Signal Construction Details for Strategies used in A Taxonomy of Anomalies and their Trading Costs

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1 Signal Construction Details

All strategies are constructed using data downloaded from the merged CRSP and COMPUSTAT industrial database. We start with all domestic common shares trading on NYSE, AMEX, and NASDAQ with available accounting data and returns. Book equity of firms is calculated by adding the deferred taxes and investment tax credits where available, and preferred stock values were incorporated in the following order of availability - redemption value, liquidation value, or par value of preferred stock. Book-to-market equity is calculated using the December of year t - 1 value for market equity. Stock returns are adjusted for delisting where applicable.

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All strategies consist of a time-series of value-weighted returns on a long/short self-financing portfolio, constructed using a decile sort on a signal using NYSE breakpoints. The period examined is between July 1963 and December 2013 (full period) for the anomalies using the annual files and between July 1973 and December 2013 (recent period) for the anomalies using the quarterly files. For the strategies using the annual files, accounting data for fiscal-year end of year t is matched with stock returns data from July of year t+1 until June of year t+2 to avoid look-ahead bias. For the ones that use the quarterly files, the accounting data for a given quarter are matched to the end of the month in which they were reported. Strategies using the signals marked with * are not used in the paper, but are nevertheless provided in the data library. For further details on the construction of the signals, please see the paper or the respective references.

1.1 Low turnover Strategies

- **Size** - follows Fama and French (1993). The portfolios are constructed at the end of each June using the CRSP end of June price times shares outstanding. Rebalanced annually, uses the full period.

- **Gross Profitability** - follows Novy-Marx (2013). Gross Profitability = GP/AT, where GP is gross profits and AT is total assets. Financial firms (those with SIC codes between 6000 and 6999) are excluded. Rebalanced annually, uses the full period.

- **Value** - follows Fama and French (1993). At the end of June of each year, we use book equity from the previous fiscal year and market equity from December of the previous year. Rebalanced annually, uses the full period.

- **ValProf** - follows Novy-Marx (2014). Firms are sorted into deciles based on the sum of their ranks in univariate sorts on book-to-market and profitability.

Annual book-to-market and profitability values are used for the entire year. Rebalanced annually, uses the full period.

- **Accruals** - follows Sloan (1996). Accruals $= \frac{\Delta\text{ACT}-\Delta\text{CHE}-\Delta\text{LCT}+\Delta\text{DLC}+\Delta\text{TXP}-\text{DP}}{(\text{AT}+\text{AT}_{-12})/2}$, where ΔACT is the annual change in total current assets, ΔCHE is the annual change in total cash and short-term investments, ΔLCT is the annual change in current liabilities, ΔDLC is the annual change in debt in current liabilities, ΔTXP is the annual change in income taxes payable, ΔDP is the annual change in depreciation and amortization, and $(\text{AT} + \text{AT}_{-12})/2$ is average total assets over the last two years. Rebalanced annually, uses the full period.

- **Net Issuance (A)** - follows Fama and French (2008). Net issuance is the year-over-year percent change in adjusted shares outstanding, CFACSHR $\times$ SHROUT, where CFACSHR is the monthly CRSP split adjustment factor and SHROUT is common shares outstanding. Rebalanced annually, uses the recent period.

- **Asset Growth** - follows Cooper et al. (2008). Asset Growth=$\text{AT}/\text{AT}_{-12}$ Rebalanced annually, uses the full period.

- **Investment** - follows Lyandres et al. (2008) and Chen et al. (2010). Investment $= (\Delta\text{PPEGT} + \Delta\text{INVT})/\text{AT}_{-12}$, where ΔPPEGT is the annual change in gross total property, plant, and equipment, ΔINVT is the annual change in total inventories, and AT_{-12} is lagged total assets. Rebalanced annually, uses the full period.

- **Piotroski's F-score** - based on Piotroski (2000). Piotroski's F-score $= \mathbb{1}_{IB>0} + \mathbb{1}_{\Delta ROA>0} + \mathbb{1}_{CFO>0} + \mathbb{1}_{CFO>IB} + \mathbb{1}_{\Delta DTA<0|DLTT=0|DLTT_{-12}=0} + \mathbb{1}_{\Delta ATL>0} + \mathbb{1}_{EqIss\leq 0} + \mathbb{1}_{\Delta GM>0} + \mathbb{1}_{\Delta ATO>0}$, where IB is income before extraordinary items, ROA is income before extraordinary items scaled by lagged total assets, CFO is cash flow from operations, DTA is total long-term debt scaled by total as-

sets, DLTT is total long-term debt, ATL is total current assets scaled by total current liabilities, EqIss is the difference between sales of of common stock and purchases of common stock recorded on the cash flow statement, GM equals one minus the ratio of cost of goods sold and total revenues, and ATO equals total revenues, scaled by total assets. Rebalanced annualy, uses the full period.

- **Asset Turnover*** - follows Novy-Marx (2013). Asset Turnover $= \frac{\text{SALE}}{\text{AT}}$, where SALE is total sales and AT is total assets. Rebalanced annually, uses the full period.

- **Gross Margins*** - follows Novy-Marx (2013). Gross Margins $= \frac{\text{GP}}{\text{SALE}}$, where GP is gross profits and SALE is total sales. Rebalanced annually, uses the full period.

- **Ohlson's O-score*** - follows Ohlson (1980). O-score$= -1.32 - 0.407 \log(\text{ADJASSET/CPI}) + 6.03\text{TLTA} - 1.43\text{WCTA} + 0.076\text{CLCA} - 1.72\text{OENEG} - 2.37\text{NITA} - 1.83\text{FUTL} + 0.285\text{INTWO} - 0.521\text{CHIN}$, in which ADJASSET is adjusted total assets calculated as total assets $(\text{Compustat quarterly item ATQ}) + 0.1 \times (\text{market equity} - \text{book equity})$. CPI is the consumer price index. TLTA is the leverage ratio defined as the book value of debt (item DLCQ plus item DLTTQ) divided by ADJASSET. WCTA is working capital divided by market assets $(\text{item ACTQ} - \text{item LCTQ})/\text{ADJASSET}$. CLCA is current liabilities (item LCTQ) divided by current assets (item ACTQ). OENEG is one if total liabilities (item LTQ) exceeds total assets (item ATQ) and is zero otherwise. NITA is net income (item NIQ) divided by assets, ADJASSET. FUTL is the fund provided by operations (item PIQ) divided by liabilities (item LTQ). INTWO is equal to one if net income (item NIQ) is negative for the last two quarters and zero otherwise. CHIN is $(NI_t - NI_{t-1})/(|NI_t| + |NI_{t-1}|)$, where NI_t is net income (item NIQ) for the most recent quarter. Rebalanced

monthly, uses the recent period.

1.2 Medium Turnover Strategies

- **Net Issuance (M)** - follows Fama and French (2008). Net issuance is the year-over-year percent change in adjusted shares outstanding, CFACSHR $\times$ SHROUT, where CFACSHR is the monthly CRSP split adjustment factor and SHROUT is common shares outstanding. Rebalanced monthly, uses the recent period.

- **Return-on-book equity** - follows Chen et al. (2010). Return-on-book equity $=$ IBQ/BEQ$_{-3}$, where IBQ is income before extraordinary items (updated quarterly), and BEQ is book value of equity (updated quarterly). Rebalanced monthly, uses the recent period.

- **Failure Probability** - follows Campbell et al. (2008). Also used in Chen et al. (2010). Failure Probability $= -9.164 - 20.264\text{NIMTAAVG} + 1.416\text{TLMTA} - 7.129\text{EXRETAVG} + 1.411\text{SIGMA} - 0.045\text{RSIZE} - 2.132\text{CASHMTA} + 0.075\text{MB} - 0.058\text{PRICE}$, where $\text{NIMTAAVG} = \frac{1-\phi^3}{1-\phi^{12}}(\text{NIMTA}_{-1,-3} + ... + \phi^9\text{NIMTA}_{-10,-12})$, $\text{EXRETAVG} = \frac{1-\phi^3}{1-\phi^{12}}(\text{EXRET}_{-1} + ... + \phi^{11}\text{EXRET}_{-12})$, NIMTA is net income (updated quarterly) divided by the sum of market equity (price times shares outstanding from CRSP) and total liabilities (updated quarterly), EXRET$=$ $log\left(\frac{1+r_{it}}{1+r_{S\&P500it}}\right)$, TLMTA is the ratio of total liabilities (updated quarterly) scaled by the sum of market equity and total liabilities, RSIZE is the relative size of each firm measured as the log of its market equity to that of the S&P500, $\text{SIGMA} = \sqrt{\frac{252}{N-1}\sum_{k\in\{t-1,t-2,t-3\}} r_k^2}$ in which r_k^2 is firm's daily return and N is the number of trading days in the three-month period, CASHMTA is the ratio of cash and short-term investments (updated quarterly) to the sum of market equity and total liabilities, MB is the the market-to-book ratio, and PRICE is each firm's log price per share, truncated above at \$15. Rebalanced

monthly, uses the recent period.

- **ValMomProf** - follows Novy-Marx (2014). Firms are sorted based on the sum of their ranks in univariate sorts on book-to-market, profitability, and momentum. Annual book-to-market and profitability values are used for the entire year. Rebalanced monthly, uses the full period.

- **ValMom** - follows Novy-Marx (2014). Firms are sorted based on the sum of their ranks in univariate sorts on book-to-market and momentum. Annual book-to-market values are used for the entire year. Rebalanced monthly, uses the full period.

- **Idiosyncratic Volatility** - follows Ang et al. (2006). In each month, firms are sorted based on the standard deviation of the residuals of regressions of their past three months' daily returns on the daily returns of the Fama-French three factors. Rebalanced monthly, uses the full period.

- **Momentum** - follows Jegadeesh and Titman (1993). In each month, firms are sorted based on their cumulated past performance in the previous year by skipping the most recent month. Rebalanced monthly, uses the full period.

- **PEAD (SUE)** - follows Foster et al. (1984). Earnings surprises are measured by Standardized Unexpected Earnings (SUE), which is the change in the most recently announced quarterly earnings per share from its value announced four quarters ago divided by the standard deviation of this change in quarterly earnings over the prior eight quarters. SUE $= \frac{\text{IBQ}-\text{IBQ}_{-12}}{\sigma_{\text{IBQ}_{-24}:\text{IBQ}_{-3}}}$, where IBQ is income before extraordinary items (updated quarterly), and $\sigma_{\text{IBQ}_{-24}:\text{IBQ}_{-3}}$ is the standard deviation of IBQ in the past two years skipping the most recent quarter. Rebalanced monthly, uses the recent period.

- **PEAD (CAR3)** - follows Brandt et al. (2008). Firms are sorted based on earnings surprised, measured by the cumulative three-day abnormal return

around the announcement (days minus one to one). Rebalanced monthly, uses the recent period.

- **Long Run Reversals*** - follows DeBondt and Thaler (1987). In each month, firms are sorted based on their cumulated past performance in the previous five years by skipping the most recent year. Rebalanced monthly, uses the full period.

- **Return-on-market equity*** - follows Chen et al. (2010). Return-on-book equity $=$ IBQ/ME$_{-3}$, where IBQ is income before extraordinary items (updated quarterly), and ME is market value of equity (updated monthly). Rebalanced monthly, uses the recent period.

- **Return-on-assets*** - follows Chen et al. (2010). Return-on-book equity $=$ IBQ/ATQ$_{-3}$, where IBQ is income before extraordinary items (updated quarterly), and ATQ is total assets (updated quarterly). Rebalanced monthly, uses the recent period.

- **Beta Arbitrage*** - based on Black (1972) and Frazzini and Pedersen (2014). Firms are sorted based on their estimated market beta, and then hedged for their market exposure using rolling betas estimated from the previous year's daily returns. Rebalanced monthly, uses the full period.

1.3 High Turnover Strategies

- **Industry Momentum** - follows Moskowitz and Grinblatt (1999). In each month, the Fama and French 49 industries are sorted on their value-weighted past month's performance and assigned to 10 industry deciles. Then, all firms in decile 10 (from the 5 winner industries) form the value-weighted long portfolio and all firms in decile 1 (the 5 loser industries) form the short portfolio. Rebalanced monthly, uses the full period.

- **Industry Relative Reversals** - follows Da et al. (2014) and Linnainmaa et al. (2014). In each month, firms are sorted based on the difference between their prior month's return and the prior month's return of their industry (based on the Fama and French 49 industries). Updated monthly, uses the full period.

- **High-Frequency Combo** In each month, firms are sorted based on sum of their ranks in the univariate sorts on industry relative reversals and industry momentum. Rebalanced monthly, uses the full period.

- **Short-term reversals** - follows Jegadeesh and Titman (1993). In each month, firms are sorted based on their prior month's returns. Rebalanced monthly, uses the full period.

- **Seasonality** - follows Heston and Sadka (2011). At the end of each month firms are sorted based on their average return in the coming calendar month over the preceding five years. Rebalanced monthly, uses the full period.

- **Industry Relative Reversals (Low Volatility)** - follows Linnainmaa et al. (2014). In each month, firms are sorted based on the difference between their prior month's return and the prior month's return of their industry (based on the Fama and French 49 industries). Only stocks with idiosyncratic volatility lower than the NYSE median for month are included in the sorts. Updated monthly, uses the full period.

- **High-Frequency Combo (with Seasonality)*** In each month, firms are sorted based on sum of their ranks in the univariate sorts on industry relative reversals, industry momentum, and seasonality. Rebalanced monthly, uses the full period.

References

Ang, A., Hodrick, R. J., Xing, Y., Zhang, X. 2006. The cross-section of volatility and expected returns. Journal of Finance, 61, 259–299.

Black, F. 1972. Capital market equilibrium with restricted borrowing. Journal of Business, 45, 444–455.

Brandt, M. W., Kishore, R., Santa-Clara, P., Venkatachalam, M. 2008. Earnings announcements are full of surprises. Working paper.

Campbell, J. Y., Hilscher, J., Szilagyi, J. 2008. In search of distress risk. Journal of Finance, 63, 2899–2939.

Chen, L., Novy-Marx, R., Zhang, L. 2010. An alternative three-factor model. Working paper.

Cooper, M. J., Gulen, H., Schill, M. J. 2008. Asset growth and the cross-section of stock returns. Journal of Finance, 63, 1609–1651.

Da, Z., Liu, Q., Schaumurg, E. 2014. A closer look at the short-term reversal. Management Science, 60, 658–674.

DeBondt, W. F. M., Thaler, R. H. 1987. Further evidence on investor overreaction and stock market seasonality. Journal of Finance, 42, 557–581.

Fama, E. F., French, K. R. 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics, 33, 3–56.

Fama, E. F., French, K. R. 2008. Dissecting anomalies. Journal of Finance, 63, 1653–1678.

Foster, G., Olsen, C., Shevlin, T. 1984. Earnings releases, anomalies, and the behavior of security returns. The Accounting Review, 59, 574–603.

Frazzini, A., Pedersen, L. H. 2014. Betting against beta. Journal of Financial Economics, 111, 1–25.

Heston, S. L., Sadka, R. 2011. Seasonality in the cross-section of stock returns. Journal of Financial Economics, 87, 418–445.

Jegadeesh, N., Titman, S. 1993. Returns to buying winners and selling losers: implications for stock market efficiency. Journal of Finance, 48, 65–91.

Linnainmaa, J., Novy-Marx, R., Tetlock, P. C. 2014. .... Working paper.

Lyandres, E., Sun, L., Zhang, L. 2008. Investment-based underperformance following seasoned equity offerings. Review of Financial Studies, 21, 2825–2855.

Moskowitz, T., Grinblatt, M. 1999. Do industries explain momenum? Journal of Finance, 54, 1249–1290.

Novy-Marx, R. 2013. The other side of value: the gross profitability premium. Journal of Financial Economics, 108, 1–28.

Novy-Marx, R. 2014. The quality dimension of value investing. Working paper.

Ohlson, J. A. 1980. Financial rations and the probabilistic prediction of bankruptcy. Journal of Accounting Research, 18, 109–131.

Piotroski, J. 2000. Value investing: the use of historical financial statement information to separate winners from losers. Journal of Accounting Research, 38, 1–41.

Sloan, R. G. 1996. Do stock prices fully reflect information in accruals and cash flows about future earnings? The Accounting Review, 71, 289–315.