Online Appendix to
“Turning Alphas into Betas: Arbitrage and Endogenous Risk”

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Abstract

The outline is as follows. Section 1 verifies the robustness of the main empirical analyses to using alternative sample cutoffs, alternative measures of latent mispricing, alternative definitions of arbitrageur funding shocks, and volatility-adjusted anomaly assets. Section 2 shows the main figures in the paper with anomaly labels. Section 3 explains the construction of anomaly signals in detail.

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1 Robustness checks on main empirical results

1.1 Alternative sample cutoffs

In the paper, I use the first-half (pre-93) and the second-half (post-93) of my original sample of 1972Q1-2015Q4 as proxies for times when arbitrageurs have negligible mass ($\mu = 0$) in equity anomaly assets and for times when arbitrageurs have positive mass ($\mu > 0$) in equity anomaly assets. However, the main empirical results are robust to using alternative sample cutoff years. I illustrate this by repeating the “Mispricing Turns into Funding Beta” and “Intermediary Asset Pricing of Anomaly Assets” regressions using the following cutoff years (and the corresponding subsamples): 1991 (1972-1991 vs. 1992-2015); 1992 (1972-1992 vs. 1993-2015); 1994 (1972-1994 vs. 1995-2015); and 1995 (1972-1995 vs. 1996-2015).

First, I repeat the “Mispricing Turns into Funding Beta” regression using four alternative sample cutoffs around the baseline cutoff of 1993. Table 1 below shows that the results are similar when these alternative cutoff years are used, although using earlier years than 1993 as the cutoff brings down the statistical significance based on GMM t-statistics to the 10% level.

Table 1: Alternative Sample Cutoffs for “Mispricing Turns into Funding Beta”

The regressions reported in this table use alternative sample cutoff years to repeat the cross-sectional regression predicting an anomaly asset’s endogenous (post-cutoff funding beta) based on its latent mispricing (pre-cutoff mean long-short return). The dependent variable in the post-cutoff funding beta $\beta_{j}^{post}$, calculated under the assumption that the beta is constant during the sample period: $r_{j,t} = a_0 + \beta_{j}^{post} f_{t} + \epsilon_{t}$. t-OLS is the t-statistic calculated using only the residuals from the cross-sectional regression and accounts for a possible heteroskedasticity of residuals across anomaly assets. t-GMM refers to a t-statistic obtained from the GMM estimation procedure and accounts for the effects of generated regressors and cross-anomaly correlations. Arbitrageur funding shocks are proxied by shocks to the leverage of broker-dealers.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Cutoff Mean Long-Short Return $r_{j}^{pre}$ (t-OLS)</td>
<td>1.09</td>
<td>1.08</td>
<td>1.24</td>
<td>1.55</td>
<td>1.66</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(3.53)</td>
<td>(3.49)</td>
<td>(3.51)</td>
<td>(3.53)</td>
<td>(3.86)</td>
</tr>
<tr>
<td>Intercept (t-OLS)</td>
<td>-3.50</td>
<td>-3.19</td>
<td>-3.84</td>
<td>-4.41</td>
<td>-4.86</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(-1.51)</td>
<td>(-1.34)</td>
<td>(-1.44)</td>
<td>(-1.32)</td>
<td>(-1.59)</td>
</tr>
<tr>
<td>Anomalies</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.31</td>
<td>0.29</td>
<td>0.26</td>
<td>0.26</td>
<td>0.30</td>
</tr>
</tbody>
</table>
Next, I repeat the “Intermediary Asset Pricing of Anomaly Assets” regression using four alternative sample cutoffs around the baseline of 1993. Table 2 below shows that using alternative cutoff years produce results similar to the baseline. Based on t-statistics that take into account the generated regressor problem but not cross-anomaly correlations, the price of risk is significant in all alternative post-cutoff periods other than that based on the cutoff of 1995. However, the results are still weak based on the more conservative GMM t-statistics. Adjusted $R^2$ remains high in all alternative post-cutoff periods.

Table 2: Alternative Sample Cutoffs for “Intermediary Asset Pricing of Anomaly Assets”

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Cutoff Funding Beta $\beta_{j}^{post}$ (t-GenReg)</td>
<td>0.19</td>
<td>0.20</td>
<td>0.18</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(2.28)</td>
<td>(2.40)</td>
<td>(2.30)</td>
<td>(2.13)</td>
<td>(1.87)</td>
</tr>
<tr>
<td>Intercept (t-GenReg)</td>
<td>3.32</td>
<td>3.18</td>
<td>3.10</td>
<td>2.92</td>
<td>3.00</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(3.32)</td>
<td>(3.18)</td>
<td>(3.10)</td>
<td>(2.92)</td>
<td>(3.00)</td>
</tr>
<tr>
<td>Anomalies</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Quarters</td>
<td>96</td>
<td>92</td>
<td>88</td>
<td>84</td>
<td>80</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.30</td>
<td>0.35</td>
<td>0.37</td>
<td>0.38</td>
<td>0.31</td>
</tr>
</tbody>
</table>
1.2 Alternative measures of latent mispricing

In the paper, I use pre-93 mean long-short return as the measure of anomaly’s latent mispricing. Below, I show that the “Mispricing Turns into Funding Beta” regression is robust to using CAPM alpha and funding alpha. When Fama-French 3-factor alpha is used, the significance based on the GMM t-statistic falls below the 10% level, although the $R^2$ remains strong.

Table 3: Alternative Measures of Latent Mispricing for “Mispricing Turns into Funding Beta”

Baseline: $\beta_{j}^{post} = b_0 + b_1 \beta_{j}^{pre} + \eta_j$

The regressions reported in this table use alternative measures of latent mispricing to repeat the cross-sectional regression predicting an anomaly asset’s post-93 funding beta based on its latent mispricing. The dependent variable in the post-93 funding beta $\beta_{j}^{post}$, calculated under the assumption that the beta is constant during the sample period: $r_{jt} = a_0 + \beta_{j}^{post} f_{t} + \epsilon_{t}$. The explanatory variable is the anomaly’s pre-93 CAPM alpha, Fama-French three-factor alpha, or arbitrageur funding alpha in the pre-93 period. t-OLS is the t-statistic calculated using only the residuals from the cross-sectional regression and accounts for a possible heteroskedasticity of residuals across anomaly assets. t-GMM refers to a t-statistic obtained from the GMM estimation procedure and accounts for the effects of generated regressors and cross-anomaly correlations. Arbitrageur funding shocks are proxied by shocks to the leverage of broker-dealers.

<table>
<thead>
<tr>
<th>Latent Mispricing Proxied by Pre-93:</th>
<th>Long-Short Return</th>
<th>CAPM Alpha</th>
<th>FF Alpha</th>
<th>Funding Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latent Mispricing</td>
<td>1.24</td>
<td>1.36</td>
<td>0.91</td>
<td>1.23</td>
</tr>
<tr>
<td>(t-OLS)</td>
<td>(3.51)</td>
<td>(3.97)</td>
<td>(3.79)</td>
<td>(3.49)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(2.03)</td>
<td>(2.01)</td>
<td>(1.53)</td>
<td>(2.04)</td>
</tr>
<tr>
<td>Intercept</td>
<td>-3.84</td>
<td>-5.03</td>
<td>-2.06</td>
<td>-3.82</td>
</tr>
<tr>
<td>(t-OLS)</td>
<td>(-1.44)</td>
<td>(-2.00)</td>
<td>(-0.87)</td>
<td>(-1.42)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(-1.68)</td>
<td>(-2.05)</td>
<td>(-0.80)</td>
<td>(-1.68)</td>
</tr>
<tr>
<td>Anomalies</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.26</td>
<td>0.35</td>
<td>0.30</td>
<td>0.25</td>
</tr>
</tbody>
</table>
1.3 Alternative definitions of arbitrageur funding shocks

As a proxy for arbitrageur funding shock, I use shocks to the leverage of broker-dealers:

\[ f_t = \ln (\text{Leverage}^{BD}_t) - \ln (\text{Leverage}^{BD}_{t-1}) \]  

(1)

However, as pointed out in the paper, using stochastically detrended leverage of broker-dealer may be a better proxy for actual changes in funding conditions faced by arbitrageurs:

\[ f_t = \ln (\text{Leverage}^{BD}_t) - \frac{1}{N} \sum_{s=1}^{N} \ln (\text{Leverage}^{BD}_{t-s}), \]  

(2)

where \( N \) is the number of quarters used to compute the moving average term. The main empirical results are robust to using different values of \( N \). To illustrate, I repeat the “Mispricing Turns into Funding Beta” and “Intermediary Asset Pricing of Anomaly Assets” regressions using \( N = 4, N = 8, \) and \( N = 12 \) instead.\(^1\)

First, I repeat the “Mispricing Turns into Funding Beta” regression using three alternative proxies for arbitrageur funding shock. Table 4 below shows that the results are robust to using these alternative proxies.

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\(^1\) All series are annualized appropriately.
The regressions reported in this table use alternative arbitrageur funding proxies to repeat the cross-sectional regression predicting an anomaly asset’s post-93 funding beta based on pre-93 mean long-short return. The dependent variable in the post-cutoff funding beta $\beta_{j}^{post}$, calculated under the assumption that the beta is constant during the sample period: $r_{j,t} = a_0 + \beta_{j}^{post} f_t + \epsilon_t$. t-OLS is the t-statistic calculated using only the residuals from the cross-sectional regression and accounts for a possible heteroskedasticity of residuals across anomaly assets. t-GMM refers to a t-statistic obtained from the GMM estimation procedure and accounts for the effects of generated regressors and cross-anomaly correlations. Arbitrageur funding shocks are proxied by the stochastically detrended (trailing $N$ quarters, where $N$ varies by column) leverage of broker-dealers.

<table>
<thead>
<tr>
<th>Detrend Arbitrageur Funding Using:</th>
<th>$N = 1$ (Baseline)</th>
<th>$N = 4$</th>
<th>$N = 8$</th>
<th>$N = 12$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-93 Mean Long-Short Return $r_{pre}^{j}$</td>
<td>1.24</td>
<td>2.64</td>
<td>3.73</td>
<td>4.69</td>
</tr>
<tr>
<td>(t-OLS)</td>
<td>(3.51)</td>
<td>(5.95)</td>
<td>(5.21)</td>
<td>(4.99)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(2.03)</td>
<td>(2.96)</td>
<td>(3.08)</td>
<td>(2.99)</td>
</tr>
<tr>
<td>Intercept</td>
<td>-3.84</td>
<td>-5.57</td>
<td>-6.38</td>
<td>-6.42</td>
</tr>
<tr>
<td>(t-OLS)</td>
<td>(-1.44)</td>
<td>(-1.53)</td>
<td>(-1.20)</td>
<td>(-0.96)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(-1.68)</td>
<td>(-1.75)</td>
<td>(-1.43)</td>
<td>(-1.16)</td>
</tr>
<tr>
<td>Anomalies</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.26</td>
<td>0.39</td>
<td>0.35</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Table 4: Alternative Arbitrageur Funding Proxies for “Mispricing Turns into Funding Beta”

$$\beta_{j}^{post} = b_0 + b_1 r_{pre}^{j} + \eta_j$$
Next, I repeat the “Intermediary Asset Pricing of Asset Pricing Anomalies” regression using three alternative proxies for arbitrageur funding shock. Table 5 shows that the results are robust to using these alternative proxies.

Table 5: Alternative Arbitrageur Funding Proxies for “Intermediary Asset Pricing of Anomaly Assets”

\[ \bar{r}_{j}^{post} = \lambda_0 + \lambda_1 \beta_{j}^{post} + e_j \]

The regressions reported in this table use alternative arbitrageur funding proxies to repeat the asset pricing regression that explains the cross-section of post-93 mean long-short returns based on post-93 funding betas. The table reports the price of risk and intercept implied by the cross-sectional regression. Returns are expressed as annualized percentages. Betas are estimated in the time-series regression \( r_{j,t} = a_j + \beta_j f_t + \varepsilon_{j,t} \) for each anomaly asset. t-GenReg refers to t-statistic corrected for generated regressors but not for cross-anomaly correlations. That is, to obtain the standard errors accounting for generated regressors, I allow for heteroskedastic residuals \( \varepsilon_{j} \) for the mean returns and do the correction derived by Shanken (1992), but under the assumption of \( \text{Cov}(\varepsilon_{j},\varepsilon_{j'}) = 0 \) for \( j' \neq j'' \). t-GMM refers to a GMM t-statistic that additionally corrects for correlations across anomaly assets. Arbitrageur funding shocks are proxied by the stochastically detrended (trailing \( N \) quarters, where \( N \) varies by column) leverage of broker-dealers.

<table>
<thead>
<tr>
<th>Detrend Arbitrageur Funding Using:</th>
<th>( N = 1 ) (Baseline)</th>
<th>( N = 4 )</th>
<th>( N = 8 )</th>
<th>( N = 12 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-93 Funding Beta ( \beta_{j}^{post} )</td>
<td>( 0.18 )</td>
<td>( 0.29 )</td>
<td>( 0.35 )</td>
<td>( 0.40 )</td>
</tr>
<tr>
<td>(t-GenReg)</td>
<td>(2.30)</td>
<td>(2.37)</td>
<td>(2.30)</td>
<td>(2.37)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(1.30)</td>
<td>(1.23)</td>
<td>(1.25)</td>
<td>(1.27)</td>
</tr>
<tr>
<td>Intercept</td>
<td>3.10</td>
<td>2.61</td>
<td>2.55</td>
<td>2.46</td>
</tr>
<tr>
<td>(t-GenReg)</td>
<td>(5.13)</td>
<td>(4.27)</td>
<td>(4.18)</td>
<td>(3.94)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(3.15)</td>
<td>(3.35)</td>
<td>(3.55)</td>
<td>(3.43)</td>
</tr>
<tr>
<td>Anomalies</td>
<td>34</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Quarters</td>
<td>88</td>
<td>88</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
<td>0.37</td>
<td>0.50</td>
<td>0.49</td>
<td>0.48</td>
</tr>
</tbody>
</table>
1.4 Results using volatility-adjusted anomaly assets

I now repeat the main analyses using anomaly assets adjusted for the cross-anomaly differences in volatility. To do this, I take the simplest approach of calculating each anomaly asset’s pre-93 return volatility and using this to normalize the anomaly time-series returns to have a pre-93 return volatility of 10:

\[
r_{vol\,adj}^{j,t} = \frac{10}{\tilde{\sigma}_{j}^{pre}} r_{j,t}^{pre},
\]

(3)

where \(\tilde{\sigma}_{j}^{pre}\) is the pre-93 volatility of anomaly asset \(j\). This way, an anomaly asset’s pre-93 average long-short return represents the anomaly’s pseudo-Sharpe ratio (“pseudo” because the numerator is a mean long-short return rather than a mean excess return),

\[
\bar{r}_{j}^{pre} \propto S_{j}^{pre} = \frac{r_{j}^{pre}}{\tilde{\sigma}_{j}^{pre}}
\]

(4)

allowing for a volatility-adjusted profitability comparison. The anomaly assets’ post-93 return volatilities based on these volatility-adjusted returns are also similar to one another. The cross-anomaly mean and variance of post-93 return volatility are 11.22% and 2.44%, respectively.

Table 6 shows that results remain strong. The first two columns show that the pseudo-Sharpe ratios of the anomaly assets strongly predict their endogenous risks measured by post-93 funding betas and post-93 funding correlations. The third column shows that the post-93 cross-sectional asset pricing result is stronger using volatility-adjusted anomaly assets, with the most conservative GMM t-statistics being close to the 10% significance level. This is because normalizing the volatilities mitigates the regression’s dependency on volatile anomaly assets.
Table 6: Tests Using Volatility-Adjusted Anomaly Assets

<table>
<thead>
<tr>
<th>Mispricing to endogenous risk: $\beta_j^{\text{post}} = b_0 + b_1 r_j^{\text{pre}} + \eta_j$</th>
<th>Endogenous risk to expected return: $r_j^{\text{post}} = \lambda_0 + \lambda_1 \beta_j^{\text{post}} + e_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>This table repeats the baseline “Mispricing Turns into Funding Beta” and “Intermediary Asset Pricing of Anomaly Assets” regressions using volatility-adjusted anomaly assets. These assets are obtained by normalizing the original anomaly assets’ returns to have pre-93 volatility of 10. t-OLS in the first two columns is the t-statistic calculated using only the residuals from the cross-sectional regression and accounts for a possible heteroskedasticity of residuals across anomaly assets. For the last column, t-OLS is the t-GenReg used in Table 6 of the paper. Specifically, it refers to t-statistic corrected for generated regressors but not for cross-anomaly correlations. That is, to obtain the standard errors accounting for generated regressors, I allow for heteroskedastic residuals $\varepsilon_j$ for the mean returns and do the correction derived by Shanken (1992), but under the assumption of $\text{Cov}(\varepsilon_j, \varepsilon_j') = 0$ for $j' \neq j''$. t-GMM refers to a t-statistic obtained from the GMM estimation procedure and accounts for the effects of generated regressors and cross-anomaly correlations. Arbitrageur funding shocks are proxied by shocks to the leverage of broker-dealers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mispricing Turns into Endogenous Risk (Proposition 1)</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Pre-93 Mean Long - Short Return $r_j^{\text{pre}}$</td>
<td>Post-93 Funding Beta $\beta_j^{\text{post}}$</td>
</tr>
<tr>
<td>(t-OLS)</td>
<td>(2.00)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(1.97)</td>
</tr>
<tr>
<td>Post-93 Funding Beta $\beta_j^{\text{post}}$</td>
<td>(t-OLS)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(1.47)</td>
</tr>
<tr>
<td>Intercept</td>
<td>-1.23</td>
</tr>
<tr>
<td>(t-OLS)</td>
<td>(-0.97)</td>
</tr>
<tr>
<td>(t-GMM)</td>
<td>(-1.31)</td>
</tr>
<tr>
<td>Anomalies</td>
<td>34</td>
</tr>
<tr>
<td>Quarters</td>
<td>176</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.16</td>
</tr>
</tbody>
</table>
2 Main figures with anomaly labels

Figure 1: Arbitrageur Funding Beta and Mean Return in the Pre-93 Period (1972-1993)

This figure plots the mean long-short returns and arbitrageur funding betas of thirty-four equity anomaly strategies in the pre-93 sample, proxying for the pre-arbitrage period. Return is expressed as annualized percentage. Funding betas are close to zero, and returns do not line up with funding betas. This is consistent with endogenous risks being small and anomaly assets not being priced by arbitrageurs in the pre-93 period. Funding beta is the beta with respect to arbitrageur funding shocks measured by shocks to the leverage of broker-dealers.
Figure 2: Arbitrageur Funding Beta and Mean Return in the Post-93 Period (1994-2015)

This figure plots the mean long-short returns and arbitrageur funding betas of thirty-four equity anomaly strategies in the post-93 sample, proxying for the post-arbitrage period. Return is expressed as annualized percentage. Funding betas tend to be positive, and returns roughly line up with funding betas. This is consistent with arbitrageurs generating positive funding betas in the anomaly assets, and the funding betas carrying a price of risk. Funding beta is the beta with respect to arbitrageur funding shocks measured by shocks to the leverage of broker-dealers.
Figure 3: **Pre-93 Mean Return Predicts Post-93 Arbitrageur Funding Beta**

This figure plots the relationship between pre-93 mean long-short return and post-93 funding beta. The pre-93 (1972-1993) and post-93 (1994-2015) samples proxy for pre-arbitrage and post-arbitrage periods. Return is expressed as annualized percentage. Funding beta is the beta with respect to arbitrageur funding shocks measured by shocks to the leverage of broker-dealers.
3 Anomaly signal construction

To construct anomaly signals, I focus on domestic common shares (share code 10 or 11) on NYSE, AMEX, and NASDAQ (exchange code 1, 2, or 3). At the end of each month from 1972 to 2015, I allocate all domestic common shares trading on NYSE, AMEX, and NASDAQ into deciles based on an anomaly signal, such as the book-to-market ratio, with decile breakpoints determined by NYSE-listed stocks alone.

I use 34 different anomaly signals to construct 34 long-short portfolios. If the signal requires annual accounting data, I assume that annual accounting information is available with a lag of 5 months. If the signal requires quarterly earnings data, I assume that the information is available immediately.

Anomaly 1: Beta arbitrage

This signal is constructed as in Green, Hand, and Zhang (2016) (GHZ). The beta is obtained by regressing a stock’s weekly returns on equal-weighted stock returns in the previous 3 years. When 3 years of past returns are unavailable, I require a minimum 1 year of past returns. For the original paper, see Fama and MacBeth (1973).

Anomaly 2: Ohlson’s O-score

This signal is constructed as in Novy-Marx and Velikov (2016) (NMV). See the paper for details. For the original paper, see Ohlson (1980).

Anomaly 3: Size

Size is the market value of common equity, calculated as shares outstanding times the price. For the original paper, see Banz (1981).

Anomaly 4: PEAD(SUE)

This signal is constructed as in NMV. See the paper for details. For the original paper, see Rendelman, Jones, and Latane (1982).

Anomaly 5: Value

Value is the book value of equity divided by the market value of equity. When calculating the book value of equity, I follow the exact method of Fama and French (1993): “COMPUSTAT
book value of stockholders’ equity, plus balance-sheet deferred taxes and investment tax credit (if available), minus the book value of preferred stock. Depending on availability, we use the redemption, liquidation, or par value (in that order) to estimate the value of preferred stock” (p.8). For the original paper, see Rosenberg, Reid, and Lanstein (1985).

**Anomaly 6: 36-month momentum**

This is the 36-month cumulative return. I omit stocks without the full 36-month return history. For the original paper, see De Bondt and Thaler (1985).

**Anomaly 7: Long-run reversals**

This is the 60-month cumulative return. I omit stocks without the full 60-month return history. For the original paper, see De Bondt and Thaler (1987).

**Anomaly 8: Short-run reversals**

This is the prior 1-month return. I omit stocks without a prior 1-month return. For the original paper, see Jegadeesh (1990).

**Anomaly 9: Momentum**

Momentum at the end of month \( t \) is the cumulative 11-month return from the end of month \( t - 13 \) to the end of month \( t - 2 \). When the full return history is unavailable, I require the return history of at least 6 months (e.g., if return information is available for the prior 6 months, the momentum variable is the cumulative 5-month return from the end of month \( t - 7 \) to the end of month \( t - 2 \)). I assign a low momentum on new stocks by assigning a momentum value of -1 for the stocks with less than 6 months of return history. For the original paper, see Jegadeesh (1990).

**Anomaly 10: Annual sales growth**

This signal is constructed as in GHZ. The annual sales growth is obtained by dividing the current accounting year’s annual sales by the previous accounting year’s annual sales. For the original paper, see Lakonshok, Shleifer, and Vishny (1994).
Anomaly 11: Industry-adjusted change in the number of employees

This signal is constructed as in GHZ. It is the number of employees minus the industry-average number of employees, where industries are defined by the 2-digit SIC codes (SIC2). For the original paper, see Asness, Porter, and Stevens (1994).

Anomaly 12: Accruals

This signal is constructed as in GHZ. It is defined as (income before extraordinary items (IB) – Operating Activities/Net Cash Flow (OANCF))/((Total Assets (AT) + Lagged Total Assets (AT_{t-1}))/2) if OANCF is available. If not, then the signal is constructed as in NMV. For the original paper, see Sloan (1996).

Anomaly 13: Industry-adjusted value

This is the value signal defined above minus the industry average of the value signal, where industries are defined by the 2-digit SIC codes (SIC2). For the original paper, see Asness, Porter, and Stevens (1994).

Anomaly 14: Industry momentum

This is the industry average of the momentum signal defined above, where industries are defined by the 2-digit SIC codes (SIC2). For the original paper, see Moskowitz and Grinblatt (1999).

Anomaly 15: Industry-adjusted firm size

This is the size signal defined above minus the industry average of the size signal, where industries are defined by the 2-digit SIC codes (SIC2). For the original paper, see Asness, Porter, and Stevens (1994).

Anomaly 16: Industry-adjusted cash-flow-to-price ratio

This signal is constructed as in GHZ. It is the cash-flow-to-price ratio minus its industry average, where industries are defined by the 2-digit SIC codes (SIC2). Cash-flow-to-price ratio is defined as the Operating Activities/Net Cash Flow (OANCF) divided by the market value of equity calculated as the shares outstanding times price. When OANCF is unavailable, the
numerator is the same as the numerator used by NMV to construct the accrual signal. For the original paper, see Asness, Porter, and Stevens (1994).

**Anomaly 17: Piotroski’s F-score**

This signal is constructed as in GHZ. The score is calculated as

\[1 \times (NI > 0) + 1 \times (OANCF > 0) + 1 \times (NI/AT > NI_{t-1}/AT_{t-1}) + 1 \times (OANCF > NI) + 1 \times (DLTT/AT > DLTT_{t-1}/AT_{t-1}) + 1 \times (ACT/LCT > ACT_{t-1}/LCT_{t-1}) + 1 \times ((SALE - COGS)/SALE > (SALE_{t-1} - COGS_{t-1})/SALE_{t-1}) + 1 \times (SALE/AT > SALE_{t-1}/AT_{t-1}) + 1 \times (SCSTKC > 0)\]

where \(NI\) is Net Income, \(OANCF\) is Operating Activities/Net Cash Flow, \(AT\) is Total Assets, \(DLTT\) is Long-Term Debt, \(ACT\) is Total Current Assets, \(LCT\) is Total Current Liabilities, \(SALE\) is Total Sales, \(COGS\) is Cost of Goods Sold, and \(SCSTKC\) is the Sale of Common Stock (Cash Flow). For the original paper, see Piotroski (2000).

**Anomaly 18: Idiosyncratic volatility**

This signal is constructed as in GHZ. It is the standard deviation of the residual return from regressing weekly stock returns to the contemporaneous equal-weighted weekly returns as well as four previous weeks’ equal-weighted returns. For the original paper, see Ali, Hwang, and Trombly (2003).

**Anomaly 19: Price delay**

This signal is constructed as in GHZ. First, I regress the weekly stock return on the contemporaneous equal-weighted weekly return and obtain the adjusted \(R^2\) squared. Second, I regress the weekly stock return on the contemporaneous equal-weighted weekly return as well as four previous weeks’ equal-weighted returns, again obtaining an adjusted \(R^2\) squared. Then, I subtract the ratio of the \(R^2\) from the first regression to the \(R^2\) from the second regression and subtract that ratio from 1. For the original paper, see Hou and Moskowitz (2005).

**Anomaly 20: Failure probability**

This signal is constructed as in NMV. See the paper for details. For the original paper, see Campbell, Hilscher, and Szilagyi (2008).
**Anomaly 21: Asset growth**

This signal is constructed as in NMV. It is the total asset in the current accounting year divided by the total asset in the previous accounting year minus one. For the original paper, see Cooper, Gulen, and Schill (2008).

**Anomaly 22: Net issuance**

This signal is constructed as in NMV. It is the 12-month growth rate in the net issuance defined as the monthly CRSP split adjustment factor times shares outstanding in the current month. For the original paper, see Fama and French (2008).

**Anomaly 23: Seasonality**

This signal is constructed as in NMV. It is the average of the coming month’s return in the previous five years. For the original paper, see Heston and Sadka (2008).

**Anomaly 24: Industry-adjusted change in profit margin**

This signal is constructed as in GHZ. The change in profit margin is defined as the ratio of net income to sales in the current accounting year minus the same ratio in the previous accounting year. The industry adjustment is made by subtracting the industry-average change in profit margin from the firm’s change in profit margin, where industries are defined by the 2-digit SIC codes (SIC2). For the original paper, see Soliman (2008).

**Anomaly 25: Industry-adjusted change in asset turnover**

This signal is constructed as in GHZ. The change in asset turnover is defined as \((\text{SALE} / (\text{AT} + \text{AT}_{t-1})/2) - (\text{SALE}_{t-1} / (\text{AT}_{t-1} + \text{AT}_{t-2})/2)\), where \(\text{SALE}\) is Total Sales and \(\text{AT}\) is Total Assets. The industry adjustment is made by subtracting the industry-average change in asset turnover from the firm’s change in asset turnover, where industries are defined by the 2-digit SIC codes (SIC2). For the original paper, see Soliman (2008).

**Anomaly 26: PEAD(CAR3)**

This signal is constructed as in NVM and GHZ. Three-day cumulative return (-1 to +1) around the date of the earnings announcement. For the original paper, see Brandt, Kishore, Santa-Clara, and Venkatachalam (2008).
Anomaly 27: Investment

This signal is constructed as in NMV. For the original paper, see Chen, Novy-Marx, and Zhang (2010).

Anomaly 28: Return on market equity

This signal is constructed as in NMV. It is the income before extraordinary items divided by the previous quarter’s market value of equity. For the original paper, see Chen, Novy-Marx, and Zhang (2010).

Anomaly 29: Return on book equity

This signal is constructed as in NMV. It is the income before extraordinary items divided by the previous quarter’s book value of equity. For the original paper, see Chen, Novy-Marx, and Zhang (2010).

Anomaly 30: Return on assets

This signal is constructed as in NMV. It is the income before extraordinary items divided by the previous quarter’s total assets. For the original paper, see Chen, Novy-Marx, and Zhang (2010).

Anomaly 31: Asset turnover

This signal is constructed as in NMV. It is total sales divided by total assets. For the original paper, see Novy-Marx (2013).

Anomaly 32: Gross margins

This signal is constructed as in NMV. It is gross profits divided by total sales. For the original paper, see Novy-Marx (2013).

Anomaly 33: Gross profitability

This signal is constructed as in NMV. It is gross profits divided by total assets. For the original paper, see Novy-Marx (2013).
Anomaly 34: Industry-adjusted reversals

This is the short-run reversal signal defined above minus the industry average of the short-run reversal signal, where industries are defined by the 2-digit SIC codes (SIC2). For the original paper, see Da, Liu, and Schaumburg (2013).
References


