The Application of Piotroski's f-Score in Selecting the Company's Stock Market

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Abstract: In general, Piotroski's F-score works in picking out winners among high book-to-market stocks in Europe. The benefits that this fundamental analysis strategy brings are most significant among the largest size value firms over two-year holding period. Given the high F-score, value firms with more R&D expenses tend to have better performance in future returns.

1. Introduction

It is widely observed that value premium exists across the world. There are three explanations for value premiums: The first one is the risk-based factor models developed on efficient market theory. The second one is other market anomalies (such as momentum) based on market inefficiency. They both assume that investors are rational [1]. By contrast, The last explanation implies investors are sometimes emotional instead of fully rational. It interprets observed value premium from behaviour and psychological perspective. Amongst these various explanations and related factor models, which investment strategy to pick?

From the risk-based models, it is noticed that book-to-market and size have impact on market performance. Given the high book-to-market (value) stocks generally outperform low book-to-market (growth) stocks, high book-to-market strategy is raised. From other factors based on market inefficiency, momentum seems to be the most popular factor. By contrast, momentum strategy generally performs better in growth stocks, whereas value strategy suits more to value stocks. When consider the investors' behaviour and preference, this study will concentrate on value stocks [1].

2. Literature Review

This studies aims to assess whether applying the fundamental investment strategy (F-score) is possible to discriminate future winners and earn excess buy-and-hold returns. This not probable to happen in semi-strong efficient market. Thus, the underlying assumption (H0) is that European stock markets are generally not semi-strong efficient markets. To test significance of empirical results, null hypothesis (H_0) is designed as that no subsequent mean return difference between two portfolios, built based on the fundamental financial analysis strategy (F-score) [1]. This null hypothesis (H_0) supports for the semi-strong efficient market view and is what empirical results try to reject. If empirical evidence shows a significant mean difference in future returns, then European stock market is not in semi-strong form.

2.1 High Book-to-Market Investment Strategy & Size Effect

In European stock market, Capaul and his colleagues first classify firms by price-book value, which is the inverse of BM, and find a significant difference exists in returns obtained from portfolios of growth stocks against value stocks. Accordingly, they define a value-growth factor relate to stock price-to-book per share. Based on their empirical evidence, they claim this value-growth factor exists in five European stock markets over 1982 to 1992 period. On average, the value-growth factor

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enables the investment strategy, which is long high BM stocks and short low BM stocks, to earn excess risk-free returns [2].

In a worldwide view, Fama and French also find that value stocks perform better than growth stocks in twelve of thirteen major security markets for the period 1975 through 1995. On global basis, the average annual excess returns is 7.68 percent for hedge strategy using portfolios of high and low BM stocks [2]. They further expand the application to North America, Europe, Japan and Asia Pacific during the 1989 to 2011 period.

2.2 Other Explanations & Strategy Comparison

In nature, value firms (with high book-to-market ratio) usually have more tangible assets than growth firms (with low book-to-market ratio). Accordingly, different equity valuation models are preferred. For example, European analysts prefer to use discounted cash flow valuation models, rather than using accounting based models, for growth firms in their equity research reports [3]. Technically, accounting-based valuation model provides equity valuation with closer to assets and income value. By contrast, discounted cash flow valuation model, which is developed based on estimated future cash flows discounted by market cost of capital, comprises investors and market factors. As a result, mispricing between equity value and intrinsic value is easier to captured in value stocks while investors' future estimation have greater impact on growth equity valuation. This may explain why it is observed that value strategy performs better in value firms and momentum strategy shows a stronger results in growth firms. To sum, fundamental accounting-based analysis may be a more predictable strategy for value firms than for growth firms.

3. F-Score

Piotroski's F-score is a composite financial performance signal as a sum of nine individual financial signals from five aspects. All of these individual signals are binary dummy variables, with favourable signals to be one. Nine proxies from these five aspects are net income before extraordinary items, change in net income, cash flows from operations, difference between net income and cash from operations, change in gross profit margin, change in assets turnover, change in leverage, change in current ratio and whether new common shares are issued. Detailed econometric specifications will be presented later (in the methodology section) [3].

3.1 Financial Performance Signals - Profitability

Profitability is often used as a measure to forecast future returns. Piotroski selects net income before extraordinary items (ROA) and cash flow from operations (CFO) as measures for profitability. ROA and CFO are both scaled on total assets in order to reflect average value-added utility of resources. Change in net income from prior fiscal year (ΔROA) is another indicator. ACCURAL is the last one, defined as net income minus cash flow from operations [4].

3.2 Financial Performance Signals - Leverage, Liquidity and New Issuance

These factors reflect major risks firms face, or key financial boundaries/ceilings for their further development. Leverage links with financial and solvency risks. Piotroski's F-score uses annual change in long-term debt leverage (Δ LEVER) to measure leverage [4]. Liquidity, which measured by changes in current ratio over last fiscal year (Δ LIQUID), is directly related to the liquidity risk. The source of funds is actually measured by whether the firm issued new common equity (EQ_OFFER). Issuing new shares dilutes the share rights on-holding, and is a signal of overpricing. Accordingly, it is also a predictor for market returns. Annual change in long-terms debts leverage (Δ LEVER) is largely caused by raising external capital if total assets are relatively steady. To reduce impact from changes in total assets, average total assets instead of beginning-of-year total assets is used [5].

3.3 Financial Performance Signals - Operating Efficiency

For operating efficiency, Piotroski defines two variables to measure. One is one-year change in gross profit margin (ΔMARGIN). Gross profit margin is gross profit scaled by total sales, which

reflects operational profitability after cost of goods sold [5]. The other is one-year change in assets turnover (ΔTURN). Assets turnover is total sales scaled by total assets. Unlike long-term leverage using average total assets to scale, current year assets turnover reflects how efficient sales are generated by using the beginning-of-year resources (total assets). The change in assets turnover (ΔTURN) signals whether the efficiency has been improved. Favourable direction for both ΔMARGIN and ΔTURN is positive [6].

4. F-Score Application in Selecting the Company's Stock Market

4.1 One-Year Raw Total Returns

From Table 1, it is clear that test 1 (High-Low) is statistically significant at 1% whereas test 2 (High-All) is not.

Table 1 One-Year Raw Total Returns to High Book-to-Market Investment Strategy Based on the Composite Financial Signal (f-Score)

Table 5 One-Year Raw Total Returns to High Book-to-Market Investment Strategy Based on the Composite Financial Signal (F-Score)							
	Mean	10th Percentile	25th Percentile	Median	75th Percentile	90th Percentile	# of Observations
All Firms	0.0162	-0.0249	-0.0034	0.0165	0.0362	0.0549	2073
F-Score							
0	0.0084	-0.0075	-0.0037	0.0013	0.0204	0.0385	4
1	-0.0037	-0.0755	-0.0195	-0.0022	0.0267	0.0504	15
2	0.0075	-0.0566	-0.0249	0.0109	0.0360	0.0643	49
3	0.0104	-0.0325	-0.0113	0.0113	0.0326	0.0482	160
4	0.0181	-0.0232	0.0005	0.0197	0.0373	0.0566	347
5	0.0142	-0.0279	-0.0038	0.0146	0.0346	0.0548	438
6	0.0189	-0.0184	0.0001	0.0179	0.0370	0.0537	422
7	0.0164	-0.0218	-0.0039	0.0142	0.0370	0.0553	357
8	0.0171	-0.0275	-0.0042	0.0166	0.0374	0.0567	223
9	0.0251	-0.0125	0.0064	0.0273	0.0434	0.0652	58
Low Score	0.0051	-0.0566	-0.0199	0.0029	0.0329	0.0611	68
High Score	0.0174	-0.0232	-0.0034	0.0156	0.0376	0.0559	638
High-Low	0.0124	0.0334	0.0166	0.0127	0.0047	-0.0051	-
t-statistics	2.6721	-	-	2.7523	-	-	-
High-All	0.0012	0.0017	0.0000	-0.0009	0.0014	0.0010	-
t-statistics	0.8671	-	-	-0.6479	-	-	-

As predicted in Hypothesis 1, if building portfolio with high F-score firms, then the following one-year raw total returns would be significantly outperform the portfolio built with low F-score firms. High F-score portfolio earns an average 1.024% (1.74% versus 0.51%) higher monthly raw returns than low F-score portfolio. The mean difference of 1.024% is statistically significant at 1% level. Thus, it is consistent with previous expectation (H1) and findings in US market [7].

4.2 One-Year Market-Adjusted Total Returns

Because fiscal year-end date are diverse among firms, the one-year holding period can be actually different calendar period [7]. Also, to reduce influence from various European stock market conditions in each fiscal year, this paper runs same tests for one-year market-adjusted total returns, which excludes the corresponding value-weighted market returns from one-year raw total returns. Market-adjusted returns provide a relative fair view of measuring effect from F-score. After controlling market conditions, it is expected to have more noticeable return difference between the portfolios. From table 1, while the mean excess monthly return improves from 1.62% to 1.79%,

excess median yield declines. When looking into returns' positive percentage (table 2) and distribution of returns (figure 1), this can be explained by average negative returns resulting from more but not strong positive returns and less but extreme low returns amongst value firms in European stock markets [8].

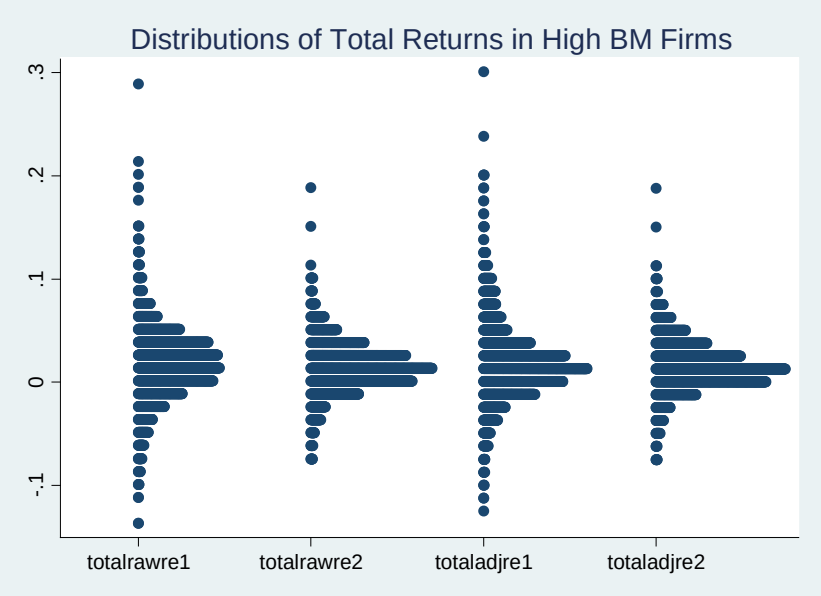

Fig.1 Distributions of Total Returns in High Bm Firms

4.3 Positive Returns Proportion & f-Score

This table (table 2) helps understand the relationship between positive return distribution and F-score distribution. It is also used to explain the difference between mean and median [8].

Table 2 Positive Percentage Of Returns

Table 9 Positive Percentage of Returns				
F-score	Raw Return1	Adj. Return1	Raw Return2	Adj. Return2
0	75.0%	50.0%	25.0%	50.0%
1	46.7%	60.0%	46.7%	46.7%
2	55.1%	53.1%	57.1%	57.1%
3	63.8%	63.8%	66.7%	67.3%
4	76.1%	74.6%	76.2%	78.0%
5	69.4%	71.5%	75.6%	78.5%
6	75.1%	74.4%	79.5%	78.8%
7	68.3%	72.0%	76.8%	79.8%
8	72.2%	72.6%	81.6%	79.8%
9	81.0%	82.8%	91.4%	87.9%

Note: Raw Return1 is one-year raw returns; Adj. Return1 is one-year market-adjusted returns; Raw Return2 is two-year raw returns; Adj. Return2 is two-year market-adjusted returns. Figured presented are positive percentage of respective returns.

As table 2 presents, lowest positive percentage has either 0 or 1 F-score; High BM firms with highest F-score also have the highest positive percentage. Therefore, positive proportion ofsubsequent returns is also in line with high F-score, especially for firms with more favourable financial signals.

4.4 Additional Test - Test of Different High & Low f-Score Classification

Based on the defined low F-Score group (0, 1 and 2) and high F-Score group (7, 8, and 9), it generates 706 observations for high versus low F-Score portfolio (test 1), and 638 observations for

high F-Score firms versus all high BM firms (test 2). Further study will carry on using the defined high and low F-score classification if the test results remain consistent.

Table 3 Statistics of Total Returns in Different High and Low f-Score Classifications

Table 10 t Statistics of Total Returns in Different High and Low F-Score Classifications					
	Return1_t	Mkt Ret1_t	Return2_t	Mkt Ret2_t	# of Obs.
Panel A: Classify 0 - 2 As Low F-Score					
Classify 9 as High F-Score					
High-low	2.967	3.617	3.541	3.541	126
high-all	2.310	2.271	3.143	3.143	58
Classify 8 & 9 as High F-Score					
High-low	2.693	3.326	3.439	3.439	349
high-all	1.165	1.449	2.472	2.472	281
Classify 7 - 9 as High F-Score					
High-low	2.672	3.393	3.172	3.172	706
High-all	0.867	1.676	2.223	2.223	638
Panel B: Classify 0 - 3 As Low F-Score					
Classify 8 & 9 as High F-Score					
High-low	2.888	3.184	4.114	4.114	508
High-all	1.165	1.449	2.472	2.472	281
Classify 7 - 9 as High F-Score					
High-low	3.015	3.498	4.181	4.181	865
High-all	0.867	1.676	2.223	2.223	638

Note: Return1_t represents t statistics of one-year total raw returns ; Mkt Ret1_t represents t statistics of one-year market-adjusted total returns; Return2_t represents t statistics of two-year total raw returns; and t statistics of Mkt Ret2_t represents two year market-adjusted returns.

This additional test is to check whether expanding (or shrinking) sample sizes of High and Low F-score portfolios would significantly influence the results. As table 3 presents, when classifying high and low F-Score differently, the results are consistent no matter in larger or smaller sample size [9].

4.5 Returns on Size Partition

To test whether F-score is a proper indicator to choose future winners with different sizes, this study ranks all samples into three groups (small, medium and large) based on individual market capitalization in prior year-end using data obtained from S&P Capital IQ Platform. Small size firms are defined as firms ranking at the bottom third of last year's market capitalization. The formation of small, medium and large size portfolios is independent of the high BM category. S&P Capital IQ yields 10,589 observations with adequate financial information in European market. Within the high BM portfolio, 899 (43.37%) observations are allocated to small size, 587 (28.32%) to medium size, and 587 (28.32%) to large size. Table 4 shows one-year market-adjusted total returns conditional on these three size categories. Unlike findings in US [9], evidence in European stock market show different results in one-year and two-year returns after applying the fundamental financial analysis strategy. Thus, this study also run tests for two-year market-adjusted total returns on the same size category (represented in table 5).

Table 4 Size Partition On Two-Year Market-Adjusted Total Returns for High Book-to-Market Firms

Table 13 Size Partition on Two-Year Market-Adjusted Total Returns for High Book-to-Market Firms									
	Small Firms			Medium Firms			Large Firms		
	Mean	Median	# of Obs.	Mean	Median	# of Obs.	Mean	Median	# of Obs.
All Firms	0.0171	0.0150	894	0.0149	0.0119	587	0.0126	0.0107	587
F-Score									
0	-0.0168	-0.0168	1	0.0046	0.0046	1	-0.0005	-0.0005	2
1	0.0210	0.0120	5	-0.0075	-0.0047	6	0.0043	0.0010	4
2	0.0098	0.0068	25	0.0153	0.0090	12	-0.0033	-0.0047	12
3	0.0095	0.0110	72	0.0122	0.0114	43	0.0087	0.0094	44
4	0.0180	0.0166	138	0.0147	0.0109	113	0.0113	0.0094	94
5	0.0154	0.0148	179	0.0187	0.0138	128	0.0127	0.0107	131
6	0.0181	0.0148	168	0.0135	0.0121	111	0.0125	0.0107	141
7	0.0195	0.0163	156	0.0118	0.0097	107	0.0176	0.0135	94
8	0.0199	0.0147	117	0.0175	0.0171	54	0.0100	0.0097	52
9	0.0203	0.0178	33	0.0268	0.0195	12	0.0266	0.0283	13
Low Score	0.0107	0.0068	31	0.0075	0.0046	19	-0.0013	-0.0014	18
High Score	0.0197	0.0159	306	0.0146	0.0125	173	0.0159	0.0128	159
High-Low	0.0090	0.0091		0.0071	0.0079	-	0.0172	0.0142	-
t-statistics	1.8731	1.9022	337	1.2369	1.3752	192	3.4516	2.8522	177
High-All	0.0026	0.0009		-0.0003	0.0006	-	0.0033	0.0020	-
t-statistics	1.7839	0.6299	306	-0.1528	0.3413	173	2.1231	1.3019	159

4.6 Alternative Explanations & Robustness Tests

As they may correlated with F-score, momentum, accruals, and new issuance of shares are argued to be alternatives for the observed return patterns [10]. Model 1 is the basic model Piotroski designed to test the robustness of F-score's explanation power to return after controlled the size and book-to-market value and whether alternative explanation is possible.

Table 5 Model 1 Regression Results

	1	2	3	4
	MA_RET	*MA_RET*	*MA_RET*	*MA_RET*
log(MVE)	-0.00307***	-0.00303***	-0.00240***	-0.00238***
	(-6.55)	(-6.48)	(-4.74)	(-4.71)
log(BM)	0.00371***	0.00372***	0.00351***	0.00352***
	(14.46)	(14.54)	(13.65)	(13.73)
F_SCORE		0.00157***		0.00148***
		(3.24)		(2.91)
MOMENTUM			0.00147	0.00169*
			(1.58)	(1.81)
ACCRUAL			0.00376	0.00472
			(0.55)	(0.69)
EQ_OFFER			-0.00000765	-0.00000642
			(-1.45)	(-1.22)
_cons	0.0417***	0.0327***	0.0376***	0.0293***
	(12.17)	(7.44)	(9.87)	(6.16)
N	2111	2111	1685	1685
R-sq	0.106	0.11	0.114	0.118
t statistics in parentheses				
* p<0.1, **p<0.05, *** p<0.01				

Note: From table 5:

Result 1, contain only two control variables for book-to-market and size risk factors. This is base group for coefficients in risk-based factors.

Result 2 shows the F-score has statistically significant power to predict the future returns.

Result 3 is the model without F-score. Neither alternatives is significant. Thus, they are not likely account for the observed excess returns.

Result 4 combined all factors together, F-score remain strongest factor. Thus, F-score's predication power is robust after considering momentum, accruals and new issuance. While F-score remain the only key explanation for future returns, momentum helps to earn a roughly 0.17% higher monthly yield. These results are consistent with Piotroski's findings of significance level and direction.

4.7 Sensitivity Test - Individual Signal Effects

Returns' sensitivity to individual signal is test through the below pooled cross-sectional model.

$$\text{MA\_RET} = \alpha + \beta_1 \log(MVE) + \beta_2 \log(BM) + \beta_3 F\_ROA + \beta_4 F\_\Delta ROA + \beta_5 F\_CFO + \beta_6 F\_ACCRUAL + \beta_7 F\_\Delta LIQUID + \beta_8 F\_\Delta LEVER + \beta_9 EQ\_OFFER + \beta_{10} F\_\Delta MARGIN + \beta_{11} F\_\Delta TURN$$

This sensitivity test is to assess whether individual signal contributes to subsequent returns. This helps to address the alternative explanation that the observed excess return is driven by single financial signal instead of the comprehensive F-score. Book-to-market ratio and size are still treated as control variables. The individual signal effect is tested separately and combined with controlling other variables. Given the various combinations and too many yields, detailed results will not be displayed. Except ΔLIQUID, the remaining individual financial signals are statistically significant and in line with expected direction, when controlled other variables [10].

5. Summary

In relation to literatures, three main reasons why this paper choose fundamental financial analysis investment strategy (F-score):

Firstly, based on value generally outperform growth findings, this paper tend to use high BM investment strategy (focusing on value firms). Fundamental financial analysis strategy may fit more to value stocks than momentum strategy do.

Secondly, try to find a strategy both consider the rational and emotional factors. Limited to time, instead of build a new model, this paper find fundamental financial analysis may comprise higher excess returns to reasonable 'naïve investors' preference.

Thirdly, when considering the transaction cost, low turnover strategy tend to have higher capacity to realise excess returns in comparison to high turnover strategy. Piotroski's F-score is one of the low turnover strategy.

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