ANOMALY REPLICATION REPORT

For Hwang and Liu (2014)

Author
Zhang Qiang
School of Finance, Renmin University of China
June, 2023

Contents

1 Introduction

Hwang and Liu (2014)[1] document 11 popular anomalies, including: 1) failure probability, 2) O score, 3) net stock issuance, 4) composite equity issuance, 5) total accruals, 6) net operating assets, 7) momentum, 8) gross profitability, 9) asset growth, 10) profitability, and 11) investment ratio. In this report, we replicate their results with WRDS data and present the correlation coefficients of our results with theirs.

ID	Anomaly	CIZ
1	Failure Probability	-
2	Oscore	0.9458
3	Net Stock Issuance	0.9457
4	Equity Issuance	-
5	Total Accruals	0.8704
6	Net Operating Assets	0.9126
7	Momentum	0.9700
8	Gross Profitability	0.9346
9	Asset Growth	0.9239
10	Profitability	0.9246
11	Investment Ratio	-

Table 1: Correlation coefficients of long-minus-short returns between two results

2 General Replication Methodology

At the end of each portfolio formation month, we sort stocks into decile portfolios based on anomaly variables and calculate value-weighted decile portfolio returns. The slight error when merging available fundamental information (from Compustat) and stock transaction records (from CRSP) might incur non-negligible deviations of the final results. Thus, we discuss the detailed replication methodology here.

According to the frequency of portfolio construction, we could classify 11 anomalies into three categories: 1)monthly portfolio, 2)quarterly portfolio, and 3) annually portfolio. Because the monthly portfolio are constructed only for momentum (anomaly 7), we specify the detailed procedure in Section 3.7. Now we introduce some key points for quarterly and annually portfolio.

2.1 Quarterly Portfolio

For anomaly 1), 2) and 10), (failure probability, O-score and profitability, respectively), we construct decile portfolio at the end of each calendar quarter q. The anomaly variables are calculated with accounting data from the fiscal quarter that ends at calendar quarter q-1. Then, we calculate value-weighted returns over the ensuing calendar quarter q+1. The

weight for each stock is its market value at the end of calendar quarter q. Hwang and Liu (2014) provides an example to illustrate the timing:

> *For instance, when forming portfolios at the end of Mar2000 (using quarterly accounting data from the fiscal quarter ending in Oct1999, Nov1999, or Dec1999), we compute returns on those portfolios from Apr2000 to Jun2000.*

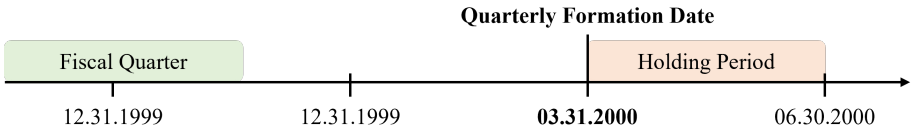

Figure 1: The timeline for the example

On the basis of the timeline, we conclude the procedures to replicate quarterly anomaly returns.

1. Prepare CRSP monthly return data and update the quarterly CRSP dataset at the end of each calendar quarter q.
2. Prepare Compustat dataset and calculate anomaly variables; The quarterly accounting information should be available no later than the end of calendar quarter q-1.
3. Merge CRSP dataset and Compustat dataset and construct decile portfolios quarterly;
4. Calculate the value-weighted portfolio monthly return in calendar quarter q+1 .

2.2 Annual Portfolio

Anomaly 3)-9) and 11) are based on annual portfolio. And the construction of annual portfolio are typical and similar with the quarterly one.

At the end of June in year t, we calculate the anomaly variables with accounting data from the fiscal year ending in calendar year t-1. Then, we calculate the monthly value-weighted portfolio returns from July in year t to June in year t+1. The weight for each stock is its market value at June 30 in year t.

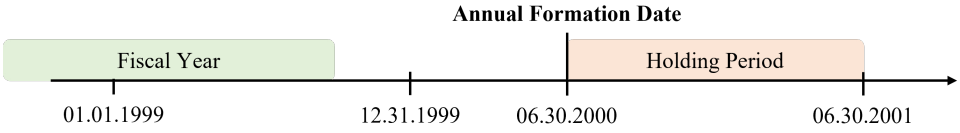

Figure 2: The timeline for Annual portfolio

The procedure to replicate annual anomalies are similar to those for quarter portfolio:

1. Prepare CRSP monthly return data and update the annual CRSP dataset at the end of June in year t.
2. Prepare Compustat dataset and calculate anomaly variables; The annual accounting information should be available no later than the end of year t-1.

3. Merge CRSP dataset and Compustat dataset and construct decile portfolios at the end of June every year;

4. Calculate the value-weighted portfolio monthly return from July in year t to June in year t+1 .

2.3 Notes

There are several points that calls for special attention:

1. Both *ccmxpf_linktable* and *ccmxpf_lnkhist* can be used to merge CRSP and Compustat. The latter is recommended, but linktable is widely used earlier, so we follow the routine to replicate earlier results with *ccmxpf_linktable*.

2. CRSP provides two versions transaction data: SIZ and CIZ (v2 data). And the two datasets generate almost identical results. We need to incorporate delisting returns manually when using SIZ data, while CIZ data include them. For simplicity, we use CIZ data.

3. At the end of portfolio formation month, we exclude stocks with a price lower than \$5. Our prepared CRSP dataset only contains the remaining stocks. We then merge it with Compustat data.

3 Detailed Replication Methodology

3.1 Failure Probability

To be completed.

3.2 O score

The calculation of O score are quite complex. Although Chen, Novy-Marx and Zhang (2011) [2] has provided applicable procedures for O-score, timing issue here are still difficult. So we discuss the computation in detail.

Following Chen, Novy-Marx and Zhang (2011) and Hwang and Liu (2014), we replicate O-score anomaly with quarterly anomaly. To avoid ambiguity, we demonstrate the timing issue with the instance mentioned before.

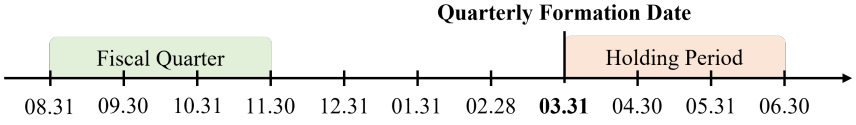

Figure 3: The detailed timeline for O-score

At March 30, we use the accounting information from the fiscal quarter ending in Oct31, Nov30 or Dec31 of the former year. To calculate $AdjAsset$, we match the market equity at the end of the fiscal quarter (Nov 30 in the figure, specifically). We standardize the

Variables	Time	Time in the example
Stock Price	End of the formation month	Mar31
Market Equity (Portfolio weight)	End of the formation month	Mar31
Accounting Info	Fiscal quarter ending in the previous calendar quarter	Nov30
CPI Index	End of the previous calendar quarter	Nov30
Market Equity ($AdjAsset$)	Fiscal quarter ending in the previous calendar quarter	Nov30

Table 2: Information needed to calculate O-score

$AdjAsset$ with monthly CPI index at the fiscal quarter end. We acquire quarterly CPI index from CRSP (Library 'crsp_a_indexes', Table 'mcti').

Why there may exists differences between Long-Minus Short returns? ME in $AdjAsset$? Non-positive BE? INTWO? Winsorization!

We also follow other definition of ME (for $AdjAsset$). For example, we use the me at the end of previous quarter or at the end of formation month. Either methods scarcely improve our results.

Besides, we follow Chen, Novy-Marx, and Zhang (2011) to drop firms with non-positive book equity; while Hong Xiang did not. This slightly affects the results. The differences in the definition of $INTWO$ have a similar effect (In our definition, $INTWO_t$ equals 1 if NIQ_t and NIQ_{t-1} are negative; while Xiang use NIQ_{t-1} and NIQ_{t-2}.

After carefully comparison, we find out the origin of differences between two version of results. Some accounting variables (for example, $FUTL$) may be relatively large (because of a small LTQ). So we winsorize all the variables at the 1th and 99th percentiles. On the contrary, Xiang did not do so. This would lead to differences in the final results (decreasing the correlation coefficient for more than 10 percent).

3.3 Net Stock Issuance

This anomaly is based on annual portfolio. We need to notice the calculation of net stock issuance and the way to group.

- The split-adjusted shares outstanding is shares outstanding (Compustat annual item CSHO) times the adjustment factor (item ADJEX_C))

$$NSI_t = CSHO_t * ADJEX\_C_t$$

- Following Chen, Novy-Marx, and Zhang (2011) , we sort all CRSP stocks into deciles. Particularly, we define all firms with negative net stock issuance as the lowest decile, and define firms with zero net issuance into decile two. Besides, we equally group firms with positive net issuance into eight deciles (labelled as decile 3 to 10).

3.4 Composite Equity Issuance

To be completed.

3.5 Total Accruals

We replicate this anomaly with annual portfolio. Unlike Sloan (1996) [3], Hwang and Liu (2014) standardize total accruals with common equity (CEQ). So we need to drop firms with non-positive common equity.

$$TotalAccruals_t = \frac{(\Delta ACT_t - \Delta CHE_t) - (\Delta LCT_t - \Delta DLC_t)}{CEQ_t}$$

where $\Delta var_t = var_t - var_{t-1}$.

There still are little difference between our final results and Xiang's. Though the way to treat records with non positive CEQ and changed fiscal year explain part of the divergence, we can not get a higher coefficient.

3.6 Net Operating Assets

We replicate this anomaly with annual portfolio.

$$NOA_t = \frac{(AT_t - CHE_t) - (AT_t - DLC_t - DLTT_t - MIB_t - PSTK_t - CEQ_t)}{AT_{t-1}}$$

If we directly drop all records with missing information, we will lose more than 10% sample. And the results might be slightly different. Thus, we fill missing accounting info (item CHE, DLC, DLTT, MIB) with zero, and fill missing preferred stocks following Chen, Novy-Marx, and Zhang (2011).

3.7 Momentum

The momentum anomaly is one of the most influential and popular anomalies. It is based on monthly portfolio. Momentum anomaly are pretty robust to different definitions of the anomaly variable mom. However, to achieve an comparable results with Hwang and Liu (2014), the timeline does matter.

At the end of month m, we sort all CRSP stocks into deciles according to their past returns from month $m-5$ to month $m-1$. The returns in the latest month t is skipped in consideration of short-term reversal of stock returns.

In Figure 4, we illustrate how portfolio are constructed at the end of June.

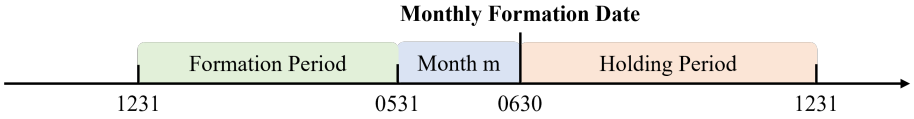

Figure 4: The timeline for Momentum (monthly portfolio)

As presented, it is also worth emphasizing that we hold portfolios for six months. For instance in July, the highest decile actually includes six portfolio: one constructed at the end of June and five portfolio constructed at each month end from February to May. The weight of a stock is its market equity at the formation date.

3.8 Gross Profitability

We replicate this anomaly with annual portfolio.

$$GrossProfitability_t = \frac{Sales_t - COGS_t}{AT_t}$$

3.9 Asset Growth

We replicate this anomaly with annual portfolio.

$$AssetGrowth_t = \frac{AT_t - AT_{t-1}}{AT_{t-1}}$$

3.10 Profitability

The profitability anomaly is replicated with quarterly portfolio. The anomaly variable, ROA, equals quarterly income before extraordinary items (IBQ) divided by quarterly total asset (ATQ). We drop firms with non-positive total assets.

$$ROA_q = IBQ_q/ATQ_q$$

3.11 Investment Ratio

To be completed.

References

[1] B.-H. Hwang and B. Liu, "Which anomalies are more popular? and why," *Unpublished working paper, Purdue University*, 2014.

[2] L. Chen, R. Novy-Marx, and L. Zhang, "An alternative three-factor model," *Available at SSRN 1418117*, 2011.

[3] R. G. Sloan, "Do stock prices fully reflect information in accruals and cash flows about future earnings?" *Accounting review*, pp. 289–315, 1996.