Effective Scoring to Capture Quality and Value in China

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In the S&P China A Quality and Value Indices, various financial ratios are combined to form the respective factor scores. In this paper, we evaluate two methods used to normalize and combine the financial ratios—z-scores and SNDZ-scores[1]—on how they resulted in different portfolio characteristics for quality and value in the China A market from 2006 through 2019.

EXECUTIVE SUMMARY

- Equal-weighted quality and value subfactor z-scores resulted in unbalanced subfactor portfolio tilts and biased subfactor contribution to final scores.
- When applying the equal-weighted z-scores approach, the quality portfolio was dominated by the accruals factor in its portfolio tilts and factor score contribution.
- The quality portfolio based on the subfactor SNDZ-scores had more balanced and consistent tilts to various quality subfactors and a reduced number of stocks with low return-on-equity (ROE) and high leverage (LEV) ratios.
- The SNDZ-score approach resulted in more all-around high-quality stocks that scored well across various quality measures.
- Quality portfolios based on two different scoring methods had similar performances over the long-term history, with opposite performance cyclicality behavior.
- The quality portfolio based on z-scores had procyclical performance characteristics while the one based on SNDZ-scores behaved defensively.
- When using SNDZ-scores, the quality portfolio had higher sector bias in defensive sectors, including Health Care and Consumer Staples.
- The quality portfolio based on SNDZ-scores had higher active exposures to profitability and low LEV. ROE attributed most to the active return and risk among all style factors.
- Portfolio characteristic differences in value portfolios based on two different scoring methods are negligible.

[1] The SNDZ-score stands for the standard normally distributed z-score on percentile rank.

1. INTRODUCTION

Factor scoring is commonly used when constructing single- and multi-factor portfolios…

Factor scoring is commonly used when constructing single- and multi-factor portfolios. Among different ways to construct composite or multi-factor scores, equal-weighted cross-sectional z-scores of different underlying factor components seems to be the most commonly adopted, owing to its simplicity. However, some market participants look for more sophisticated scoring approaches to achieve more refined portfolio objectives. No approach has proven to be superior.

…and scoring methods adopted in various S&P DJI single- and multi-factor index series have evolved over time.

Factor scoring methods adopted in various S&P DJI single- and multi-factor index series have evolved over time. For example, in the S&P Quality and Value Indices, equal-weighted z-scores of quality subfactors and value subfactors are used to compute the composite quality and value scores, respectively.[2]

On the other hand, in the S&P Quality, Value & Momentum Multi-factor Indices, we first compute cross-sectional percentile ranks of the underlying quality, value, and momentum scores and then convert them into standard normally distributed z-scores (SNDZ-scores)[3] before equal weighting them to form the QVM scores.

We examined the characteristics of quality and value portfolios in the China A market that from two different scoring methods.

Different scoring methods result in variations in the score values and the contribution from underlying components to the scores, hence influencing the performance and fundamental characteristics of the factor portfolios.

In this paper, we examined the characteristics of quality and value portfolios in the China A market[4] that used two different scoring methods: the equal-weighted z-scores and the transformed equal-weighted SNDZ-scores. We compared these portfolios across various aspects, including portfolio performance, portfolio turnover, factor exposures, sector bias, subfactor tilts, and subfactor contributions to final scores.

[2] Quality was measured as the average z-score of the balance sheet accrual (ACC) ratio, financial leverage (LEV), and return on equity (ROE). Value was measured as the average z-score of earnings-to-price (EP), sales-to-price (SP), and book value-to-price (BP) ratios. The z-score for each subfactor for each security was calculated as the number of standard deviations from its mean within the universe. A higher z-score implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. For each security, the average z-score was computed by taking a simple average of the three subfactor z-scores. A security must have at least one z-score for it to be included in the index. Outlier average z-scores were winsorized at ±4.

[3] Each set of percentile scores are transformed into a new set of z-scores (the SNDZ-scores), using the inverse of the normal cumulative distribution function with a mean of 0 and a standard deviation of 1. For more information, please see the S&P Quality, Value & Momentum Multi-factor Indices Methodology.

[4] All portfolio constituents are drawn from the universe of stocks in the S&P China A BMI and S&P China A Venture Enterprises Index with investability criteria in which stocks must have a float-adjusted market capitalization greater than or equal to RMB 1 billion and a three-month average daily value traded greater than or equal to RMB 20 million.

2. UNIVERSE AND METHODOLOGY

Our analysis was based on the China A stock universe subject to certain criteria.

Our analysis was based on the investable China A stock universe, including index constituents from the S&P China A BMI[5] and S&P China A Venture Enterprises Index[6] with a float-adjusted market capitalization of greater than or equal to RMB 1 billion and a three-month average daily value traded greater than or equal to RMB 20 million. Our study period for the analysis was from June 30, 2006, to Dec. 31, 2019.

In order to compare the scoring methods using simple z-scores and SNDZ-scores, we created two hypothetical equal-weighted[7] quality and value portfolios for both scoring methods: Quality 100 and Value 100. The Quality 100 and Value 100 portfolios included the top 100 stocks with the highest quality and value scores, respectively, and were rebalanced semiannually.[8]

In order to compare the scoring methods, we created two hypothetical equal-weighted quality and value portfolios.

In sections three and four, we evaluated the quality and value subfactor score distributions in the universe based on two scoring methods and showed how these two methods resulted in different subfactor tilts and score contributions for the Quality 100 and Value 100 portfolios.

In section five, we compared the performance characteristics, factor exposure, and sector bias of both scoring methods of the Quality 100 and Value 100 portfolios.

[5] The S&P China A BMI is the broad market index measuring the large-, mid-, and small-cap China A-shares, excluding the ones listed on the STAR board of the Shanghai Stock Exchange and the ChiNext board of the Shenzhen Stock Exchange.

[6] The S&P China A Venture Enterprises Index measures all stocks listed on the ChiNext board of the Shenzhen Stock Exchange. Constituents of both the S&P China A BMI and the S&P China A Venture Enterprises Index must meet the size and liquidity criteria of the S&P Global BMI.

[7] For an apples-to-apples comparison, all the back-tested portfolios in this report were equally weighted instead of market cap weighted to avoid different levels of market-cap effects in the portfolios. However, similar conclusions were drawn from scenarios utilizing the market-capitalization weighted method (see Exhibits 11-17).

[8] Rebalancing reference dates are the end of May and November. Effective rebalancing dates are the third Friday of June and December after the market close.

3. QUALITY AND VALUE PORTFOLIOS BASED ON AVERAGE SUBFACTOR Z-SCORES

The Construction of Z-Scores

Z-score transformation converts the raw factor values into z-scores by subtracting the mean of the series and dividing by the standard deviation.

Different fundamental quality ratios (ROE, LEV, and ACC) and valuation ratios (EP, BP, and SP) lie on different value ranges and tend to be non-normally distributed. Transforming these financial ratios into cross-sectional z-scores and equally weighting them is a straightforward and commonly used approach to construct quality and value scores.

When computing the value and quality scores, financial ratios for each company are first winsorized and transformed to subfactor z-scores as the number of standard deviations from the universe mean. Equally weighting the subfactor z-scores and then winsorizing the averaged values at ±4 forms the composite value and quality scores for companies. These composite scores were used for the construction of the Quality 100 and Value 100 portfolios in our analysis.

Portfolio Tilts of Quality and Value Subfactors

We observed several undesirable characteristics in the Quality 100 and Value 100 portfolios for an investor that is looking for all-around high-quality stocks and expects the portfolio to have strong and consistent tilts across all the fundamental subfactors.

When applying the equal-weighted z-scores approach, the quality portfolio was dominated by the accruals factor in portfolio tilts and quality score contribution.

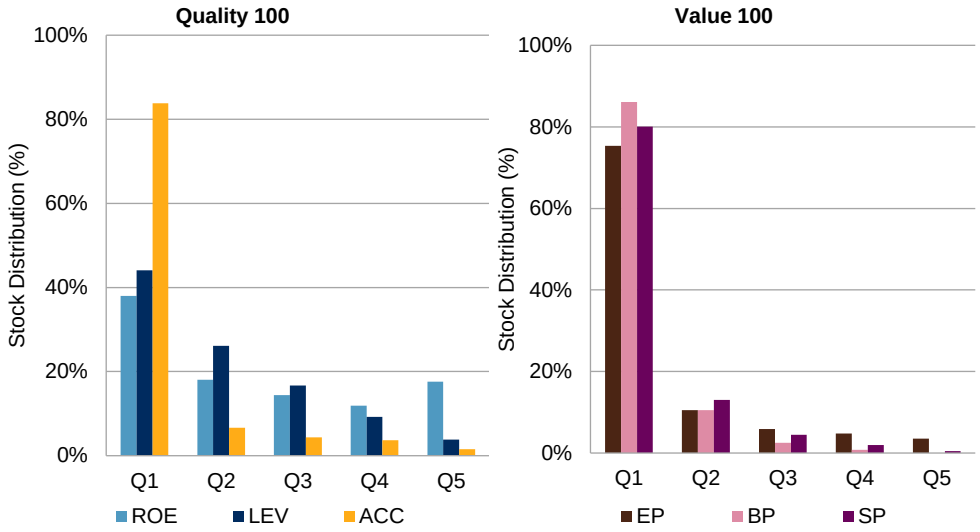
Exhibit 1 shows how the Quality 100 and Value 100 portfolio stocks were distributed in the universe quintiles for each of the subfactors. Q1 corresponds to the top quintile of stocks with the highest subfactor z-scores in the universe.[9]

In the Quality 100 portfolio, more than 80% of the constituents were highly scored in ACC ratio and ranked in the top ACC quintile of the eligible universe, but less than 50% of constituents ranked high enough in ROE and LEV to get into their respective top quintiles. Of the constituents, 18% had a poor ranking in ROE ratio and fell into the bottom ROE quintile. This demonstrates that high-quality stocks selected with this scoring approach were more likely to have a low ACC ratio but less likely to have high ROE or low LEV ratios. This outcome is disappointing for those looking for companies that are favorably scored in all quality measures.

In the Value 100 portfolio, the stock distribution on subfactor quintiles looked more favorable, with the majority of stocks residing in the top quintile for the BP, SP, and EP ratios. Only a small number of stocks fell into the bottom quintile of the value subfactors.

[9] A higher quintile implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio. These figures are average values of all semiannual rebalanced portfolios over the examined period.

Exhibit 1: Distribution of Subfactor Z-Scores by Quintile for the Quality 100 and Value 100 Portfolios



The Quality 100 and Value 100 are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Q1 represents the highest score quintile. Subfactor z-scores are calculated semiannually, and the distribution is the average result of each rebalance. A higher z-scores of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

In the Value 100 portfolio, the majority of stocks were in the top quintile for the BP, SP, and EP ratios.

Exhibit 2 further shows how the Quality 100 and Value 100 portfolios tilted to their subfactors over the study period. We computed the percentile rank of each subfactor for all the stocks in the universe and calculated the average percentile ranks of subfactors for the Quality 100 and Value 100 portfolios to indicate the subfactor tilts of these portfolios.[10]

The subfactor tilts for the Quality 100 portfolio were quite volatile and unbalanced over the period with the most pronounced tilt to ACC and the weakest tilt to ROE.

The subfactor tilts for the Quality 100 portfolio were quite volatile and unbalanced over the period, with the most pronounced tilt to the ACC ratio and the weakest portfolio tilt to the ROE ratio. The average portfolio percentile rank for the ACC ratio stayed high over the examined period, with an average of 88.3%, while the rankings for the ROE and LEV ratios were much lower, with averages of 60.2% and 70.4%, respectively. The trends in the ACC and ROE ratio tilts also tended to move in opposite directions over the period.

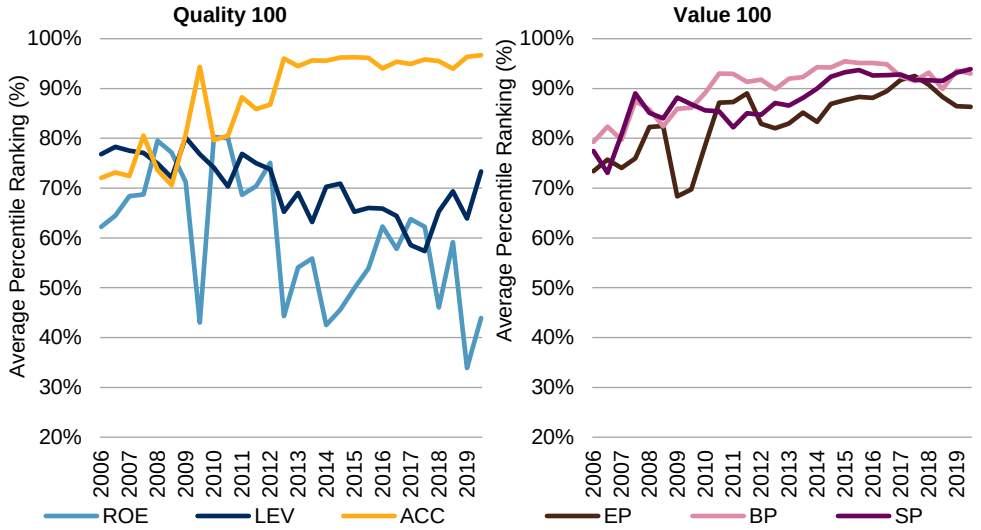
[10] A higher percentile ranking of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively.

In contrast, the Value 100 portfolio percentile rankings for all the value subfactors tended to be high for the entire examined period, with a much smaller disparity among the subfactor tilts compared with those observed in the Quality 100 portfolio. Though the portfolio percentile ranking on BP was slightly higher than the other two subfactors (the EP and SP ratios) for most of the period, the tilt to the EP ratio was the most volatile throughout the period.

The Value 100 portfolio percentile rankings for all subfactors tended to be high for the entire examined period…

…with a much smaller disparity among the subfactor tilts compared with those observed in the quality portfolio.

Exhibit 2: Average Percentile Rankings of Subfactor Z-Scores for the Quality 100 and Value 100 Portfolios



The Quality 100 and Value 100 are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Subfactor z-scores are calculated semiannually. A higher percentile ranking of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Subfactor Contribution to Quality and Value Scores

Distributions of portfolio stocks across subfactor quintiles and subfactor portfolio tilts could well be explained by the subfactor contribution to quality and value scores.

Distributions of portfolio stocks across subfactor quintiles and subfactor portfolio tilts might be explained by the subfactor contribution to the quality and value scores. To measure subfactor contributions, we calculated the individual subfactor z-score divided by the sum of all subfactor z-scores for all the stocks in the Quality 100 and Value 100 portfolios and averaged them for all the historical portfolios.

Exhibit 3 shows the imbalanced subfactor contribution to the quality and value factors averaged from June 30, 2006, to Dec. 31, 2019. We also showed the standard deviation of the contribution divided by the average contribution as indicators of the fluctuation of the subfactor contributions over time. In the Quality 100 portfolio, the contribution of the ACC ratio (average of 67.9%) was dominant in the quality score, compared with the contributions of the ROE (14.3%) and LEV (17.8%) ratios, and the ROE contribution had the highest fluctuation over the period. This explained the

high portfolio percentile ranking in the ACC ratio and the high portion of stocks in the top quintile for the ACC ratio but not for other quality subfactors among the Quality 100 constituents.

Disparity in subfactor contributions in the value scores was smaller in the Value 100 portfolio…

Disparity in subfactor contributions in the value scores was smaller in the Value 100 portfolio, though the BP ratio tended to have a higher contribution (average of 39.4%) to the value factor than the EP (28.5%) and SP (32.1%) ratios. This could explain why we see a much smaller disparity in the average percentile ranking across the value subfactors and a slightly higher percentile ranking for the BP ratio in the Value 100 portfolio.

Exhibit 3: Average Contribution of Subfactor Z-Scores to the Composite Z-Score for the Quality 100 and Value 100 Portfolios

CONTRIBUTION	QUALITY 100			VALUE 100		
	ROE	LEV	ACC	EP	BP	SP
Average (%)	14.3	17.8	67.9	28.5	39.4	32.1
Standard Deviation (%)	15.4	11.9	23.5	6.1	5.3	6.7
Standard Deviation/Average	1.08	0.67	0.35	0.21	0.13	0.21

The Quality 100 and Value 100 are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Factor contributions were averaged across all the rebalances in the examined period. Subfactor z-scores are calculated semiannually. A higher z-score of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

…though the BP ratio tended to have a higher contribution to the value factor than the EP and SP ratios.

Quality and Value Subfactor Z-Score Distributions and Correlations

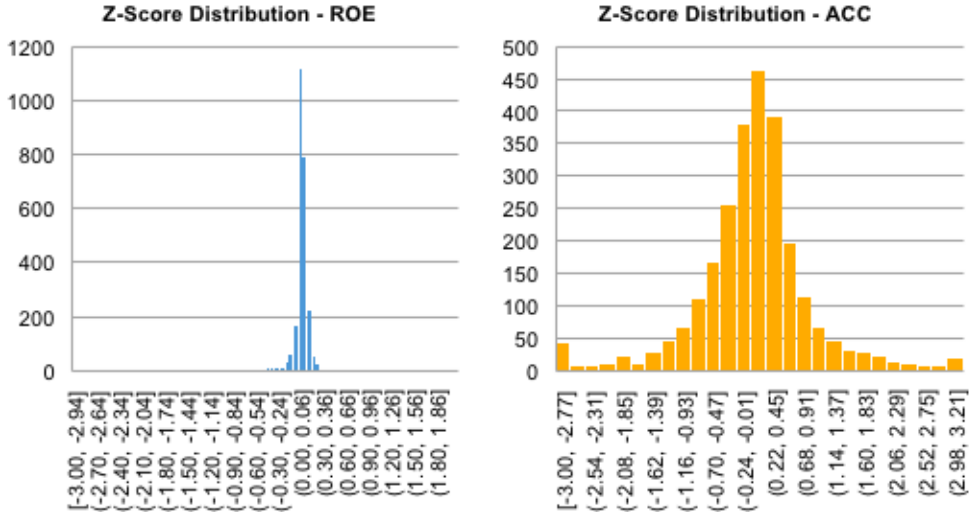
The unbalanced subfactor contributions to the quality and value scores resulted from variations in subfactor z-score distributions and the low correlation among subfactors.

The unbalanced subfactor contributions to the quality and value scores resulted from variations in subfactor z-score distributions and the low correlation among subfactors.

Even after the z-score transformation and winsorization, distributions for some of the subfactors were still largely different and were not normally distributed. Exhibit 4 shows the big difference in z-score distribution of the ACC and ROE ratios as of Dec. 20, 2019. For z-score distribution of all the quality and value subfactors, please see Exhibit 14 in the Appendix.

Even after the z-score transformation and winsorization, distributions for some of the sub-factors were still largely different…

Exhibit 4: Subfactor Z-Score Distributions in the Universe[11]



Source: S&P Dow Jones Indices LLC. Data as of Dec. 20, 2019. A higher z-score of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

…for example, the ROE and ACC ratios.

Exhibit 5 shows the characteristics of the quality and value subfactors distributions averaged over time. The differences in distributions of the three quality subfactors were much more pronounced than those for the value subfactors. The z-scores of the ROE and LEV ratios were negatively skewed at -1.34 and -3.25, respectively, with excess kurtosis of 65.64 and 16.87, respectively, while the z-scores of the ACC ratio tended to be normally distributed. The distinct z-score distributions of the ACC and ROE ratios combined with the negative correlation between the ACC and ROE ratios shown in Exhibit 6 can explain why the ACC ratio had the highest contribution to the quality scores, while the ROE ratio had the lowest contribution. Furthermore, the annual distributions and correlation data of the ACC and ROE ratios shown in Exhibit 16 in the Appendix suggest that the widened difference in their distributions plays a more important role than their negative correlation in explaining the widened opposite trends in the ACC and ROE percentile rankings since 2009 for the Quality 100 portfolio.

The differences in distributions of the three quality subfactors were much more pronounced than those for the value subfactors.

In contrast, variation in the distributions for the value subfactors was much smaller, and the historical average correlations of the value subfactors were higher. These explain the smaller disparity in subfactor contributions in value scores.

Despite low or negative correlations among subfactors, constructing factor scores with a more balanced subfactor contribution should help to capture more all-around high-quality stocks that have favorable quality across all the subfactors.

[11] See Exhibit 14 in the Appendix for a full view of subfactor distributions as of Dec. 20, 2019.

Variation in distributions for value subfactors was smaller, and the average correlations of value subfactors were higher.

Exhibit 5: Average Statistics of Subfactor Z-Score Distribution

SUBFACTOR	MEAN (%)	STANDARD DEVIATION (%)	MEDIAN (%)	SKEWNESS	KURTOSIS
ROE	1.44	2.02	0.33	-1.34	65.64
LEV	3.31	0.43	19.09	-3.25	16.87
ACC	0.46	1.21	14.34	-0.63	2.85
EP	1.63	1.35	-7.61	-0.05	3.91
BP	-1.15	0.41	-19.90	1.04	0.92
SP	-3.93	0.37	-30.58	2.45	6.74

Source: S&P Dow Jones Indices LLC, FactSet Alpha Testing Report. Data from June 30, 2006, to Dec. 31, 2019. Distribution statistics were averaged across all the rebalances in the examined period. Subfactor z-scores are calculated semiannually. A higher z-scores of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Despite low or negative correlations among subfactors in the quality factor…

Exhibit 6: Average Correlation of Subfactor Z-Scores in the Universe for the Quality and Value Factors

CORRELATION	QUALITY SUBFACTOR Z-SCORES			
	ROE	LEV	ACC	COMPOSITE QUALITY
ROE	1.00	0.17	-0.22	0.28
LEV	-	1.00	0.02	0.54
ACC	-	-	1.00	0.74
COMPOSITE QUALITY	-	-	-	1.00
CORRELATION	**VALUE SUBFACTOR Z-SCORES**			
	EP	BP	SP	COMPOSITE VALUE
EP	1.00	0.30	0.18	0.66
BP	-	1.00	0.46	0.82
SP	-	-	1.00	0.71
COMPOSITE VALUE	-	-	-	1.00

…constructing scores with a more balanced subfactor contribution should help capture higher quality stocks across all the subfactors.

Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Subfactor z-scores and correlations are calculated semiannually. A higher z-score of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

4. QUALITY AND VALUE PORTFOLIOS BASED ON AVERAGE SUBFACTOR SNDZ-SCORES

In the previous sections, we showed that the equal-weighted z-scores resulted in uneven subfactor contributions to the quality and value scores and unbalanced subfactor tilts for the Quality 100 and Value 100 portfolios. In this section, we examined if using equal-weighted SNDZ-scores instead of simple z-scores could help to achieve more balanced subfactors score contribution and portfolio tilts.

The SNDZ-score transformation converts the factor raw values into a new standardized z-score set, which ensures the same distribution for all subfactors.

The Construction of SNDZ-Scores

To transform the subfactor fundamental values into standard normally distributed z-scores (SNDZ-scores), we first calculated cross-sectional percentile rankings of the raw factor values for all stocks in the universe, then we used the inverse of the normal cumulative distribution function (with a mean of 0 and standard deviation of 1)[12] to transform the percentile rankings into SNDZ-scores. We equally weighted the SNDZ-scores of the respective subfactors to form the quality and value scores that are used to construct the Quality 100 and Value 100 portfolios, respectively, for the following analysis.

Subfactor SNDZ-Score Distributions and Subfactor Contribution to Quality and Value Scores

Transforming subfactor raw values to SNDZ-scores ensures all the subfactors' SNDZ-score distributions are standard normal distributions. Exhibit 15 in the Appendix shows the factor SNDZ-score distributions as of Dec. 20, 2019.

With the SNDZ-scores, we can see more equalized and stable subfactor contributions to the quality and value scores.

With normally distributed subfactor SNDZ-scores, more equalized and stable subfactor contributions are seen in both the quality and value scores in the Quality 100 and Value 100 portfolio stocks[13] as shown in Exhibit 7. The ACC, ROE, and LEV ratios had similar average contributions of 31.5%, 36.8%, and 30.7%, respectively, to the quality scores. No subfactor was found dominant in the contribution as previously seen in the portfolio based on equal-weighted subfactor z-scores. The subfactor contribution also tended to be more stable with the application of SNDZ-scores.

A similar observation was seen in the subfactor contribution to the value scores, though with much smaller contrast between the two factors as was seen in the previous section.

[12] For more information, please see the S&P Quality, Value & Momentum Multi-factor Indices Methodology.

[13] For a stock, a subfactor's contribution is calculated using its SNDZ-score divided by the sum of all desired subfactors' SNDZ-scores. For a portfolio, a subfactor's contribution is measured by the average of its constituents' contribution.

There was an improvement on the sub-factors' percentile rankings over the studied period for the portfolios based on SNDZ-scores.

Exhibit 7: Contribution of Subfactor SNDZ-Scores to the Composite Score for the Quality 100 and Value 100 Portfolios

CONTRIBUTION	QUALITY 100			VALUE 100		
	ROE	LEV	ACC	EP	BP	SP
Average (%)	31.5	36.8	30.7	34.1	34.0	32.0
Standard Deviation (%)	5.5	5.4	3.6	2.0	1.5	2.0
Standard Deviation/Average	0.17	0.15	0.12	0.06	0.04	0.06

The Quality 100 and Value 100 are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Subfactor contribution are averaged across all rebalances in the examined period. Subfactor SNDZ-scores are calculated semiannually. A higher SNDZ-score of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Portfolio Tilts of Quality and Value Subfactors

With more stable and balanced subfactor contributions to the quality and value scores, the Quality 100 and Value 100 portfolios exhibited more consistent and stronger fundamental tilts across all of their respective subfactors.

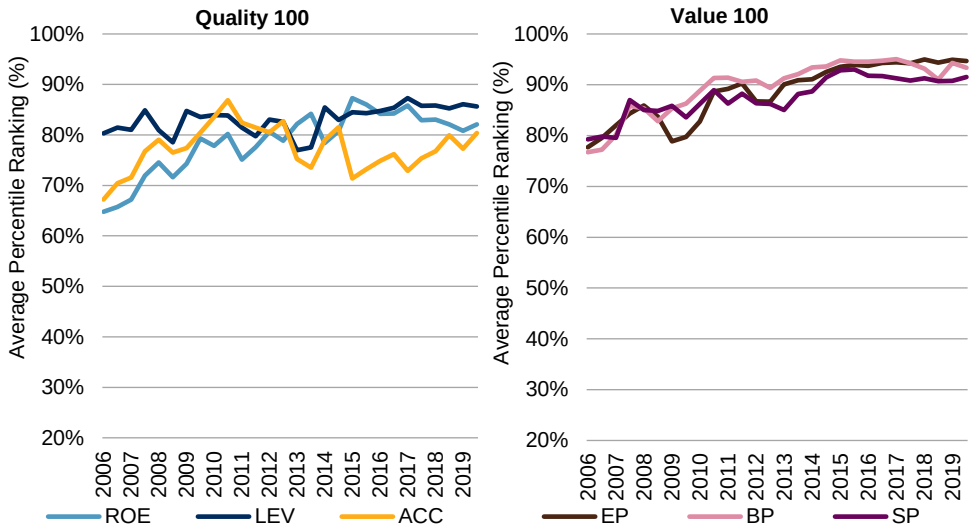
The SNDZ-score based quality and value portfolios exhibited more consistent and balanced fundamental tilts across all of their respective subfactors.

With the application of SNDZ-scores, we observed an upward shift in the portfolio average percentile rankings for the ROE and LEV ratios and more stable trends in the percentile rankings across all subfactors (see Exhibit 8). In the Quality 100 portfolio, the long-term portfolio average percentile ranking improved from 60.2% to 78.7% for the ROE ratio and from 70.4% to 83.1% for the LEV ratio, while the average ranking for the ACC ratio decreased from 88.3% to 77.3%.

In the Value 100 portfolio, the long-term portfolio average percentile ranking of the EP ratio improved from 83.5% to 88.7%, with barely reduced rankings for the BP and SP ratios. The fluctuations of the subfactor percentile rankings were also reduced over the period for most of the subfactors.

With the application of SNDZ-scores, we observed an upward shift in the portfolio average percentile rankings for the ROE and LEV ratios.

Exhibit 8: Average Percentile Ranking of Subfactor SNDZ-Scores for the Quality 100 and Value 100 Portfolios



The Quality 100 and Value 100 are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Subfactor SNDZ-scores are calculated semiannually. A higher percentile ranking of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

In the Value 100 portfolio, the long-term portfolio average percentile ranking of the EP ratio was improved from 83.5% to 88.7%...

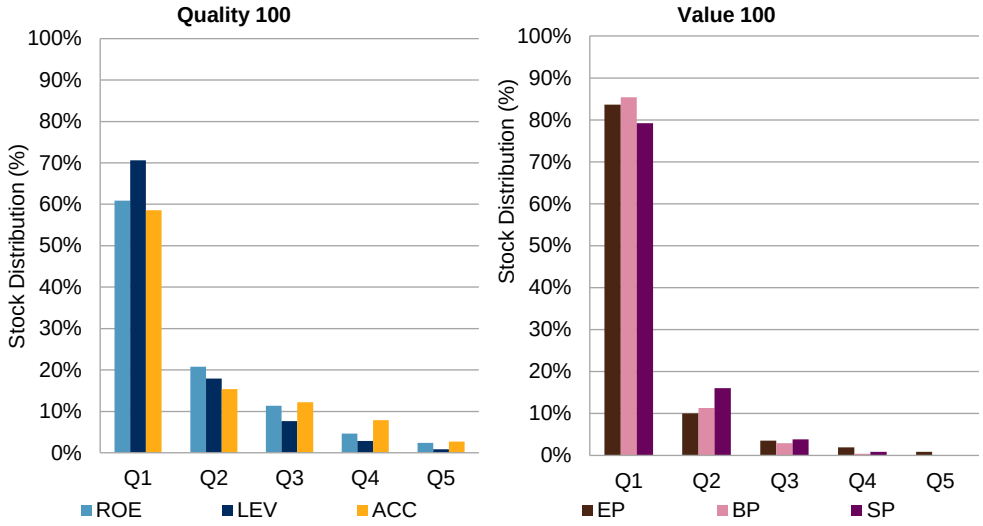
There was also a reduction in the percentage of low quintile stocks in the Quality 100 and Value 100 portfolios, implying that the number of stocks in the resulting factor portfolios with poor ranking in any of the subfactors was significantly reduced (see Exhibit 9). The improvement in the Quality 100 portfolio was more pronounced, with 16% and 3% reductions in constituents in the lowest ROE and LEV quintiles, respectively. Although the percentage of stocks in the top ACC quintile fell to 59%, the percentage of stocks in the top LEV and ROE quintiles increased to more than 60%.

…with barely reduced rankings for the BP and SP ratios.

In the Value 100 portfolio, there were also small reductions of 3% and 1% in constituents from the bottom EP and SP quintiles, respectively. The percentage of stocks in the top EP, BP, and SP quintiles remained high. These observations suggest that the equal-weighted SNDZ-score based method helps to capture stocks that scored well across all subfactors and avoid stocks with low scores on any individual subfactors.

Equal-weighted SNDZ-scores helps to capture stocks that scored well across all sub-factors and avoid stocks with low scores on any individual subfactors.

Exhibit 9: Distribution of Subfactor SNDZ-Scores by Quintile for the Quality 100 and Value 100 Portfolios



The Quality 100 and Value 100 are hypothetical portfolios.
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Q1 represents the highest-percentile-ranking quintile. Subfactor SNDZ-scores are calculated semiannually and the distribution is the average result of each rebalance. A higher SNDZ-score of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

While the Quality 100 attained similar absolute and risk-adjusted returns for both scoring methods over the period…

5. PERFORMANCE, FACTOR EXPOSURE, AND SECTOR BIAS OF QUALITY AND VALUE PORTFOLIOS CONSTRUCTED BASED ON THE TWO METHODS

In this section, we examined the risk/return profiles, factor exposure, and sector bias of the Quality 100 and Value 100 portfolios constructed based on the two different scoring methods over the same period.

Historical Performance of Quality 100 and Value 100 Portfolios

…the different scoring methods resulted in opposite cyclicality behaviors during up and down markets.

Though the Quality 100 portfolios based on the two different methods attained similar absolute and risk-adjusted return over the entire back-tested history (see Exhibit 10), the two scoring methods resulted in opposite performance cyclicality behaviors during up and down markets. The Quality 100 portfolio based on z-scores had procyclical performance, while the portfolio based on SNDZ-scores was defensive, with higher average monthly excess returns and win ratios during down markets than in up markets (see Exhibit 11).

The Quality 100 portfolio based on SNDZ-scores was more defensive than the Quality 100 portfolio based on z-scores.

In our previous paper, "How Smart Beta Strategies Work in the Chinese Market," we observed that the ACC ratio was the most cyclical among the three quality subfactors, while the ROE and LEV ratios were more defensive. As the ACC ratio was the most dominating in the quality portfolio constructed with equal-weighted average z-scores, it resulted in the cyclical behavior of the overall portfolio. With the SNDZ-score approach that resulted in more equalized factor score contribution and balanced portfolio subfactor tilts, the quality portfolio revealed defensive behavior.

This behavioral difference is critical, especially for market participants that expect high-quality stocks to be defensive…

This performance behavioral difference is critical, especially for market participants that expect high-quality stocks to be defensive and adopt quality as a defensive strategy during market downturn. On the other hand, performance features for the Value 100 portfolios based on both scoring methods were negligible.

Exhibit 10: Risk/Return Profiles of the Quality 100 and Value 100 Portfolios

PORTFOLIOS	QUALITY 100		VALUE 100	
	Z-SCORE BASED	SNDZ-SCORE BASED	Z-SCORE BASED	SNDZ-SCORE BASED
Annualized Return (%)	14.8	14.0	16.6	16.8
Annualized Volatility (%)	30.2	30.2	30.3	30.4
Risk-Adjusted Return	0.49	0.46	0.55	0.55
Rolling 252-Day Maximum Drawdown (%)	-70.0	-69.1	-69.4	-69.0
Average Annual Turnover (%; One-Way)	113.6	106.3	76.6	77.9

Portfolios shown are hypothetical and equally weighted.
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Information ratio of the portfolios were calculated relative to the equally weighted universe. Performance based on total return in RMB. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

…and adopt quality as a defensive strategy during market downturn.

The Value 100 portfolios behaved similarly across different market conditions.

Exhibit 11: Quality 100 and Value 100 Portfolio Performance versus the Eligible Universe in Up and Down Markets

MARKET	QUALITY 100		VALUE 100	
	Z-SCORE BASED	SNDZ-SCORE BASED	Z-SCORE BASED	SNDZ-SCORE BASED
AVERAGE EXCESS RETURN (ANNUALIZED, %)				
Up Months	0.62	**0.22**	0.54	0.53
Down Months	0.00	**0.39**	0.39	0.40
All Months	0.36	0.29	0.48	0.47
PERCENTAGE OF OUTPERFORMANCE (%)				
Up Months	58.5	**54.3**	45.7	46.8
Down Months	47.9	**56.3**	57.7	56.3
All Months	53.9	55.2	50.9	50.9

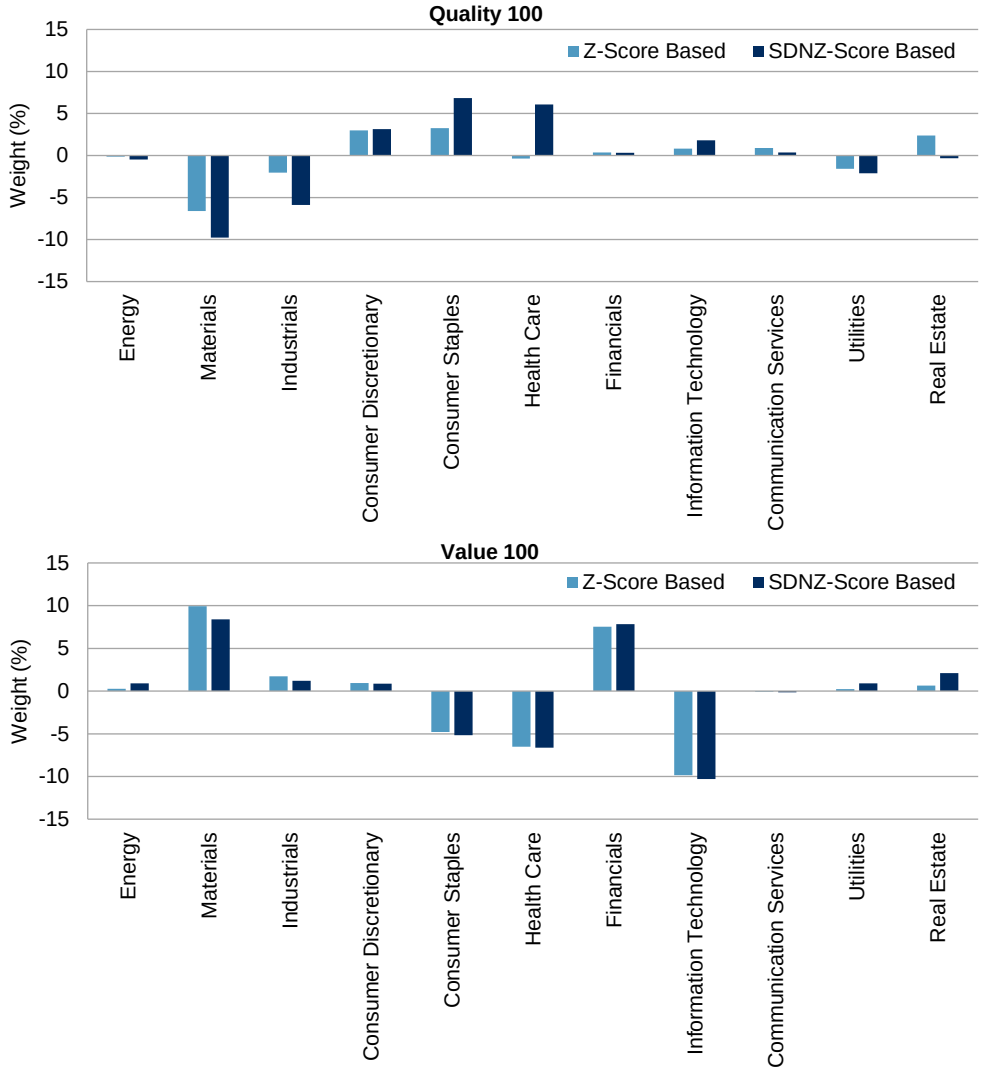
Portfolios shown are hypothetical and are equally weighted.
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. The average monthly excess return and win ratio of the portfolios are calculated relative to the equally weighted universe. Performance based on total return in RMB. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Sector Bias

The Quality 100 portfolio based on SNDZ-score had higher sector bets toward defensive sectors, including Consumer Staples and Health Care.

Apart from performance characteristics, different average sector biases were also observed in the portfolios constructed based on the two scoring methods since June 30, 2006 (see Exhibit 12). The Quality 100 portfolio based on SNDZ-scores had higher sector bets in defensive sectors, including Consumer Staples and Health Care, while it was more underweight in the Materials and Industrials sectors. This aligned with earlier observations that the quality portfolio based on SNDZ-scores had more defensive performance behavior than the one based on z-scores. On the other hand, sector bets for the Value 100 portfolios based on both scoring methods were broadly aligned.

Exhibit 12: Sector Bias of Quality and Value Portfolios under Two Scoring Methods Relative to the Universe



Sector bets for the Value 100 portfolios based on both scoring methods were broadly aligned.

Portfolios shown are hypothetical and are equally weighted
Source: S&P Dow Jones Indices LLC. Data from June 30, 2006, to Dec. 31, 2019. Average sector bias is calculated relative to the equally weighted universe on a semiannual basis. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Factor exposure and active risk and return attribution analysis helped to explain the performance difference in the Quality 100 portfolios based on the two scoring methods.

Factor Exposure and Active Risk/Return Attribution

Factor exposure and active risk/return attribution analysis based on the equity factor risk model helped to further explain the performance characteristic difference in the Quality 100 portfolios based on the two scoring methods. As shown in Exhibit 13, over the period from June 30, 2006, to Dec. 31, 2019, the Quality 100 portfolio based on SNDZ-scores had much higher average active exposures to profitability and low leverage, as expected due to higher ROE and LEV contributions to the quality SNDZ-scores. We also observed that higher exposure in dividend yield, growth,

low beta, and size (large cap) were unintentionally captured in the quality portfolio based on SNDZ-scores.

The Quality 100 portfolio based on SNDZ-scores had much higher average active exposure to profitability and leverage.

The profitability factor had more significant performance impact on the quality portfolio based on SNDZ-scores due to high cumulative returns of profitability factor and high exposure to this factor. In contrast, active return attribution to the quality portfolio based on z-scores by the profitability factor was much smaller. The active risk attribution by the profitability and leverage factors was also higher in the quality portfolio based on SNDZ-scores.

As the ACC ratio is not a style factor in this factor risk model, the active risk/return attribution from the ACC ratio might be captured into stock-specific risk. The quality portfolio based on z-scores had higher stock-specific risk than the portfolio based on SNDZ-scores.

Exhibit 13: Performance Attribution of the Quality 100 Portfolios

STYLE/INDUSTRY FACTORS	COMPOUNDED FACTOR TOTAL RETURN (%)	Z-SCORE BASED			SNDZ-SCORE BASED		
		ACTIVE EXPOSURE	PERFORMANCE IMPACT	% OF ACTIVE RISK	ACTIVE EXPOSURE	PERFORMANCE IMPACT	% OF ACTIVE RISK
Market Sensitivity	3.8	-0.07	7.6	1.9	-0.20	23.3	6.2
Size	-74.5	0.01	-13.4	4.5	0.11	-65.6	4.6
Medium-Term Momentum	-19.9	0.03	1.8	0.8	0.10	-21.9	2.6
Volatility	-44.0	0.00	-25.7	3.2	-0.02	11.1	2.9
Liquidity	-30.4	-0.10	30.9	2.1	-0.10	37.7	1.9
Exchange Rate Sensitivity	18.8	-0.01	0.6	0.1	0.04	5.9	0.2
Growth	10.1	-0.05	4.4	1.2	0.21	9.7	2.3
Value	85.8	-0.16	-28.8	3.1	-0.15	-20.7	2.4
Dividend Yield	15.9	0.15	11.8	0.8	0.42	34.4	2.0
Profitability	24.7	0.43	12.8	9.2	0.94	113.0	15.6
Leverage	-1.5	-0.56	-3.3	4.0	-0.76	2.2	5.3
RISK TYPE							
Style Factor Risk	-	-	-1.3	30.9	-	129.2	46.0
Industry Factor Risk	-	-	73.0	15.0	-	110.3	20.5
Common Factor Risk	-	-	71.7	45.9	-	239.6	66.5
Stock Specific Risk	-	-	60.9	54.1	-	-167.9	33.5
Total Risk	-	-	132.6	100.0	-	71.7	100.0

The Quality 100 portfolios are hypothetical portfolios and are equally weighted.
Source: S&P Dow Jones Indices LLC, Axioma AXCN4-MH China Equity Factor Risk Model. Data from June 30, 2006, to Dec. 31, 2019. Average active factor exposures, return and risk attributions of the Quality 100 portfolios are calculated relative to the equally weighted universe. Performance based on total return in RMB. For details of the risk factor definition in the Axioma AXCN4-MH China equity factor risk model, please see Exhibit 17 in the Appendix. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

6. CONCLUSION

In this paper, we evaluated two factor scoring methods, the equal-weighted z-scores and equal-weighted SNDZ-scores on percentile rankings, when constructing quality and value scores for stock selection in the quality and value portfolios. We examined how these two scoring methods affected characteristics of the quality and value portfolios in the China A market.

While the z-scores method is straightforward and commonly adopted…

The equal-weighted z-scores method to form quality and value scores is straightforward and commonly adopted, but we observed unbalanced subfactor portfolio tilts and biased subfactor contribution to the composite quality scores. This resulted in the inclusion of low-ROE stocks in the high-quality portfolio, which is undesirable for those looking for all-around high-quality stocks that are expected to score favorably well across different quality measures applied.

…we observed unbalanced subfactor tilts and biased subfactor contribution to the quality scores…

The Quality 100 and Value 100 portfolios based on SNDZ-scores tended to have more balanced and consistent tilts to subfactors. The normally distributed subfactor SNDZ-scores helped mitigate the unbalanced subfactor contributions caused by the difference in subfactor distributions. Using the SNDZ-scoring approach also largely reduced the number of low-ROE stocks in the quality portfolio and maintained a high proportion of stocks with favorable ROE, LEV, and ACC ratios.

…resulting in the inclusion of low-ROE stocks in the high-quality portfolio...

While the Quality 100 portfolio based on the two different methods attained similar absolute and risk-adjusted returns over the long back-tested history, the different scoring methods resulted in opposite performance cyclicality behaviors. The Quality 100 portfolio based on z-scores had procyclical performance, while the one based on SNDZ-scores had defensive performance behavior. Historically, the Quality 100portfolio based on SNDZ-scores tended to have a higher weight in defensive sectors, including Health Care and Consumer Staples.

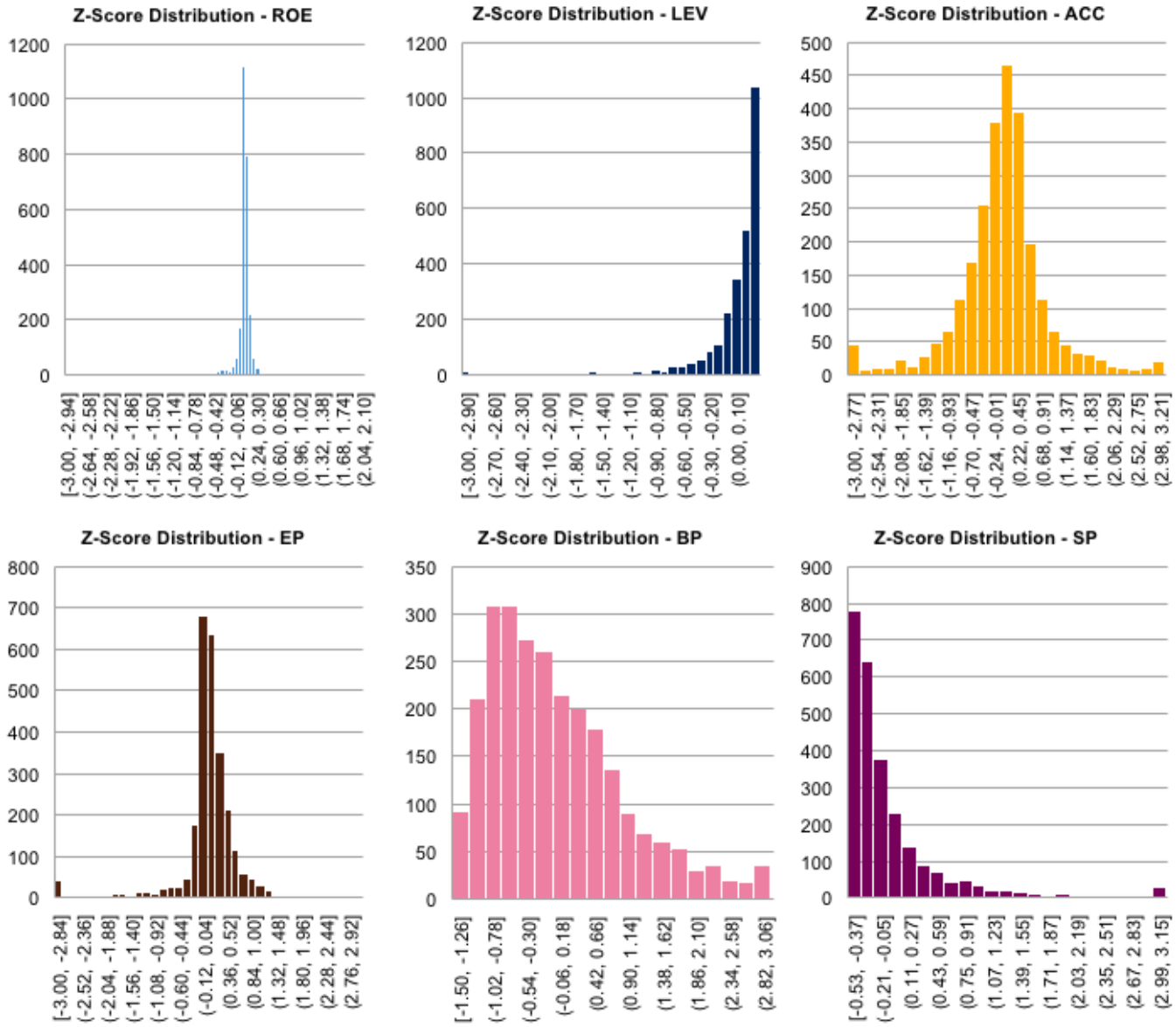
…whereas the SNDZ-scores method tended to be more balanced and resulted in a more defensive quality portfolio.

This observation is important, as many market participants expect high-quality stocks to perform defensively and deliver better performance during market downturns. On the other hand, performance behavior and sector allocation differences for the Value 100 portfolios based on the two scoring methods were negligible.

The factor attribution analysis further explained the performance difference in the Quality 100 portfolios based on the two scoring methods. The Quality 100 portfolio based on the SNDZ-score achieved much higher active exposures to profitability and low leverage, with the ROE ratio attributing most to the portfolio's active return and risk among all style factors. It also captured higher exposures in dividend yield, growth, low beta, and size (large cap) than the portfolio based on z-scores.

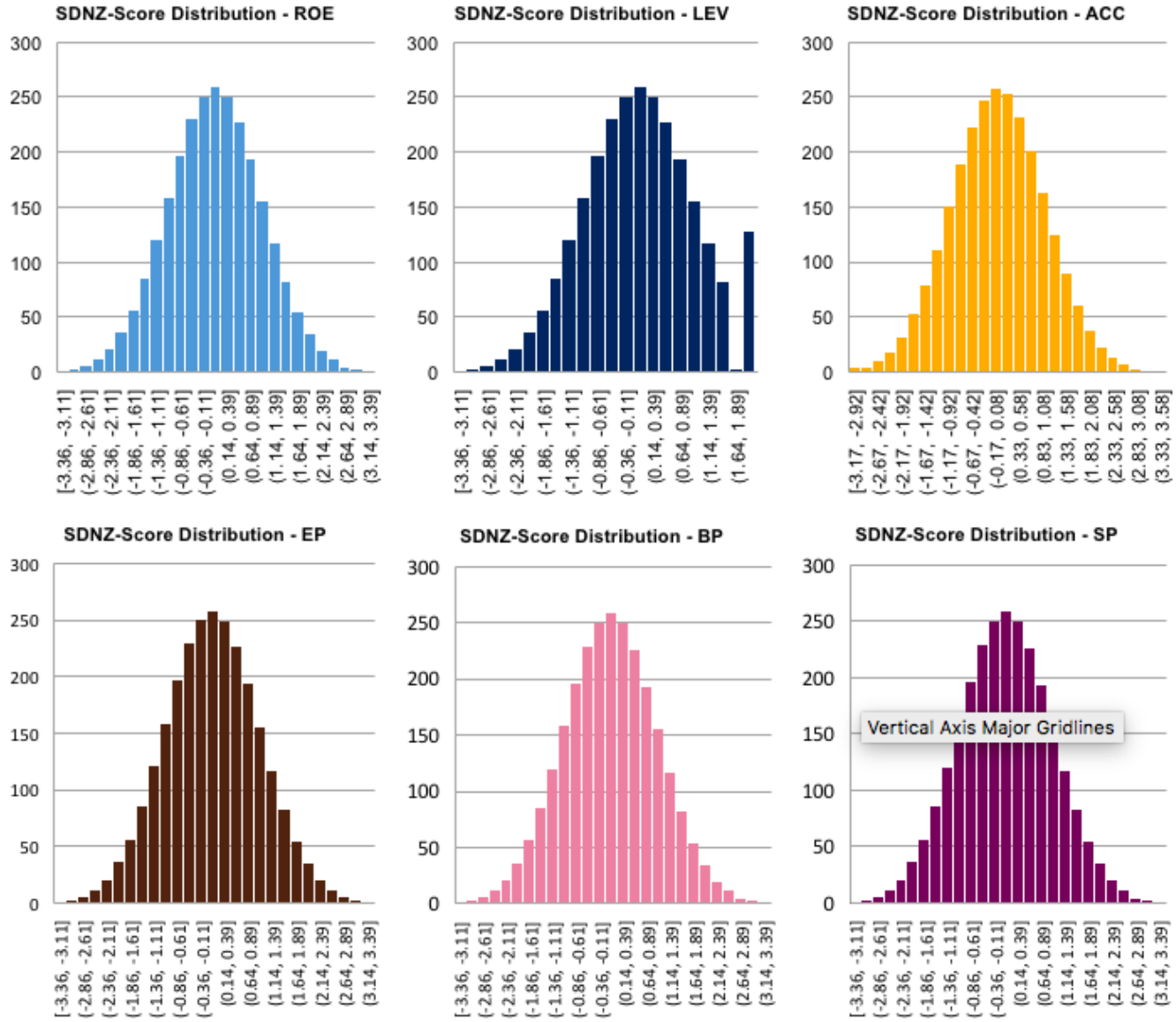
APPENDIX

Exhibit 14: Subfactor Z-Score Distributions in the Universe



Source: S&P Dow Jones Indices LLC. Data as of Dec. 20, 2019. A higher z-score of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 15: Subfactor SNDZ-Score Distributions in the Universe



Source: S&P Dow Jones Indices LLC. Data as of Dec. 20, 2019. A higher z-score of ROE, LEV, ACC, EP, BP, and SP implies higher ROE ratio, lower LEV ratio, lower ACC ratio, higher EP ratio, higher BP ratio, and higher SP ratio, respectively. Past performance is no guarantee of future results. Charts are provided for illustrative purposes and reflect hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 16: ROE and ACC Z-Score Distributions and Correlation

DATE	ROE		ACC		CORRELATION BETWEEN ROE AND ACC
	SKEWNESS	KURTOSIS	SKEWNESS	KURTOSIS	
December 2006	-1.03	6.37	-0.10	2.58	-0.28
June 2007	-0.54	4.81	-0.15	3.32	-0.30
December 2007	-0.63	6.54	-0.49	3.20	-0.32
June 2008	0.33	2.90	-0.25	3.17	-0.20
December 2008	0.81	2.70	0.07	3.12	-0.12
June 2009	-1.14	5.42	-0.56	2.57	-0.32
December 2009	-1.42	10.84	-0.66	2.70	-0.34
June 2010	-0.02	3.46	-0.38	3.39	-0.22
December 2010	0.25	3.04	-0.45	3.50	-0.23
June 2011	0.26	10.71	-0.68	3.40	-0.25
December 2011	0.58	9.29	-0.78	3.16	-0.22
June 2012	-0.17	10.48	-0.72	3.15	-0.20
December 2012	-2.38	38.37	-0.70	3.58	-0.19
June 2013	3.32	102.66	-1.09	2.06	-0.12
December 2013	1.70	129.07	-1.08	1.87	-0.14
June 2014	7.99	320.18	-1.25	3.34	-0.17
December 2014	10.26	332.16	-1.22	3.28	-0.17
June 2015	-9.55	137.71	-0.75	2.35	-0.18
December 2015	-7.14	91.52	-0.79	2.44	-0.16
June 2016	-2.81	38.47	-0.83	2.32	-0.23
December 2016	-1.37	60.79	-0.82	2.41	-0.19
June 2017	-1.03	23.98	-0.99	2.44	-0.15
December 2017	-0.16	32.22	-1.02	2.58	-0.11
June 2018	-8.19	140.67	-0.75	2.33	-0.21
December 2018	-4.87	78.14	-0.72	2.51	-0.17
June 2019	-10.42	127.58	-0.25	3.17	-0.31
December 2019	-8.31	99.94	-0.25	2.93	-0.34

Source: S&P Dow Jones Indices LLC, FactSet Alpha Testing Report. Data from June 30, 2006, to Dec. 31, 2019. Subfactor z-scores are calculated semiannually. Past performance is no guarantee of future results. Table is provided for illustrative purposes and reflects hypothetical historical performance. Please see the Performance Disclosure at the end of this document for more information regarding the inherent limitations associated with back-tested performance.

Exhibit 17: Definition of Risk Factors in the Axioma AXCN4-MH China Equity Factor Risk Model

RISK FACTOR	FACTOR DEFINITION
Market Sensitivity	Two-year weekly beta versus the emerging market
Size	Natural logarithm of market capitalization
Medium-Term Momentum	Cumulative return over past year, excluding the most recent month
Volatility	Six-month average of absolute returns over cross-sectional standard deviation, fully orthogonalized to market sensitivity
Liquidity	Natural logarithm of the ratio of the three-month average daily volume and one-month average market capitalization, inverse of six-month Amihud illiquidity ratio, and proportion of returns traded over the past calendar year
Exchange Rate Sensitivity	Two-year weekly beta to returns of a basket of major currencies
Growth	Realized sales growth, forecast sales growth, realized earnings growth, forecast earnings growth
Value	Book-to-price, earnings-to-price, and estimated earnings-to-price ratios
Dividend Yield	Ratio of the sum of the dividends paid (excluding non-recurring, special dividends) over the most recent year to average market capitalization
Profitability	Return-on-equity, return-on-assets, cash flow to assets, cash flow to income, gross margin, and sales-to-assets ratios
Leverage	Total debt (current and long-term liabilities) to total assets and total debt to equity ratios

Source: S&P Dow Jones Indices LLC, Axioma. Table is provided for illustrative purposes.

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The back-test period does not necessarily correspond to the entire available history of the Index. Please refer to the methodology paper for the Index, available at www.spdji.com for more details about the index, including the manner in which it is rebalanced, the timing of such rebalancing, criteria for additions and deletions, as well as all index calculations.

Another limitation of using back-tested information is that the back-tested calculation is generally prepared with the benefit of hindsight. Back-tested information reflects the application of the index methodology and selection of index constituents in hindsight. No hypothetical record can completely account for the impact of financial risk in actual trading. For example, there are numerous factors related to the equities, fixed income, or commodities markets in general which cannot be, and have not been accounted for in the preparation of the index information set forth, all of which can affect actual performance.

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