The Chinese University of Hong Kong

NOA Trading Strategy

I. Theoretical Foundation

1. NOA

Net operating assets (NOA), measured as the difference between a company's operating assets and operating liabilities, is a measure of the resources employed by a business to generate revenue, excluding non-operating items like investments and financing activities. Essentially, it is a useful instrument for stakeholders to evaluate a firm's operating performance apart from financing and investing performances.

Based on accounting principles, NOA could be calculated as the difference between the cumulative operating income and cumulative free cash flows, where we regard NOA as the cash value added deviation from its accounting value added.

$$NOA_T = \sum_{0}^{T} Operating\ income_t - \sum_{0}^{T} Free\ Cash\ Flow_t$$

After breaking down the NOA, it is obvious that such indicator is influenced by both the cumulative operating income and free cash flows, which usually fluctuate with time and may not be sustainable. It can be referred to as a "balance sheet bloat" for representing the accumulation of assets that are not necessarily translating into cash flow or immediate profitability. Therefore, it is not wise to evaluate a company's future performance simply based on its NOA behaviors.

Unfortunately, most of investors fail to realize this. With limited horizons, these investors tend to chase companies with relatively higher net operating assets, which inevitably leads to the overvaluation of firms with high NOA and undervaluation of firms with low NOA. Temporarily, high normalized NOA can bring positive earnings due to the overvaluation. While in the long run, as public information penetrates into the market, the mispricing generated by higher NOA will on average be rectified and the overvaluation of high-NOA firms will vanish. Therefore, companies with higher NOA are prone to earn negative abnormal returns in the long term, and those with lower NOA will earn positive long-run abnormal returns. Such phenomenon indicates that the rising trend in earnings generated by high NOA is not subsequently sustainable in the long run, and high NOA could function as a warning signal towards the future profitability of relative investments.

To gain a deeper insight into the factors influencing investor perceptions, we can decompose net operating assets as follows. Given that free cash flow is the difference between cash flow from operations and investments, we derive:

$$\begin{aligned} NOA_T &= \sum_{0}^{T} Operating\ income_t - \sum_{0}^{T} (\ Operating\ Cash\ Flow_t - Investment_t) \\ &= \sum_{0}^{T} \ (Operating\ income\ Before\ Depreciation_t - Opreating\ Cash\ Flow_t + Investment_t \\ &\quad - Depreciation_t) \\ &= \sum_{0}^{T} Operating\ Accruals_t + \sum_{0}^{T} (Investment_t - Depreciation_t) \end{aligned}$$

This transformation indicates that net operating assets comprise two cumulative differences between accounting and cash value added: (Operating Income Before Depreciation - Operating Cash Flow) and (Investment - Depreciation). Therefore, firms with high net operating assets exhibit a significant cumulative deviation between accounting and cash profitability from both operating and investing activities.

The further decomposition of NOA could better explain why investors focusing on accounting income tend to overvalue the firm. Let's take two simple examples to illustrate why a transaction increasing accounting profitability relative to cash-based profitability contributes to balance sheet bloat. First, according to the accrual accounting principles, a firm should record its sales revenue as receivables before it receives the actual cash flows, which increases its net operating assets on book during the interval. Second situation happens when a firm books an expenditure as an investment rather than an expense, common for R&D projects.

$$
\begin{gathered}
Dr \;\; Account\ Receivables \\
Cr \;\; Sales\ Revenue \\
Dr \;\; Investment \\
Cr\ Cash
\end{gathered}
$$

For both examples, the NOA will increase due to the increase of accounting income. However, as time goes by, NOA will decrease with more cash flows received and related entries written off. This explains why the profitability with NOA is not sustainable in the long term.

2. Cause of mispricing

The mispricing of a firm with high NOA can be attributed to various factors in aspects of accounting accruals and investment. Factors might include:

2.1. Investor's Limited Attention

Because there is so much information available, people—including investors—tend to simplify their assessments and decision-making procedures. They often ignore cash flow data in favor of accounting profitability metrics like earnings. Consequently, companies with bloated balance sheets—which are reflected by large NOA—become salient stimuli. Consequently, overvaluation results from investors' failure to account for the unsustainable growth in earnings that is linked to excessive NOA. This can be explained by:

(a) Simplification Bias: When faced with a deluge of information, investors often oversimplify their analyses and concentrate on metrics that are simple to obtain, like profits. They might undervalue the significance of cash flow data.

(b) Availability Heuristic: When making decisions, investors often rely on easily accessible data, such as accounting performance metrics like earnings. They might give this information more weight than other considerations like cash flow. Due to the fact that these companies draw attention as conspicuous stimuli, this heuristic causes them to overvalue businesses with bloated balance sheets (high NOA).

2.2. Managerial Earnings Manipulation

Intentional manipulation of earnings by managers can also result in mispricing. Businesses can generate the appearance of greater profitability by manipulating accounting earnings upward, which can result in overvaluation. This can be explained by:

(a) Representativeness Bias: Past earnings are frequently used by investors as a proxy for a company's potential future performance. By artificially inflating accounting results, managers use this bias to depict the company's profitability in a favorable light. By using this heuristic, investors could overvalue the company without taking the sustainability of the claimed profitability into account.

2.3. Over-Optimism about Investment and Future Profitability

Mispricing may result from investors' overly optimistic views on the connection between their current investments and future profits. This bias is attributable to:

(a) Confirmation Bias: Investors frequently look for data to support their preconceived conceptions or worldviews. They can have unrealistic expectations that higher investment will result in long-term success, which would make them unduly enthusiastic about the future of businesses with high NOA. Firms with high NOA may be overvalued as a result of this bias.

3. Sustainability Effect

High NOA indicates that the company performs well in the accounting accruals and investment aspects, however, it does not necessarily contribute to long-term profitability and returns.

This is due to the fact that companies with large net operating assets typically have recent profit performance that is not sustainable when scaled to account for firm size. This suggests that future profitability is called into question when accounting earnings accumulate without free cash flows accumulating in tandem. An unsustainable upward trend in earnings is linked to high normalized net operating assets, which show relative weakness in cumulative free cash flow relative to cumulative earnings.

Furthermore, when more public information becomes available, it is anticipated that the mispricing brought on by excessive NOA will eventually be corrected. High NOA businesses typically generate negative long-run abnormal returns, whereas low net operating asset businesses typically generate positive long-run abnormal returns. After balance sheet information is made public, the predictability of future stock returns based on NOA is strong and holds significance for at least three years.

II. Empirical Findings & Evidence

In the analysis of Net Operating Assets (NOA) and its impact on stock performance, a hierarchical data analysis method was implemented, and the data used in the analysis covers the period from January 1980 to December 2022, and the stock returns are calculated by the closing price at end of each month. Firstly, companies from the sample were categorized into five different groups based on their market capitalization (MV), which is the market value of equity at the end of the month. This step of categorization was used to determine whether the effect of NOA on stock performance varies with the market value of a company and how the effectiveness of the investment strategy varies with company size.

Following the categorization by market value, each group of companies is further divided into five groups based on their NOA, resulting in 25 unique groups totally. This detailed method of grouping not only helps in a more accurate analysis of the data but also allows for a comprehensive assessment of how NOA affects stock returns and how these effects change with the company's size.

After conducting preliminary statistical analysis, the average stock return in the following month was calculated for each group. As shown in Figure 1, these statistics show the differences in stock performance across various levels of market value and NOA. The initial findings indicate that groups with lower NOA values generally perform better than those with high NOA values, and in the three groups with larger market values, this trend is clearer, that there is a negative relationship between NOA and expected return in one month, which means the smaller the NOA, the higher the expected return. Based on this trend, our strategy is to short the companies with higher NOA levels and long those with lower NOA levels. The reason for both shorting and going long is to create a hedging strategy, which helps to reduce the overall impact of market volatility on the portfolio and lessen the effect of a single market direction (only rising or only falling) on investment outcomes.

To determine our investment cycle, we also calculated the cumulative return for periods of 3 months, 6 months, and 12 months, and then divided by the corresponding period to calculate their average monthly expected return. As shown in the figure, the average expected return is highest for a 3-month cycle at 0.64% after deducting the corresponding transaction cost. Therefore, we have set the cycle to 3 months.

To test which group our strategy works best, from the Figure 2, the results show that Group 3 (MV3) have the highest cumulative 3-month return at 2.77%, and the T-test (7.1478) also indicates that the result is significant for this group, although the Group 1&2 also have relatively high returns, the main reason for not selecting these small companies is that the NOA data of small-cap companies usually contains more noise, which makes it more difficult to accurately capture the company's true operating efficiency and value. The financial data of these companies tends to be more volatile, mainly because these companies may still be in the early stages of business development and their business models are not yet fully stable. In such a context, their operating assets and liabilities often change rapidly and significantly, which has a significant impact on the calculation of NOA. In addition, small-cap companies are highly sensitive to individual events due to their smaller size. For example, the acquisition or loss of a major order, the purchase or sale of key assets can have a significant and direct impact on the company's NOA. This scale effect increases the volatility of the NOA indicator, reflecting the company's short-term financial fluctuations rather than its long-term operating performance. The combination of data instability and scale effect can make the NOA data of small-cap companies appear noisy in some cases. Therefore, NOA-based strategies are not very effective in small-cap companies.

On the other hand, the T-test for the Group 5 with the largest market value also indicates particularly significant results, the decision to not select that group for the strategy implementation is that large-cap companies tend to receive more attention from analysts due to their size and influence, and their financial reports and business dynamics being widely tracked, analyzed, and frequently becoming the focus of financial news and market commentary. This high level of market attention and transparency typically results in stock prices for these companies closely aligning with their intrinsic value, reducing the potential for arbitrage based on unreflected information. Additionally, large-cap companies have rapid updates of market information, and their stock prices tend to react very quickly, further diminish opportunities to exploit market delays. Even if arbitrage opportunities arise, they tend to disappear quickly due to the presence of numerous market participants. In contrast, medium-cap companies may offer more investment opportunities that are overlooked or misunderstood as a result of their relatively lower level of attention. In addition, mid-cap companies also do not have the same high transaction costs as small companies, and because small-cap stocks have lower liquidity, short selling costs are higher, and the amount that can be borrowed is limited, making it difficult to execute the strategies according to expectations.

Furthermore, to examine if our strategy can remain strong under recession, we rerun the codes by limiting the time within the recession period, which is from 1980 to 1990. The result shown in *Figure 4* demonstrates impressive returns all with significant t statistic. Similar as our previous experiment, the middle market value group (MV3) yields the highest return and is the most significant with a t statistic of 9.342. This test proves the resilience of our NOA strategy which can ensure profitability for investors even under difficult scenarios.

According to CAPM, portfolios with high-risk levels generate high returns correspondingly. To examine if the returns of our trading strategy are derived from its inherent high risk rather than behavioral biases, we merged our dataset with the Fama-French Factors dataset, which contains entries of size factors (SMB), value factor (HML), market risk premium (MKTRF) and so on. This enables us to further calculate the excess returns by subtracting the risk-free rate from portfolio returns. Next, by running the regression model of the excess returns on market risk premium, we are able to obtain the alphas of this capital asset pricing model. In total, we have the results like *Figure 5* for each of our 25 groups.

We only kept the results of the NOA1 and NOA5 groups to fill in the *Figure 6* since our strategy is to long the NOA1 set and short the NOA5 set. There are some findings regarding this experiment. Firstly, it is noteworthy that the t statistic of alpha of our long side is quite significant. The middle group (MV 3), the one we decided to apply our trading strategy, demonstrates an extremely significant t statistic of 6.76. This significant alpha indicates that there are some returns that cannot be explained away by the traditional high-risk theory, which supports our behavioral bias theory. For the short side (NOA1), the alpha's t statistic is also significant for all groups, even though it is slightly lower than the long side. Hence, based on the overall results, we consider that for our trading portfolio, the long side contributes most of the excess returns, whereas the short side primarily acts as a hedging role to balance the risks.

Following this t test, concerns such as the limits of arbitrage, and short selling constraints arise, which may hinder our profitability and feasibility if the associated costs are too high. However, the stocks of MV3 group belong to S&P1500, which are relatively easy to trade and borrow with a transaction cost of 20-30bps. With a raw return of 92bps per month, we can cover this cost easily while still maintaining a sound profit. Therefore, we consider that our trading strategy remains strong under these concerns.

Next, to examine if the predictability of our strategy is stable, we performed the Fama-MacBeth Regression for 3-month cumulative returns. As shown in *Figure 7*, the coefficient of our NOA variable is -0.0049, which is extremely significant with a t statistic of -6.8. This demonstrates that our NOA strategy exhibits a very stable predictive power over the cumulative 3-month returns.

Lastly, we did some final tests to ensure our trading strategy based on NOA will not be absorbed by other variables. Here we used accounting accruals and investment to assets as an example. By repeating the Fama-MacBeth Regression test, we found that these variables do not take much predictability away from NOA, with the t statistic (-7.23) of NOA's coefficient still remaining significant as shown in *Figure 8*.

Overall, by conducting various regression and stress tests, our trading strategy remains profitable and sustainable under different scenarios. Hence, we believe that by gripping the key to public investors' behavioral biases towards NOA, our hedge fund can deliver promising returns with low risk for our investors.

III. Appendix

1. Figure 1: the expected return in one month

MV1 Smallest		MV2	MV3	MV4	MV5
NOA1 Lowest	0.895%	1.045%	1.223%	1.103%	1.247%
2	1.049%	1.278%	1.191%	1.227%	1.180%
3	1.195%	1.277%	1.195%	1.154%	1.057%
4	0.985%	0.936%	1.050%	1.115%	0.967%
5	0.458%	0.435%	0.387%	0.548%	0.691%

2. Figure 2: the returns in this table are expected monthly return

Expected Monthly Return After Transaction Cost (*Assume 25bps transaction costs)*						
	MV 1 (smallest)	2	3	4	5	Average
cumulative 12-month	0.27%	0.57%	0.63%	0.48%	0.52%	0.50%
cumulative 6-month	0.33%	0.68%	0.69%	0.48%	0.49%	0.53%
cumulative 3-month	**0.64%**	**0.78%**	**0.84%**	**0.48%**	**0.46%**	**0.64%**
1-month	0.19%	0.36%	0.59%	0.31%	0.31%	0.35%

3. Figure 3: the cumulative raw return of 3 month for portfolio

	MV 1 (smallest)	2	3	4	5
NOA1-NOA5	2.18%	2.59%	**2.77%**	1.69%	1.64%
t stat	6.5947	6.2423	**7.1478**	6.2577	9.7324

4. Figure 4: Cumulative raw 3-month returns for 25 groups, 1980-1990)

	MV 1 (smallest)	2	3	4	5
NOA 1 (lowest)	5.20%	3.80%	4.60%	4.09%	3.95%
beta	1.425605	1.656038	1.550852	1.396821	1.296712
alpha	0.0371946	0.02197	0.0305245	0.0262964	0.025377
t stat of alpha	4.18	2.33	3.3	3.11	3.55
2	4.88%	4.47%	4.23%	4.15%	3.46%
3	4.82%	4.21%	4.31%	3.65%	2.74%
4	3.49%	3.42%	3.42%	3.00%	2.78%
5 (highest)	2.67%	1.40%	1.28%	2.05%	2.29%
beta	1.578853	1.692121	1.768885	1.642619	1.249986
alpha	0.0110428	-0.0022776	-0.0038618	0.004507	0.0090045
t stat of alpha	1.13	-0.23	-0.4	0.49	1.29
NOA1-NOA5	**2.53%**	**2.41%**	**3.32%**	**2.04%**	**1.66%**
t stat	5.525	6.4661	9.342	6.6204	6.5531
Monthly return	**0.84%**	**0.80%**	**1.11%**	**0.68%**	**0.55%**

5. Figure 5: CAPM of Cumulative raw 3-month returns

```
-> G_mv = 3, G_noa = 1

      Source |       SS           df       MS      Number of obs   =       516
-------------+----------------------------------   F(1, 514)       =    153.21
       Model |  2.48393642         1  2.48393642   Prob > F        =    0.0000
    Residual |  8.33311811       514  .016212292   R-squared       =    0.2296
-------------+----------------------------------   Adj R-squared   =    0.2281
       Total |  10.8170545       515  .021003989   Root MSE        =    .12733

------------------------------------------------------------------------------
 ex_ret_f0f1 | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
       mktrf |   1.524751   .1231831    12.38   0.000     1.282747    1.766755
       _cons |   .0383414   .0056681     6.76   0.000     .0272059    .0494768
------------------------------------------------------------------------------
```

```
-> G_mv = 3, G_noa = 5

      Source |       SS           df       MS      Number of obs   =       516
-------------+----------------------------------   F(1, 514)       =    269.25
       Model |  2.63414749         1  2.63414749   Prob > F        =    0.0000
    Residual |  5.02867844       514  .009783421   R-squared       =    0.3438
-------------+----------------------------------   Adj R-squared   =    0.3425
       Total |  7.66282593       515  .014879274   Root MSE        =    .09891

------------------------------------------------------------------------------
 ex_ret_f0f1 | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
       mktrf |   1.570178   .0956917    16.41   0.000     1.382183    1.758173
       _cons |   .0102908   .0044031     2.34   0.020     .0016404    .0189411
------------------------------------------------------------------------------
```

6. Figure 6: Cumulative raw 3-month returns for 25 groups, all time range

cum_rawret_1_3m

	MV 1 (smallest)	2	3	4	5	
NOA 1 (lowest)	5.24%	5.34%	5.20%	4.25%	4.02%	LONG
beta	1.408961	1.597272	1.524751	1.3306	1.215012	
alpha	0.0395635	0.0392571	0.0383414	0.030129	0.0286536	
t stat of alpha	8.05	6.55	6.76	6.88	7.89	
2	4.82%	6.05%	4.60%	4.11%	3.51%	
3	5.65%	4.90%	4.29%	3.78%	3.09%	
4	4.33%	4.00%	3.98%	3.64%	2.84%	
5 (highest)	3.07%	2.75%	2.43%	2.56%	2.38%	SHORT
beta	1.363788	1.557291	1.570178	1.422846	1.201214	
alpha	0.0181063	0.0135826	0.0102908	0.0125927	0.0123718	
t stat of alpha	4.15	2.94	2.34	3.09	3.61	
NOA1-NOA5	**2.18%**	**2.59%**	**2.77%**	**1.69%**	**1.64%**	
t stat	6.5947	6.2423	7.1478	6.2577	9.7324	
Monthly return	0.73%	0.86%	0.92%	0.56%	0.55%	

7. Figure 7: Fama-MacBeth Test - Predictability of NOA on cumulative raw 3-month returns

```
Fama-MacBeth (1973) Two-Step procedure          Number of obs     =   1828044
                                                Num. time periods =       516
                                                F(  2,    515)    =     35.46
                                                Prob > F          =    0.0000
                                                avg. R-squared    =    0.0069
------------------------------------------------------------------------------
             |             Fama-MacBeth
cum_rawre~3m | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      log_mv |  -.0030996     .00061    -5.08   0.000    -.0042979   -.0019013
         noa |  -.0048999    .000718    -6.82   0.000    -.0063105   -.0034893
       _cons |   .0627592   .0072751     8.63   0.000     .0484667    .0770517
------------------------------------------------------------------------------
```

8. Figure 8: Fama-MacBeth Test - Predictability of NOA, Accrual, Investment to assets on cumulative raw 3-month returns returns

```
Fama-MacBeth (1973) Two-Step procedure          Number of obs     =   1442911
                                                Num. time periods =       516
                                                F(  4,    515)    =     38.09
                                                Prob > F          =    0.0000
                                                avg. R-squared    =    0.0125

             |             Fama-MacBeth
cum_rawre~3m | Coefficient  std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
      log_mv |  -.0033239   .0005177    -6.42   0.000    -.0043409   -.0023068
         noa |  -.0101611   .0014056    -7.23   0.000    -.0129226   -.0073996
     accrual |  -.0351971   .0090598    -3.88   0.000    -.0529959   -.0173983
          ia |  -.0009347   .0001388    -6.73   0.000    -.0012075    -.000662
       _cons |   .0675148    .006517    10.36   0.000     .0547117    .0803179
```