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QRAFT Market Anomaly Series

Enhancing Growth Portfolio:
G-Score with Low BM Tilting

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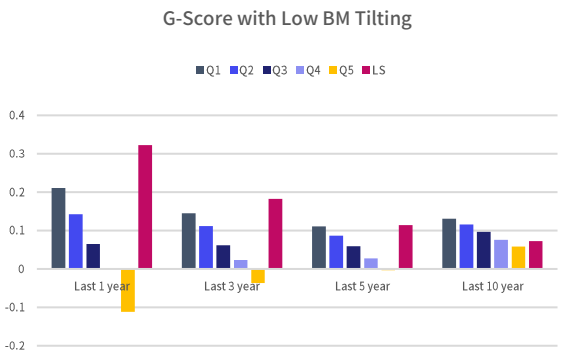
Summary

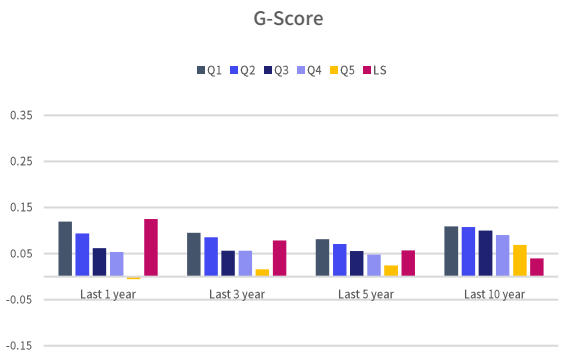
Growth Stock have been doing well lately. IWF, an ETF based on Growth Stock in the past 5 years, is, observed to outperform SPY, an ETF tracking the S&P 500. Growth Stocks usually mean companies with low book-to-market(BM). A low BM means that the market value is too high or the book value is low, and the high market value is likely to change into a bubble if such an increase in firm's value is not achieved. As these growth stocks are exposed to downside risks, fundamental analysis is important. Fundamental analysis is a traditional investment method and is considered an important factor from the past to the present. By combining the results of fundamental analysis with growth stocks, growth stock's exposure to downward risk can be reduced and the probability of mispricing can be greatly reduced.

Mohanram(2005) suggested G-Score as a model that expanded F-Score in terms of growth. G-Score captures a company's growth signal by adding several variables and growth variables that were covered in the existing F-Score, and the costs that are considered as intangible assets such as R&D Expense and Advertisement Expense that have been in the spotlight recently. We maximize the effectiveness of the strategy through fundamental analysis based on this growth and Low BM tilting that gives more weight to growth stocks.

When examining the performance of entire period, it was confirmed that G-Score achieved excess returns. The results of low BM tilting on the G-Score showed better results than the general G-Score. In the result of the past 5 years, it was observed that the explanation and robustness of the factor also became more pronounced in recent years. Furthermore, even when comparing the performance of F-Score and G-Score showed better performance in recent years.

G-Score with Low BM Tilting



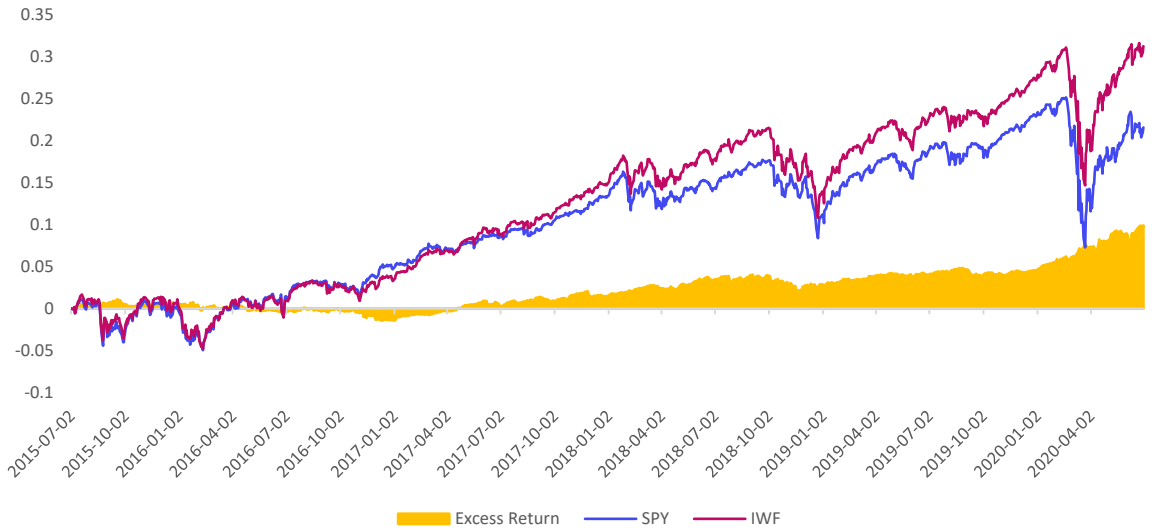


Source: Qraft Technologies, Compustat

Background

Growth stocks have been doing well lately. [Figure 1] shows the recent performance of the iShares Russell 1000 Growth ETF(IWF), is an ETF based on the growth stock and SPY(SPDR S&P 500 ETF Trust), is an ETF tracking the S&P 500. IWF ETF has been outperforming SPY for past 5 years.

Figure 1. IWF and SPY ETF Log Return of recent 5 years



Source: Qraft Technologies, Compustat

Growth Stocks mean companies with low book-to-market(BM). Growth Stock attract market attention and interest due to an increase in market value compared to book value. What are the risks of low BM Growth Stocks? Low BM means that the market value is high or the book value is low. High market value is likely to change into a common bubble if such an increase in firm's value is not achieved. Most Growth Stocks have experienced high market performance based on short-term issues and facts exposed to the media rather than financial statements. In this case, exposure to downside risks is inevitable, and the expected rate of return may be lower for Growth Stocks that already have relatively high stock prices.

In other words, fundamental analysis is equally important for Growth Stocks with low BM as well as firms with high BM. Fundamental analysis on financial statements is a traditional investment method and is considered an important factor from the past to the present. By combining fundamental analysis results with Growth Stocks, Growth Stock's exposure to downside risk will be reduced and the probability of mispricing will be greatly reduced.

In general, the perspective of fundamental analysis differs depending on the philosophy and values of the subject of the investment, but there are models well-known by Quants. Piostroski(2000)[1] proposed F-Score as a quant investment method based on the fundamentals of financial statements. F-Score has 4 variables (ROA, Cashflow ROA, dROA, ACC) representing profitability indicators, 2 variables(dMargin, dTurn) representing changes in the efficiency of firm operations, and 3 representing changes in capital structure and future debt repayment capacity.

[1] Piotroski, Joseph D., 2000, Value investing : The use of historical financial statement information to separate winners from losers, Journal of Accounting Research 38

It consist of 4 variables (dLever, dLiquid, Eq). However, F-Score is strong to identify firms that are performing poorly with risk of listing abolishment, and is there suitable for companies with high BM potential to face financial risks. Mohanram(2005)[2] suggested G-Score as a model that expanded this F-Score in terms of growh. G-Score captures the company's growth signal by adding several variables related to F-Score and growth. It is not only grasp about the basic current financial structure, but also considering costs that are considered as intangible assets such as R&D expenses and advertisement expense that recently been spotlighted. These variables have become more important factors in recent years, and in fact, R&D costs related to intangible assets have resulted in high financial market performance(Li, 2011)[3].

This paper examines G-Score with more focus on growth stocks and checks performance at past. And to maximize the performance of G-Score, tilt low book-to-market to give more weight to growth stocks. In addition, the usefulness of strategy is verified by comparing the recent performance of G-Score and F-Score.

G-Score Components

G-Score is calculated by adding of 8 indicator values as shown in the above formula. The description of each detail item is as follows.

$$G - Score = G1 + G2 + G3 + G4 + G5 + G6 + G7 + G8$$

G-Score captures a total of three main components through financial analysis. The first is to capture fundamental signals through the performance of a firm's profitability and cash flow. When calculating this factor, we assume that the current revenues imply future revenues. If the current profit connotes future profit, the firms that are currently profitable are fundamentally strong and their strong fundamentals may last in the future. There are 2 ways to measure profitability.

Signals based on Earnings and Cash flow Profitability

1) G1 : ROA(Return on Assets)

$$\boldsymbol{ROA} = \frac{\boldsymbol{Net\ Income\ before\ extraordinary\ items}(item\ IB)}{\boldsymbol{Average}(\boldsymbol{Total\ Asset}(item\ AT)_{\boldsymbol{t}}\ ,\ \boldsymbol{Total\ Asset}(item\ AT_{\boldsymbol{t-1}}))}$$

ROA(Return on Assets) is one of the ratio that measure how well a gross asset is converted to revenue. In this case, total assets are measured by the averaging the previous period (t-1) and the current(t) total assets. After the firms in the investment universe are classified based on the SIC(Standard Industrial Classification)[4] 2-Digit Code, and the firms with ROA above the median value of each industry for each period are assigned a value of 1, else 0.

[2] Mohanram, Partha S., 2005, Separating winners from losers among low book-to-market stocks using financial statement analysis, Review of Accounting Studies 10, 133-170
[3] Li, Dongmei, 2011, Financial constraints, R&D investment, and stock returns, Review of Financial Studies 24, 2974-3007
[4] SIC (Standard Industrial Classification) refers to a system for classifying industrial groups by a 4-digit code. Because it has a hierarchical structure, using first 2 digits(2-Digit Code) means that it is divided into slightly larger categories.

(2) G2 : Cash flow ROA

$$\textbf{Cash flow ROA} = \frac{\textbf{Cash flow from operation}\ (item\ OANCF)}{\textbf{Average}(\textbf{Total Asset}(item\ AT)_{t}\ ,\ \textbf{Total Asset}(item\ AT_{t-1}))}$$

Next, we calculated the ROA using cash flow. For this score, only cashflow from operating activities are used, and denominators are measured in the same manner as in G1. Mohanram(2005) argues that earnings of a company in its early stage is less meaningful than cash flow, due to the high depreciation cost of companies which invest heavily in fixed or intangible assets. Since depreciation or amortization is not cash flow, accounting performance may be less useful than cash flow. The firms with cash flow ROA above the median value of each industry in each period are assigned a value of 1, else 0.

(3) G3 : Accrual Component

$$\textbf{Accrual} = \textbf{Cash flow from operation}(item\ OANCF) - \textbf{Net Income before extraordinary items}(item\ IB)$$

Sloan(1996)[5] revealed that companies with larger accrual components in the company's earnings are likely to have a potentially lower quality of earnings, and thus perform poorly in the financial markets in the future. Accrual is usually defined as income generated with non-cash basis, and is the remainder of net income minus earnings with cash basis. We categorize 1 if the firm's cash flow of operating activities exceeds net in come, and 0 otherwise.

Signal With Extrapolation[6]

(4) G4 : Earnings Variability

$$\textbf{Earnings Variability} = Rolling.Std\ (\frac{\textbf{Net Income before extraordinary items}(item\ IBQ)}{\textbf{Total Asset}(item\ ATQ_{t-1})})$$

For growth firms with low BM, profit stability can help distinguish between firms with relatively solid outlook and short-term-orientated, overvalued firms. At this time, the stability of profit is simply derived using past trends. According the Barth, Elliott and Finn(1999)[7] , firms whose previous profits were stable are more likely to reward investor in the stock market. This is because these firms may have higher probability of quality earnings in the future. To measure the stability of profits, we calculated the volatility of firm's profit for past 16 quarters. The data must exist for at least six quarters, and we categorize the measured volatility by SIC Code. The value of 1 is assigned if it is lower than the median value of each industry and 0 otherwise.

[5] Sloan, R., 1996, Do Stock Prices Fully Reflect Information in Accruals and Cash Flows about Future Earnings, The Accounting Review 71, 289-316
[6] The action of estimating or concluding something by assuming that existing trends will continue or a current method will remain applicable.
[7] Barth, M., J. Elliott and M. Finn, 1999, Market Rewards Associated with Patterns of Increasing Earnings, Journal of Accounting Research 37-2, 387-413

(5) G5: Sales Growth Variability

$$\textbf{Sales Growth Variability} = Rolling.Std(\frac{\textbf{Sales}(item\ SALEQ)_t}{\textbf{Sales}(item\ SALEQ)_{t-1}} - 1)$$

For G5, the growth stability is measured. Firms with stable growth are less likely to have earned it by chance and may have a relatively higher future growth potential. We measure scores based on sales, not operating profit, because it is rather ambiguous to define the profits of companies with negative operating profits. In addition, quite a few companies with low BM showed negative operating profit values. Therefore, we focus on the growth of sales, not the growth of operating profit, and measure the volatility of sales growth rate over the past 16 quarters. Again, the data must exist for at least 6 quarters, and categorize volatility using the SIC Code. We categorize using binary classification in the same manner used for the above G4 scores. For the same reason as the G4 above, the use of stocks with no data for at least 6 quarters is less valid because there are too few samples or revenue for the company.

Signals Related to Accounting Conservatism

The last 3 signals are measured on the basis of R&D Expense, Capital Expenditures and advertisement Expense. These accounts may harm the company's profits and book value; but it is also possible to promote future growth. Even when the intangible assets are grown R&D expenses and advertising expenses are taken as expenditures, so the possibility of asset return of costs is also implied, thereby solidifying the growth signal.

(6) G6 : R&D Expense

$$\textbf{R\&D Expense} = \frac{\textbf{R\&D Expense}(item\ XRD)_t}{\textbf{Total Asset}(item\ AT)_{t-1}}$$

The Strength is measured based on companies with high R&D costs. To calculate the score, we use the ratio of R&D cost and the total assets(Rca Factor[8]). The denominator uses previous quarter's total asset. R&D cost compared to total assets is categorized using SIC Code, and if it is higher than the median value of the industry to which each company belongs, a value of 1 is assigned and otherwise 0.

(7) G7 : Capital Expenditure

$$\textbf{Capital Expenditure} = \frac{\textbf{Capital Expenditure}(item\ capx)_t}{\textbf{Total Asset}(item\ AT)_{t-1}}$$

For capital expenditure metric, it is divided by total assets of previous quarter. The ratio is categorized using SIC Code, and we use binary classification, comparing with industry median value.

[8] [QRAFT Market Anomaly Series 001] R&D capital-to-assets, 2020 (https://www.qraftec.com/research/2020/6/14/qraft-market-anomaly-series-001-rampd-capital-to-assets)

(8) G8 : Advertisement Expense

$$\textbf{Advertisement Expense} = \frac{\textbf{Advertisement Expense}(item\ xad)_t}{\textbf{Total Asset}(item\ AT)_{t-1}}$$

Advertisement Expense is measured as advertisement expense relative to total asset of previous quarter. Then, it is categorized by the SIC Code, and if it is higher than the median value of the industry to which each firm belongs, a value of 1 is assigned and otherwise 0. In fact, depending on whether the business orientation is B2C or B2B, the cost expenditure pattern is different, so it may be ambiguous to classify it using only the SIC Code. It is appropriate to look at whether the advertising cost is a bleeding competition to protect existing profits or to stay ahead in growth industry.

Table 1. Definition of Each Variables and Criteria

Comp	Name	Definition	Criteria
G1	ROA	$\frac{Net\ Income\ before\ extraordinary\ items(item\ IB)}{Average(Total\ Asset(item\ AT)_t\ ,\ Total\ Asset(item\ AT_{t-1})}$	Industries in each period (based on SIC 2-Digit Code) are assigned 1 to firms with ROA above the median value, and 0 otherwise.
G2	Cash flow ROA	$\frac{Cash\ flow\ from\ operation\ (item\ OANCF)}{Average(Total\ Asset(item\ AT)_t\ ,\ Total\ Asset(item\ AT_{t-1})}$	Industries in each period (based on SIC 2-Digit Code) are assigned 1 to firms with Cashflow ROA above the median value, and 0 otherwise.
G3	Accrual Component	$Cash\ flow\ from\ operation(item\ OANCF) - Net\ Income\ before\ extraordinary\ items(item\ IB)$	If Cash flow of operating activities exceeds the net income, 1 is assigned and 0 otherwise.
G4	Earnings Variability	$Rolling.Std\ (\frac{Net\ Income\ before\ extraordinary\ items(item\ IBQ)}{Total\ Asset(item\ ATQ_{t-1})})$	Industries in each period (based on SIC 2-Digit Code) are assigned 1 to firms with Earnings Variability below the median value, and 0 otherwise.
G5	Sales Growth Variability	$Rolling.Std(\frac{Sales(item\ SALEQ)_t}{Sales(item\ SALEQ)_{t-1}} - 1)$	Industries in each period (based on SIC 2-Digit Code) are assigned 1 to firms with Sales Growth Variability below the median value, and 0 otherwise.
G6	R&D Expense	$\frac{R\&D\ Expense(item\ XRD)_t}{Total\ Asset(item\ AT)_{t-1}}$	Industries in each period (based on SIC 2-Digit Code) are assigned 1 to firms with R&D Expense above the median value, and 0 otherwise.
G7	Capital Expenditure	$\frac{Capital\ Expenditure(item\ capx)_t}{Total\ Asset(item\ AT)_{t-1}}$	Industries in each period (based on SIC 2-Digit Code) are assigned 1 to firms with Capital Expenditure above the median value, and 0 otherwise.
G8	Advertisement Expense	$\frac{Advertisement\ Expense(item\ xad)_t}{Total\ Asset(item\ AT)_{t-1}}$	Industries in each period (based on SIC 2-Digit Code) are assigned 1 to firms with Advertisement Expense above the median value, and 0 otherwise.

Methodology

In order to examine G-Score performance, this analysis defines the investment universe as shown below and forms an equal weighted portfolio and market value weighted portfolio.

- ✓ Investment Universe : Top 20% Market value of NYSE + NASDAQ
- ✓ Weight : Equal Weight and Market value Weighted
- ✓ Benchmark : S&P500
- ✓ Rebalancing : Half-Yearly Rebalancing

Figure 2. QRAFT Kirin API Code

```
elif factor_name == 'G':
        backtest_mode = False
        # G1
        ib = api.high_level.equity.get_fundamental_data('ib', backtest_mode=backtest_mode).resample('1Q').last()
        at = api.high_level.equity.get_fundamental_data('at', backtest_mode=backtest_mode).resample('1Q').last()
        avg_at = (at + at.shift(4)) / 2
        roa = (ib / avg_at.replace(0, np.nan))
        G1 = industry_median_binary(roa, criteria='high').dropna(axis=1)

        .
        .
        .

        # G8
        xad = api.high_level.equity.get_fundamental_data('xad', backtest_mode=backtest_mode).resample('1Q').last()
        xad_at = (xad/at.shift(4)) # Deflated by one-year-lagged total assets
        G8 = industry_median_binary(xad_at, criteria='high').dropna(axis=1)

        bm = api.high_level.equity.get_book_to_market(ffill=True).resample('1Q').last()
        G1, G2, G3, G4, G5, G6, G7, G8, bm = sync_index([G1, G2, G3, G4, G5, G6, G7, G8, bm])
        G1, G2, G3, G4, G5, G6, G7, G8, bm = sync_column([G1, G2, G3, G4, G5, G6, G7, G8, bm])

        G = G1+G2+G3+G4+G5+G6+G7+G8

        # Low BM Tilting
        G = (G * -z_score(bm))
        G = G.resample('1M').pad().shift(12).dropna(axis=1, how='all').dropna(axis=0, how='all')

        rebalancing = [6,12]
        sub_port = True

        return G, rebalancing, sub_port
```

Source: Qraft Technologies

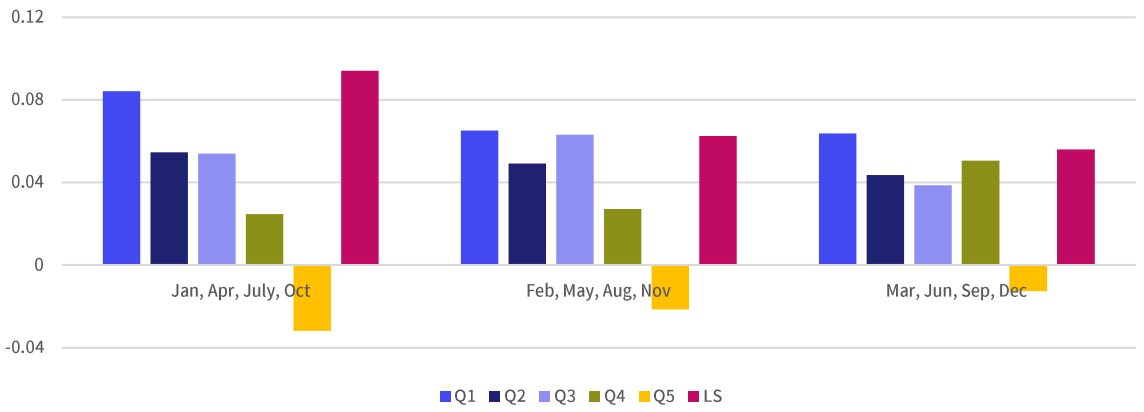
[Figure 2] shows the code to configure G-Score using our Kirin API. Data required for variable assignment is called through the Kirin API. Since the data are lagged by 12-months totally, when the data is called, the 'backtest_mode' parameter is set equal to False, and the called data are reorganized using quarterly data. In addition, for total assets(item AT) used in this analysis, the value of avg_at variable is assigned because the average of the values from the previous year(t-1) and the current year(t) is used. After that, the values derived through the method of industry_median_binary are classified into industry groups based on the SIC 2-Digit code, and a value of 1 is assigned if it is higher than the median value and 0 otherwise. The investment portfolio is constructed by re-indexing both the index(datetime) and columns(stocks) of all data and finally tilting the book-to-market value in G-Score.

Sub-Portfolios for Robustness

Before verifying the effectiveness of the factor, there is a point to note. If the rebalancing cycle is at regular intervals, the portfolio performance will be greatly affected by the calendar month of rebalancing. In the case of quarterly rebalancing, the portfolio will be held for the first quarter(3-month) after rebalancing. Depending on when the rebalancing started, there are a total of three cases, (Jan, April, July, Oct), (Feb, May, Aug, Nov) and (Mar, Jun, Sep, Dec). Similarly, for half-yearly rebalancing, we have 6 back-test cases and 12 for annual. For monthly rebalancing, we do not have separate cases, so there is no need to consider them.

As an example, we briefly examine whether a difference in performance exists in 12-1m momentum factor, which is one of the major factors, for quarterly rebalancing. Like [Figure 3] shows that there is a difference of Performance of 12-1m momentum depending on rebalancing period. The investment universe is defined the top 20% of the market cap based on the NYSE+NASDAQ stocks. The period is from Jan 1991 to May 2020.

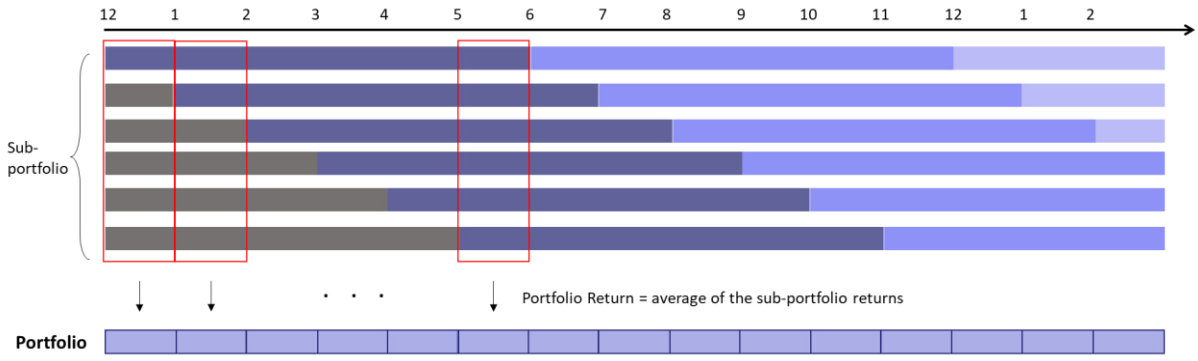
Figure 3. 12-1M momentum portfolio returns



Source: Qraft Technologies, Compustat

For portfolios that started rebalancing in the order of (Jan, Apr, Jul, Oct), the linearity of the portfolio returns of each quintile of the factor is strong and the size of the long-short return also increased. On the other hand, for portfolios rebalancing in Feb, May, Aug, Nov, it can be seen that the 3rd quintile return is similar to that of the 1st quintile, and the size of long-short return is also relatively low when compared to the first case. In addition, for portfolios in (Mar, Jun, Sep, Dec), the 4th quintile returns were larger than those in the 2nd and 3rd quintile, and the long-short returns were also lowest among three cases, indicating that the trend was inconsistent.

Figure 4. Sub-portfolios for robustness



Source: Qraft Technologies

This performance can be caused by a calendar effect or a seasonal effect(1989, Keim[9]), and this effect is likely to get worse when using financial data. Unless you are rebalancing every month, the effect of the portfolio commencement month can be reflected, and in order to prevent such distortion, the above method can be used to more firmly grasp the tendency of the pure factor effect. In this article, half-annual rebalancing is conducted. To offset the above-mentioned effects, a portfolio is composed as shown in [Figure 4] below.

① Sub-Portfolio held from Jan(1) to Jun(6) rebalancing at the end of Dec
② Sub-Portfolio held from Feb(2) to Jul(7) rebalancing at the end of Jan
③ Sub-Portfolio held from Mar(3) to Aug(8) rebalancing at the end of Feb
④ Sub-Portfolio held from Apr(4) to Sep(9) rebalancing at the end of Mar
⑤ Sub-Portfolio held from May(5) to Oct(10) rebalancing at the end of Apr
⑥ Sub-Portfolio held from Jun(6) to Nov(11) rebalancing at the end of May

If the portfolio is rebalanced every six months, there will be a total of six portfolios depending on the calendar month of rebalancing. For example, portfolio return from the end of May to June is calculated the average of ①~⑥ sub-portfolios return in [figure 4]. In other words, the final portfolio is composed by combining different portfolios with equal weight according to the rebalancing start month. This offsets the effect of different rebalancing start months for the same factor, and allow you to look at the general trend of the factor(Hou 2020[10] , Liu 2014 [11]). In our code shown in [Figure 2], the above method can be implemented through the 'rebal_port = True' parameter and if the parameter is set to False, portfolio rebalancing is performed only in the specified month.

[9] Keim, Donald, 1989, The case of common stocks at calendar turning points, Journal of Financial Economics 25, 75-98
[10] Kewei Hou, Chen Xue, Lu Zhang, 2020, Replicating Anomalies, The Review of Financial Studies 33-5, 2019–2133
[11] Laura Xiaolei Liu, Lu Zhang, 2014, A Neoclassical Interpretation of Momentum, Journal of Monetary Economics 67, 109-128

Low BM Tilting Method

In this article, we look at the results of G-Score with and without tilting to BM. The reason for the tilting of BM, as mentioned above, it is possible to expect better performance if companies with growth signals are calculated using both the G-Score and BM.

$$Low\ BM\ Tilting\ G-score\ = G-Score \times z-score(-1 \times Book\ to\ Market)$$

There are many ways to tilt the factor, but in this paper, the method of multiplying the G-Score by BM's Z-Score is used. In this way, G-Score is reflected more to companies with low BM in the existing G-Score, and reflected less for companies with large BM. This is similar to Russell's Tilt-tilt method[12]. Russell's Tilt-tilt method is a form that multiples the based market value by the product of two factor scores, as shown in the following equation.

$$Tilting\ weight\ = Cap\ weight \times \{z-score(factor\ 1) \times z-score(factor\ 2)\}$$

This can be mainly interpreted in two ways. First, by tilting from factor 1 to factor 2 (or factor 2 to factor 1), a new factor is generated to add weight to the market value. This can be understood as a multi-factor configuration combining factor 1 and factor 2. Second, multiply the market value weight by the z-score(factor 1) to calculate the weight of stocks tilted from the market value to factor 1. After that, multiply it by z-score(factor 2) again to tile the weight tilted to factor 1 once again to factor 2.

In the end, both have the same meaning, but the former is focused on constructing a multi-factor that combines the two factors by multiplying each factor's Z-Score, and the latter means that the effect of factor1 is tilted to factor 2. In this paper, similar to the former concept, the factor calculated by G-Score is multiplied by the Z-Score of (-1) × BM. Though this, a new G-Score with an effect of weighting low BM (Growth Stock) from the existing G-Score was calculated.

[12] FTSE Russell, 2016, Comprehensive Factor Indexes

Historical Performance of G-Score

Based on G-Score, the results of the quintile portfolio composed from July 1988 to June 2020 are as follows.

Figure 5. EW portfolio

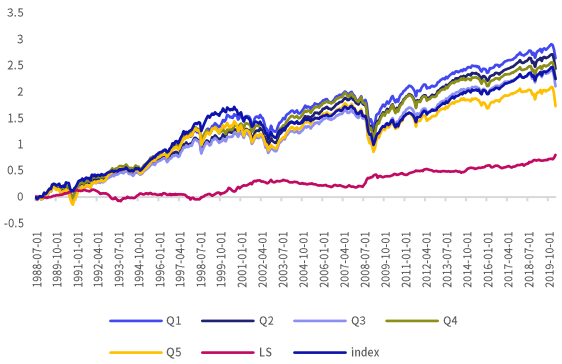
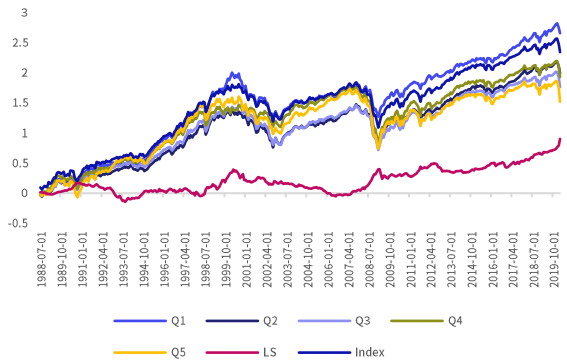


Figure 6. VW portfolio



Source: Qraft Technologies, Compustat

[Figure 5] and [Figure 6] show the cumulative rate of return of the equal weighted and market value weighted quintile portfolio based on G-Score. It is clear the 1st quintile portfolio has highest performance in both the equal weighted and market value weighted method; and we see linear tendency in quintile portfolio returns. The specific performance is examined through [Table 2] below.

Table 2. Portfolio performance

Panel A: EW portfolio					
	Ann CAGR	Ann Std	Ann Sharpe	Mdd	Win Ratio
Q1(High)	0.0929	0.16	0.6381	-0.4952	0.6042
Q2	0.0864	0.1529	0.6214	-0.5145	0.6276
Q3	0.0748	0.1544	0.5471	-0.5283	0.6302
Q4	0.0794	0.1587	0.5643	-0.5819	0.6224
Q5(Low)	0.0616	0.1697	0.4405	-0.6031	0.6224
Long-Short	0.0261	0.0562	0.4868	-0.1991	0.5625
Panel B: VW portfolio					
	Ann CAGR	Ann Std	Ann Sharpe	Mdd	Win Ratio
Q1(High)	0.0928	0.146	0.6833	-0.5444	0.6154
Q2	0.0693	0.1386	0.5544	-0.4908	0.6077
Q3	0.0617	0.1428	0.4925	-0.5308	0.6103
Q4	0.0674	0.1531	0.5054	-0.6211	0.6026
Q5(Low)	0.0524	0.1687	0.3899	-0.6276	0.6
Long-Short	0.0311	0.0825	0.4125	-0.3597	0.5462

Source: Qraft Technologies, Compustat

When building the quintile long-only portfolio, there are only very slight differences in terms of CAGR, but the market value weighted portfolio has higher sharpe ratio. For long-short portfolios, the market value weighted portfolio has higher CAGR, but sharpe ratio is higher in an equal weighted portfolio. It is necessary to check at the robustness of the results statistically as to whether this performance is caused by G-Score and sustainable.

To examine factor robustness, we examine the significance of IC, Rank IC and Alpha. The portfolio for checking robustness is equal weighted portfolio. The IC value is calculated using the Pearson correlation between the factor value at time t-1 and the return at time t. The Rank IC value uses only Spearman's correlation considering only the rank of the factor value and return value.

Table 3. IC Table

This table shows the IC and Rank IC of G-Score during the sample period. The values in the table below are monthly values, and Newey and West(1987) t-statistics with a delay time of 12 were used.

	Coefficient	Std. Error	t-value
IC	0.0065*	0.004	1.804
Rank IC	0.0066*	0.004	1.684

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10
Source: Qraft Technologies, Compustat

[Table 3] shows that IC and Rank IC values are both positive, but their size is relatively low. IC is not statistically significant; Rank IC has weak statistical significance.

Table 4. G-Score Alpha result

The table shows alphas of quintile portfolios constructed by G-Score figures: the average monthly return that exceeds risk-free rate of each quintile portfolio, the alphas calculated by using Sharpe's CAPM (1964), the alphas of Fama and French 3-Factor model (1993). The values in parentheses are Newey-West's t-statistics using lag of 12 (1987).

	Excess Return Mean	CAPM Alpha	Fama 3 factor Alpha
Q1(High)	0.0061(2.578)**	0.0011(1.1448)	0.0009(1.2562)
Q2	0.0055(2.4346)**	0.0007(0.6784)	0.0005(0.6299)
Q3	0.0046(2.0247)**	-0.0002(-0.2007)	-0.0005(-0.681)
Q4	0.005(2.1527)**	0.0001(0.0901)	-0.0002(-0.228)
Q5(Low)	0.0038(1.5205)	-0.0015(-1.375)	-0.0018(-2.6403)**
Long Short	-0.0001(-0.1787)	0.0001(0.1126)	0.0002(0.2187)

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10
Source: Qraft Technologies, Compustat

[Table 4] shows that we have positive significant excess return for the equal weighted portfolio based on G-Score. It is statistically significant in all quartiles except Q5, and high level of alphas exists in Q1 and Q2. When testing against, CAPM's alpha and FF3F, it is not significant. However, in common, the return decreases from Q1 with higher G-Score value to G5 with low value. This means that the higher the G-Score, the higher the return, and the smaller the G-Score, the lower the return. In other words, it suggests that buying a stock with high-G-Score may be effective.

G-Score with Low BM Tilting

Enhanced G-Score with Tilting

In order to examine the usefulness of actual strategy, it is necessary to pay attention to recent performances. We look at the 1st quintile returns and long-short returns from last 5 years, from June 2015 to June 2020. As mentioned in the introduction, the effectiveness of strategy is maximized through tilting (-)1* Book-to-market to the existing G-Score Strategy. When looking at annualized returns of differently composed portfolios, we find that the concentration of factor increases as we separate quartiles more. The point this case becomes clearer when compared against the equal weighted portfolio.

Table 5 Annual Average Returns of G-Score with Low BM Tilting & G-Score

Panel A : G-Score with Low BM Tilting				
	Half (Least Concentrated)	Tercile(1/3)	Quintile(1/5)	Decile (Most Concentrated)
Long Only	9.37%	11.13%	11.52%	11.46%
Long Short	6.35%	9.38%	11.28%	10.82%
Panel B : G-Score				
	Half (Least Concentrated)	Tercile(1/3)	Quintile(1/5)	Decile (Most Concentrated)
Long Only	7.74%	8.75%	8.76%	10.67%
Long Short	3.51%	5.27%	5.72%	7.30%

Source: Qraft Technologies, Compustat

Figure 7. G-Score with Low BM Tilting

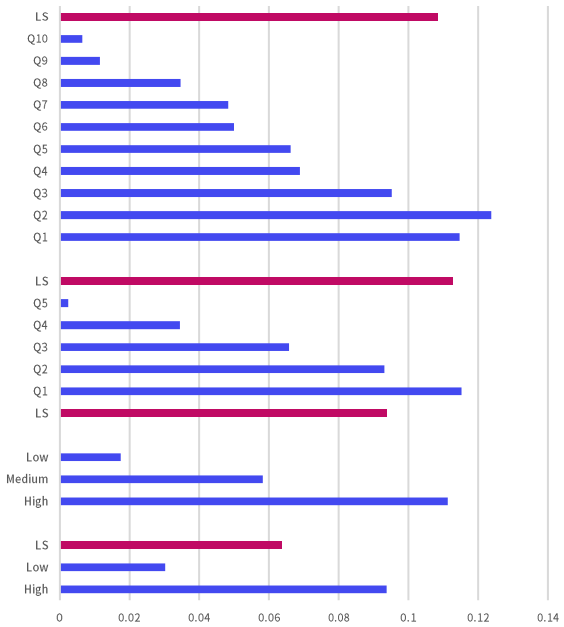
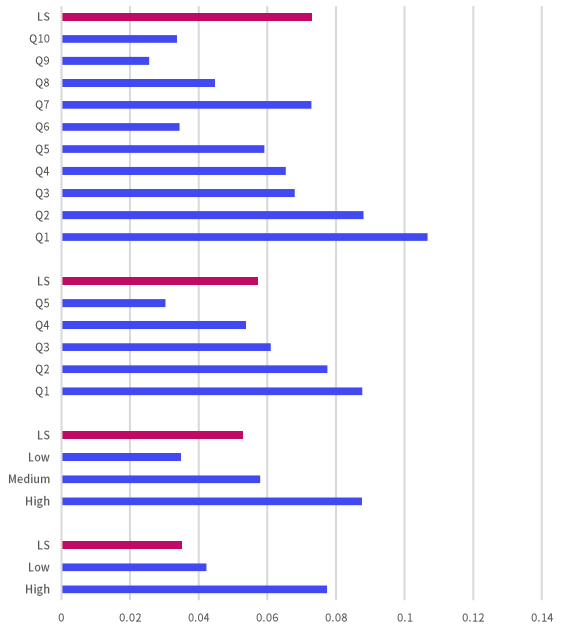


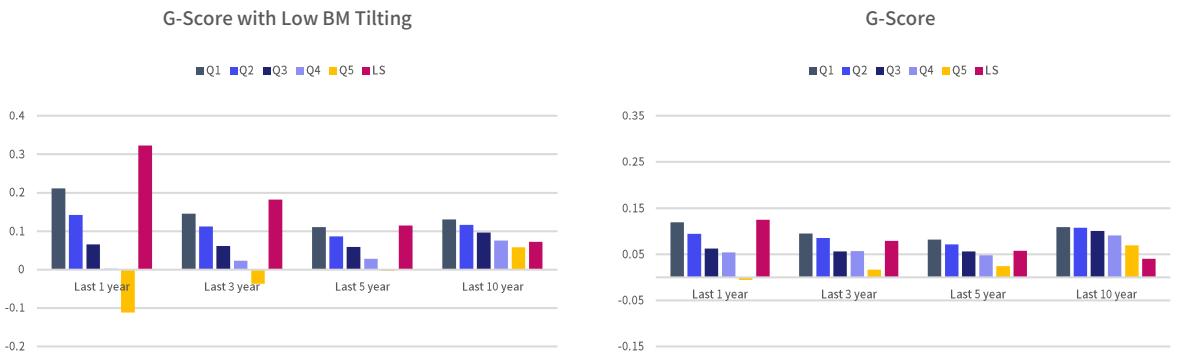
Figure 8. G-Score



Source: Qraft Technologies, Compustat

[Table 5] and [Figure 7,8] shows that the greater the number of quantiles(n), the better the G-Score Performance of concentration without tilting. However, in terms of overall performance, G-Score with tilting was superior in terms of annual average returns, suggesting that the tilting effect of growth stock is significant.

Figure 9: Recent period Annual Average Returns of G-Score with Low BM Tilting & G-Score



Source: Qraft Technologies, Compustat

Above [Figure 8] shows the average return of the portfolio by period. The performance of both G-Score tilted portfolio and normal G-Score portfolio improved, but the degree of improvement was larger with tilted-to-BM portfolios. In addition, it is noticeable that the long-short returns has greatly increased because of the negative 5th quintile return. It can be observed that when tilting, higher portfolio returns can be obtained both in Long-only and Long-short portfolios.

Table 6. Recent Period IC Tables of G-Score with Low BM Tilting & G-Score

This table shows the IC and Rank IC of G-Score with and without Tilting from the last 3 to 10 years. The values in the table below are monthly values, and Newey and West(1987) t-statistics with a delay time difference of 12 were used.

Panel A : G-Score with Tilting				
		Coefficient	Std. Error	t-value
Last 3 years	IC	0.0605***	0.017	3.583
	Rank IC	0.0707***	0.018	4.039
Last 5 years	IC	0.0391**	0.017	2.362
	Rank IC	0.0451**	0.019	2.414
Last 10 years	IC	0.0261**	0.011	2.409
	Rank IC	0.0290**	0.012	2.470
Panel B : G-Score				
		Coefficient	Std. Error	t-value
Last 3 years	IC	0.0276***	0.005	5.381
	Rank IC	0.0345***	0.008	4.464
Last 5 years	IC	0.0205***	0.006	3.396
	Rank IC	0.0234***	0.008	2.778
Last 10 years	IC	0.0141***	0.005	2.841
	Rank IC	0.0160***	0.006	2.714

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10
Source: Qraft Technologies, Compustat

[Table 6] shows the IC and Rank IC values of G-Score with and without tilting during the recent period. In terms of IC and Rank IC, the more recent the period, the greater the value of the G-Score with tilting strategy. This indicates that the G-Score with BM tilting is working better for current market, and the gap is getting bigger and more effective compared to the G-Score without tilting in recent years.

To summarize, when looking at the quintile aspect, the performance of the strategy that been tilted on G-Score in recent years has been greatly improved, and the price forecasting ability of the factor viewed with IC has also been greatly improved. This shows the justification of the tilting strategy with G-Score is superior to the G-Score without Tilting.

G-Score with Tilting / F-Score with Tilting

Next, we analyze the recent performance of tilted G-Score with tilted F-Score. As above, we examine portfolio returns and long-short returns for different quantiles for the last 5 years, from July 2015 to June 2020. In addition, both strategies are tilted with Low BM and compared to the equal weighted portfolio. The result shows that the concentration of factor increases as it goes from Half to Decile, and the annualized return of portfolio composed Half, Tercile, Quintile and Decile is shown in [Table 7] below.

Table 7. Annual Average Returns of G-Score with Low BM Tilting & F-Score with Low BM Tilting

Panel A : G-Score with Low BM Tilting				
	Half (Least Concentrated)	Tercile(1/3)	Quintile(1/5)	Decile (Most Concentrated)
Long Only	9.37%	11.13%	11.52%	11.46%
Long Short	6.35%	9.38%	11.28%	10.82%
Panel B : F-Score with Low BM Tilting				
	Half (Least Concentrated)	Tercile(1/3)	Quintile(1/5)	Decile (Most Concentrated)
Long Only	8.96%	8.74%	10.18%	11.08%
Long Short	3.23%	3.16%	8.76%	5.94%

Source: Qraft Technologies, Compustat

Figure 10. G-Score with Low BM Tilting

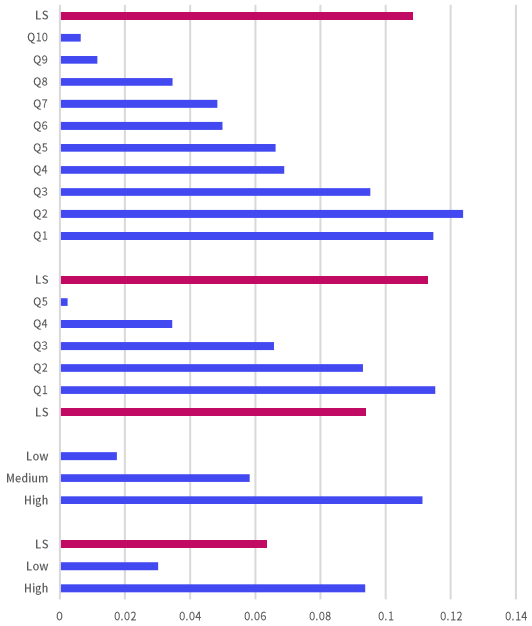
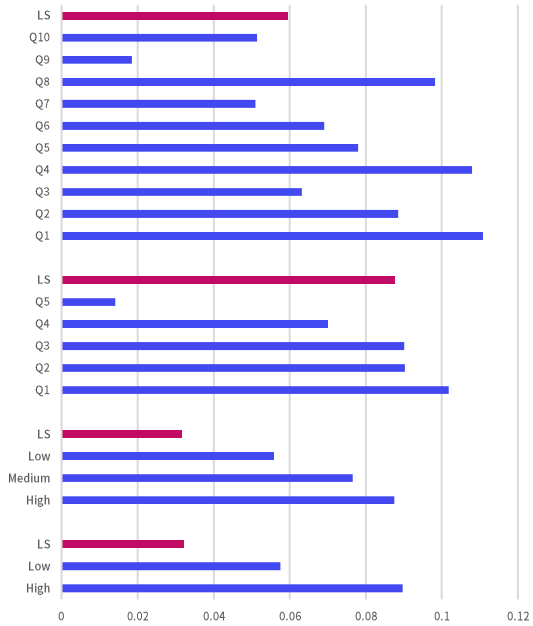


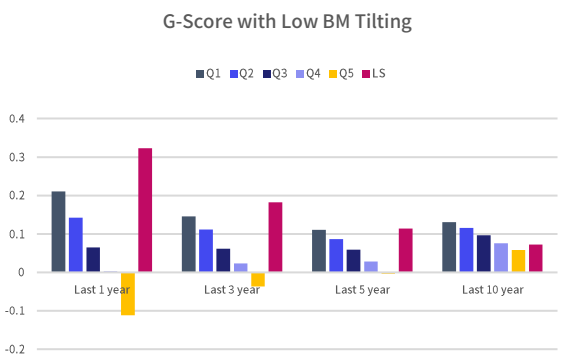
Figure 11. F-Score with Low BM Tilting

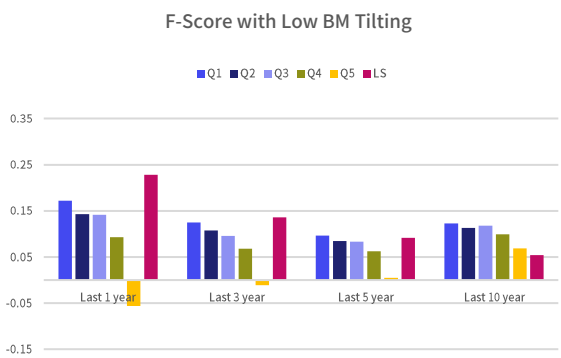


Source: Qraft Technologies, Compustat

[Table 7] and [Figure 10, 11] shows that both G-Score and F-Score with tilting have smaller quantile(n) in the last 5 years, the long only portfolio has tended to have higher returns. In the case of the long-short portfolio, the G-Score showed the highest value at quintile, but the difference from the decile was not significant. The F-Score with tilting also showed some difference between the quintile and decile. Overall, we can observe that G-score with tilting compared to F-Score with tilting has brought higher returns more in the last 5 years. Therefore, when looking at the factor concentration, G-Score with tilting is generally superior to F-Score with tilting.

Figure 12. Recent period Annual Average Returns of G-Score with Low BM Tilting & F-Score with Low BM Tilting





Source: Qraft Technologies, Compustat

As shown in [Figure 12] above, the average return of the portfolio can be observed by splitting it by period. G-Score and F-Score both show higher long-short portfolio returns for more recent period. In addition, it can be confirmed that the G-Score is very high compared to the F-Score. This shows that the performance of G-Score has been greatly improved in recent years, and the increase of the improvement compared to F-Score has increased, showing the need to pay more attention recently.

Table 8. Recent Period IC Tables of G-Score with Low BM Tilting & F-Score with Low BM Tilting

This table shows the IC and Rank IC of G-Score and F-Score with Tilting from the last 3 to 10 years. The values in the table below are monthly values, and Newey and West(1987) t-statistics with a delay time difference of 12 were used.

Panel A : G-Score with Low BM Tilting				
		Coefficient	Std. Error	t-value
Last 3 years	IC	0.0605***	0.017	3.583
	Rank IC	0.0707***	0.018	4.039
Last 5 years	IC	0.0391**	0.017	2.362
	Rank IC	0.0451**	0.019	2.414
Last 10 years	IC	0.0261**	0.011	2.409
	Rank IC	0.0290**	0.012	2.470
Panel B : F-Score with Low BM Tilting				
		Coefficient	Std. Error	t-value
Last 3 years	IC	0.0360***	0.012	2.894
	Rank IC	0.0486***	0.014	3.587
Last 5 years	IC	0.0234**	0.012	1.975
	Rank IC	0.0322**	0.014	2.280
Last 10 years	IC	0.0164**	0.008	2.098
	Rank IC	0.0207**	0.009	2.399

*** p-value < 0.01, ** p-value < 0.05, * p-value < 0.10
Source: Qraft Technologies, Compustat

[Table 8] shows the IC and the Rank IC values of G-Score and F-Score with tilting for the recent period. In order to examine the superiority of G-Score, we compared it with F-Score, and the IC values of G-Score has shown increases. This indicates that G-Score factor has been working well in the current market situation. In addition, the gap of both the IC and the Rank IC values between G-Score and F-Score has recently increased.

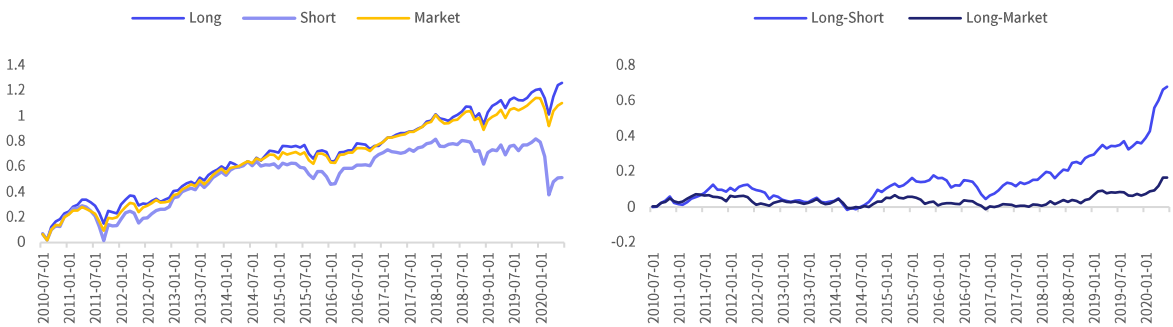
When examining at the factor's quintile return pattern, the performance of G-Score has been greatly improved in recent years, and the factor's ability to predict prices movements by IC is also significantly improving. This improvement can be said to show the superiority of G-Score over F-Score, as it shows a wider gap compared to F-Score.

Strategy with G-Score

Based on strong factor robustness, long only strategy and long-short strategy can be performed. In case of the long only strategy, the group ranked in the top 20% based the factor value (G-Score × (-1) × BM Tilting) is composed of the portfolio by equal weight or market value weight.

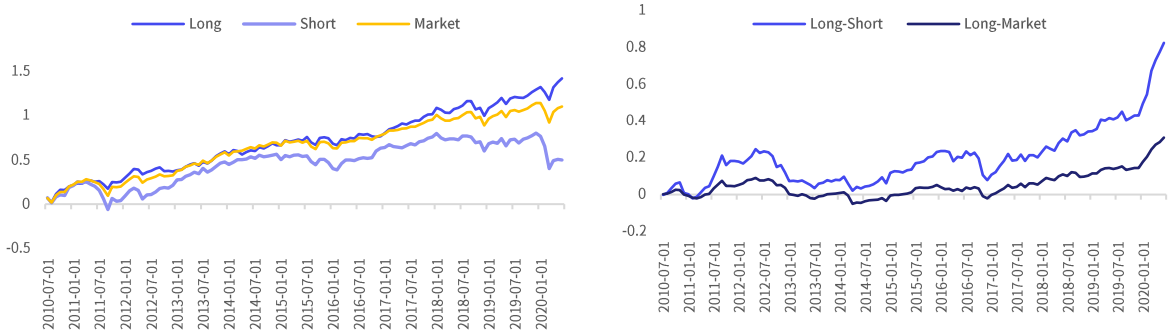
In the case of the long-short strategy, a strategy of buying the stock belonging to the top 20% based on the factor value and selling the stock belonging to the bottom 20% can be constructed. In addition, we propose a strategy to get only alpha that corresponds to the excess return of benchmark index by buying the top 20% of the factor and selling the benchmark index. [Figure 11] and [Figure 12] below show that performance of each strategy in the last 10 years.

Figure 13. Equal Weighted : Strategy Performance based on G-Score with Tilting



Source: Qraft Technologies, Compustat

Figure 14. Market Value Weighted : Strategy Performance based on G-Score with Tilting



Source: Qraft Technologies, Compustat

Appendix

Long/Short List

Source: Qraft Technologies, Compustat

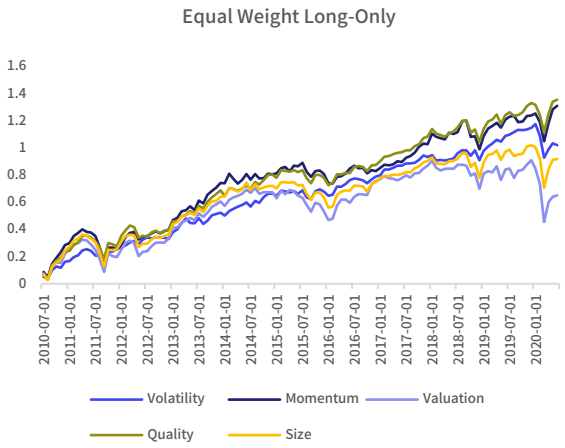
Long list			
Ticker	Name	Sector	Market Cap($:MM)
KMB	KIMBERLY-CLARK CORP	Consumer Staples	48,172
MCD	MCDONALD'S CORP	Consumer Discretionary	137,164
ULTA	ULTA BEAUTY INC	Consumer Discretionary	11,455
CMG	CHIPOTLE MEXICAN GRILL INC	Consumer Discretionary	29,271
AMZN	AMAZON.COM INC	Consumer Discretionary	1,376,651
ILMN	ILLUMINA INC	Health Care	54,441
PM	PHILIP MORRIS INTERNATIONAL	Consumer Staples	109,091
HSY	HERSHEY CO	Consumer Staples	26,982
HPQ	HP INC	Information Technology	24,924
SPG	SIMON PROPERTY GROUP INC	Real Estate	20,908
ACN	ACCENTURE PLC	Information Technology	136,555
SIRI	SIRIUS XM HOLDINGS INC	Communication Services	25,705
AZO	AUTOZONE INC	Consumer Discretionary	26,339
DNKN	DUNKIN' BRANDS GROUP INC	Consumer Discretionary	5,355
FB	FACEBOOK INC	Communication Services	647,377
ZEN	ZENDESK INC	Information Technology	10,090
PAYC	PAYCOM SOFTWARE INC	Information Technology	17,847
RACE	FERRARI NV	Consumer Discretionary	31,594
ETSY	ETSY INC	Consumer Discretionary	12,575
LW	LAMB WESTON HOLDINGS INC	Consumer Staples	9,336

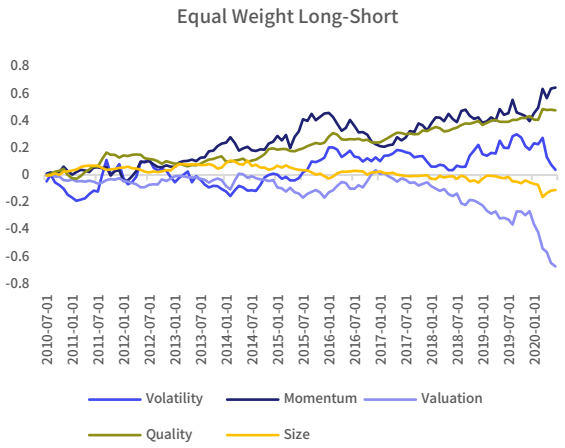
Short list			
Ticker	Name	Sector	Market Cap($:MM)
WRK	WESTROCK CO	Materials	7,325
L	LOEWS CORP	Financials	9,650
T	AT&T INC	Communication Services	215,395
MYL	MYLAN NV	Health Care	8,312
CNQ	CANADIAN NATURAL RESOURCES	Energy	24,911
DB	DEUTSCHE BANK AG	Financials	19,656
DD	DUPONT DE NEMOURS INC	Materials	38,986
MET	METLIFE INC	Financials	33,144
CTL	CENTURYLINK INC	Communication Services	11,010
TECK	TECK RESOURCES LTD	Materials	6,671
CVE	CENOVUS ENERGY INC	Energy	6,904
MPC	MARATHON PETROLEUM CORP	Energy	24,297
BPY	BROOKFIELD PROPERTY PRTRS LP	Real Estate	6,073
NWSA	NEWS CORP	Communication Services	6,979
BEP	BROOKFIELD RENEWABLE PRTS LP	Utilities	10,260
CFG	CITIZENS FINANCIAL GROUP INC	Financials	10,767
HPE	HEWLETT PACKARD ENTERPRISE	Information Technology	12,474
ADT	ADT INC	Industrials	6,146
BKR	BAKER HUGHES CO	Energy	10,077
CTVA	CORTEVA INC	Materials	20,049

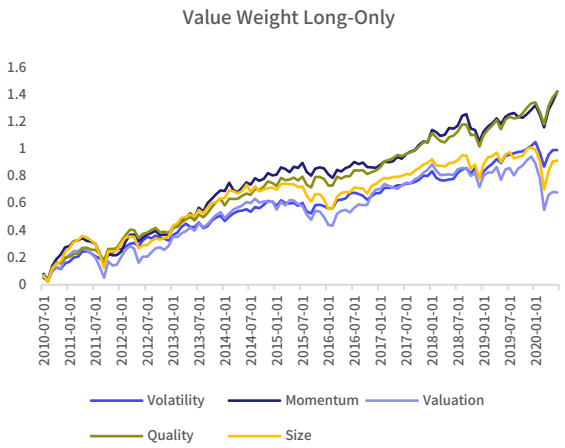
Appendix

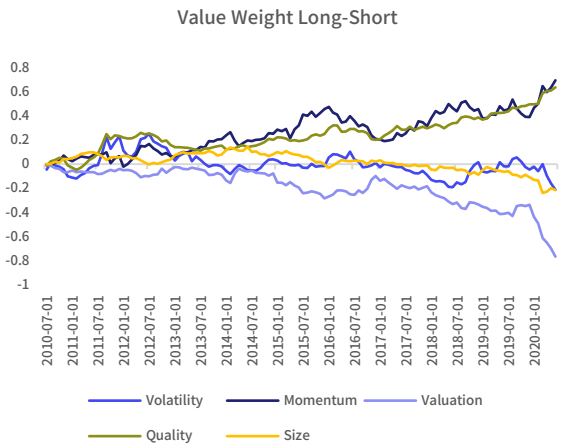
Factor Performance

(1) Volatility : Reciprocal Number of Volatility of 36 months Return
(2) Size : Reciprocal Number of Market Value
(3) Value : Arithmetic Mean(PER(Price Earning Ratio), PBR(Price Book-value Ratio), PCR(Price Cashflow Ratio))
(4) Momentum : Δ12-1m Return
(5) Quality : Arithmetic Mean(ROE(Returns on Equity), ROA(Returns on Asset), GPA(Gross Profits to Asset))
- Data Period : last 10 year
- Long only indicates performance of highest quintile portfolio returns and Long-Short indicates long-short return of highest and lowest quintile portfolios.









Source: Qraft Technologies, Compustat