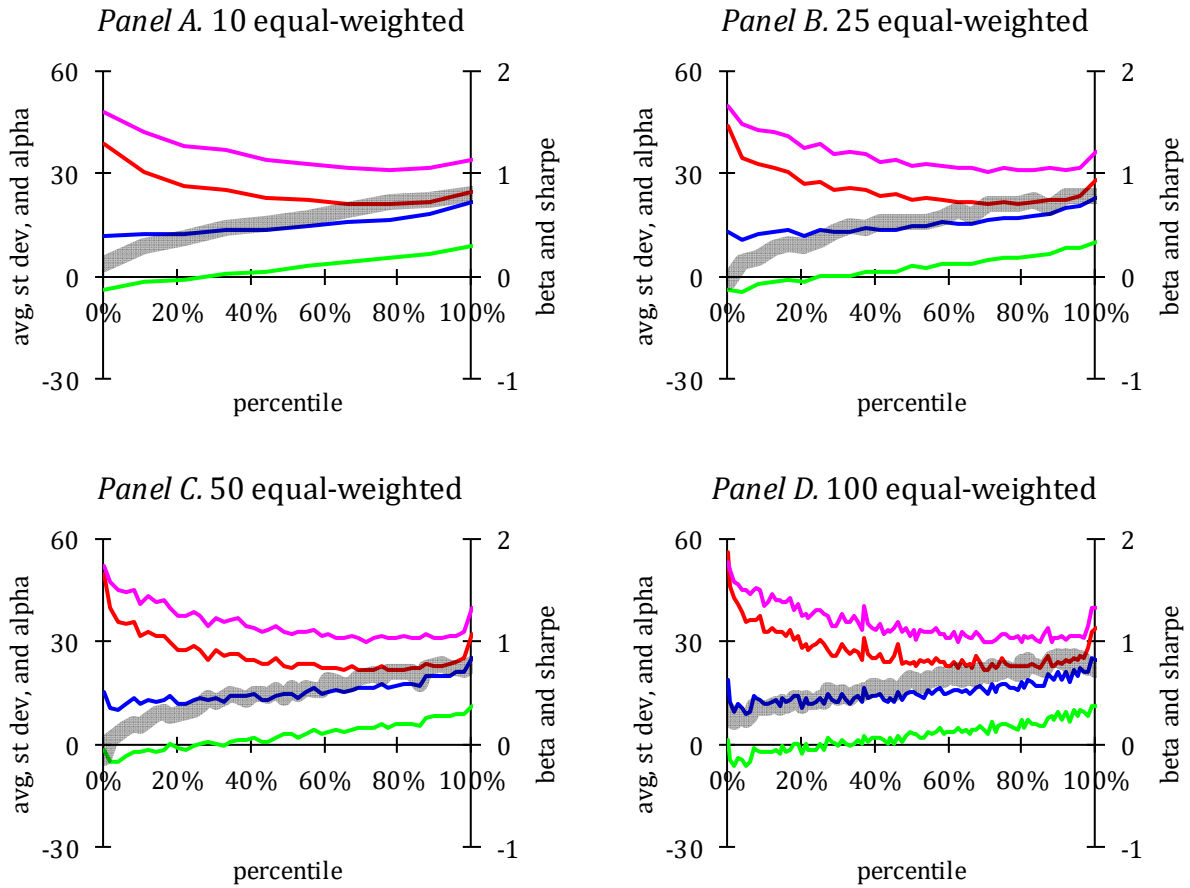


Figure A1. Average returns, standard deviations, Sharpe ratios, alphas, and betas of equal-weighted momentum portfolios.

The figure shows the annualized monthly average returns, standard deviations, Sharpe ratios, CAPM alphas, and market betas of 10 (Panel A), 25 (Panel B), 50 (Panel C), and 100 (Panel D) equal-weighted momentum portfolios. The x-axis shows the percentile—the most loser and the most winner portfolio are at 0% and 100%, respectively. Blue, red, green, and magenta lines are the average returns, standard deviations, alphas, and betas of the momentum portfolios, respectively. Black shades are the Sharpe ratios. The data are based on the Center for Research in Security Prices (CRSP) and span December 1926 to December 2019.

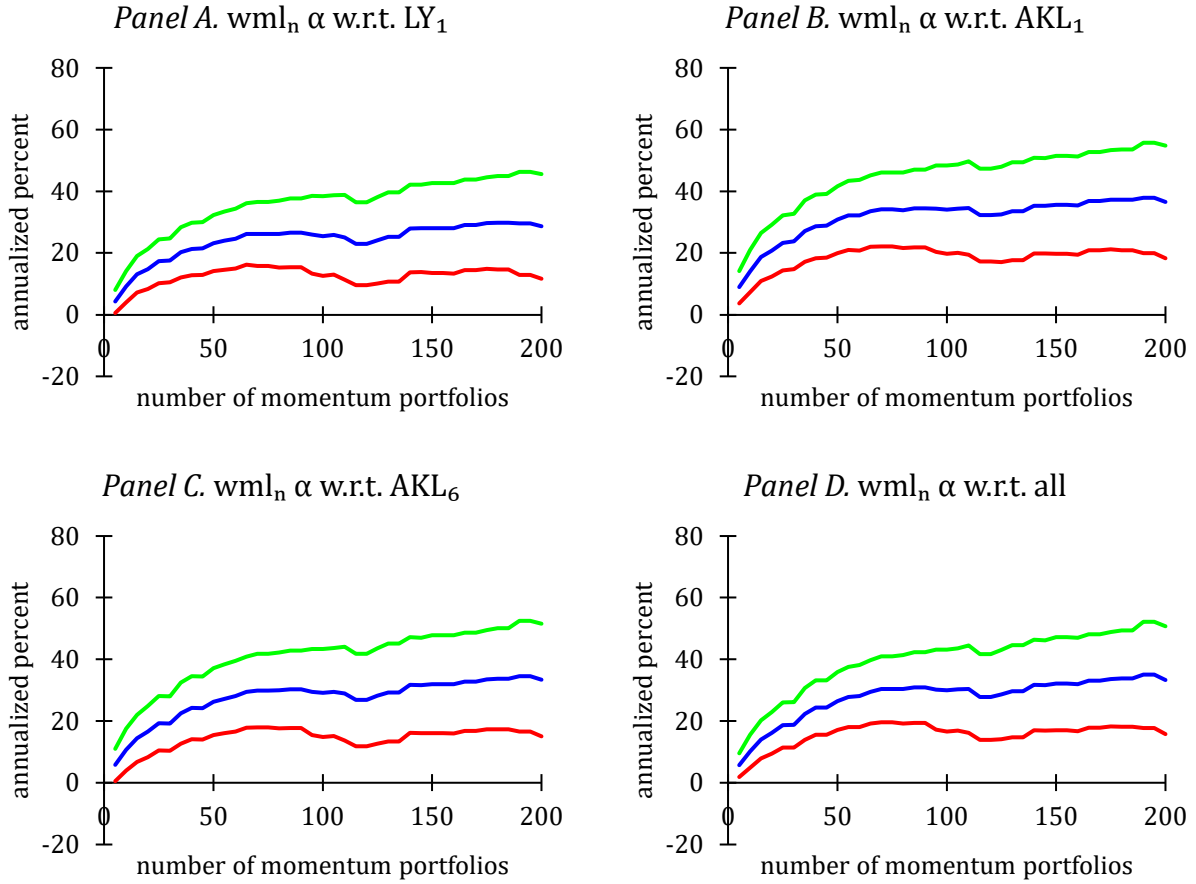


Figure A2. Number of momentum portfolios and WML alpha against factor momentum. This figure shows the spanning alphas of the n -portfolio winner-minus-loser factors (WML_n) with respect to three different types of factor momentum—the Leippold–Yang (2021) one-month (LY_1) factor momentum and the Arnott–Kalesnik–Linnainmaa (2023) one- (AKL_1) and six-month (AKL_6) factor momentum—based on 210 US equity factors, as functions of $n \in \{5, 10, \dots, 200\}$, the number of portfolios. The 210 factors are from Professor Leippold’s website (<https://osf.io/6sxc8>). Panels A, B, C, and D regress WML_n on LY_1 , AKL_1 , AKL_6 , and all three types of factor momentum, respectively. Blue, green, and red are the statistics and their two standard error bands. The data span July 1966 to December 2018.

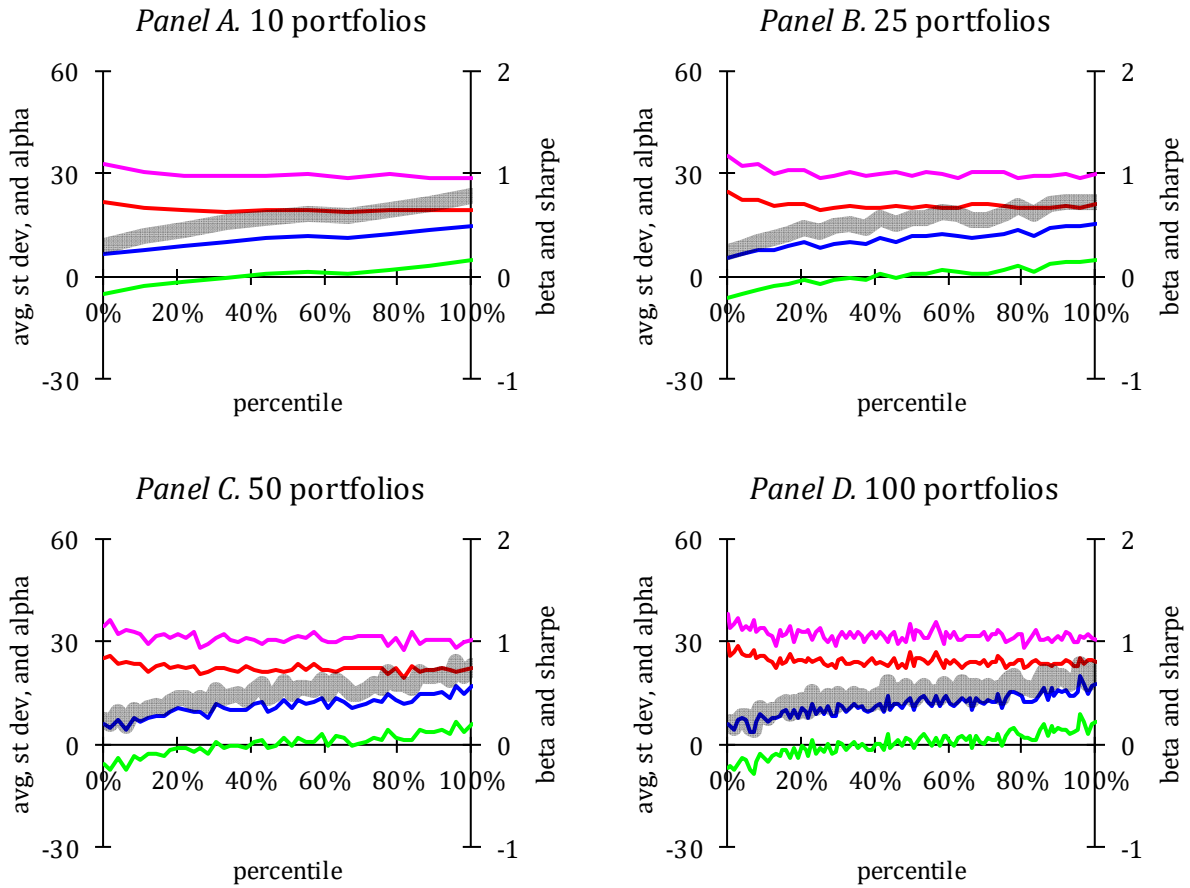


Figure A3. Average returns, standard deviations, Sharpe ratios, alphas, and betas of value-weighted residual momentum portfolios.

The figure shows the annualized monthly average returns, standard deviations, Sharpe ratios, CAPM alphas, and market betas of 10 (Panel A), 25 (Panel B), 50 (Panel C), and 100 (Panel D) value-weighted residual momentum portfolios (Blitz, Huij, and Martens, 2011). The x-axis shows the percentile—the most loser and the most winner portfolio are at 0% and 100%, respectively. Blue, red, green, and magenta lines are the average returns, standard deviations, alphas, and betas of the momentum portfolios, respectively. Black shades are the Sharpe ratios. The data are based on CRSP and span December 1926 to December 2019.

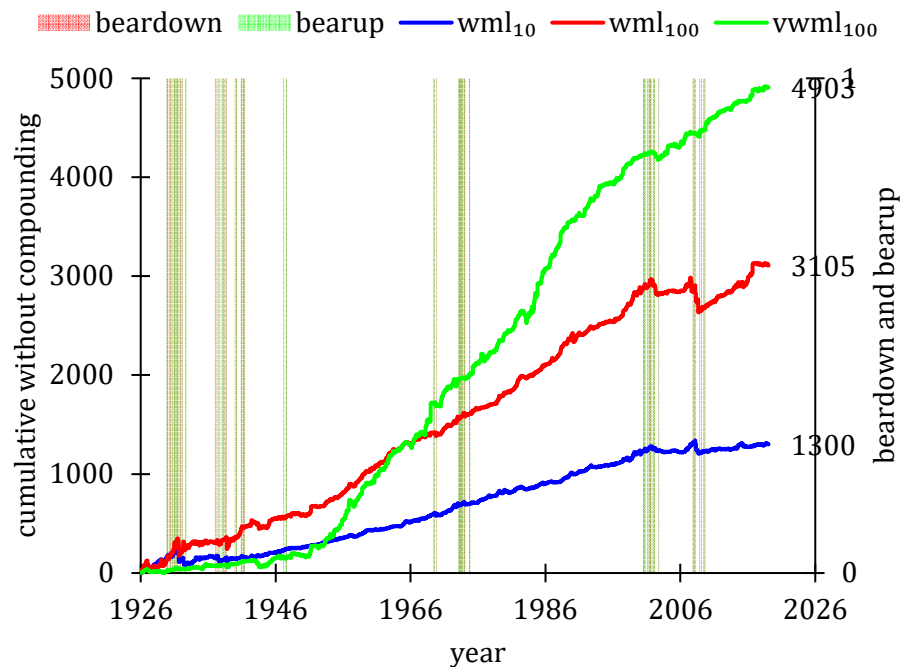


Figure A4. Cumulative WML and vWML returns in bear markets.

Blue, red, and green lines are cumulative, non-compounding, returns to simple decile WML, simple percentile WML, and volatility-managed (Moreira and Muir, 2017) percentile WML positions from value-weighted momentum portfolios, respectively. Red and green shades are bear-down and bear-up markets, respectively. Following Daniel and Moskowitz (2016), the bear-market indicator equals 1 if the trailing two-year cumulative market return is negative, and the up-market indicator equals 1 if the contemporaneous excess market return is positive. The data span January 1927 to December 2019.

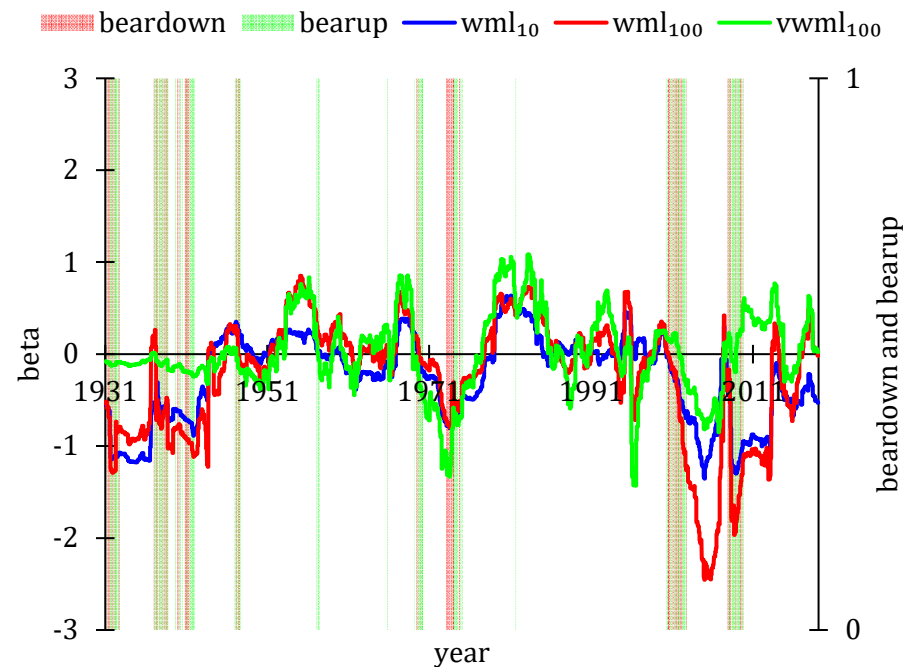


Figure A5. 60-month market betas of WML and vWML returns.

Blue, red, and green lines are trailing 60-month market betas of simple decile WML, simple percentile WML, and volatility-managed percentile WML positions from value-weighted momentum portfolios, respectively. Red and green shades are bear-down and bear-up markets, respectively. Following Daniel and Moskowitz (2016), the bear-market indicator equals 1 if the trailing two-year cumulative market return is negative, and the up-market indicator equals 1 if the contemporaneous excess market return is positive. The data span December 1931 to December 2019.

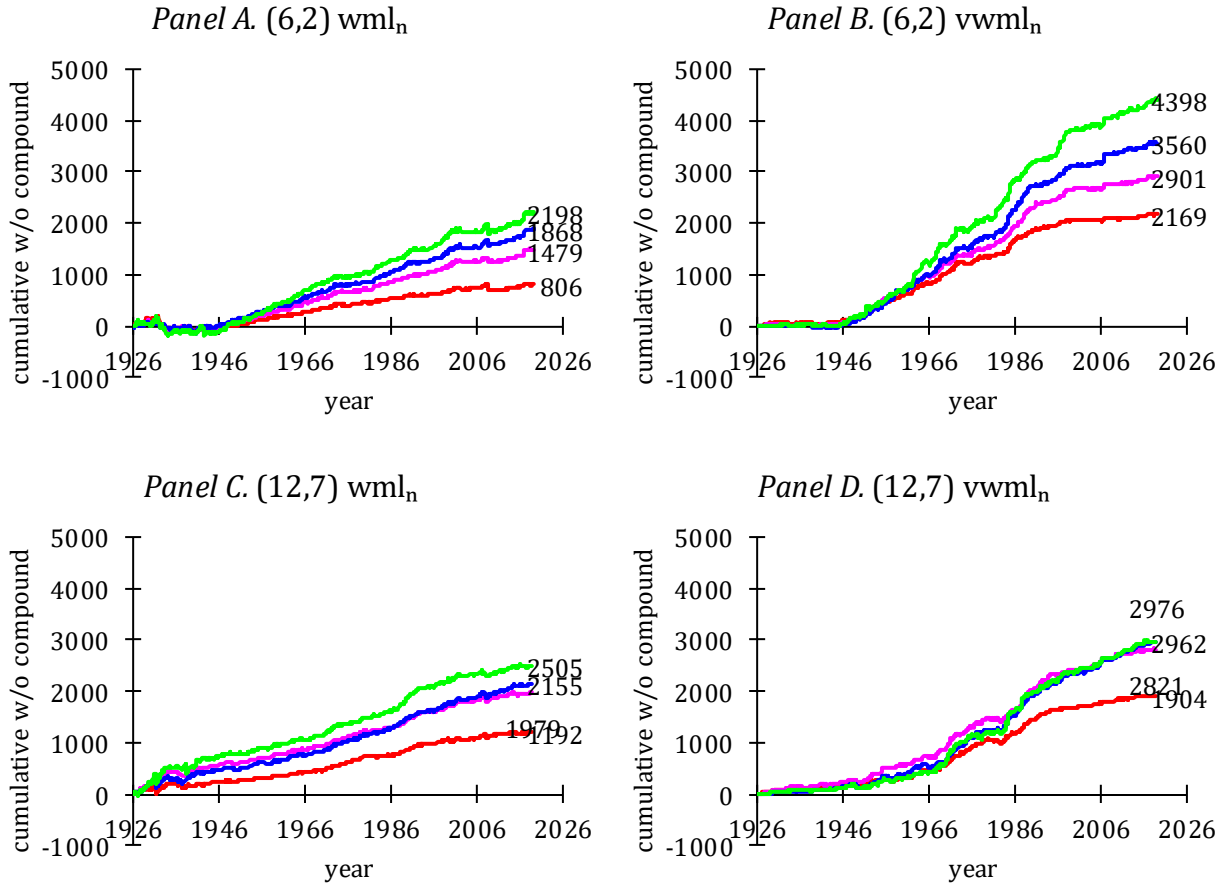


Figure A6. Term structure of momentum: cumulative WML_ns and vWML_ns.

The figure shows cumulative, non-compounding, returns to recent (top) and intermediate horizon (bottom) past performance WML_ns (left) and vWML_ns (right) (Novy-Marx, 2012; Goyal and Wahal, 2015; Moreira and Muir, 2017). Red, magenta, blue, and green lines are the WML positions from 10, 25, 50, and 100 momentum portfolios, respectively. The data are based on CRSP and are from July 1926 (Panel A), August 1926 (Panel B), January 1927 (Panel C), and February 1927 (Panel D) to December 2019, respectively.

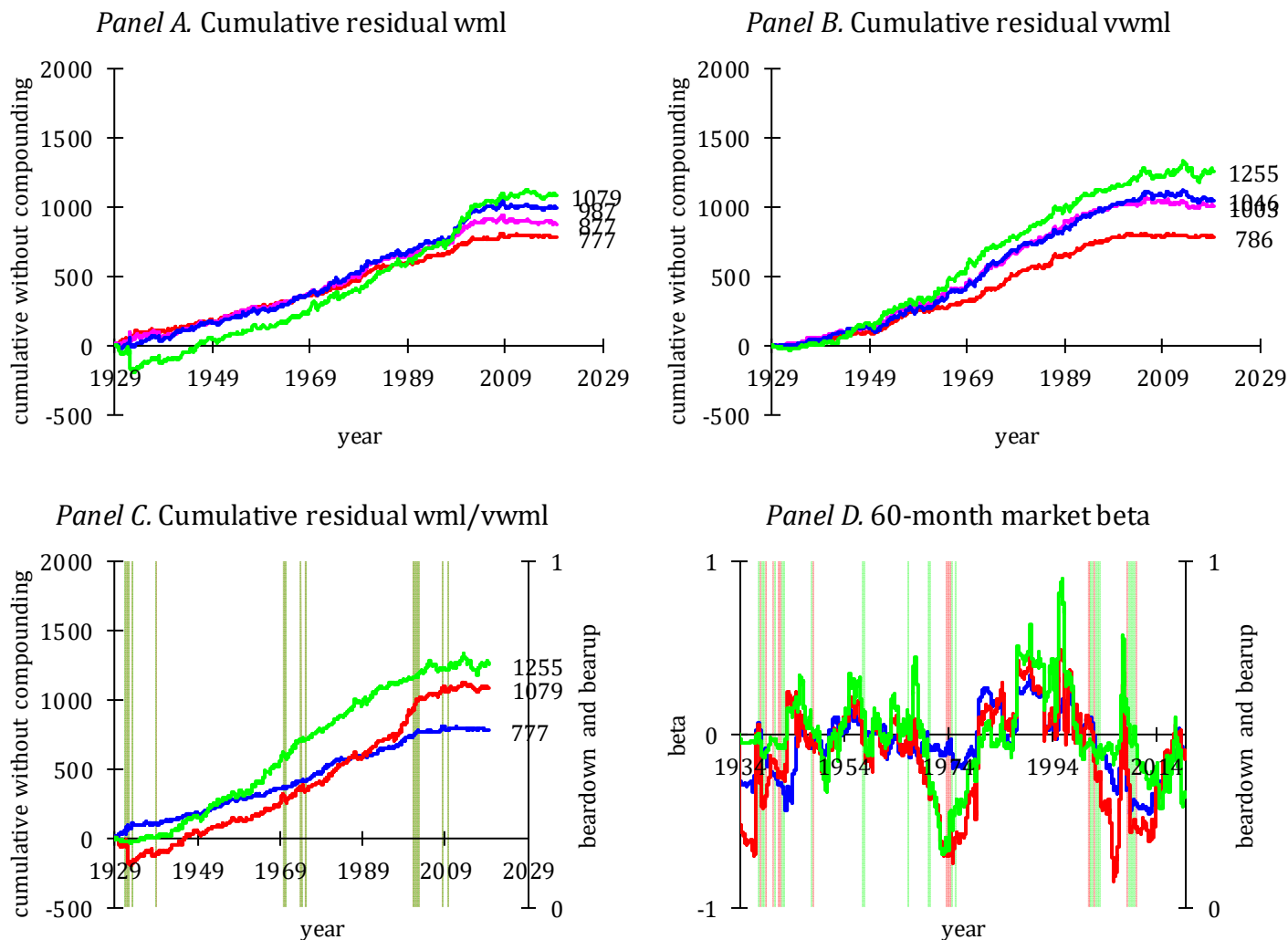


Figure A7. Cumulative returns and 60-month betas of simple and volatility-managed residual momentum portfolios. The figure shows the cumulative simple (Panel A) and volatility-managed (Panel B) residual momentum returns, the cumulative returns in bear markets (Panel C), and the trailing 60-month market betas (Panel D). Panels A, B, C, and D correspond to Figures 4, 5, 6, and 7, respectively. In Panels A and B, red, magenta, blue, and green are the WML positions from 10, 25, 50, and 100 residual momentum portfolios, respectively. In Panels C and D, red, blue, and green are WML₁₀, WML₁₀₀, and vWML₁₀₀, respectively. The data span July 1929 (Panels A, B, and C) or June 1934 (Panel D) to December 2019, respectively.

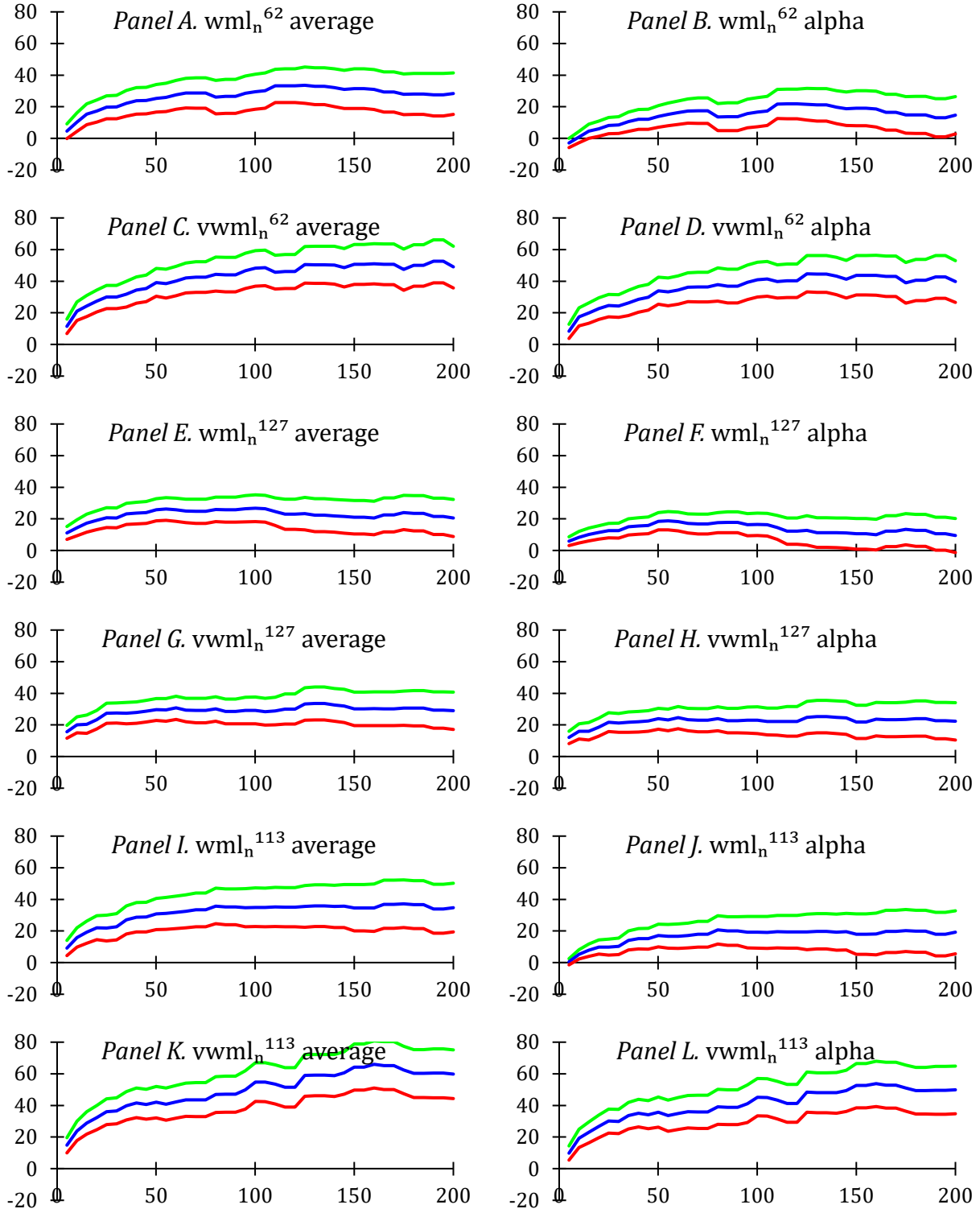


Figure A8. Number of recent/intermediate horizon momentum portfolios and WML performance. The figure shows the average return and alpha (Fama and French, 2018) of the recent past performance WML (Panels A, B) and vWML (Panels C, D), respectively, those of the intermediate horizon past performance WML (Panels E, F) and vWML (Panels G, H), respectively, and those of the $(t-11, t-3)$ WML (Panels I, J) and vWML (Panels K, L) (Gong, Liu, and Liu, 2015), respectively, as functions of $n=5, 10, \dots, 200$, the number of momentum portfolios. Blue, green, and red are the statistics and their two standard error bands. Average returns and alphas are annualized. The data are based on CRSP and span July 1963 to December 2019.

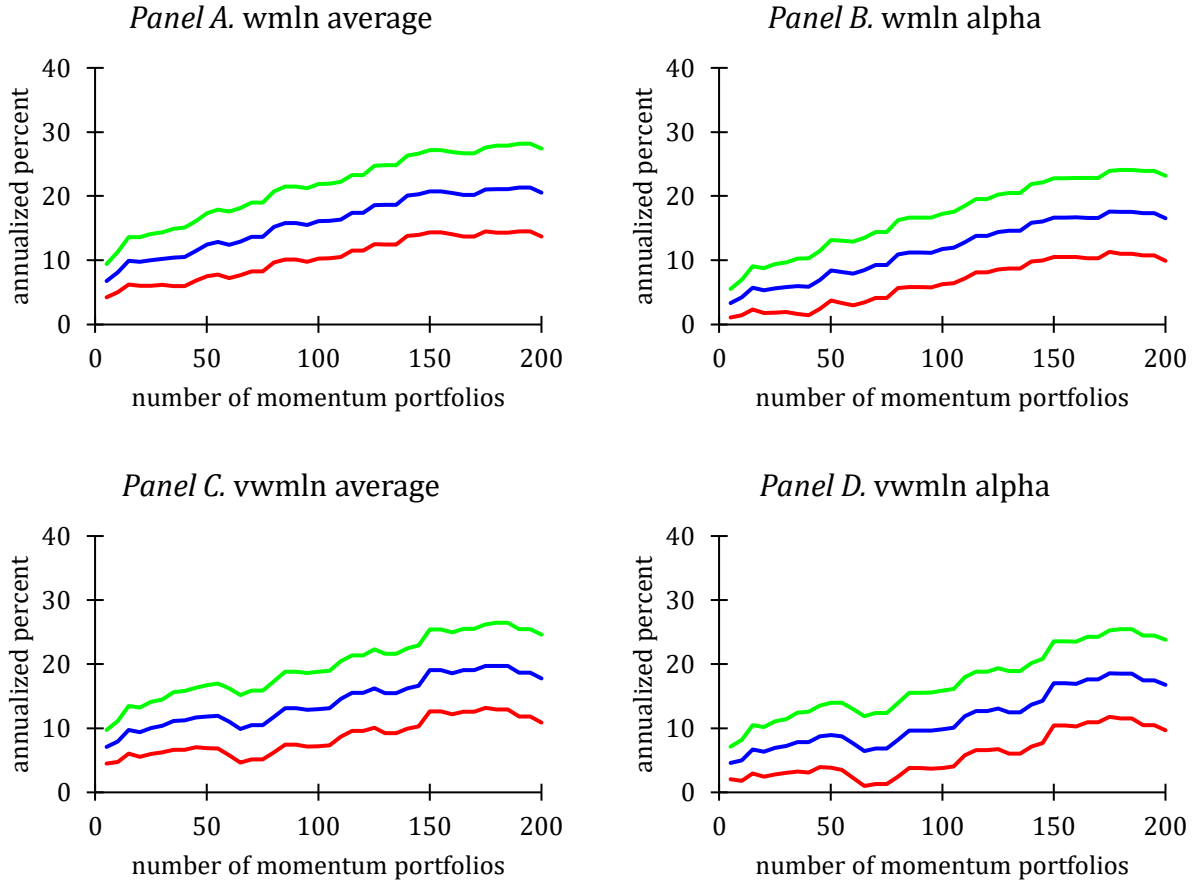


Figure A9. Number of residual momentum portfolios and WML performance.

The figure shows the average return (Panel A) and alpha (Fama and French, 2018) (Panel B) of the simple residual (Blitz, Huij, and Martens, 2011) WML and the average return (Panel C) and alpha (Panel D) of the volatility-managed (Moreira and Muir, 2017) residual WML as functions of $n=5,10,\dots,200$, the number of momentum portfolios—for example, WML_5 and WML_{200} are on the left and right. Blue, green, and red are the statistics and their two standard error bands. Average returns and alphas are annualized. The data are based on CRSP and span July 1963 to December 2019.

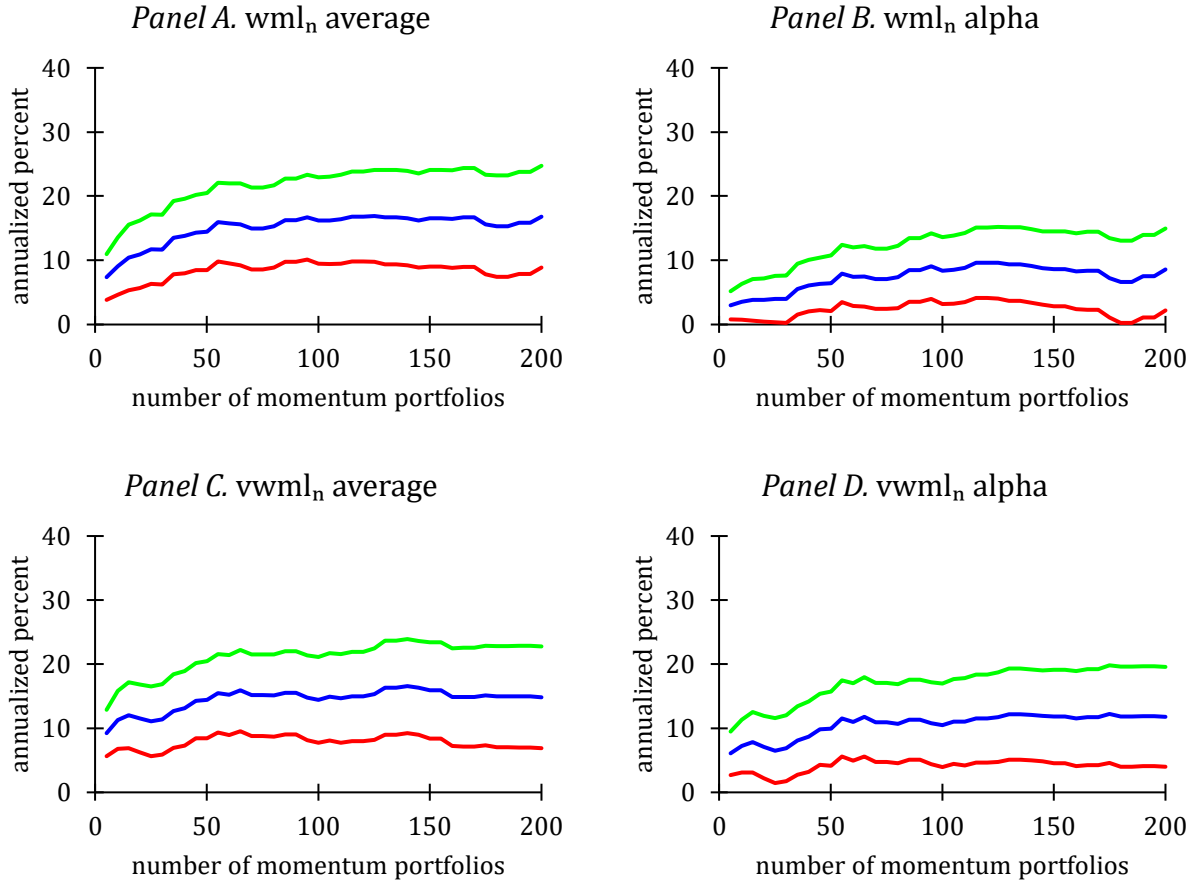


Figure A10. Number of alpha momentum portfolios and WML performance.

The figure shows the average return (Panel A) and alpha (Fama and French, 2018) (Panel B) of the simple alpha (Hühn and Scholz, 2018; Zaremba, Umutlu, and Karathanasopoulos, 2019) WML and the average return (Panel C) and alpha (Panel D) of the volatility-managed (Moreira and Muir, 2017) alpha WML as functions of $n=5,10,\dots,200$, the number of momentum portfolios—for example, WML₅ and WML₂₀₀ are on the left and right. Blue, green, and red are the statistics and their two standard error bands. Average returns and alphas are annualized. The data are based on CRSP and span July 1963 to December 2019.

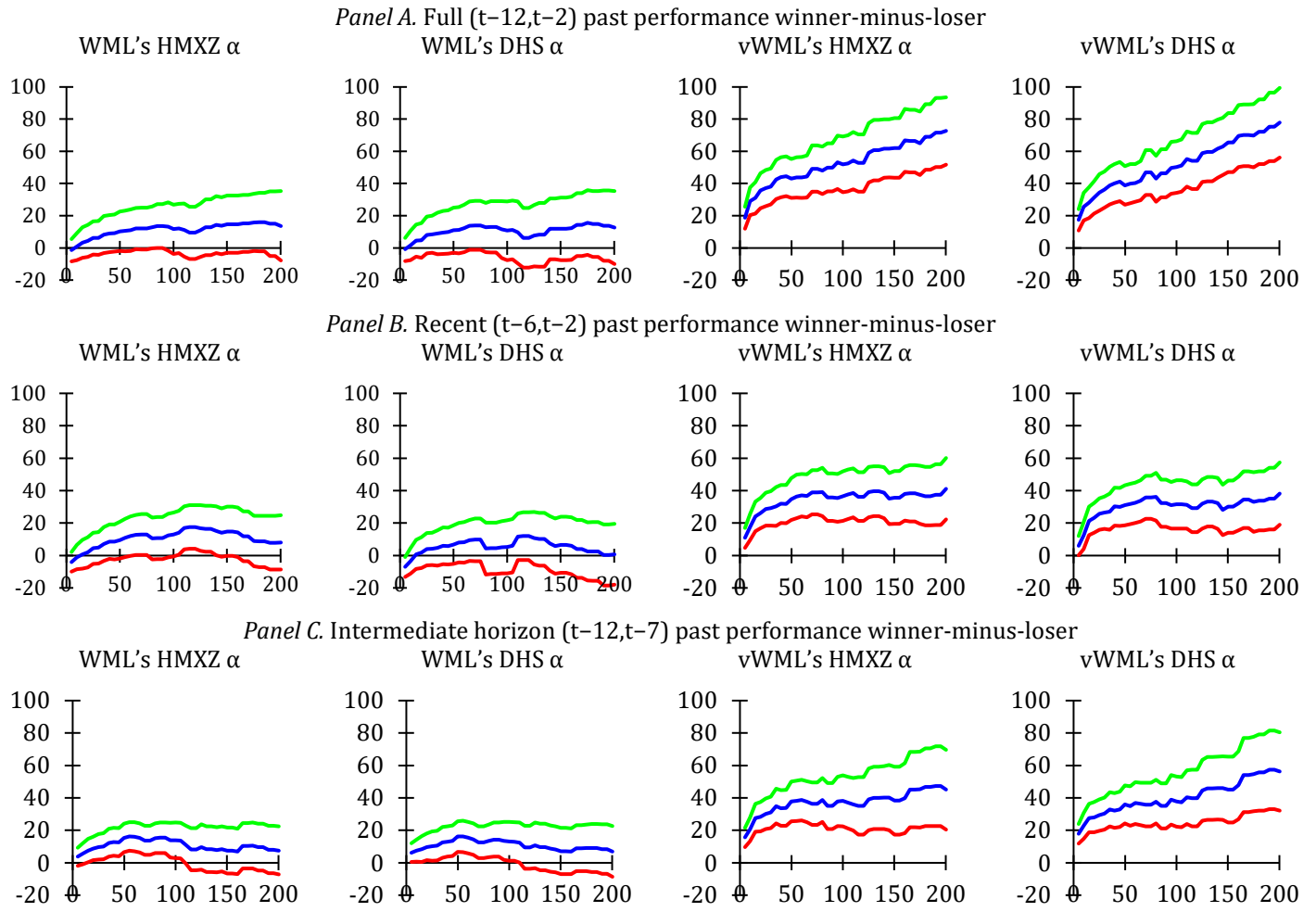


Figure A11. Number of momentum portfolios and other winner-minus-loser alphas.

The figure shows Hou–Mo–Xue–Zhang (2020) five-factor alphas and Daniel–Hirshleifer–Sun (2020) three-factor alphas of the simple and the volatility-managed (Moreira and Muir, 2017) WML position based on full ($t-12, t-2$; Panel A), recent ($t-6, t-2$; B), and intermediate horizon ($t-12, t-7$; C) past performance (Novy-Marx, 2012), respectively, as functions of $n=5, 10, \dots, 200$, the number of momentum portfolios—for example, WML_5 and WML_{200} are on the left and right. Blue, green, and red are the statistics and their two standard error bands. Average returns and alphas are annualized. The data are based on CRSP and span January 1967 to December 2019 for HMXZ and span July 1972 to December 2018 for DHS.

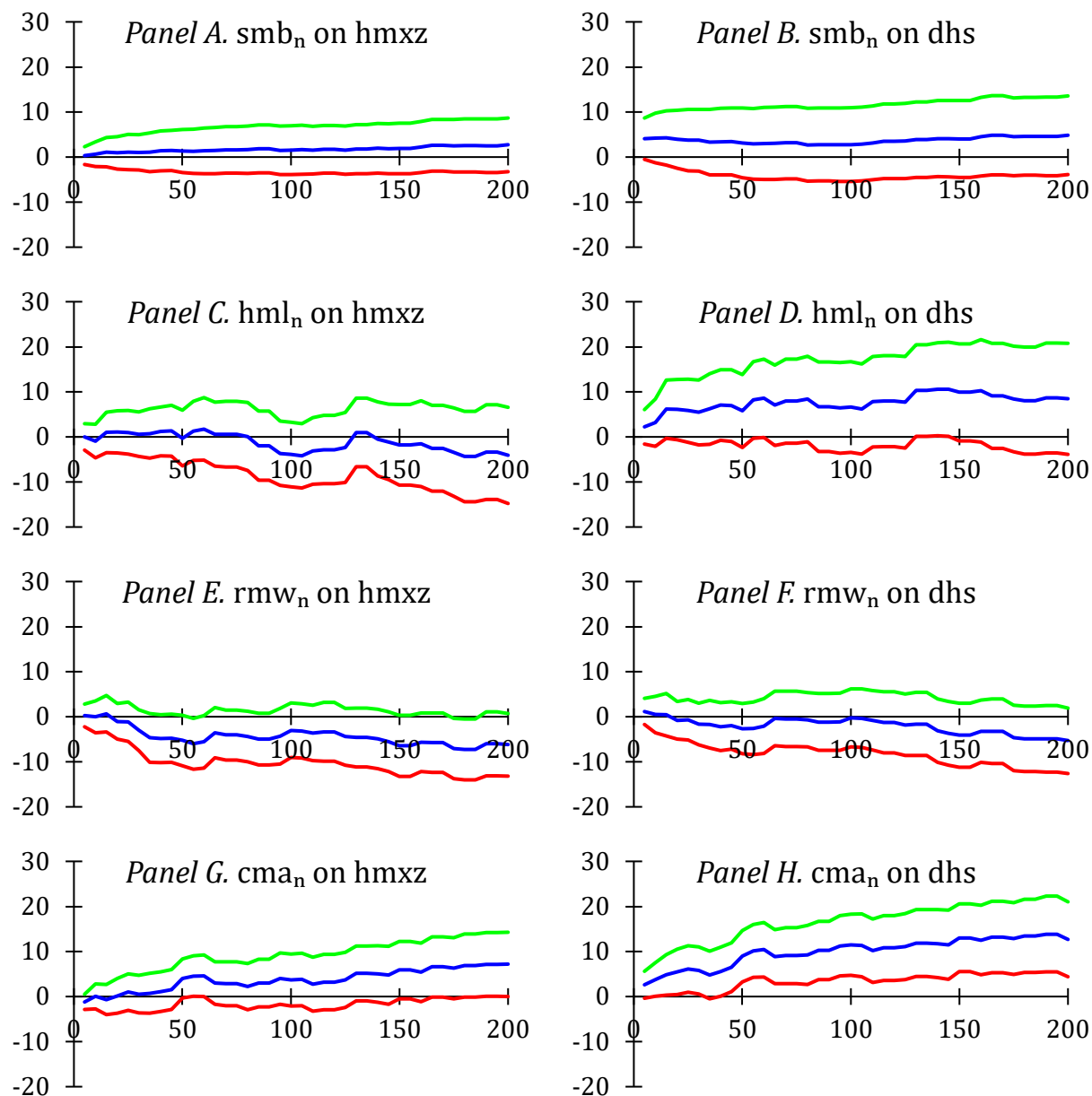


Figure A12. Number of portfolios and other long-short alphas.

The figure shows Hou-Mo-Xue-Zhang (2020) five-factor alphas (left) and Daniel-Hirshleifer-Sun (2020) three-factor alphas (right) of the size (first; small-minus-big), the book-to-market (second; high-minus-low), the operating profitability (third; robust-minus-weak), and the investment (fourth; conservative-minus-aggressive) long-short positions, respectively, as functions of $n \in \{5, 10, \dots, 200\}$. Blue, green, and red are the statistics and their two standard error bands. The data span July 1963 to December 2019.

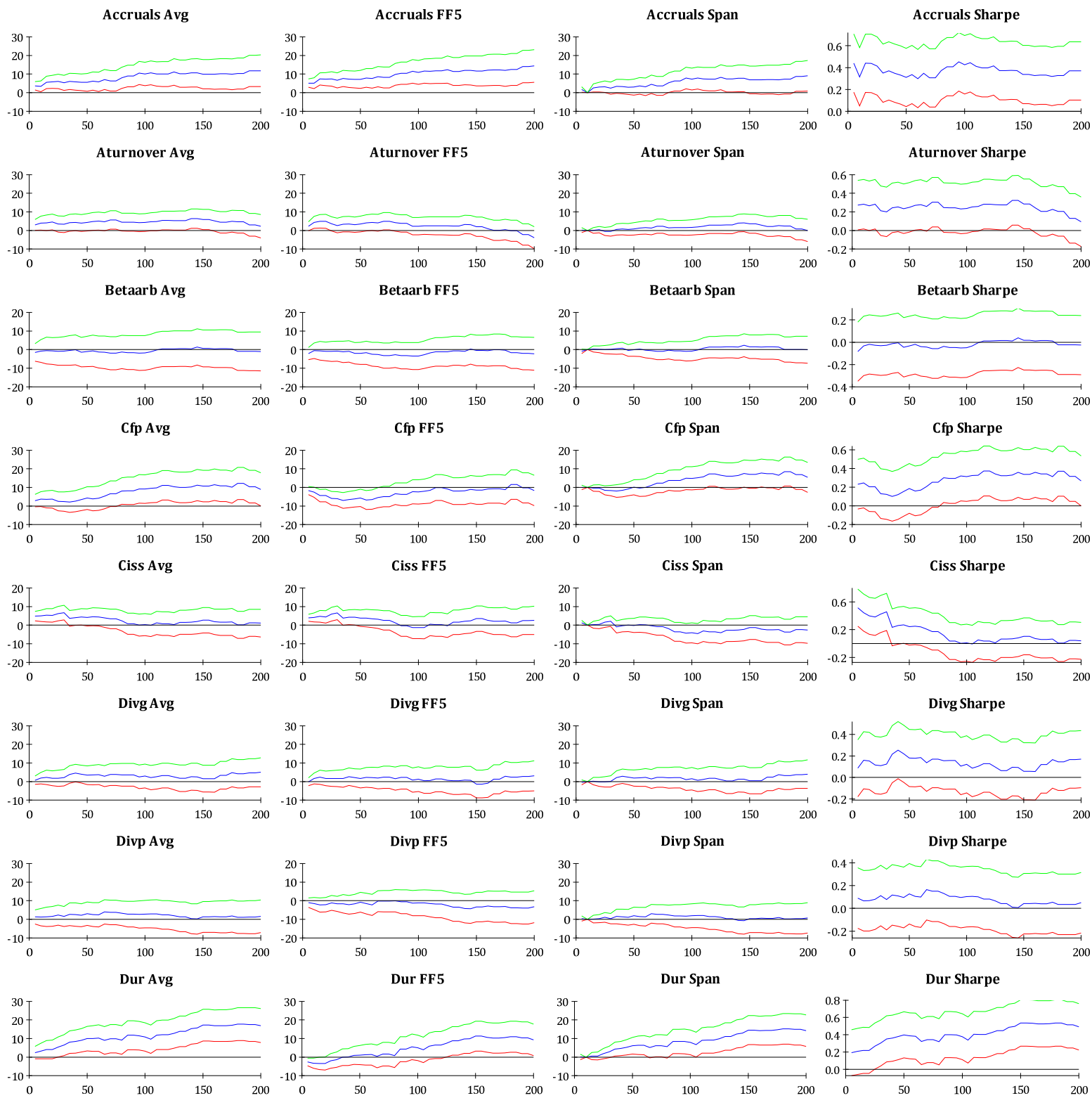


Figure A13. Number of anomaly portfolios and long-short performance: Kozak's (2020) 49 anomalies.

The figure shows the average return (first column), Fama–French (2018) five-factor alpha (second), decile-portfolio long-short spanning alpha (third), and Sharpe ratio (last) of each long-short portfolio based on Kozak's (2020) 49 anomaly characteristics as functions of $n=5,10,\dots,200$, the number of portfolios—for example, a long-short portfolio formed on five (200) portfolios is on the left (right) of each panel. Each row corresponds to each anomaly. Blue, green, and red are the statistics and their two standard error bands. Shaded are conventional one-year momentum (Mom12). Average returns, alphas, and Sharpe ratios are annualized. The data are based on Professor Serhiy Kozak's website (<https://www.serhiykozak.com/data>) and CRSP and span July 1963 to December 2019 (at most). From the 54 anomalies of the original data, I exclude 5 anomalies that do not show enough cross-sectional variation (*i.e.*, the number of unique values less than the number of formed portfolios).

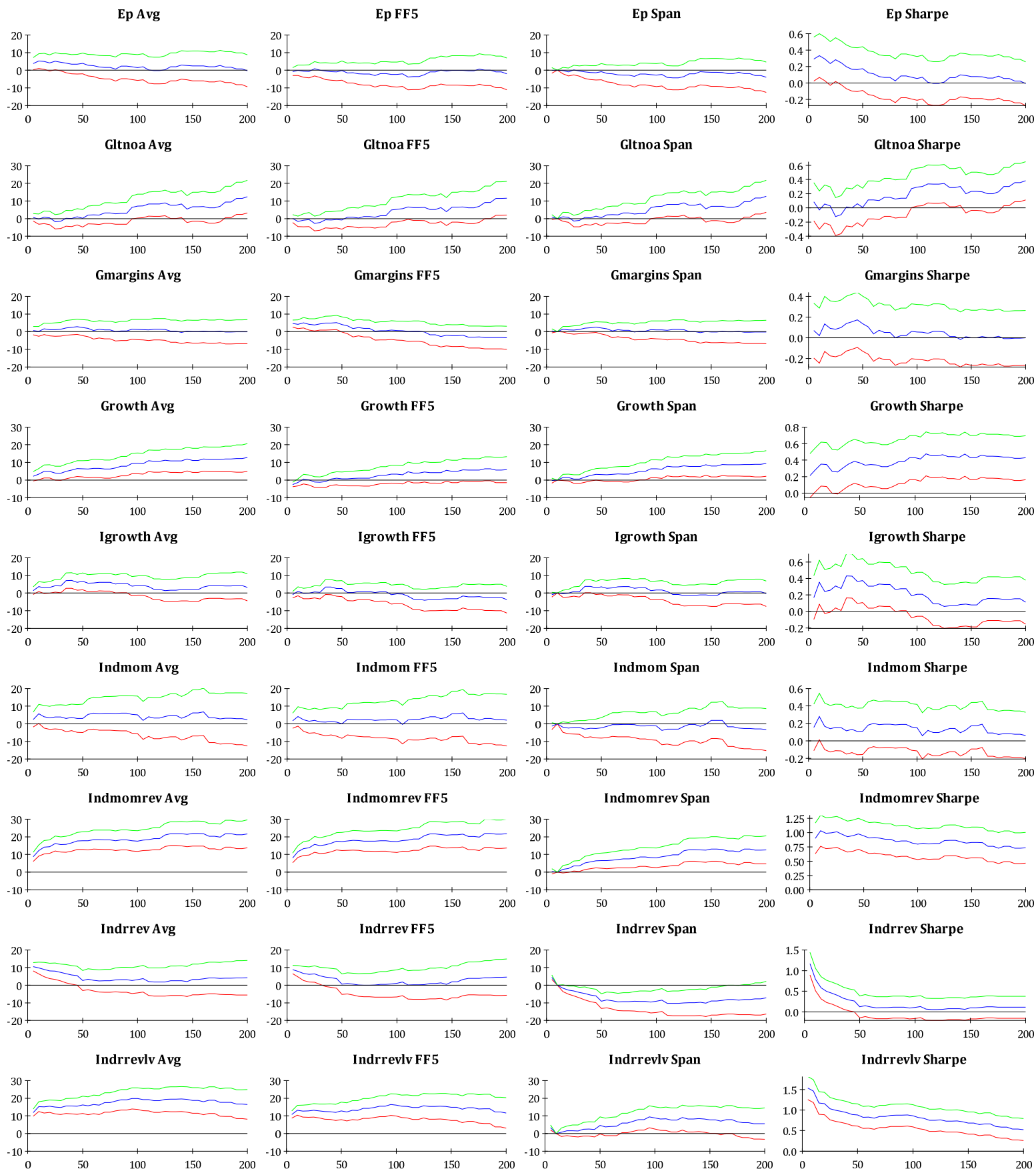


Figure A13. Continued. Number of anomaly portfolios and long-short performance: Kozak's (2020) 49 anomalies.

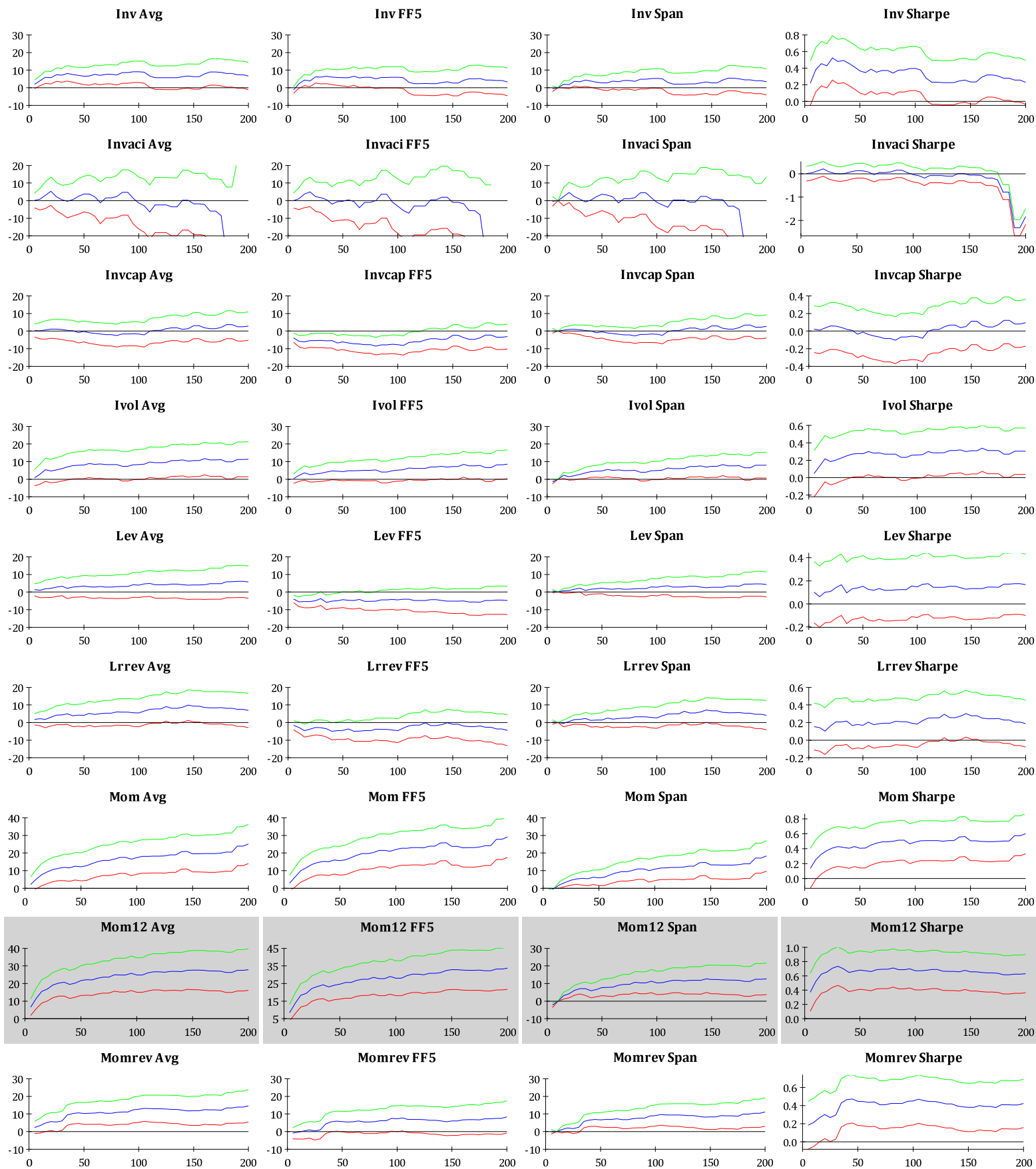


Figure A13. Continued. Number of anomaly portfolios and long-short performance: Kozak's (2020) 49 anomalies.

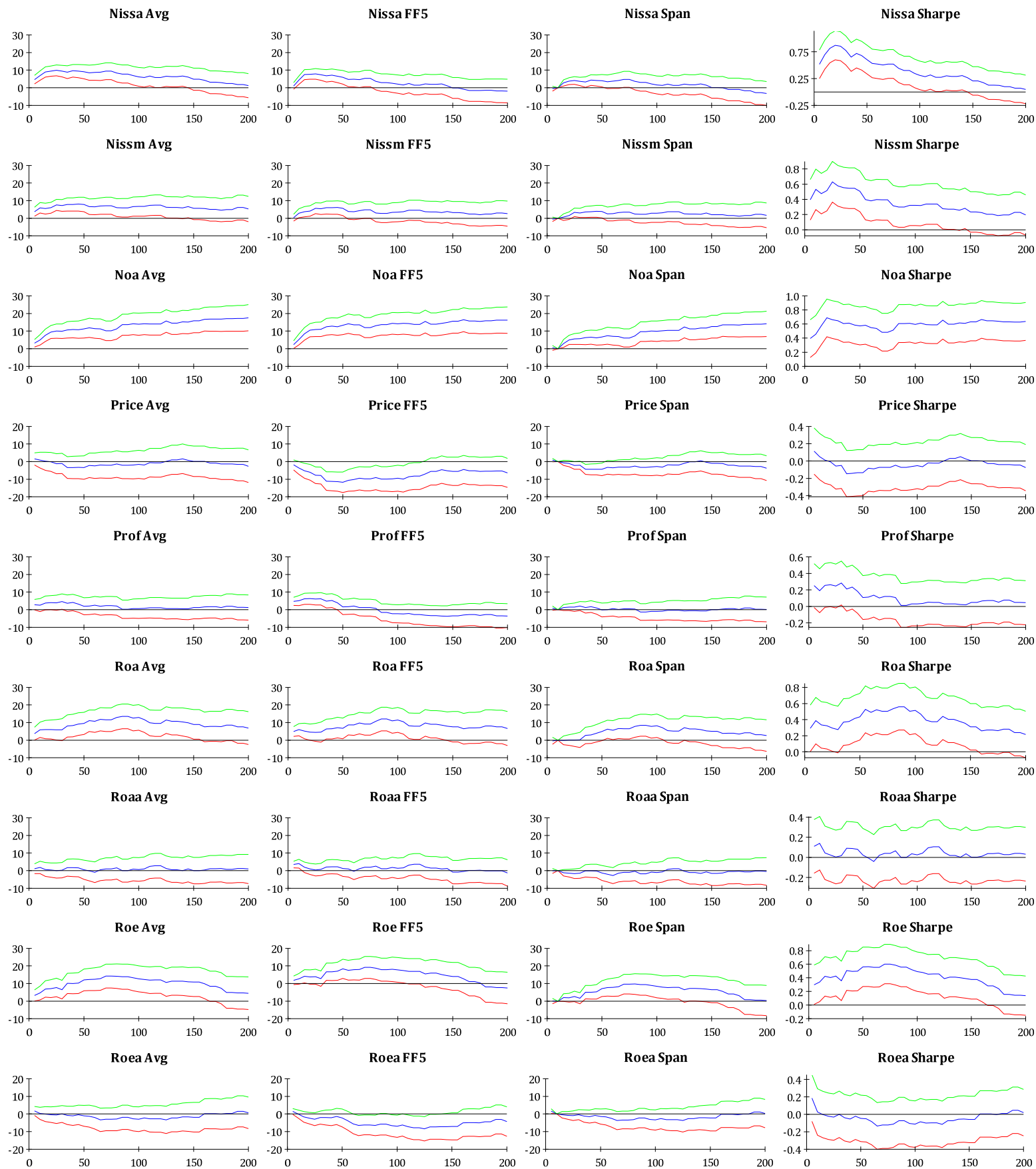


Figure A13. Continued. Number of anomaly portfolios and long-short performance: Kozak's (2020) 49 anomalies.

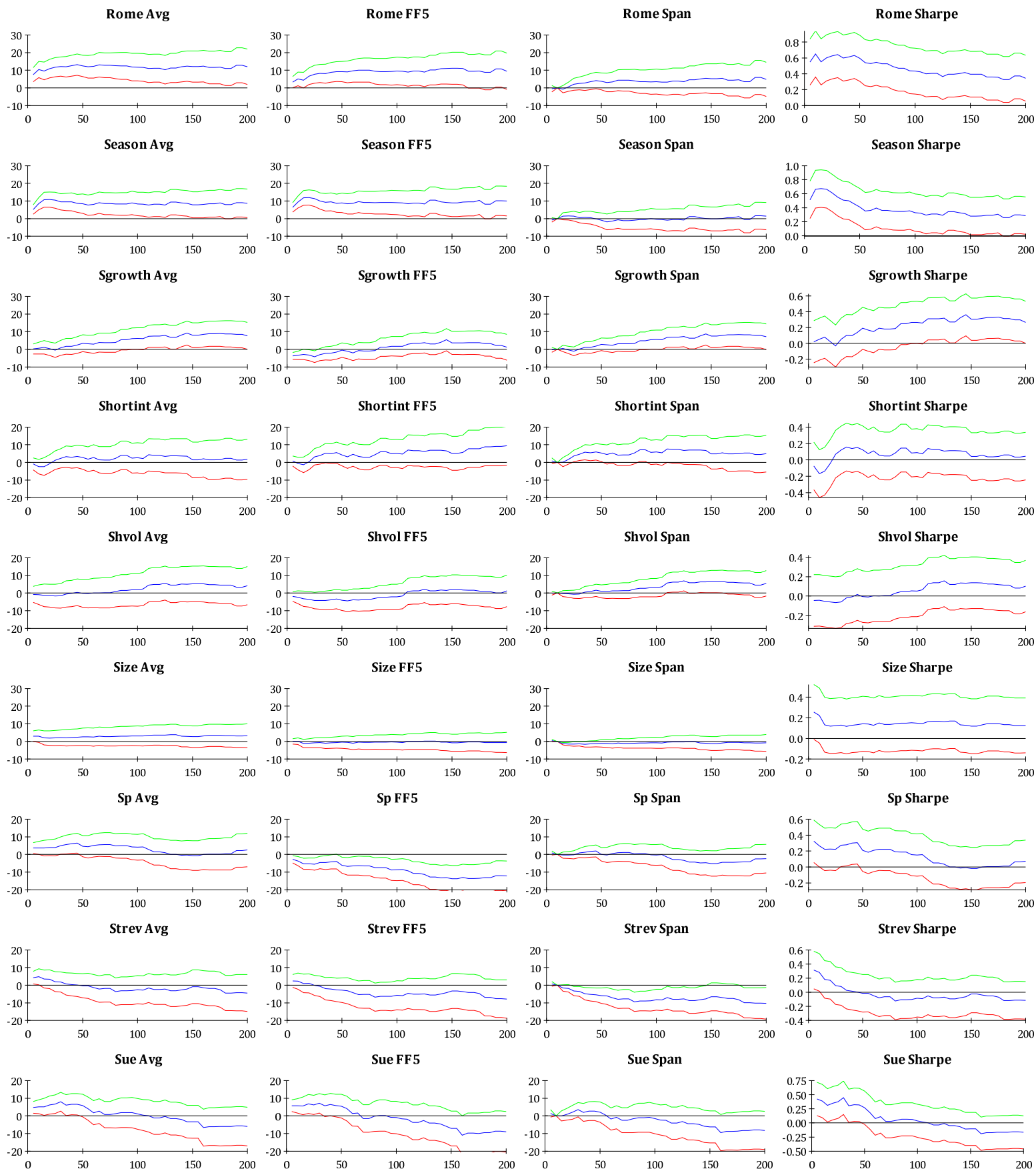


Figure A13. Continued. Number of anomaly portfolios and long-short performance: Kozak's (2020) 49 anomalies.

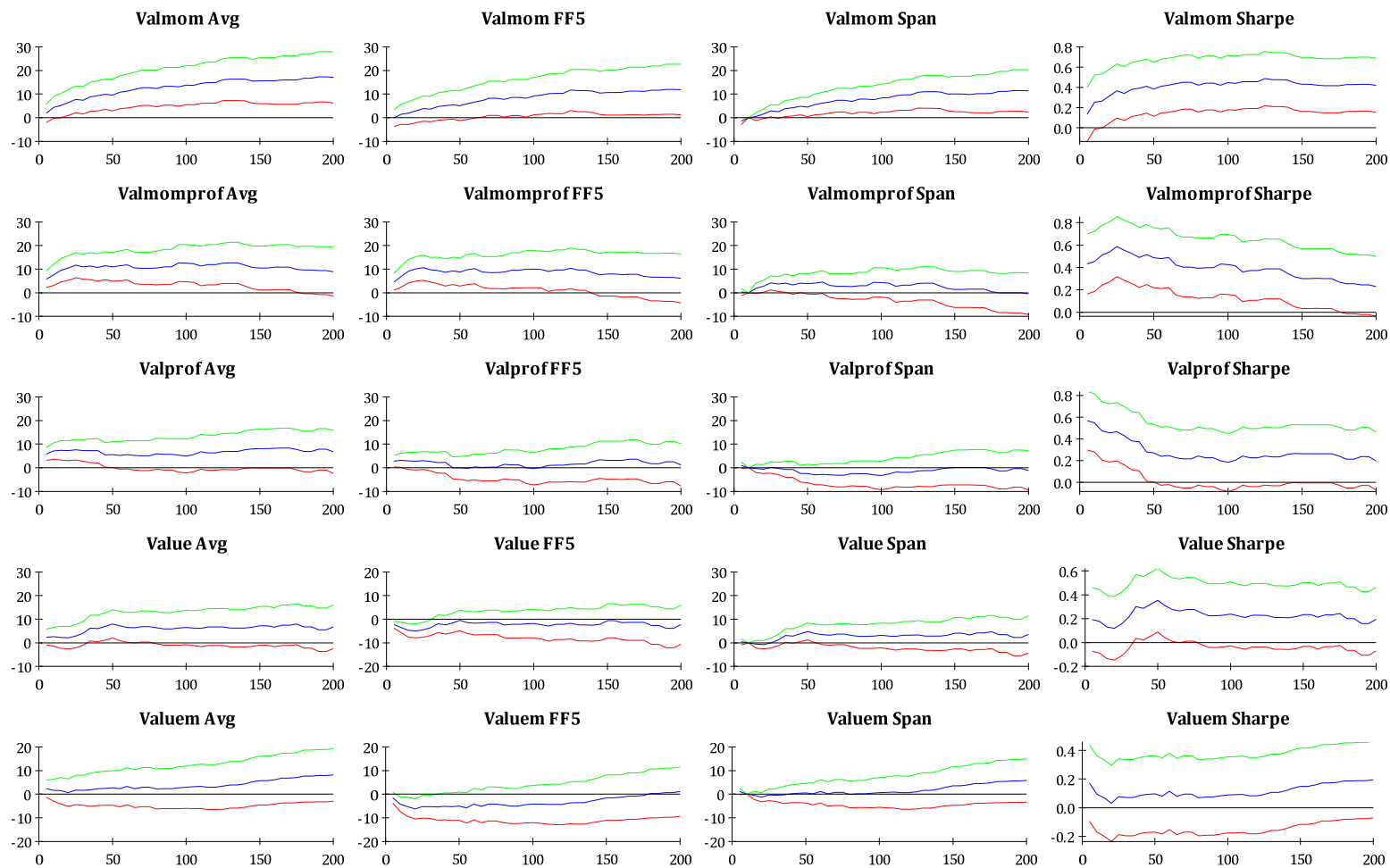


Figure A13. Continued. Number of anomaly portfolios and long-short performance: Kozak's (2020) 49 anomalies.

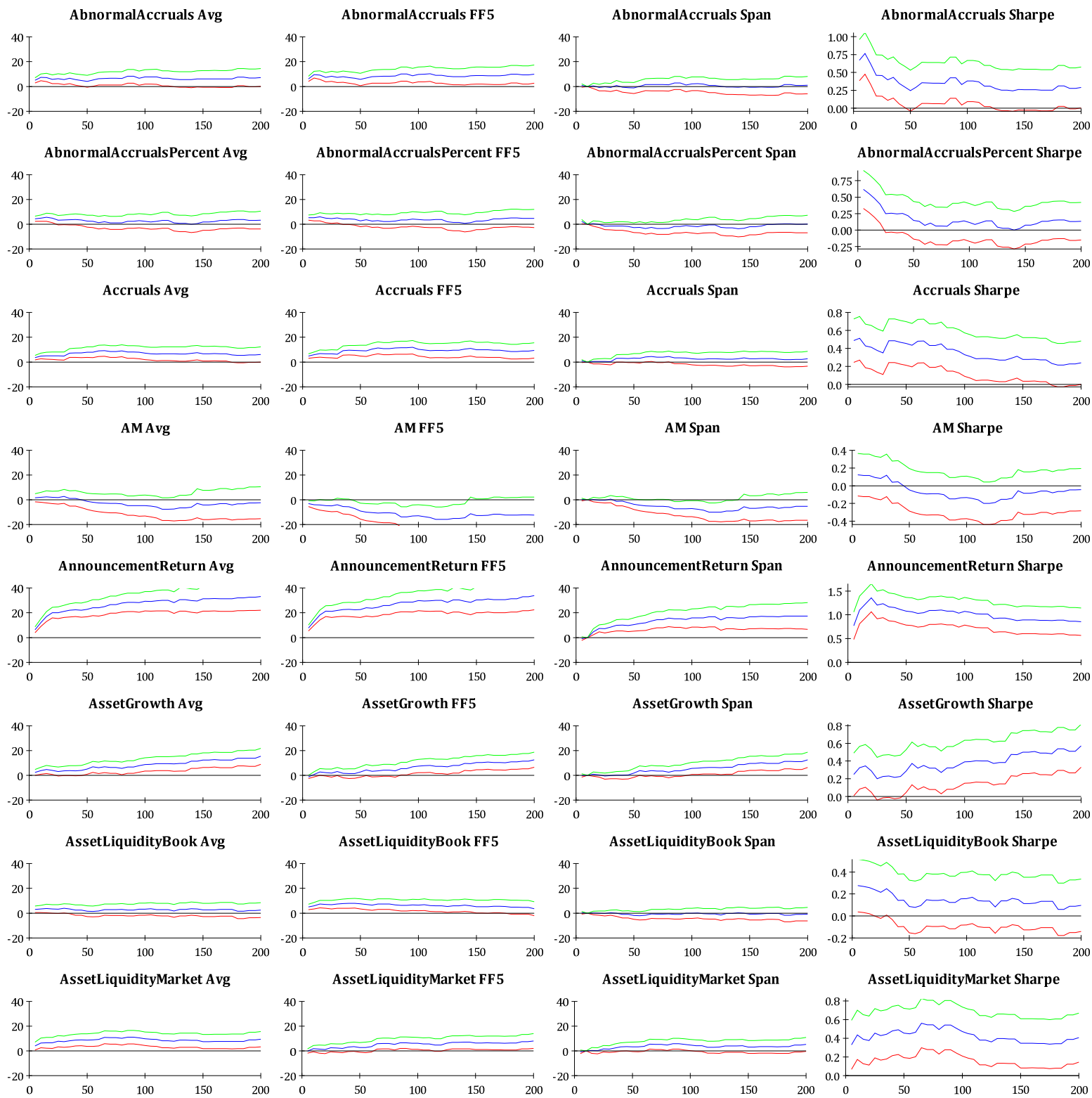


Figure A14. Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

The figure shows the average return (first column), Fama–French (2018) five-factor alpha (second), decile-portfolio long-short spanning alpha (third), and Sharpe ratio (last) of each long-short portfolio based on Chen and Zimmermann’s (2022) 128 anomaly characteristics as functions of $n=5,10,\dots,200$, the number of portfolios—for example, a long-short portfolio formed on five (200) portfolios is on the left (right) of each panel. Each row corresponds to each anomaly. Blue, green, and red are the statistics and their two standard error bands. Shaded are conventional one-year momentum (Mom12m). Average returns, alphas, and Sharpe ratios are annualized. The data are based on Professors Andrew Y. Chen and Tom Zimmermann’s website (<https://www.openassetpricing.com/data>) and CRSP and span July 1926 to December 2020 (at most). From the 315 anomalies of the original data, I exclude 187 anomalies that do not show enough cross-sectional variation (*i.e.*, the number of unique values less than the number of formed portfolios) or predictability (*i.e.*, a univariate Fama–MacBeth estimate whose absolute t -statistic is less than 2).

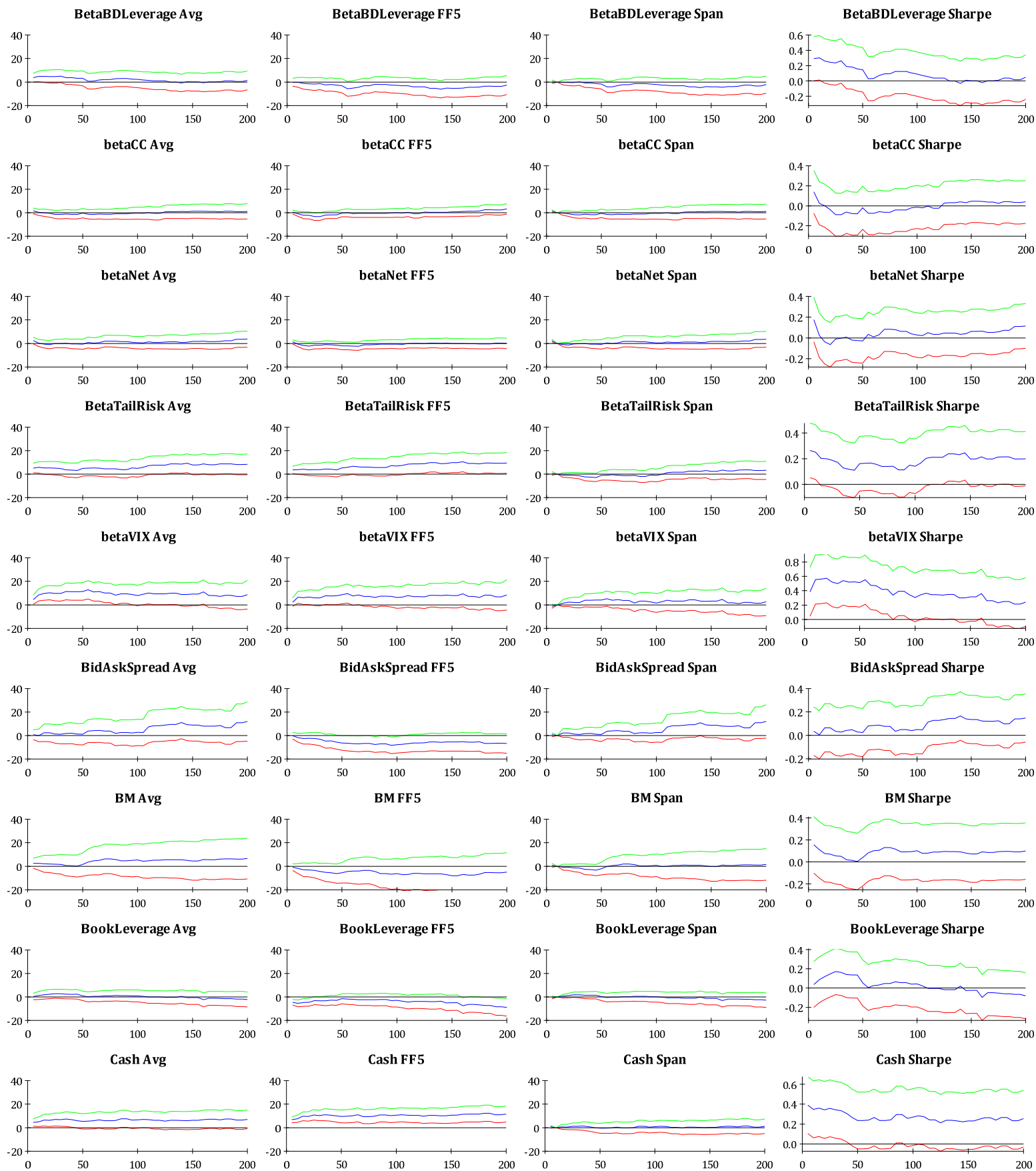


Figure A14. Continued. Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

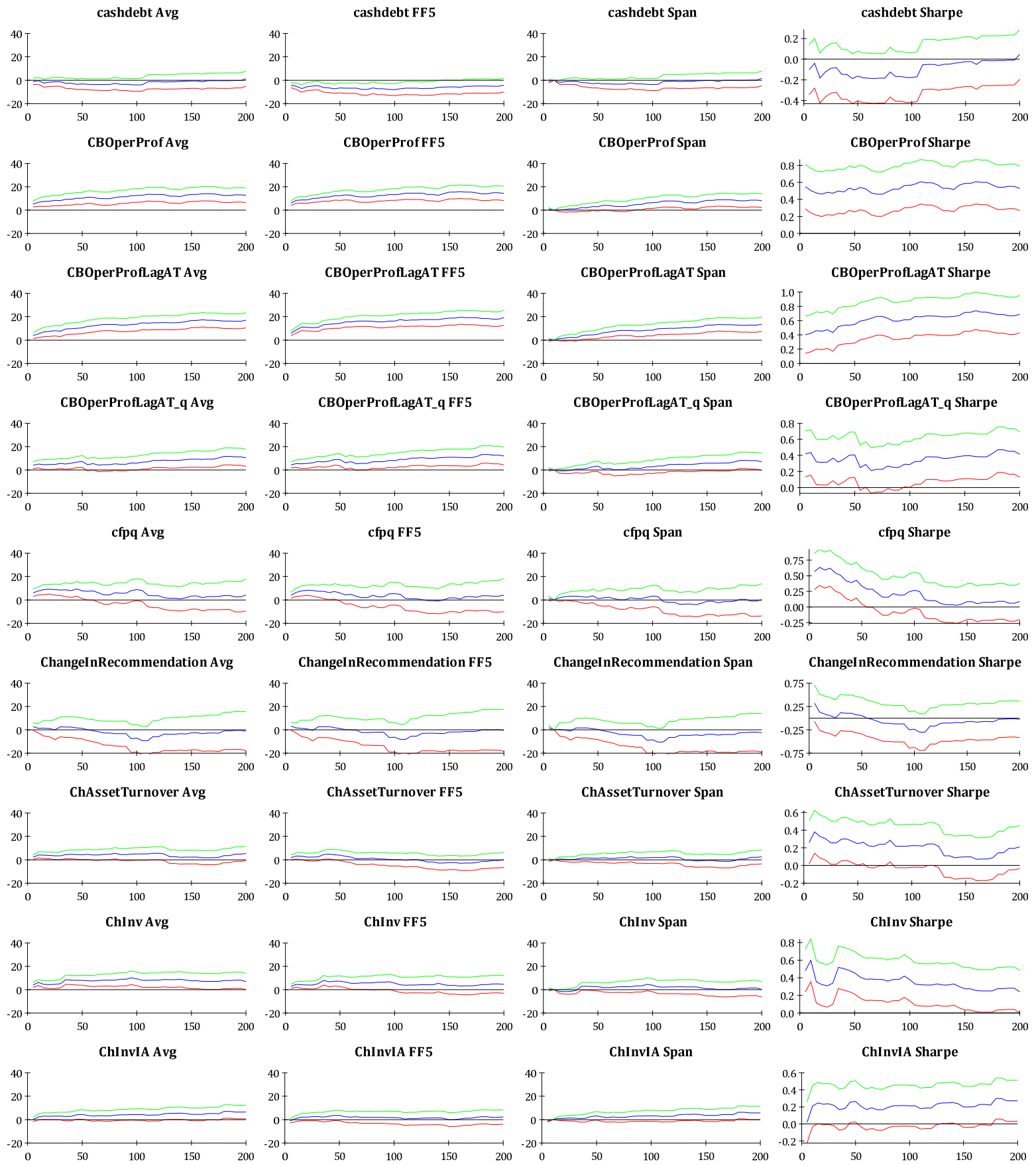


Figure A14. Continued. Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

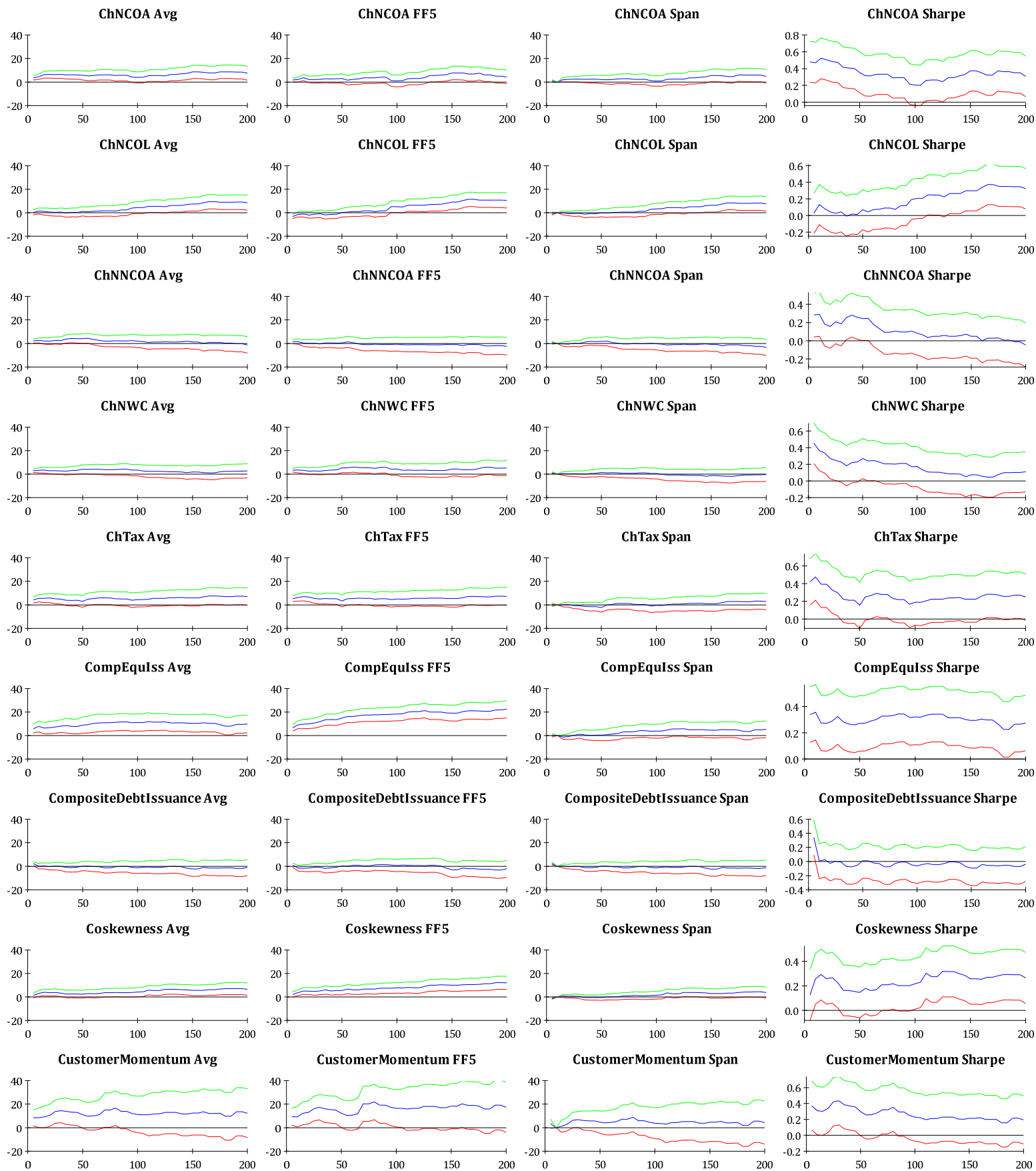


Figure A14. *Continued.* Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

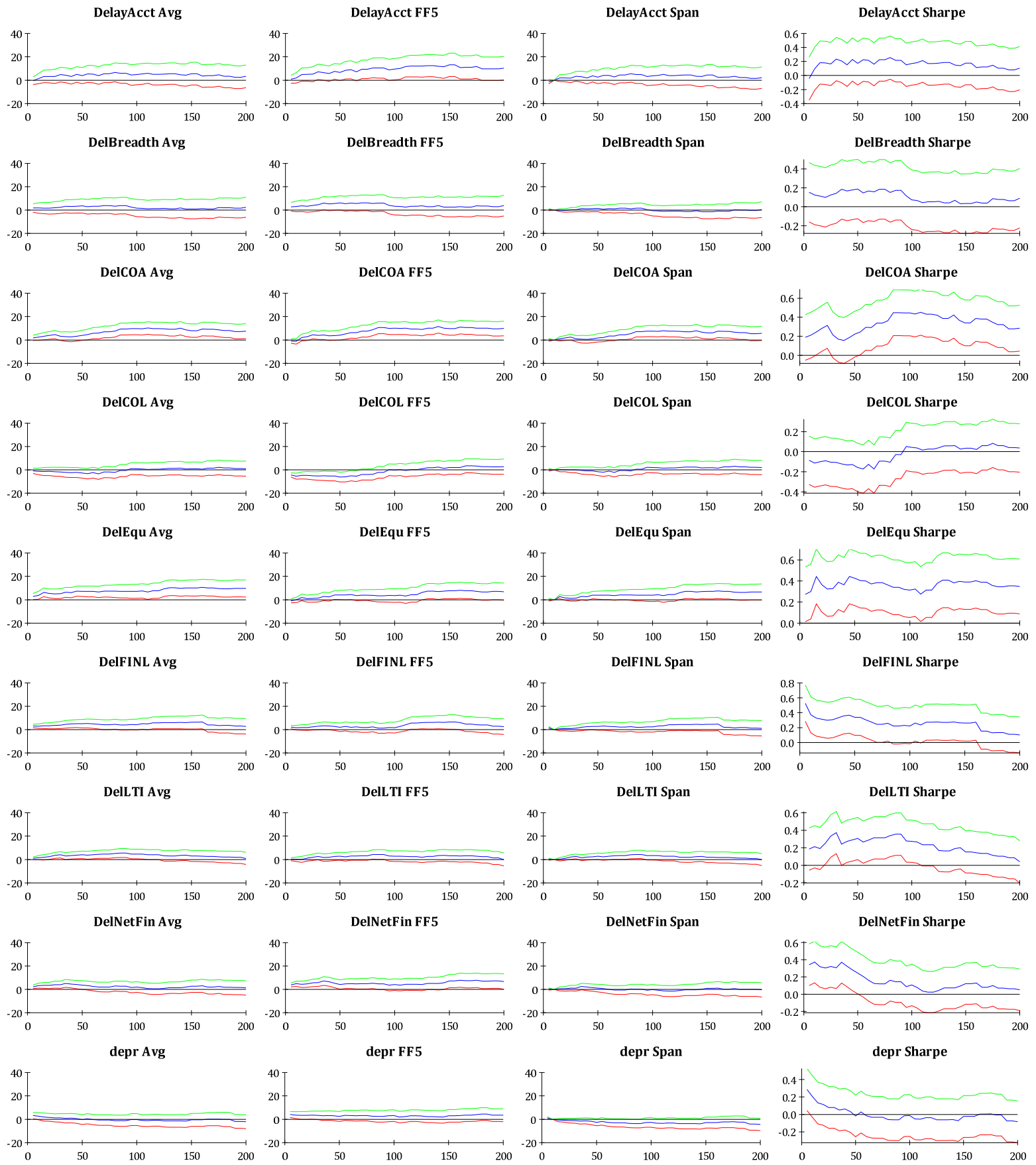


Figure A14. *Continued.* Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

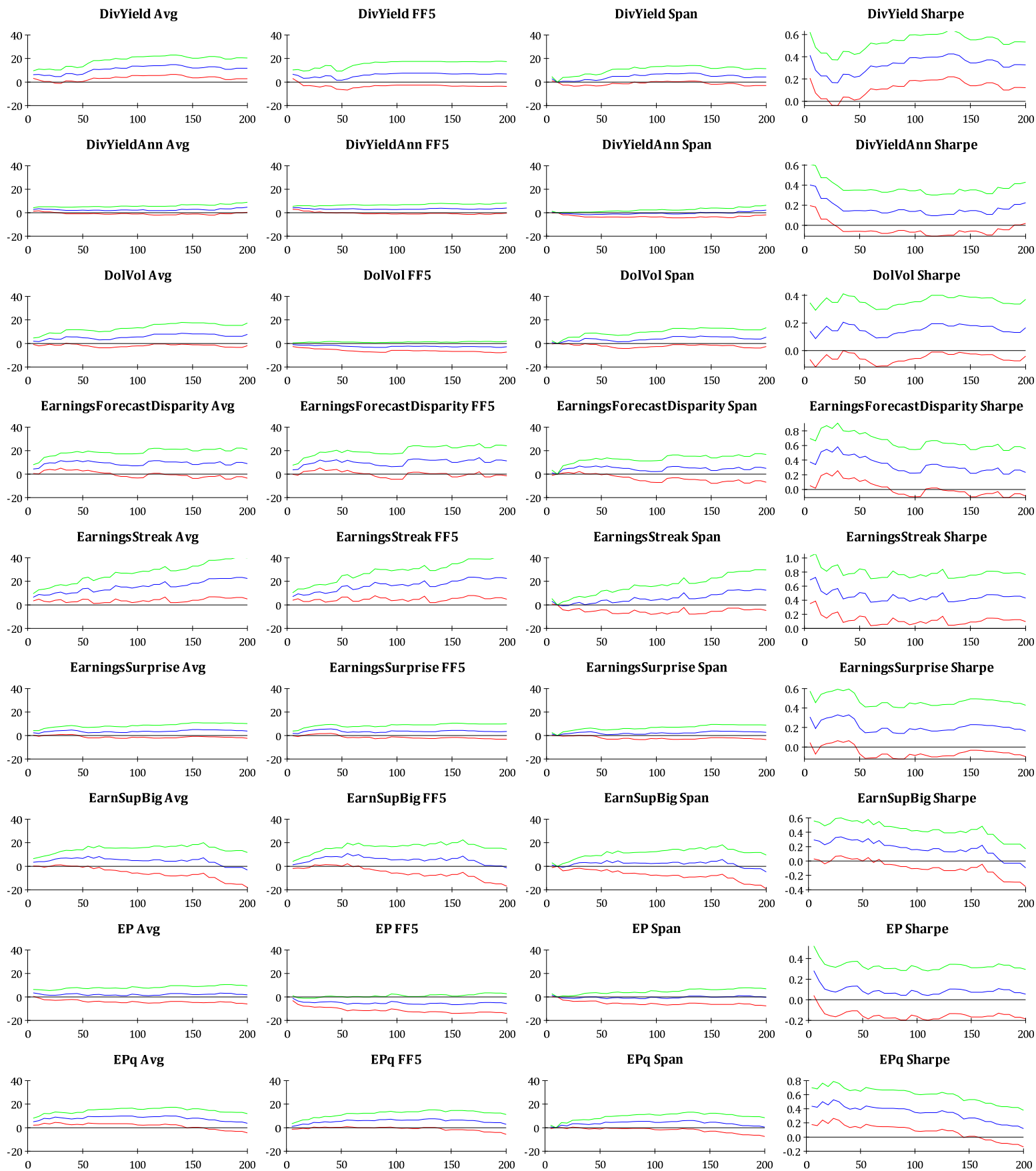


Figure A14. *Continued.* Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

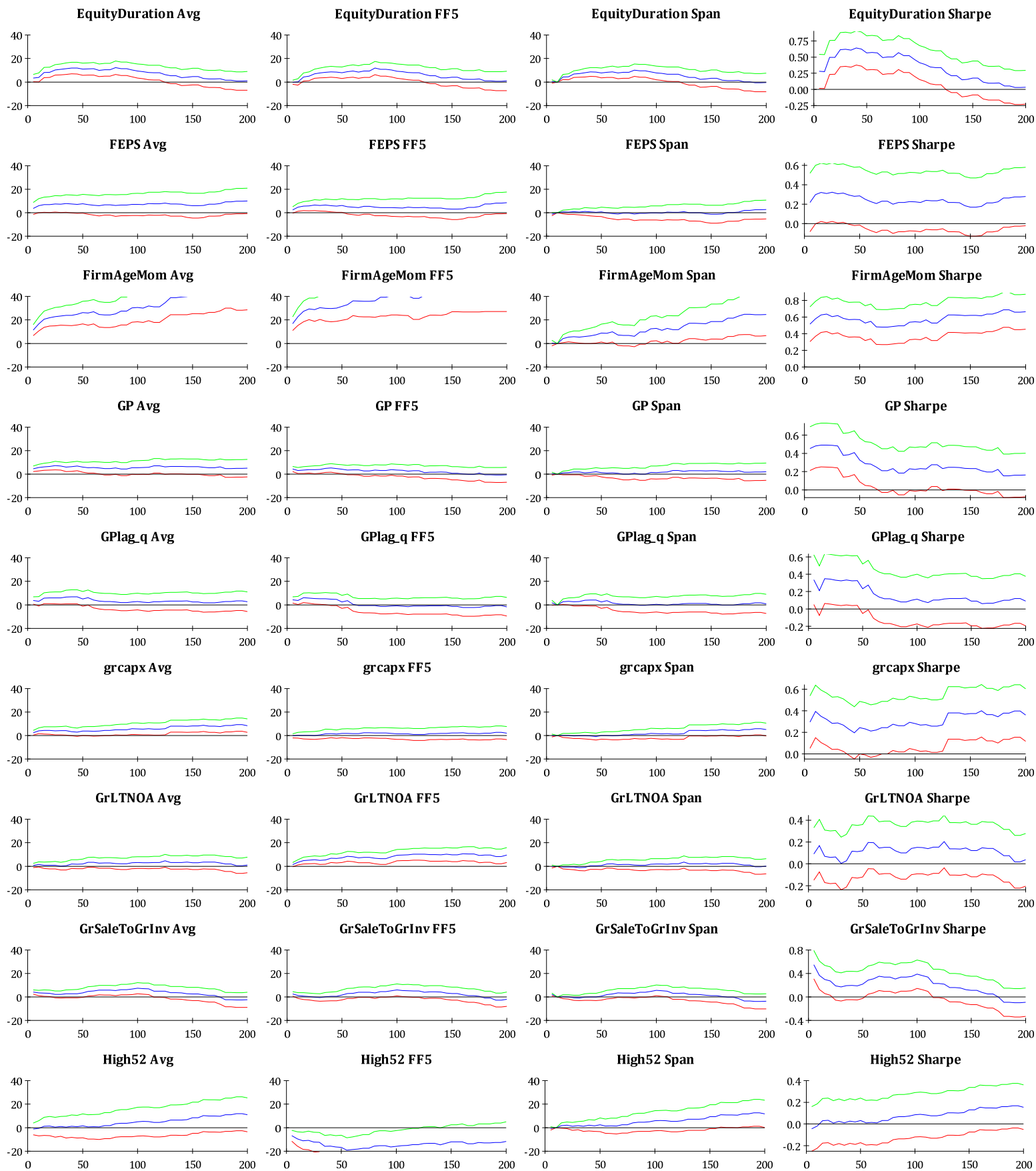


Figure A14. *Continued.* Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

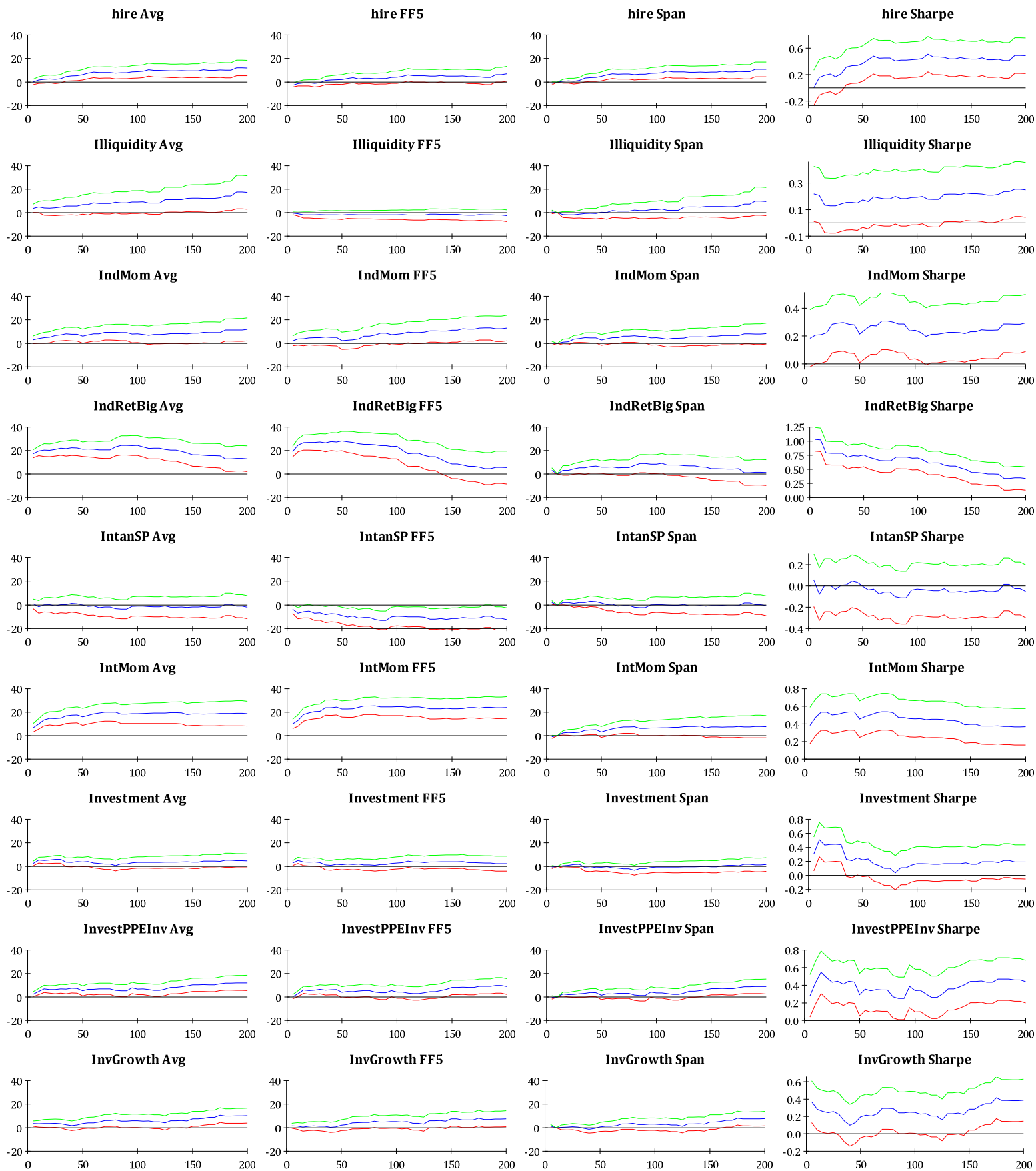


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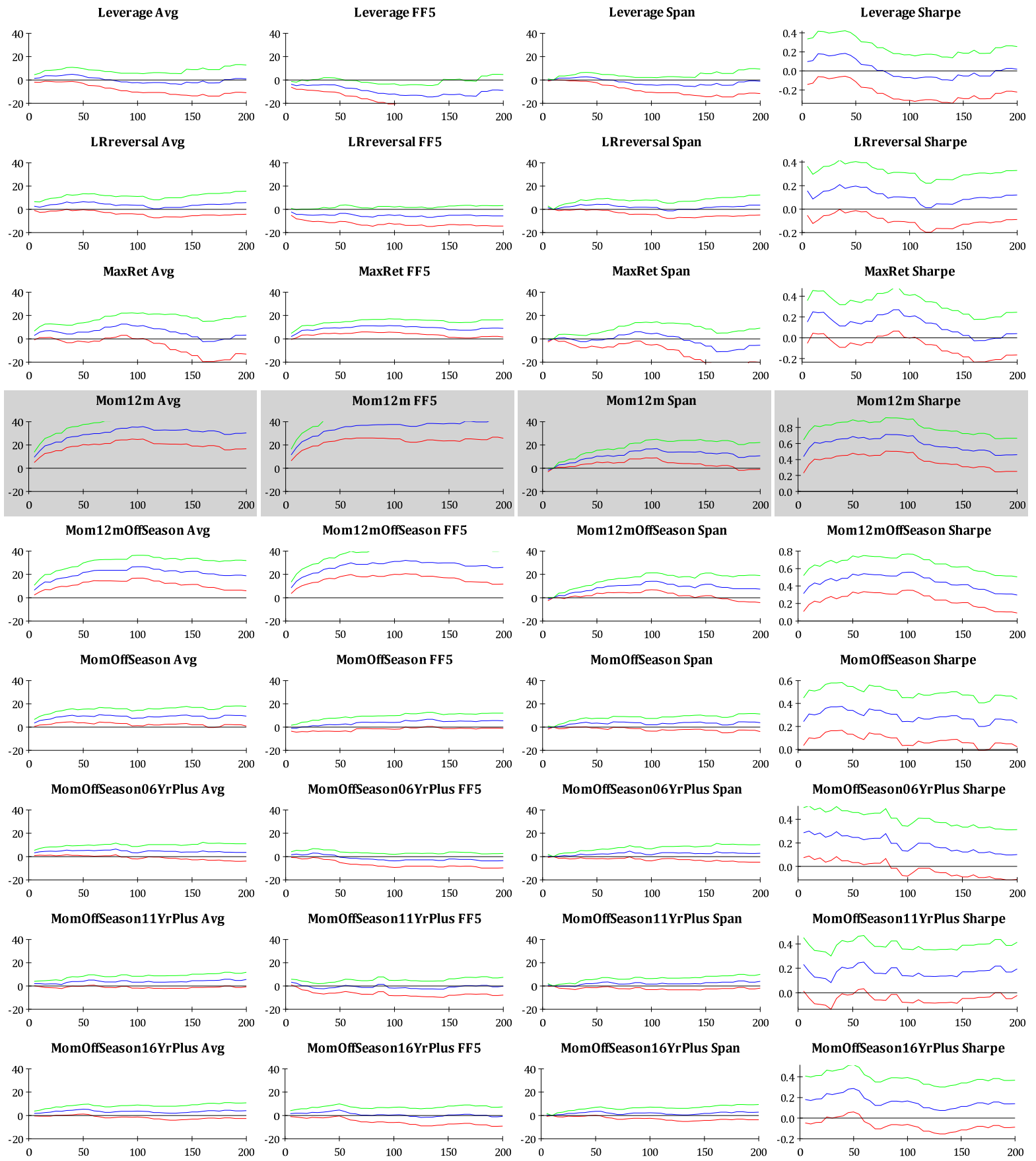


Figure A14. *Continued.* Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

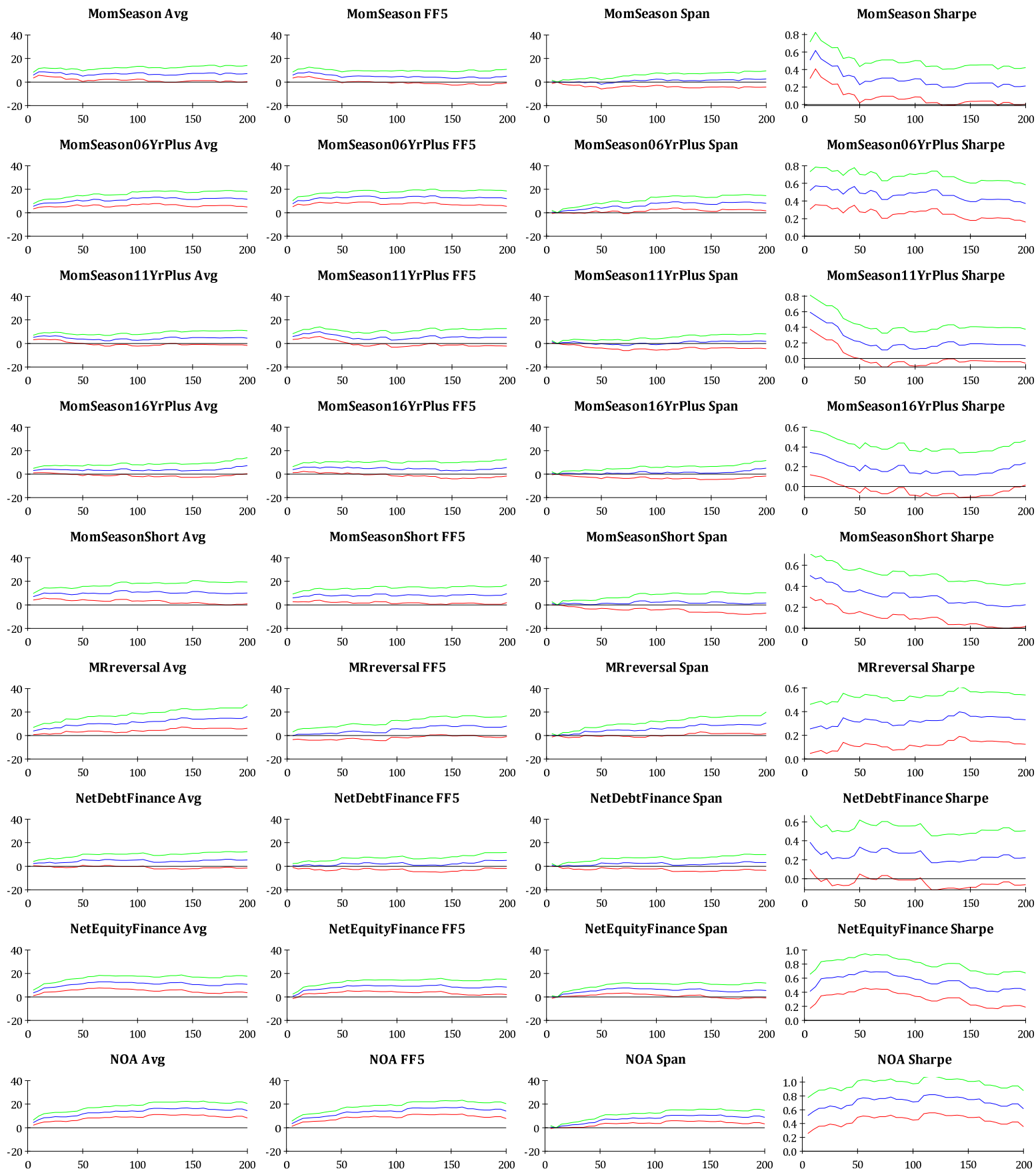


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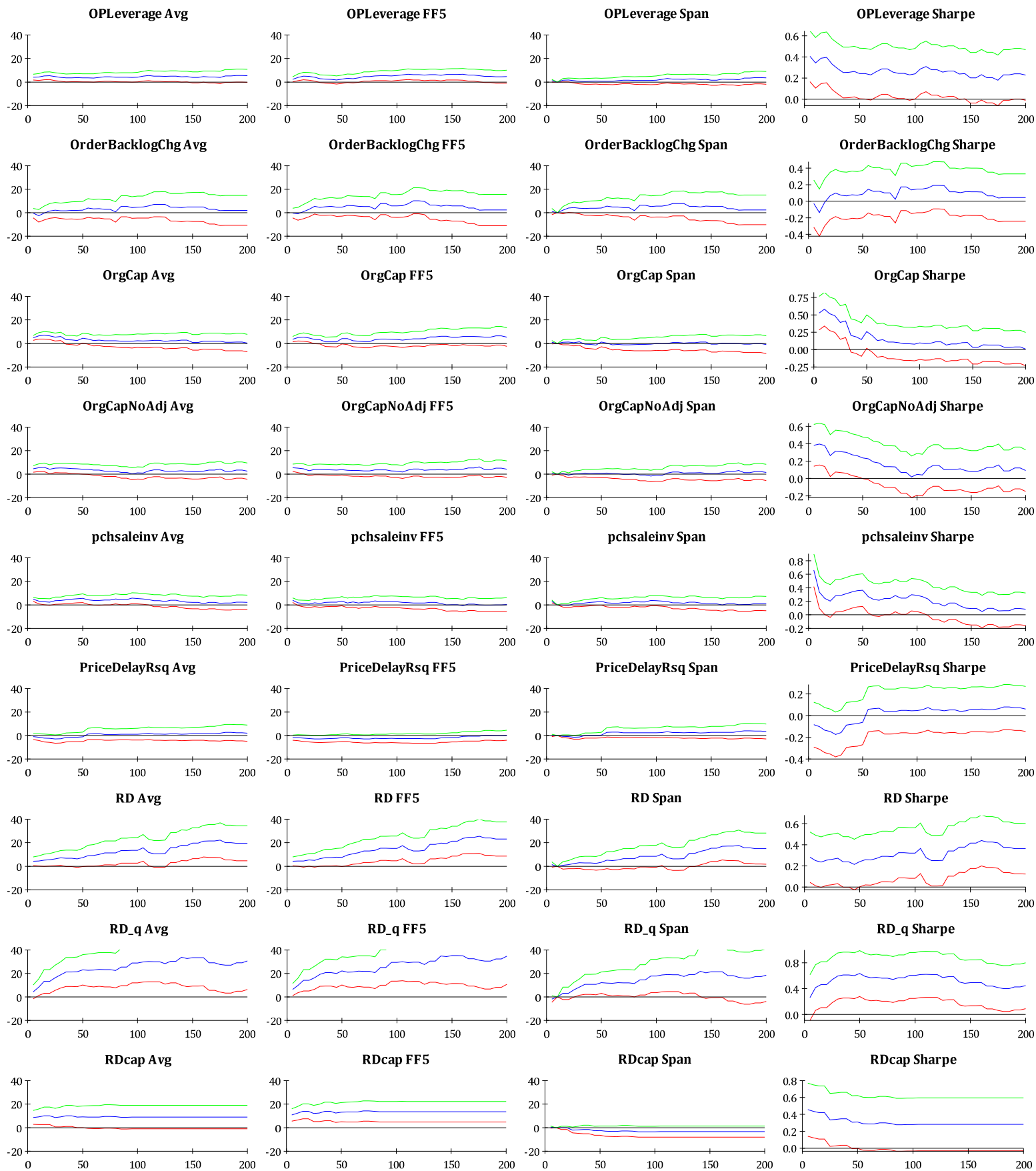


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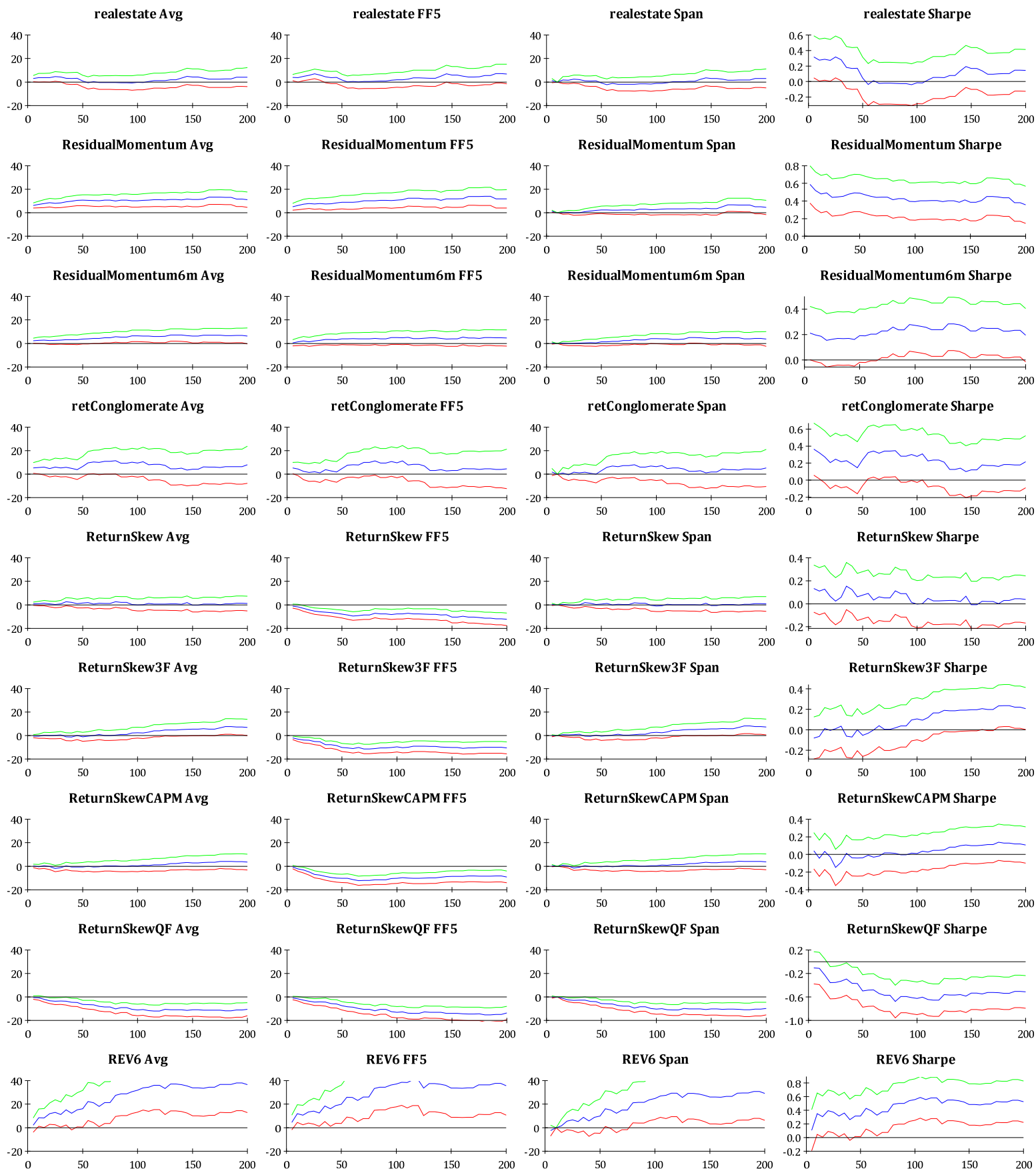


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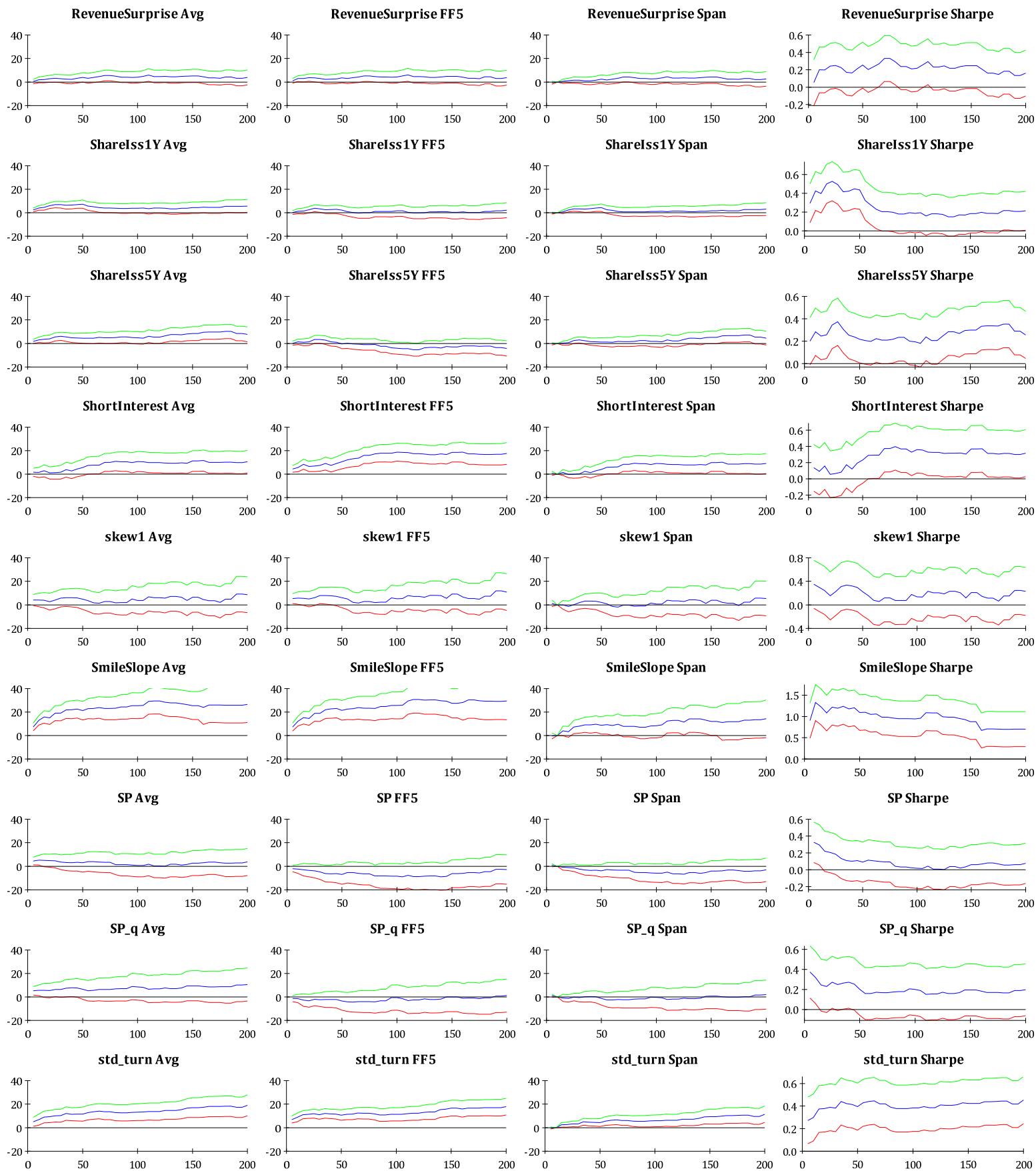


Figure A14. Continued. Number of anomaly portfolios and long-short performance: Chen–Zimmermann (2022) 128 anomalies.

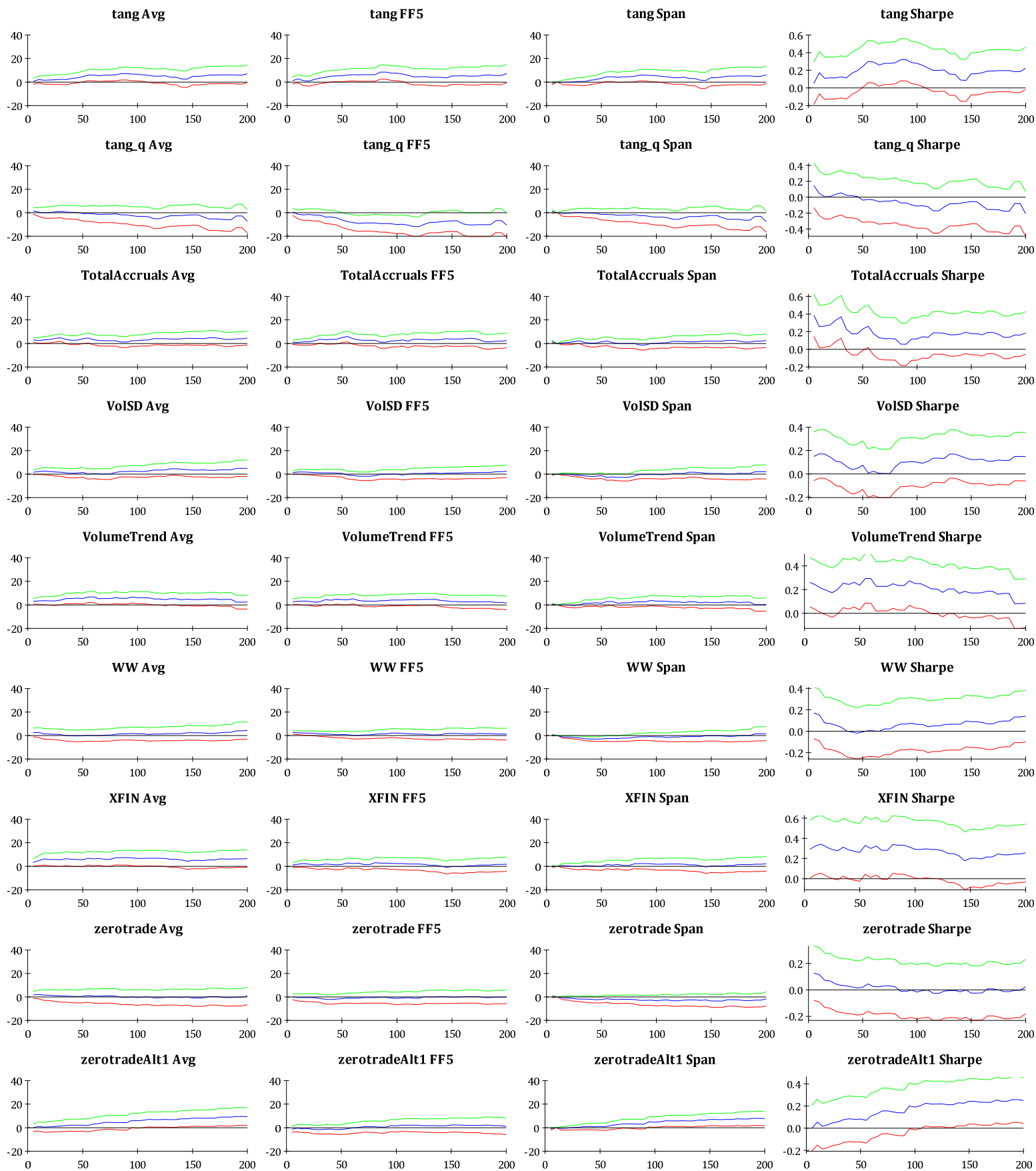


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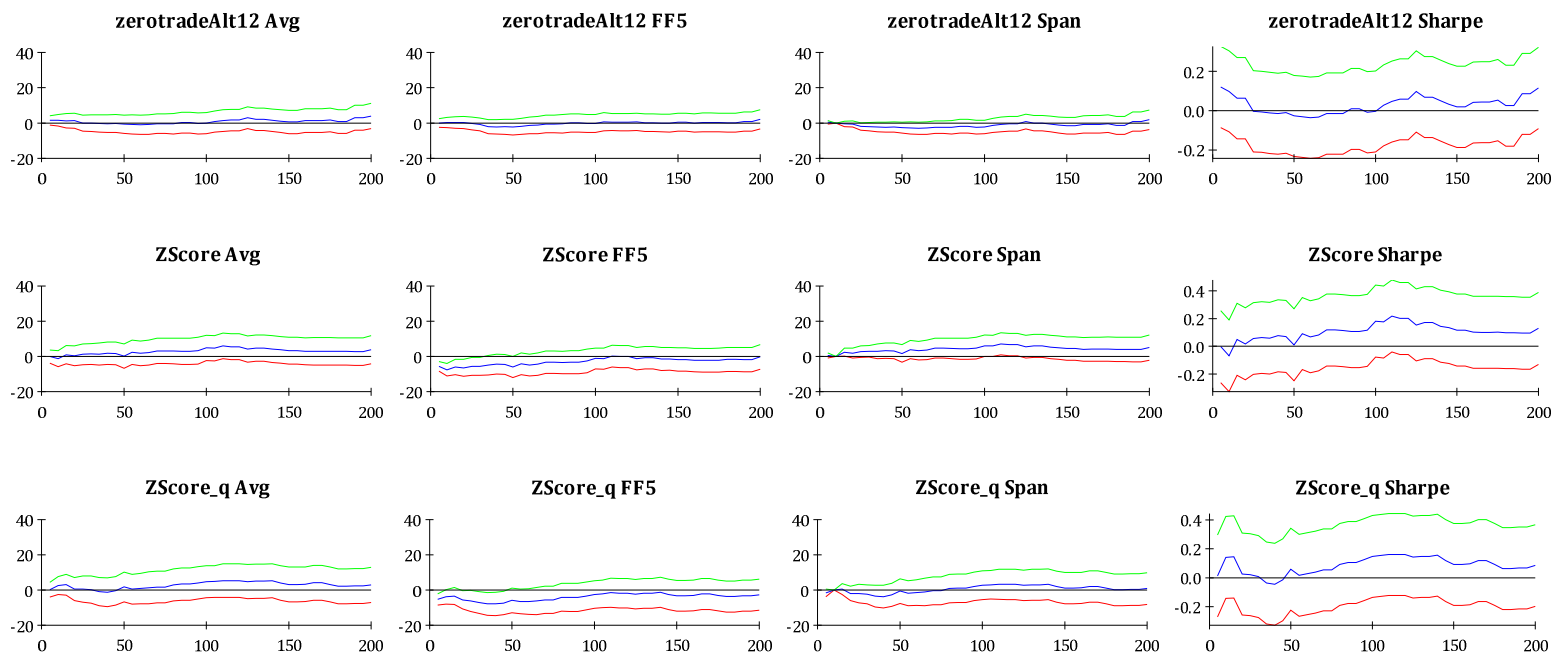


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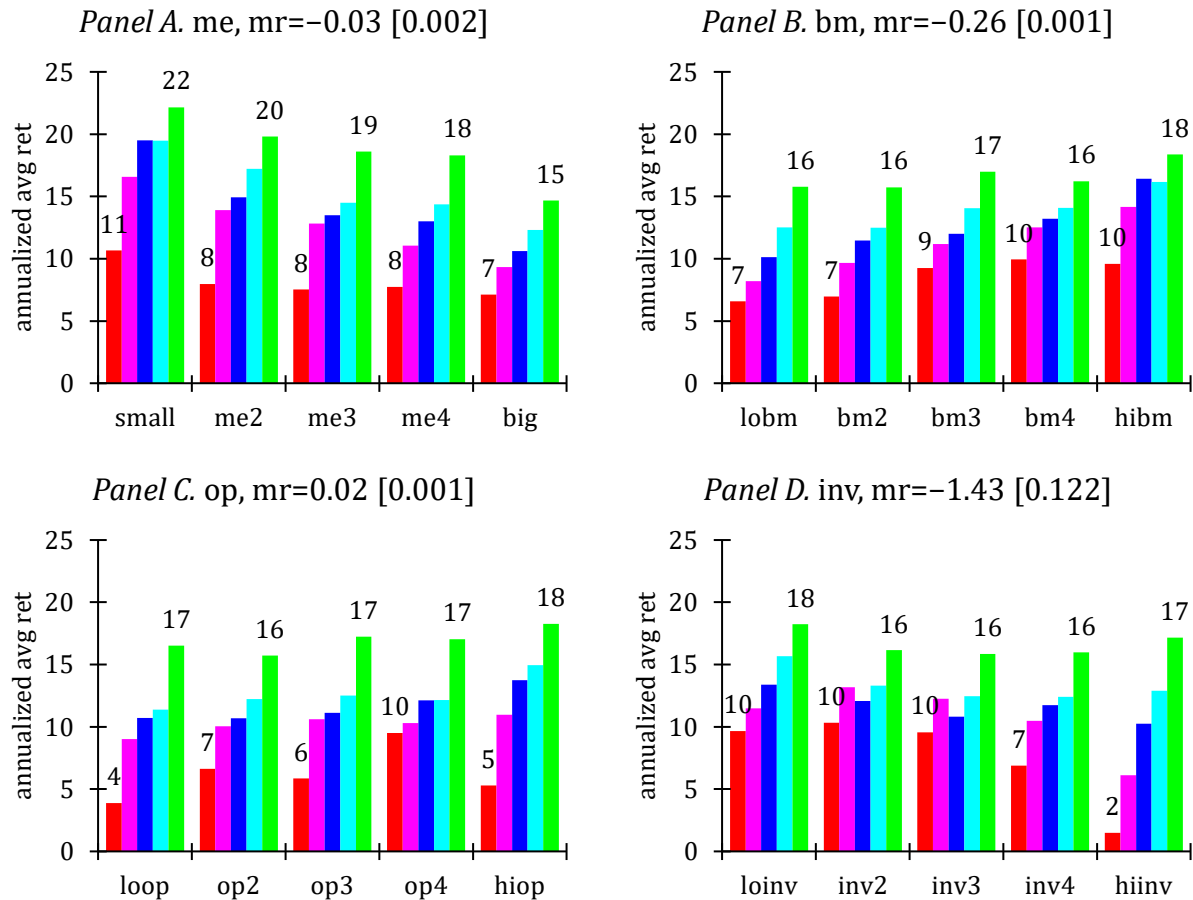


Figure A15. Average returns and monotonicity-relation statistics of two-way momentum portfolios. The figure shows the annualized monthly average returns of 5×5 portfolios formed on size/momentum (Panel A), book-to-market/momentum (Panel B), operating profitability/momentum (Panel C), and investment/momentum (Panel D), respectively, and their Patton-Timmermann (2010) monotonicity test results. Red (left), magenta, blue, cyan, and green (right) bars are the most loser, three intermediate, and the most winner portfolio, respectively. Average returns and monotonicity-relation (MR) statistics are annualized. Bootstrap p -values are in brackets. The data are from Professor Kenneth R. French's website (Panel A) or based on CRSP (Panels B, C, and D). The data of Panels A, B, C, and D start in January 1927, January 1927, July 1951, and July 1952, respectively, and end in December 2019.

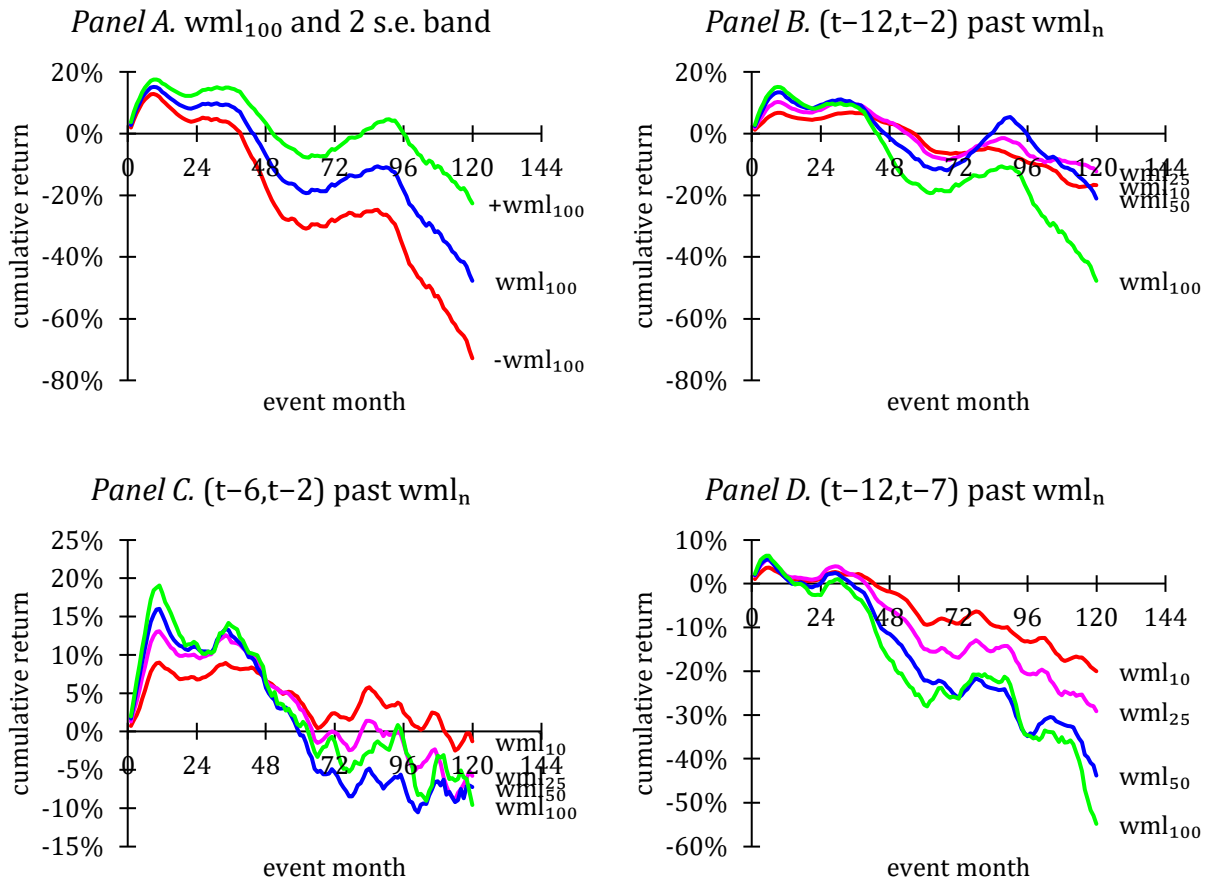


Figure A16. Postholding period winner-minus-loser performance.

The figure shows cumulative WML performance over 10 years after formation (Jegadeesh and Titman, 2001). Panel A shows WML_{100} 's performance (blue) and its two standard error bands (green and red). Panels B, C, and D show the performance of WML_{10} (red), WML_{25} (magenta), WML_{50} (blue), and WML_{100} (green) based on full $(t-12, t-2)$, recent $(t-6, t-2)$, and intermediate horizon $(t-12, t-7)$ past performance (Novy-Marx, 2012), respectively. Cumulative returns are not annualized. The data span January 1927 to December 2019.

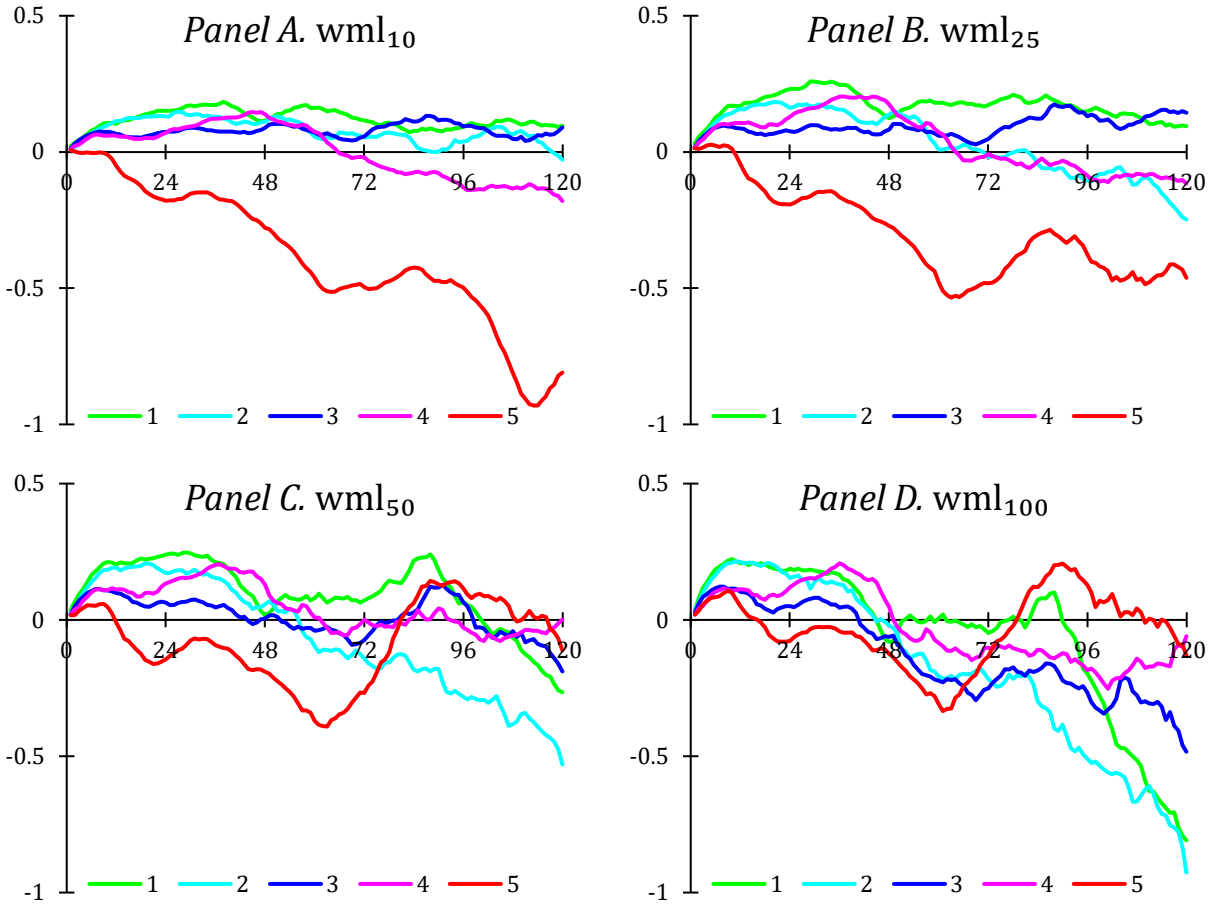


Figure A17. Postholding period winner-minus-loser performance by past momentum performance. The figure shows the cumulative performance of WML₁₀ (Panel A), WML₂₅ (Panel B), WML₅₀ (Panel C), and WML₁₀₀ (Panel D) over 10 years after formation by past momentum performance (PMP) quintiles (Ali, Daniel, and Hirshleifer, 2017), where PMP in month t is WML₁₀'s average monthly return from $t-24$ to $t-1$. The monthly PMPs from December 1928 to December 2019 are ranked to quintiles, so the data span December 1928 to December 2019. Green, cyan, blue, magenta, and red are from the first to the last PMP quintile, respectively. Cumulative returns are not annualized.

Panel A. Full (t-12,t-2) past performance winner-minus-loser

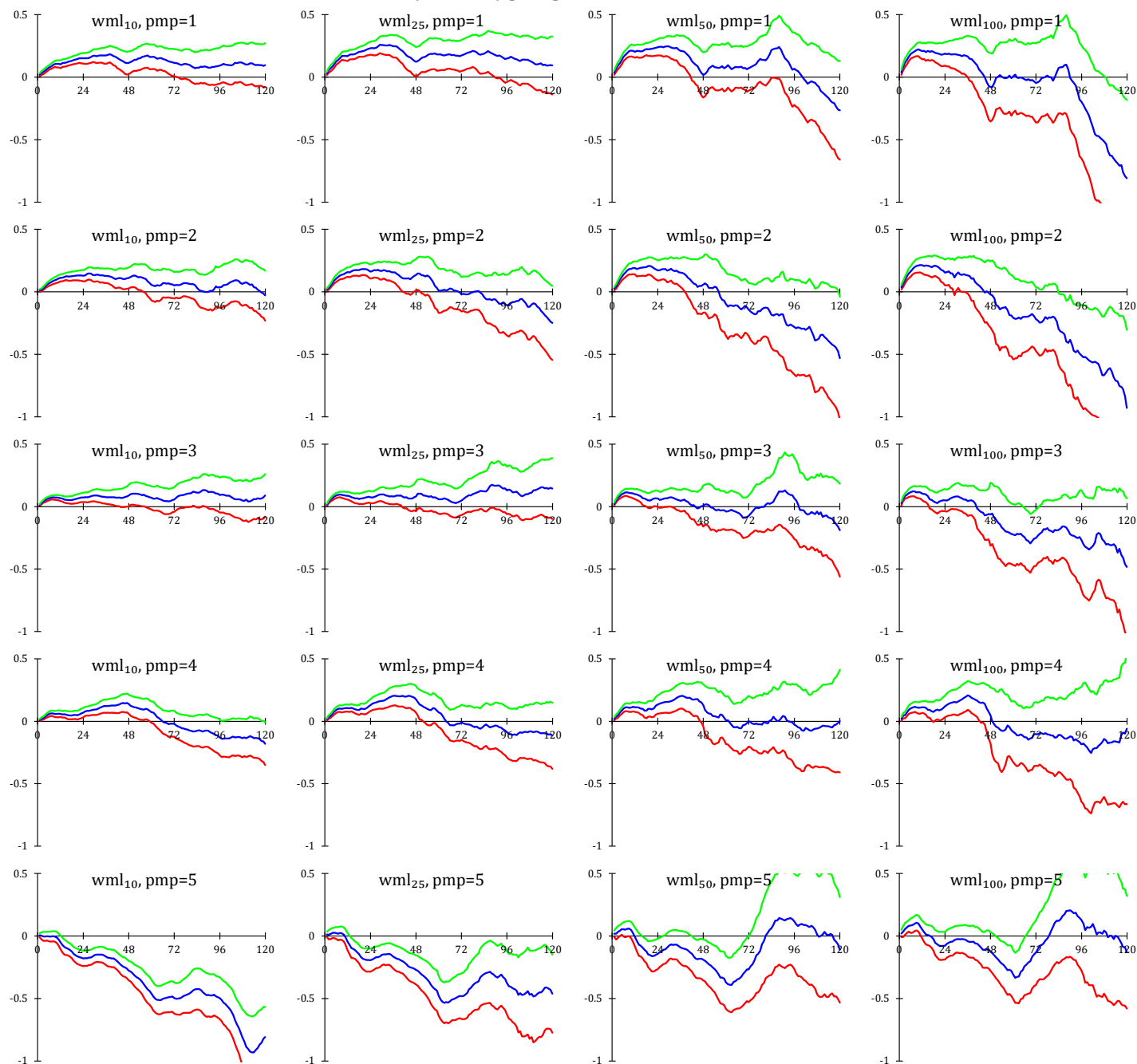


Figure A18. Postholding period winner-minus-loser performance by past momentum performance.

The figure shows the cumulative performance of WML₁₀ (first column), WML₂₅ (second), WML₅₀ (third), and WML₁₀₀ (last) over 10 years after formation by past momentum performance (PMP) quintiles (Ali, Daniel, and Hirshleifer, 2017), where PMP in month t is WML₁₀'s average monthly return from $t-24$ to $t-1$. The monthly PMPs from December 1928 to December 2019 are ranked to quintiles, so the data span December 1928 to December 2019. The first, second, third, fourth, and last rows are from the first to the last PMP quintile, respectively. Blue, green, and red are the statistics and their two standard error bands. Cumulative returns are not annualized. Panels A, B, and C use the (t-12,t-2), (t-6,t-2), and (t-12,t-7) horizons, respectively.

Panel B. Recent (t-6,t-2) past performance winner-minus-loser

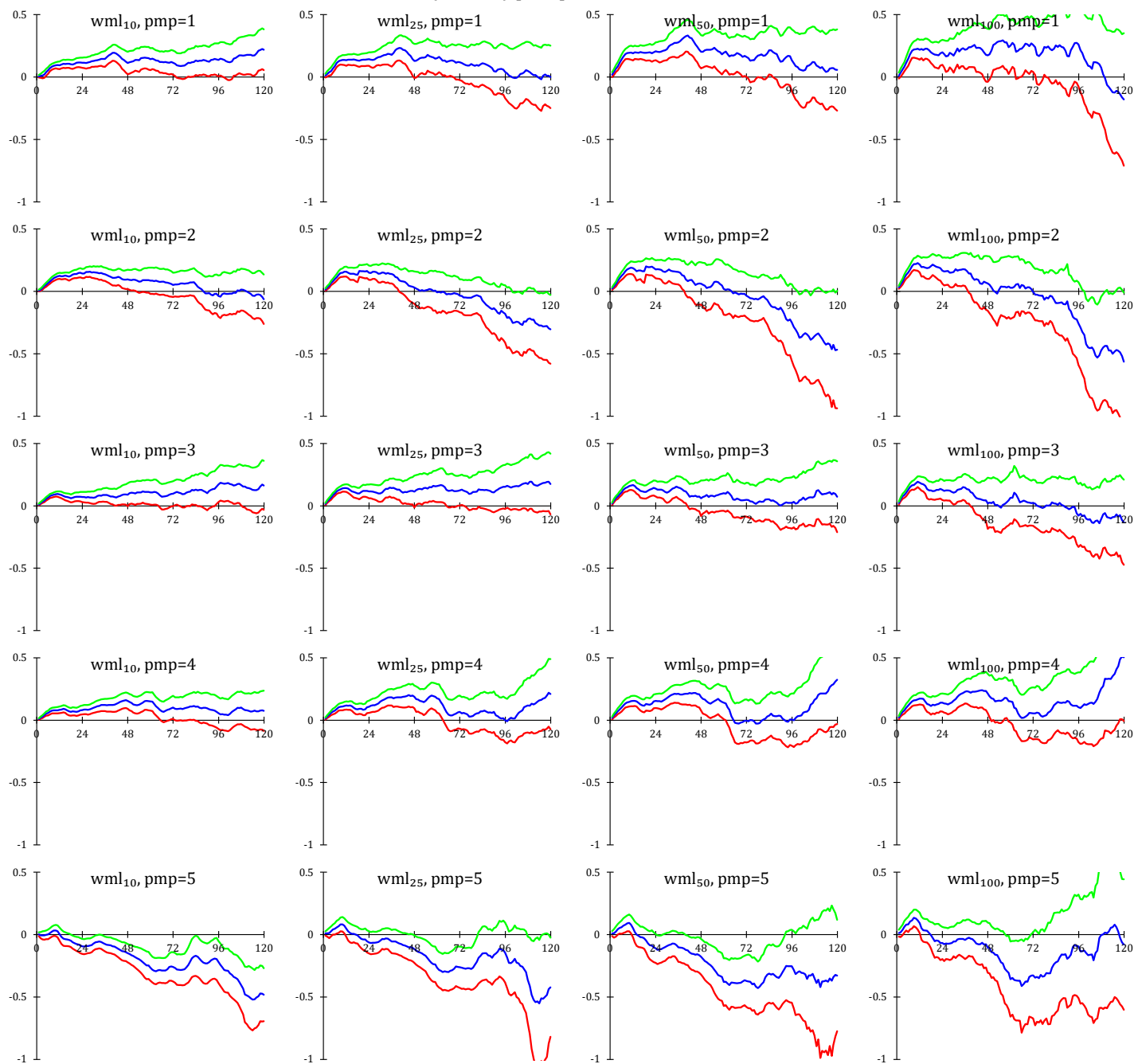


Figure A18. Continued. Postholding period winner-minus-loser performance by past momentum performance.

Panel C. Intermediate horizon (t-12,t-7) past performance winner-minus-loser

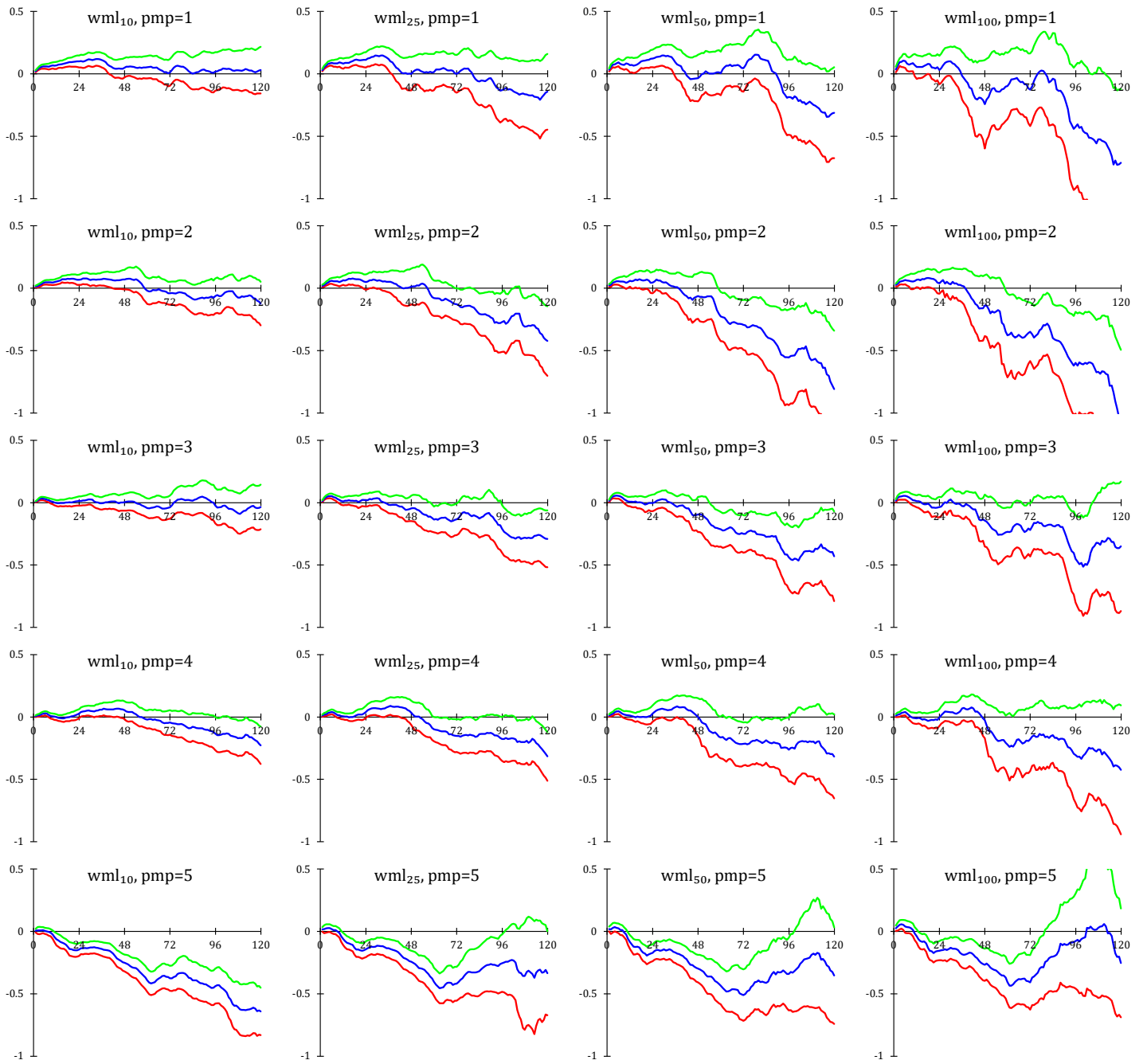


Figure A18. Continued. Postholding period winner-minus-loser performance by past momentum performance.

