

## 1. Descriptive statistics

|              | Utilities | Consumer  | Financials | Fin.<br>Services | Healthcare | Industrials | Con.<br>Staples | Materials | Real<br>Estate | Transportation | Technology | Telecom   |
|--------------|-----------|-----------|------------|------------------|------------|-------------|-----------------|-----------|----------------|----------------|------------|-----------|
| count        | 89.000000 | 89.000000 | 89.000000  | 89.000000        | 89.000000  | 89.000000   | 89.000000       | 89.000000 | 89.000000      | 89.000000      | 89.000000  | 89.000000 |
| mean         | 0.000242  | 0.003190  | 0.001772   | 0.009381         | 0.010140   | 0.004413    | 0.008173        | 0.006772  | 0.003837       | 0.008810       | 0.009179   | 0.001801  |
| std          | 0.066115  | 0.092505  | 0.069744   | 0.058649         | 0.040766   | 0.072140    | 0.041077        | 0.055106  | 0.044371       | 0.054617       | 0.094143   | 0.043159  |
| min          | -0.500868 | -0.742240 | -0.475615  | -0.224605        | -0.099103  | -0.489512   | -0.123958       | -0.164818 | -0.204005      | -0.180762      | -0.738336  | -0.112183 |
| 25%          | -0.019774 | -0.012720 | -0.021237  | -0.020734        | -0.009760  | -0.020049   | -0.015303       | -0.022288 | -0.016697      | -0.011662      | -0.017074  | -0.025273 |
| 50%          | 0.012605  | 0.010803  | 0.017944   | 0.021254         | 0.010405   | 0.009759    | 0.006491        | 0.007687  | 0.005065       | 0.011699       | 0.021401   | 0.000310  |
| 75%          | 0.032318  | 0.034728  | 0.033936   | 0.038968         | 0.037505   | 0.035959    | 0.027978        | 0.035130  | 0.029183       | 0.041493       | 0.047152   | 0.027958  |
| max          | 0.084260  | 0.155848  | 0.146394   | 0.177839         | 0.129286   | 0.156714    | 0.127564        | 0.171214  | 0.114758       | 0.118417       | 0.146240   | 0.119835  |
| Sharpe ratio | -0.005274 | 0.028098  | 0.016937   | 0.149881         | 0.234241   | 0.052980    | 0.184586        | 0.112179  | 0.073169       | 0.150486       | 0.091223   | 0.028044  |
| Skewness     | -5.012742 | -5.924199 | -3.884567  | -0.655885        | -0.263935  | -3.725537   | -0.090281       | -0.009428 | -0.984885      | -0.759845      | -5.661164  | 0.237314  |
| Kurtosis     | 38.276162 | 48.765834 | 26.777055  | 5.468435         | 3.384529   | 26.423327   | 4.497131        | 4.039391  | 7.433235       | 4.430607       | 45.906590  | 3.193619  |
| VaR          | 0.067959  | 0.075277  | 0.075421   | 0.085825         | 0.067385   | 0.079737    | 0.060723        | 0.084630  | 0.066074       | 0.092345       | 0.074876   | 0.063923  |
| annu. return | -0.031817 | -0.056286 | -0.015514  | 0.095608         | 0.117737   | 0.013496    | 0.091735        | 0.065141  | 0.034522       | 0.091190       | 0.013102   | 0.010682  |

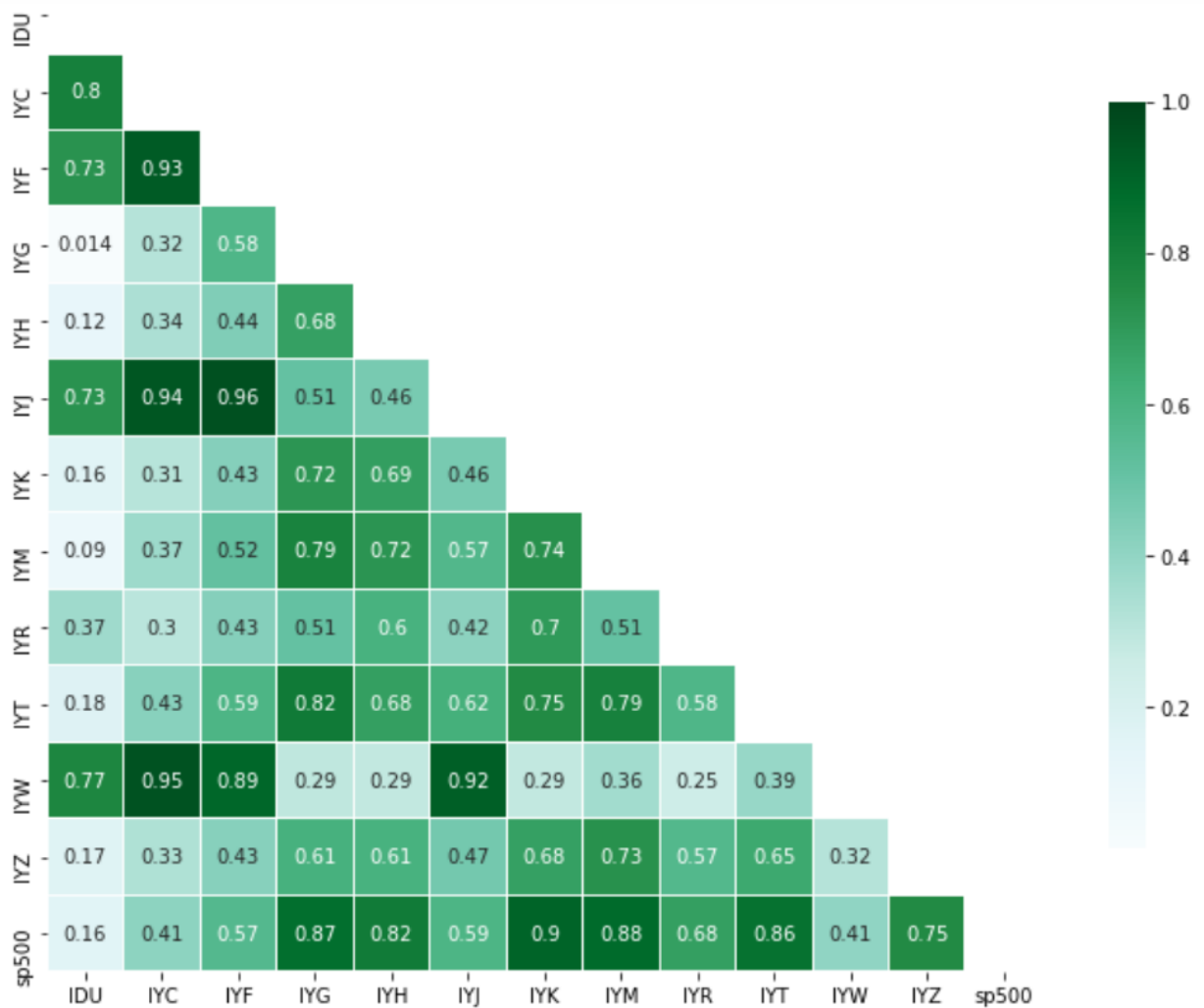
- First developed by William Sharpe (1966), Sharpe ratio, which is considered as one of the most cited ratio in measuring financial performance, calculates the excess expected return over its volatility (standard deviation) of an investment. The higher the ratio, the better the investment. While the ratio for sector ETFs ranged from practically zero (Utilities) to 0.23 (Healthcare), the ratio for factor ETFs had higher spectrum, ranging from 0.07 (EM minimized volatility) to 0.33 (US momentum), indicating that on average, the factor ETFs earned more excess returns after adjusting for its risk.

- For skewness - a measure of symmetry in data distributions, all sector ETFs were negative, except Telecommunication (0.23), and they varied notably across industries. Factor ETFs had lower level of variability, from -0.8 (US Min Vol) to -0.28 (US Quality). The same pattern arose in terms of measuring statistical distributions by Kurtosis. A larger, wider Kurtosis range was found in sector ETFs, from 3.19 (Telecommunication) to 48.7 (Consumer), compared to the factor ETFs range (from 3.4 to 7.6), suggesting a higher level of risk associated with sector investments.

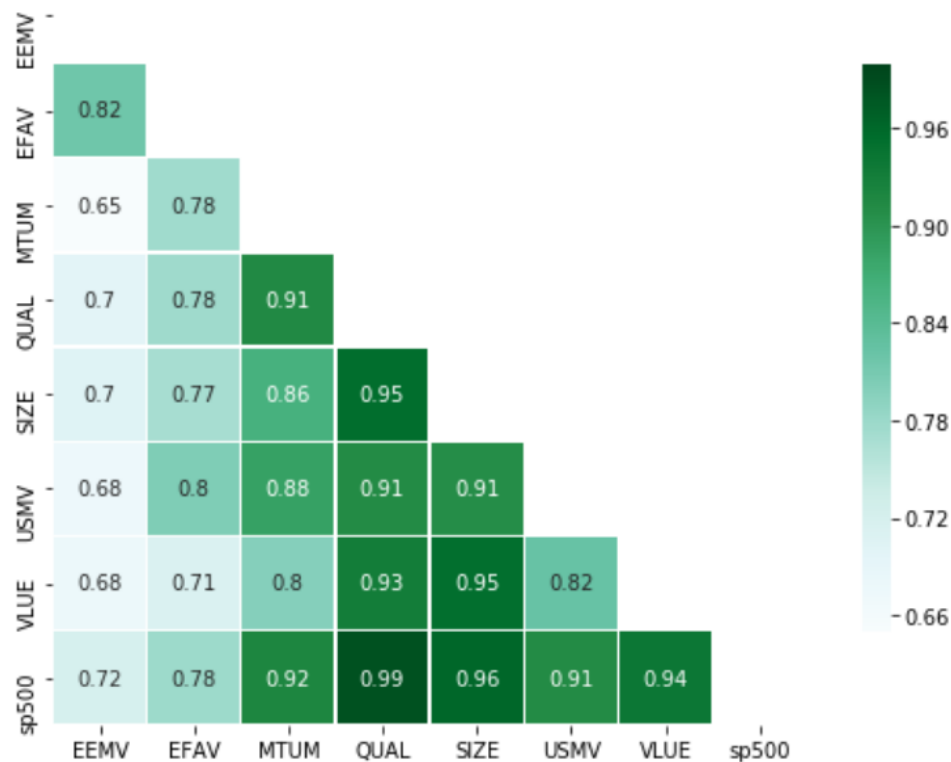
|                     | EM Min Vol | EAFE Min Vol | US Momentum | US Quality | US Size   | US Min Vol | US Value  |
|---------------------|------------|--------------|-------------|------------|-----------|------------|-----------|
| <b>count</b>        | 89.000000  | 89.000000    | 89.000000   | 89.000000  | 89.000000 | 89.000000  | 89.000000 |
| <b>mean</b>         | 0.003573   | 0.005456     | 0.014154    | 0.011736   | 0.010718  | 0.010156   | 0.008362  |
| <b>std</b>          | 0.038336   | 0.029994     | 0.040643    | 0.039724   | 0.043765  | 0.032169   | 0.047238  |
| <b>min</b>          | -0.120690  | -0.098373    | -0.115587   | -0.114189  | -0.182781 | -0.113379  | -0.183625 |
| <b>25%</b>          | -0.020833  | -0.009781    | -0.009944   | -0.007563  | -0.006475 | -0.004941  | -0.011091 |
| <b>50%</b>          | 0.008851   | 0.008436     | 0.017960    | 0.010710   | 0.013109  | 0.012605   | 0.012419  |
| <b>75%</b>          | 0.029075   | 0.024261     | 0.037432    | 0.036972   | 0.034141  | 0.030596   | 0.034136  |
| <b>max</b>          | 0.092282   | 0.087952     | 0.117017    | 0.122779   | 0.143132  | 0.093686   | 0.164269  |
| <b>Sharpe ratio</b> | 0.077793   | 0.162203     | 0.333710    | 0.280573   | 0.231394  | 0.297357   | 0.164505  |
| <b>Skewness</b>     | -0.399998  | -0.568746    | -0.413289   | -0.287832  | -0.676955 | -0.805963  | -0.610647 |
| <b>Kurtosis</b>     | 3.439174   | 4.349340     | 4.037773    | 4.322428   | 7.643459  | 5.425457   | 6.565718  |
| <b>VaR</b>          | 0.053060   | 0.046717     | 0.052755    | 0.061150   | 0.054953  | 0.041739   | 0.075688  |
| <b>annu. return</b> | 0.034619   | 0.061776     | 0.172327    | 0.139704   | 0.123560  | 0.122014   | 0.090412  |

- As pointed out by Ang, Chen, and Xing (2006), investors pay more attention to downside risks, rather than the overall volatility. Specifically, the latter measures the variability of returns around the expected value, regardless of the sign. This is rarely the case in reality where "agents who place greater weight on the risk of downside losses than they are attach to upside gains demand greater compensation for holding stocks with high downside risk". In order to measure this downside risk, many methods have been proposed over the years, however Value at Risk (VaR) is considered as the most widely accepted approach. First developed by J.P. Morgan in 1996, VaR enabled investors to gauge the maximum estimated loss at a commonly 95% confident level. VaR in sector ETFs ranged from 0.064 (Telecommunication) to 0.092 (Transportation), which was greater than that of factor ETFs from 0.042 to 0.076, implying repeatedly the fact that an investment in sector ETFs was more presumably risky than in factor ETFs.

- Regarding annualized returns, there was three sector ETFs that lost money over the sample period (Utilities, Consumers, and Financials), whilst the best performing sectors belonged to Healthcare and Financial Services (approximately around 10%). As for factor ETFs, the lowest annualized return was 3.4% (EM Min Vol), while the US momentum ETF captured the highest return at 17.2%, followed by the US quality ETF at 14%.



- The obvious observation from the correlation map above is that there were substantively positive correlations between S&P500 and sector ETFs (mostly around 0.6 to 0.8), except Utilities with 0.16. The highly correlated returns would potentially reduce the benefit of diversification across industries - especially when the market index performed poorly, which was the uttermost important element in considering this approach. Moreover, two highest correlations were detected between Industrials and Financials (0.96), trailed by Technology and Consumer (0.95). In contrast, Utilities and Financial Services had the lowest correlation (0.014), followed by Utilities and Materials (0.09).



- All factor ETFs seemed to closely move with the S&P500 index (predominantly over 0.9), closely reached 1 for Quality and Size ETFs. Furthermore, correlations among factor ETFs also exhibited more homogeneous than that of sector ETFs. The lowest correlation was between the US Momentum ETF and the EM Min Vol (0.65), while the highest value (0.95) belonged to two pairs, specifically between the US Size ETF and the US Quality ETF, and the US Size ETF with the US Value ETF. Since the primary objective of these smart betas was to exploit any mispricing that potentially appeared in the market, diversification benefit was understandably neglected.