

Implementing Portfolio Models for Investing in the Mongolian Stock Exchange

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ABSTRACT

In this study, in terms of riskless investment for prospective investors, we implement financial portfolio theories to generate financial portfolios on the Mongolian Stock Exchange. To conduct the analysis, we use models of financial portfolio optimization with limited scope and quantitative computational techniques. The research defines portfolio optimization on the Mongolian Stock Exchange using Markowitz's Mean-Variance Portfolio and Telser's Safety First model. We used Mongolian Stock Exchange weekly trading data with the 20 most traded stocks selected from over 200 stocks listed for the 2017 to 2019 MSE period. For 2019, we developed 52 weeks of Mean-Variance portfolio and Safety-First portfolio and found the portfolio of Safety-First performed better.

Keywords: Portfolio optimization, Mean-Variance portfolio, Safety-First portfolio, Sharpe ratio.

1. INTRODUCTION

Portfolio optimization is the process of selecting the best distribution of assets according to defined objectives from the set of all portfolios being considered. Typically, the target maximizes variables such as expected returns, and minimizes risks such as financial risk.

Financial portfolio is intended before it happens to identify potential issues, so that portfolio measures can be prepared and used as appropriate over a product's or project's entire life to minimize negative impacts on achieving goals. For the Mongolian Stock Exchange, which is a young and small market, a large number of investor is traditional investors (investor who buy stocks and hold for unspecific period to sell, in other words, they are inactive traders in the market) due to lack of financial or economical knowledge of the market. It is reasonable to be inactive investors but we may address it to their knowledge of the market. If the investors are fully provided with market information, they would be trading more actively.

In order to achieve a high reward, every investor needs to spend their hard earned money without risk. In the stock market, everybody has the ability to invest freely in all financial assets. The composition of equity portfolios depends on a number of factors, with the shareholder's risk appetite, the investment timeframe and the sum invested being the most relevant. Modern portfolio theory suggests investors are risk-averse, meaning they select a less risky portfolio for a given amount of return over a more volatile one. It means that only if he or she wants more gains will an investor take on more exposure.

Why do we consider a portfolio? Each investor needs to take a position their capital to realize high profit while there is no risk present. In financial market, everyone has probabilities to take a position financial assets with free alternatives. The composition of investments during a portfolio is depending on variety of stocks, a large number of factors are the risk tolerance of the investor, the investment horizon and quantity of investment.

One possibility is to try to improve portfolio performance with Modern Portfolio Theory, a financial theory that seeks to maximize the expected portfolio returns for a given amount of risk tolerance, or to minimize risk equivalently for a given level of expected return, when investors have built up a stock portfolio by choosing the appropriate composition of different assets. Modern Portfolio theory later developed to Mean-Variance portfolio by Harry Markowitz. Mean-Variance analysis is a method of measuring risk versus expected return, expressed as variance. Depending on how much risk they are able to take on in exchange for varying rates of compensation, investors use Mean-Variance analysis to make assumptions on which financial instruments to invest in.

Safety First portfolio ensures the probability of negative returns is minimized. The change relates to a better estimate of negative probability of return by mean functions of excess chance of return.

Proper study of financial portfolio in Mongolian Stock Exchange is significant for all investors in the market or prospect investors. In assessing investment prospects, risks are an important component. Most investors consider less risk to be favorable while making an investment. As the investment risk is lower, investment is more lucrative.

2. LITERATURE REVIEW

Harry Markowitz presented the Modern Portfolio theory in a 1952 essay. Modern Portfolio theory implies an investor would like to optimize the expected return dependent of a portfolio on certain given amount of risk. Investments that meet these criteria, known as efficient portfolios, in order to produce a higher expected return, it is necessary to take on more risk because investors face a trade-off between risk and expected return. Mean errors are much more important in contrast to variance and covariance errors with higher risk tolerance. The relative effect is greater for the means, variances and co-variances of the errors.

The use of a limited quantity of historical data exposes the model to parameter estimation errors. Broadie (1993) studied the impact of errors in calculated parameters on the Mean-Variance outcome. He observed that the frequency of the errors is rising with the amount of securities his research used. He also discussed ways to minimize anomalies in the Mean-Variance measurement would strengthen historical forecasts of the securities' mean returns. Boost the historical mean return minus the standard deviation and correlation effect. In the maximization Mean-Variance would give higher predicted return and less standard deviation on the real frontier than the corresponding point.

Throughout the sense of long-term financial strategy, the Mean-Variance portfolio started to take notice. There the utility function is based on capital consumption rather than the mean and variation of the target property. Robert Merton used expected utility criteria for portfolio management in his work to pioneer continuous-time models Merton (1971) and Merton (1973). He used dynamic programming and partial differential equation to maximize the expected effectiveness of the richness of the investor.

Not just are certain buyers considering standard deviation, they were able to downsize the risk, so they needed to build another model. Safety First models are one of

the models that focuses on negative outcomes. Roy (1952) the portfolio introduced has the least probability of yielding below the specified rate. Many investors may consider minimum level of their projected cost, or other investors may find resulting in a loss to them.

Bawa (1978) simplified Safety First model condition of and built according to the Stochastic Dominance criteria. There are other cases where safety-first approach for security from financial instability will be acceptable. Engles (2004) presented the Telser's first Safety First model with an explicit theoretical approach assuming that volatile assets are allocated together in elliptic form. Levy (2009) find that Safety First model plays a significant role in decision taking. Anthony and Achmad (2019) used risk and return measured for a portfolio based on the Indonesian Stock Exchange investment strategy.

3. METHODOLOGY

3.1. Mean-Variance portfolio

$$\begin{aligned} \bar{R}_p &= \sum_{i=1}^n x_i \bar{r}_i && \text{Portfolio expected return} \\ \sigma_p^2 &= \sum_{i=1}^n \sum_{j=1}^n x_i x_j \sigma_i \sigma_j \rho_{ij} \quad \text{or} \\ \sigma_p^2 &= x^T \Sigma x && \text{Portfolio variance or portfolio risk} \\ \max & \quad s\bar{R}_p - (1-s)\sigma_p^2 && \text{objective function} \\ \text{subject to} & \quad \sum_{i=1}^n x_i = 1 && \text{budget constraint} \\ & \quad x_i \geq 0 && \text{long only constraint} \\ & \quad x_i \leq 0.33 && \text{ceiling constraint} \end{aligned}$$

The portfolio utility function have expected return, portfolio variance and tradeoff between expected return and variance. We let $s=0.5$ consider the estimated return and portfolio volatility of the portfolio equally. The formulation considers mathematical returns for assets as measure of return and standard deviation as measure of risk. There is short-selling not permitted for long-sale even in terms of portfolio restriction. For ceiling constraint, one third of the overall budget no more weight for one security.

3.2. Safety First portfolio

$$\text{Portfolio expected return: } \bar{R}_p = \sum_{i=1}^n x_i \bar{r}_i$$

$$\text{Portfolio variance or portfolio risk: } \begin{aligned} \sigma_p^2 &= \sum_{i=1}^n \sum_{j=1}^n x_i x_j \sigma_i \sigma_j \rho_{ij} \quad \text{or} \\ \sigma_p^2 &= x^T \Sigma x \end{aligned}$$

$$\begin{aligned} \max & \quad \bar{R}_p \\ \text{subject to} & \quad \bar{R}_p \geq R_L - k_\alpha \sigma_p \end{aligned}$$

$$\sigma_p^2 = x^T \Sigma x$$

$$\sum_{i=1}^n x_i = 1$$

$$x_i \geq 0$$

In terms of portfolio constraint, there is short-selling is not allowed long-sale only. For ceiling constraint no more weight for one security one third of total budget.

3.3. Mongolian Stock Exchange main index MSE20

Benchmark is a criterion that measures efficiency of a security. A benchmark is usually an index the same or related type the securities. In this study, the benchmark will be the MSE20 index securities basket, the Mongolian Stock Exchange's key tracker, is updated every six months. It is determined on the basis of the market capitalization of the top 20 stocks listed on the MSE and the daily average value of the trade. The index data for MSE 20 was downloaded from the official MSE web site.

$$MSE\ 20\ returns = \frac{Current\ market\ index - Previous\ market\ index}{Current\ market\ index}$$

4. RESULTS

Table 1. Weekly Mean-Variance portfolio returns and portfolio risk or portfolio standard deviations.

Date	Portfolio return	Portfolio risk	Date	Portfolio return	Portfolio risk
1/4/2019	4.21%	4.60%	7/5/2019	5.63%	4.80%
1/11/2019	1.15%	2.96%	7/12/2019	3.21%	4.17%
1/18/2019	2.51%	3.75%	7/19/2019	0.06%	2.36%
1/25/2019	9.62%	3.55%	7/26/2019	9.94%	4.99%
2/1/2019	4.00%	3.76%	8/2/2019	6.70%	3.36%
2/8/2019	1.60%	3.41%	8/9/2019	3.11%	2.48%
2/15/2019	8.65%	3.86%	8/16/2019	15.42%	2.53%
2/22/2019	5.87%	2.95%	8/23/2019	12.97%	2.99%
3/1/2019	2.67%	1.81%	8/30/2019	8.45%	3.51%
3/8/2019	7.19%	4.47%	9/6/2019	9.58%	2.59%
3/15/2019	10.80%	3.60%	9/13/2019	11.51%	3.08%
3/22/2019	4.66%	2.78%	9/20/2019	4.55%	5.58%
3/29/2019	6.19%	3.09%	9/27/2019	10.98%	2.46%
4/5/2019	3.16%	2.29%	10/4/2019	9.98%	5.17%
4/12/2019	4.50%	3.78%	10/11/2019	3.01%	2.87%
4/19/2019	5.57%	2.87%	10/18/2019	7.23%	2.86%
4/26/2019	7.08%	6.19%	10/25/2019	13.31%	2.86%
5/3/2019	12.97%	4.14%	11/1/2019	11.26%	3.05%
5/10/2019	2.47%	3.69%	11/8/2019	11.06%	3.96%
5/17/2019	5.92%	3.08%	11/15/2019	8.15%	4.37%

5/24/2019	0.54%	3.40%	11/22/2019	15.57%	3.39%
5/31/2019	4.76%	3.88%	11/29/2019	14.44%	4.67%
6/7/2019	2.51%	4.63%	12/6/2019	7.11%	5.12%
6/14/2019	5.69%	3.36%	12/13/2019	11.96%	3.60%
6/21/2019	5.84%	2.74%	12/20/2019	7.91%	3.07%
6/28/2019	8.70%	5.09%	12/27/2019	4.79%	4.55%

Table 1 shows all positive results for the test 52 weeks in 2019. The lowest is 0.06% and the peak is 15.57%. Most standard deviations or portfolio risk are quiet small and stable within 2% and 5%.

Table 2. Mean-Variance portfolio’s weekly average return against benchmark MSE20 weekly returns.

	Mean-Variance portfolio	MSE20
Weekly average return	7.05%	-0.16%
Weekly average standard deviation	3.62%	1.63%

Table 2 reveals that the mean return (7.05%) of the Mean-Variance portfolios over the full period is much higher than the MSE20 (-0.16%) benchmark. The mean return produced negatively by the MSE 20 meant that stock market dropped during testing times. MSE20 (1.63%) is lower than the Mean-Variance portfolios (3.62%) in terms of standard deviation of benchmark. Standard deviation of the Mean-Variance portfolio performed very well but the standard deviation of MSE20 benchmark was even lower by 2 percent weekly.

Figure 1. Weekly Mean-Variance portfolio returns against benchmark MSE20.

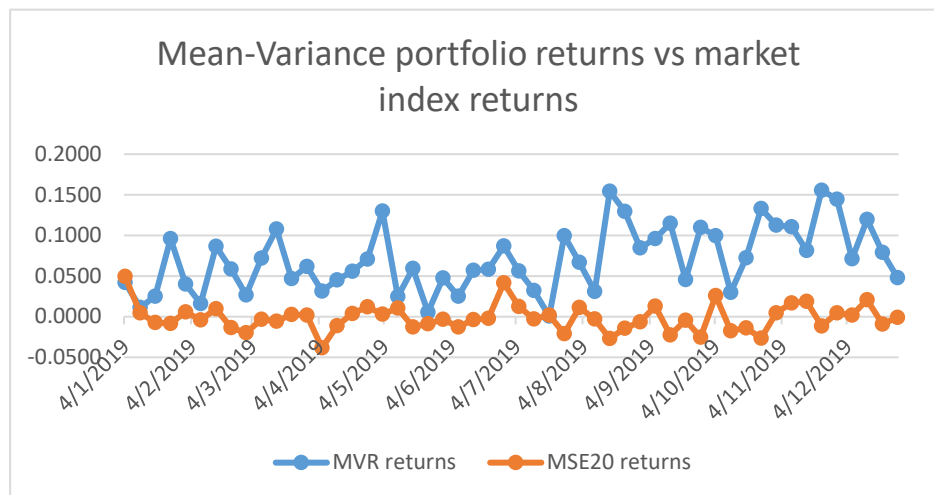


Figure 1 shows weekly Mean-Variance portfolio returns for 52 weeks surpassed the MSE20 benchmark. The portfolio of Mean-Variations has relatively stable positive returns over the full period of testing. But benchmark MSE20 was only higher in the first week than the portfolio of Mean-Variance. From the figure, the Mean-Variance portfolio is obvious to have relatively low volatility compared to MSE20 benchmark.

We found $R_L=0.26\%$ using Mongolian government bond yield rate per week for protection first portfolio, and predetermined probability α equal to 0.05. Short-selling is not available in Mongolian market so constraint formulation will be used.

Table 3. Weekly portfolio returns and standard deviations of Safety First portfolio

Date	Portfolio return	Portfolio risk	Date	Portfolio return	Portfolio risk
1/4/2019	2.76%	4.94%	7/5/2019	3.78%	1.26%
1/11/2019	0.38%	0.46%	7/12/2019	2.68%	-0.27%
1/18/2019	2.16%	-0.70%	7/19/2019	-0.06%	0.18%
1/25/2019	9.62%	-0.83%	7/26/2019	8.58%	-2.08%
2/1/2019	2.55%	0.58%	8/2/2019	6.45%	1.15%
2/8/2019	0.80%	-0.39%	8/9/2019	2.66%	-0.29%
2/15/2019	7.17%	0.97%	8/16/2019	15.27%	-2.67%
2/22/2019	5.29%	-1.34%	8/23/2019	12.73%	-1.43%
3/1/2019	2.65%	-1.99%	8/30/2019	7.36%	-0.63%
3/8/2019	5.63%	-0.31%	9/6/2019	9.40%	1.28%
3/15/2019	10.04%	-0.56%	9/13/2019	11.43%	-2.25%
3/22/2019	4.23%	0.27%	9/20/2019	2.11%	-0.44%
3/29/2019	5.92%	0.18%	9/27/2019	10.95%	-2.52%
4/5/2019	3.07%	-3.84%	10/4/2019	7.90%	2.60%
4/12/2019	2.83%	-1.12%	10/11/2019	2.46%	-1.75%
4/19/2019	5.30%	0.40%	10/18/2019	7.13%	-1.40%
4/26/2019	5.81%	1.23%	10/25/2019	12.82%	-2.63%
5/3/2019	12.74%	0.31%	11/1/2019	11.03%	0.48%
5/10/2019	1.75%	1.04%	11/8/2019	9.91%	1.68%
5/17/2019	5.76%	-1.28%	11/15/2019	7.64%	1.87%
5/24/2019	0.04%	-0.88%	11/22/2019	15.33%	-1.16%
5/31/2019	3.76%	-0.31%	11/29/2019	12.70%	0.48%
6/7/2019	0.46%	-1.27%	12/6/2019	6.04%	0.20%
6/14/2019	4.46%	-0.37%	12/13/2019	11.81%	2.09%
6/21/2019	5.53%	-0.21%	12/20/2019	7.06%	-0.92%
6/28/2019	6.33%	4.16%	12/27/2019	3.64%	-0.07%

Table 3 reports the result of the weekly investment over a full 52-week period. Highest portfolio return is 15.33 percent. In this portfolio, we chose $R_L=0.26\%$, but there are some weeks where portfolio return could not be generated higher than acceptable rate. Safety First portfolio standard deviation over 52 weeks of test performed relatively consistent. 4.9 percent was performed the highest standard deviation, which is quite reasonable standard deviation for portfolio.

Table 4. Safety First portfolio's weekly average return against benchmark MSE20 weekly returns.

	Safety First portfolio	MSE20
Weekly average return	6.27%	-0.16%
Weekly average standard deviation	2.51%	1.63%

The mean return (2.51%) for the Safety First portfolios for the full period is higher than the MSE20 (-016%) market index. The mean return of the benchmark MSE20 was performed poorly for the entire test duration. Safety First portfolio has relatively higher standard deviation (2.51%) than market index MSE20 (1.63%) in terms of portfolio risk.

Figure 2. Safety First portfolio returns against benchmark MSE20.

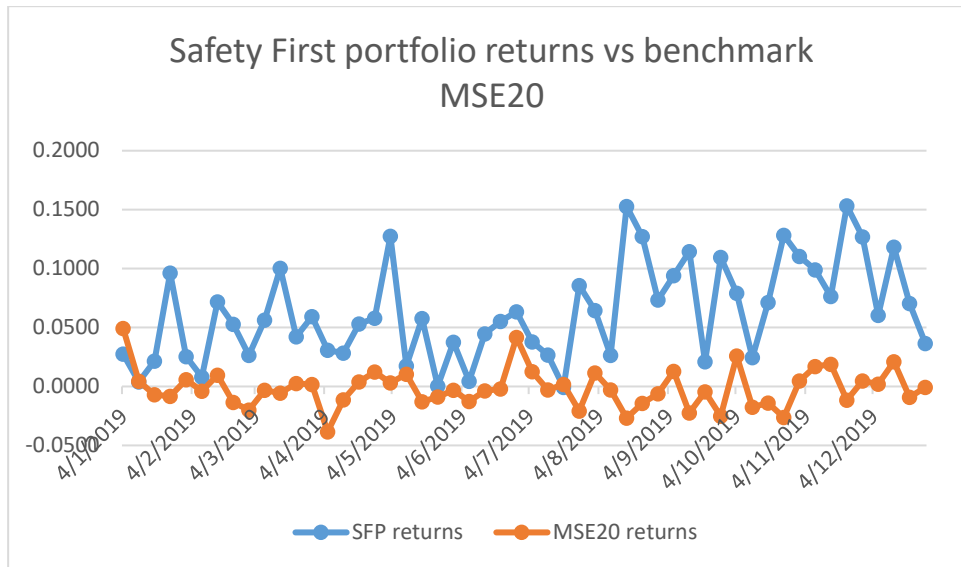


Figure 2 reports presented very stable compared to benchmark MSE20 returns over 52 weeks of Safety First portfolio. It looks like Safety First portfolio from the table is less risky than the benchmark MSE20. Over 52 weeks monitoring, there are no significant changes in portfolio returns.

4.1. Comparison between Mean-Variance and Safety First portfolio in Mongolian Stock Exchange

For over 52 weeks in 2019, we generated 2 portfolios using the Mongolian Stock Exchange historical data. Both portfolios were over-performed than the MSE20 index Mongolian market benchmark. Within this section we compared the portfolio of Mean-Variance portfolio and Safety First portfolio. For the evaluation, we considered standard deviation difference for the risk and portfolio return for the efficiency.

Table 5. Statistics of Mean-Variance portfolio and Safety First portfolio

	Mean-Variance portfolio	Safety First portfolio
Average return	7.05%	6.27%
Average standard deviation	3.62%	2.51%

Table 5 reveals a slightly higher Mean-Variance portfolio returns than Safety First portfolio’s returns, but in terms of standard deviations, Safety First portfolio have lower standard deviations than Mean-Variance portfolio.

The regularized portfolio rules analyze portfolio risk and have lower risk than other methods for portfolio selection. This can be attributed to the Safety First portfolio downside risk measure, taken into account in the regularized strategies. The Mean-Variance portfolio and the Safety First portfolio have demonstrated lower risk mitigation as a consolidated risk measure.

The study used Sharpe ratio to compare 2 portfolios in this study. It is the measure of an asset's return relative to its risk. The return is defined as the asset's incremental average return over the risk-free rate. The risk is defined as the standard deviation of the asset's returns.

$$\text{Sharpe ratio} = \frac{\text{Expected portfolio return} - \text{Riskfree rate}}{\text{Portfolio standard deviation}}$$

Relative to equivalent portfolios or lower-return investment, a high Sharpe ratio is acceptable.

From Table 6, we can clearly see that Safety First portfolio has better result of Sharpe ratio. Although one portfolio or fund that receive higher returns than its competitors, it is only a good investment if such higher returns do not result in an extra risk. The higher the Sharpe ratio of a portfolio, the greater the risk-adjusted-performance. If the evaluation results in a negative Sharpe ratio, it either means that the risk-free yield is higher than the return from the portfolio, or it is assumed that the return from the portfolio is lower.

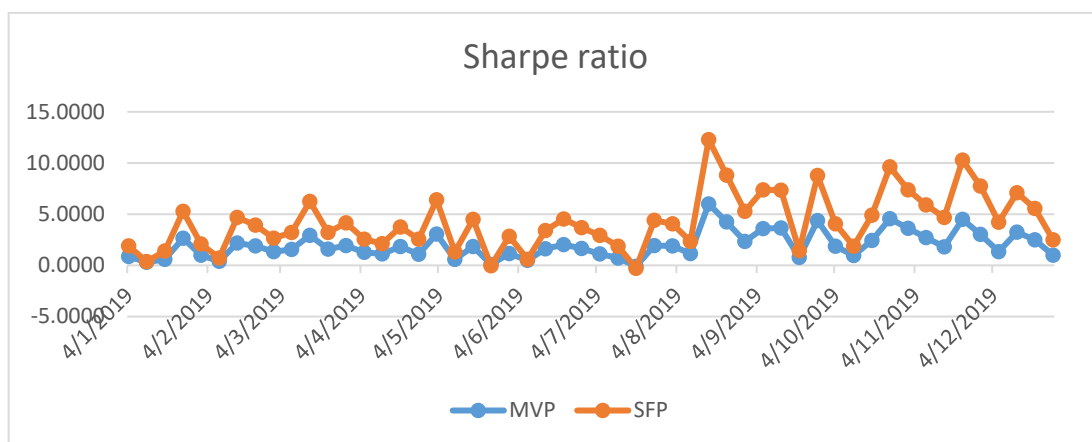


Figure 3. Mean-Variance portfolio's Sharpe ratio vs Safety First portfolio's Sharpe ratio.

Figure 3 shows the Safety First portfolio has substantially better returns from the Mean-Variance for complete periods. It is suggestion that prefer Safety First portfolio if investor wants to reduce the portfolio risk and prefer high portfolio returns.

Table 6. Portfolios Sharpe ratio comparison.

Date	Mean Variance portfolio	Safety First portfolio	Date	Mean Variance portfolio	Safety First portfolio
1/4/2019	0.8569	1.0490	7/5/2019	1.1173	1.8045
1/11/2019	0.2989	0.0580	7/12/2019	0.7047	1.1734
1/18/2019	0.5964	0.8108	7/19/2019	-0.0891	0.2040
1/25/2019	2.6377	2.6403	7/26/2019	1.9371	2.4496
2/1/2019	0.9920	1.1051	8/2/2019	1.9136	2.1567
2/8/2019	0.3900	0.3103	8/9/2019	1.1433	1.2092
2/15/2019	2.1737	2.4982	8/16/2019	6.0002	6.2817
2/22/2019	1.8977	2.0461	8/23/2019	4.2545	4.5465
3/1/2019	1.3280	1.3336	8/30/2019	2.3334	2.9535
3/8/2019	1.5471	1.6683	9/6/2019	3.5979	3.7632
3/15/2019	2.9212	3.3125	9/13/2019	3.6449	3.6815
3/22/2019	1.5815	1.6268	9/20/2019	0.7679	0.6763
3/29/2019	1.9196	2.2278	9/27/2019	4.3586	4.4145
4/5/2019	1.2635	1.2861	10/4/2019	1.8792	2.1743
4/12/2019	1.1199	1.0029	10/11/2019	0.9533	0.9168
4/19/2019	1.8465	1.8956	10/18/2019	2.4313	2.4710
4/26/2019	1.1006	1.4475	10/25/2019	4.5551	5.0762
5/3/2019	3.0673	3.3390	11/1/2019	3.6049	3.7754
5/10/2019	0.5964	0.6976	11/8/2019	2.7260	3.1694
5/17/2019	1.8383	2.6530	11/15/2019	1.8042	2.8838
5/24/2019	0.0798	0.1306	11/22/2019	4.5097	5.7705
5/31/2019	1.1553	1.6916	11/29/2019	3.0349	4.7138
6/7/2019	0.4848	0.1036	12/6/2019	1.3365	2.8887
6/14/2019	1.6135	1.7828	12/13/2019	3.2472	3.8504
6/21/2019	2.0371	2.4781	12/20/2019	2.4856	3.0832
6/28/2019	1.6568	2.0317	12/27/2019	0.9935	1.5154

5. CONCLUSIONS

We used weekly trading data from Mongolian Stock Exchange with the chosen 20 most traded stocks out of over 200 stocks listed at the MSE period of 2017 to 2019. We generated 52 weeks Mean-Variance portfolio and Safety First portfolio for 2019 and found Mean-Variance portfolio has higher returns in all weeks in 2019, but Safety First portfolio has safer result in terms of standard deviation of the portfolio. Both Mean-Variance portfolio and Safety First portfolio outperformed than Mongolian Stock Exchange benchmark index MSE20 for 52 weeks in 2019, which is promising using both portfolio approaches are beneficial for investors in Mongolian Stock Exchange. For the prospect investment, study suggest that Safety First portfolio, because 52 weeks of Sharpe ratio estimation has higher in Safety First portfolio than Mean-Variance portfolio, great opportunity for prospect investor who is willing to gain profits with low risk in Mongolian Stock Exchange.

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