Data Assignment 3

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https://github.com/thomaswsu/Trading_Assignment_3

Our portfolio with the optimal Sharpe ratio is generated by a random generation of 10,000 different portfolios from 1,000 different stocks of the Russell 3000. A portfolio is generated through a random generation of 1,000 different weights with respect to the restrictions specified in the assignment. Once the portfolios are generated, each portfolio's mean return, standard deviation, and Sharpe ratio is calculated. The portfolio is the highest Sharpe Ratio is then selected.

In Figure 1 we can observe the distribution of randomly generated portfolios. Portfolios that are in the top right corner have a higher Sharpe ratio and are more ideal.

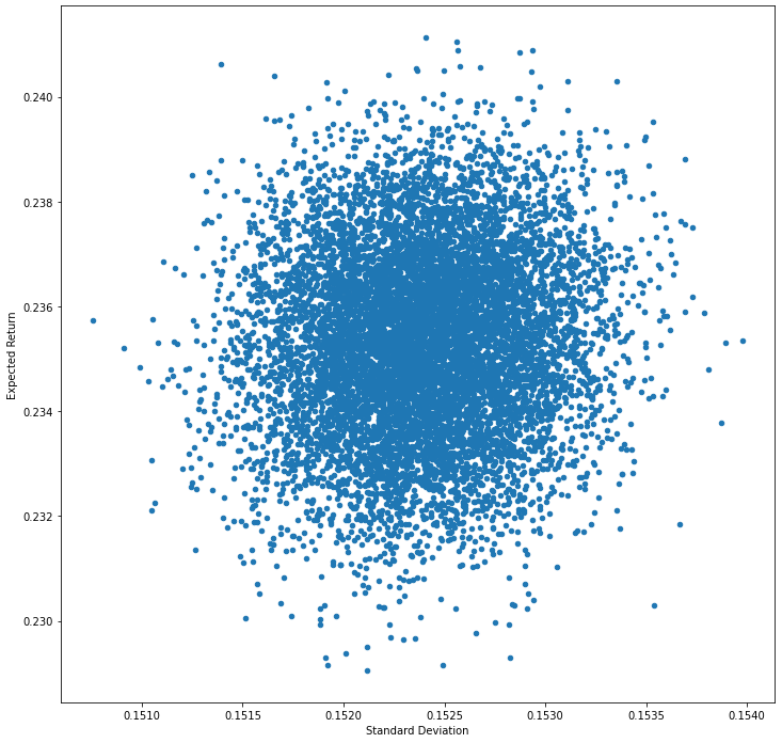

Figure 1: Plot of Randomly Generated Portfolios

Figure 2 shows us the characteristics of the top 10 portfolios sorted by Sharpe ratio. Notice that the portfolio with the highest historical return does not necessarily have the highest return. It is interesting to see all the top performing portfolios have an alpha of around 8%.

	w	mu	sigma	beta	alpha	Sharpe Ratio	Treynor Ratio
210	[0.0014231391033085138, 0.0010132750415556618,...	0.240617	0.151394	1.084078	0.088847	1.533195	0.214114
6015	[0.0006610373112451069, 0.0007530077197661653,...	0.240394	0.151657	1.086382	0.088625	1.529076	0.213456
8531	[0.000691929792190419, 0.001020596443480868, 0...	0.241130	0.152409	1.091307	0.089361	1.526355	0.213167
63	[0.0005852650906587101, 0.001050034427358274, ...	0.240282	0.151915	1.087592	0.088513	1.525738	0.213115
4257	[0.0009257821709304398, 0.0013512969575692755,...	0.241059	0.152559	1.091193	0.089289	1.524388	0.213123
4618	[0.0009079572685427286, 0.0010228885683582639,...	0.239585	0.151614	1.086035	0.087815	1.524162	0.212778
8311	[0.0006017427833442139, 0.0006585109704521586,...	0.240125	0.152008	1.088189	0.088355	1.523769	0.212853
4403	[0.001192079548385248, 0.0007851677794652836, ...	0.239976	0.151920	1.088698	0.088206	1.523673	0.212617
2366	[0.0010095968418903283, 0.0010095968418903283,...	0.240422	0.152224	1.090101	0.088653	1.523564	0.212753
3247	[0.000695772160928008, 0.001233680050048821, 0...	0.239540	0.151657	1.087283	0.087770	1.523437	0.212493

Figure 2: Top 10 Portfolios

The smart beta portfolio that uses firm characteristics is generated by calculating the Z-Score from each metric and taking the sum all the Z-scores to generate weights for a 1,000 randomly selected stocks from the index. The Z-score for each metric is calculated by the following formula:

$$Z = \frac{x - \mu_p}{\sigma_p}$$

Where x is the metric that we want to calculate a Z-score for and μ_p and σ_p are mean and standard deviation for the entire portfolio. This portfolio in all honesty is quite random. There is really no empirical evidence to back up the quality of this portfolio.

Figure 3 displays the first 10 weights that were generated the smart beta portfolio.

```
{'VFC': 0.0012775960752248 57,
 'IRWD': 0.0011640319796493 14,
 'ZIOP': 0.0012605614608885256,
 'SCI': 0.0012719178704460798,
 'LRN': 0.0006529935495593714,
 'WYN': 0.0010504678840737712,
 'CPLA': 0.0009141909693831198,
 'ELGX': 0.0011810665939856455,
 'FAST': 0.0014195511946942854,
 'ORBC': 0.0010447896792949941}
```

Figure 3: First 10 Weights for Heuristic Portfolio

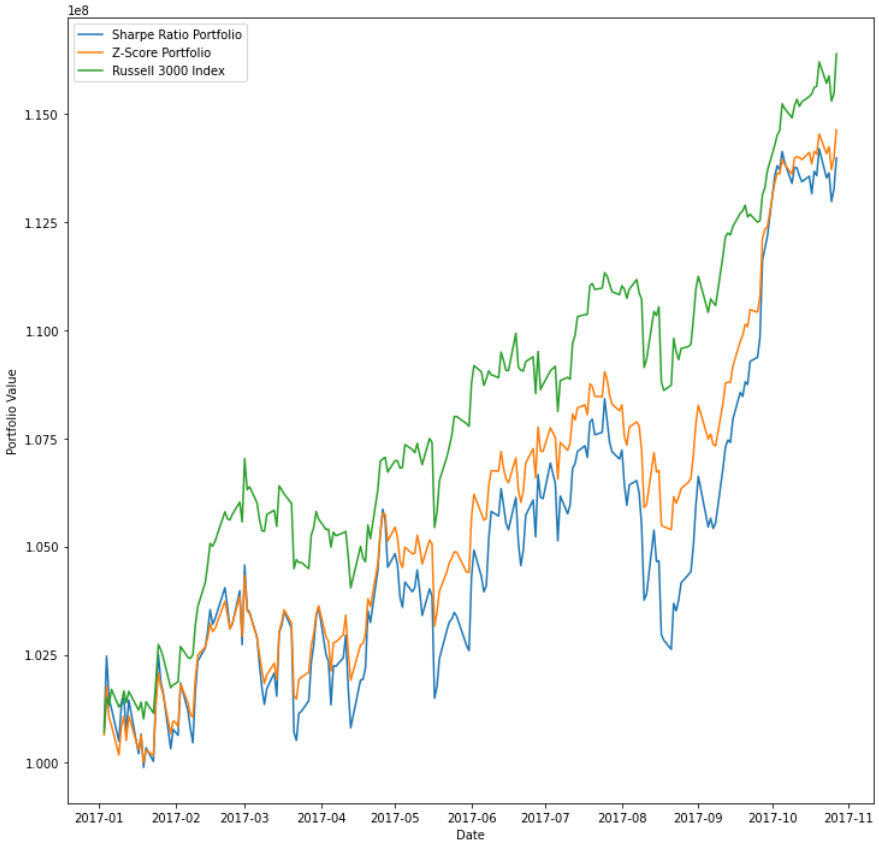

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Figure 4 we can see the performance of the two portfolios relative the Russell 300 Index. While the performance of the Z-score Portfolio is quite random and can vary randomly, i.e., in some runs the Z-score portfolio outperforms the index and in some it does not, the Sharpe Ratio portfolio is quite consistent in underperforming the index by an alpha of around 0.2%. This is because the highest Sharpe Ratio does not necessarily imply the highest returns as explained prior. The Sharpe Ratio simply tells you the best risk adjusted portfolio, where the risk of measure is historical standard deviation.

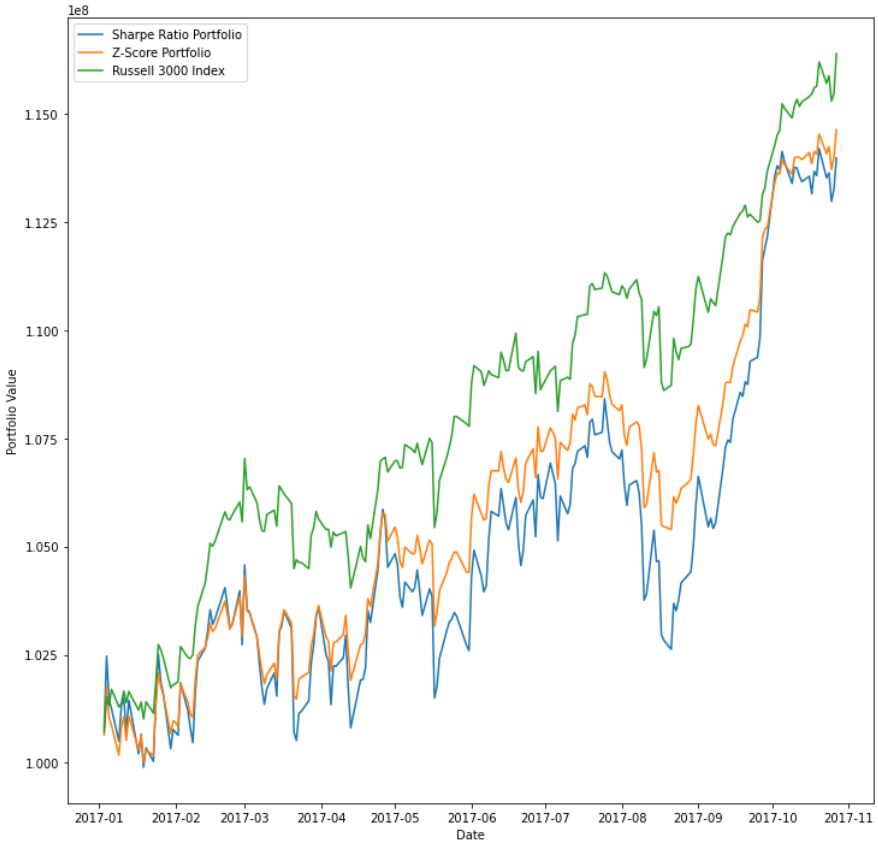

Figure 4: Portfolio Return in 2017