Online Investment Game:
Build up and Strategy Analysis

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Stat 157, Fall 2017
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1. Abstract

Inspired by Buttonwood's article "Picking a fund manager? The odds aren't great" on the newspaper *The Economist*, a simple game was built to show the conclusion in the article: it is hard for the market investor to pick a successful fund manager. In this game, real-life funds are simulated and the existence of a better performance fund is assumed. Several strategies for the game players to find the better performance fund were tried, and the results of these strategies were compared and analyzed.

2. Introduction

Instead of buying stocks, many market investors choose to buy funds from professional fund managers. The investors might believe that they can pick a better performance funds managed by successful fund managers easily, where better refers to the funds that have annual returns better than the average stock market annual return. However, as Buttonwood stated in his article "Picking a fund manager? The odds aren't great", this might not be the truth.

Assuming that better performance funds exist, a game was built in order to checked whether these good funds can be found by market investors. There are twenty-five funds in the game, while one of them is a better performance fund. A game player is told at the end of the game whether he or she gets a better portfolio return than the market cumulative return and the fund number of the worthwhile fund ("good fund"). After attempting by playing around and making several strategies for finding the better performance fund, we considered that it is hard to find the worthwhile fund, no matter what the strategy is. This result also supported the conclusion in Buttonwood's article: funds managed by successful managers are hard to find by the market investors.

3. Background

If people want to invest in the stock market, the direct way is buying stocks; however, buying stocks is risky. In some countries, stocks have maximum daily increase/decrease of 10% of the total value of the stocks. On the contrary, in the U.S., stocks don't have these maximums. For example, the stock of Linkedin once decreased about 42% in one day. Because of the risk, many market investors turn to put their money into funds. There are mainly three types of funds: index funds, mutual funds, exchange-traded funds. An index fund buys many shares in an index, so it is basically a representation of the performance of the whole market. If people invest all their money into index funds, these people will essentially only get the average return of the market. According to the game, returns of the index funds are basically the same as the market index profit displayed on the game website. But who just wants to get the average profit? Therefore, mutual funds become popular. Mutual funds are managed by professional fund managers. The fund managers can also use their judgments to buy good performance stocks and avoid bad ones. Therefore, if the managers indeed have the skills for selecting stocks, they can provide better performance funds. The question here is, however, can the market investors find these better performance funds?

4. Game Description

In the game, the stock market return average is set as 5% for each year, and the variance of it is 200%. There are 25 funds, and for 24 of them, the annual return averages are the market return in that year minus a 1% fee charged additionally by the hypothetical fund managers. There is only one better performance fund that is "worthwhile". The annual return average for this "worthwhile" fund is the market return in that year plus 2% and minus a 1% fee. For all 25 funds, they have additional variances 200% than the original stock market's, which means the funds have variances 400% in total. The annual market return and the 25 funds are all under normal distributions. So, actually, the "worthwhile" fund has mean 6% and variance 400%, and the other 24 funds have mean 4% and variance 400%. The 5% and the variance 400% mentioned above are simulations of the real stock market properties.

Below is a specific explanation of some terms shown on the game page:

	2 Years ago	1 Year ago	0 Year	1 Year	2 Year	3 Year	4 Year	5 Year	6 Year	7 Year	8 Year	9 Year	10 Year	11 Year	12 Year	Current Allocation(%)	Funds value	Last 3 years gain	New Allocation(%)
Fund 1	18.1%	-29.78%	-30.03%	-9.07%	26.99%	-2.31%	-5.38%	0.65%	15.61%	42.7%	-9.47%	-15.35%	-22.53%	21.03%	63.53%		120.91	53.32%	
Fund 2	3.45%	-9%	-41.89%	22.67%	15.39%	-18.07%	-1.82%	14.12%	-3.51%	-14.81%	13.63%	-15.53%	-21.45%	-15.11%	41.62%		52.95	-5.56%	
Fund 3	1.6%	-30.14%	27.72%	30.64%	55.04%	-2.49%	4.63%	-0.88%	-4.1%	21.22%	10.4%	-8.03%	-27.3%	5.18%	5.51%		176.83	-19.32%	
Fund 4	28.98%	-28.71%	-25.54%	32.07%	-14.63%	-12.13%	-29.67%	-19.68%	28.79%	37.92%	21.38%	-11.53%	2.11%	14.27%	30.04%		110.86	51.73%	

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	2 Years ago	1 Year ago	0 Year	1 Year	2 Year	3 Year	4 Year	5 Year	6 Year	7 Year	8 Year	9 Year	10 Year	11 Year	12 Year	Current Allocation(%)	Funds value	Last 3 years gain	New Allocation(%)
Fund 22	-3.95%	-15.46%	-26%	34.25%	23.74%	-18.5%	9.42%	4.66%	4.6%	15.69%	-5.13%	-12.72%	-5.27%	-0.11%	37.46%		121.43	30.07%	
Fund 23	2.49%	-25.66%	-29.97%	2.56%	19%		-24.81%	-9.1%	-25.98%	-9.03%	21.7%	1.27%	8.66%	-30.19%	8.66%	31.18%	39.94	-0.49%	
Fund 24	18.59%	3.52%	-12.3%	-0.6%	15.58%	-23.71%	-38.03%	1.64%	-10.78%	24.66%	25.44%	-12.97%	13.06%	5.17%	21.78%		104.51	44.81%	
Fund 25	19.23%	-15.8%	-17.48%	4.69%	11.84%	-33.35%	-7.61%	-12.77%	12.04%	14.47%	23.96%	14.84%	10.39%	9.43%	36.96%	1	157.36	65.44%	

Start Over   Simulate next year results

The worthwhile fund is 4.

Best fund growth rates:

Rank	Since inception	Last 3 years
1	Fund 5	Fund 25
2	Fund 16	Fund 21
3	Fund 19	Fund 1

Your gain for each year:

	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Year8	Year9	Year10	Year11	Year12
Your gain	0.05%	0.12%	-0.33%	-0.08%	-0.13%	0.12%	0.14%	0.24%	0.15%	0.1%	0.09%	0.37%
Index gain	15.82 %	18.96 %	-11.89 %	-7.1 %	0.29 %	9.15 %	21.67 %	4.56 %	-2 %	-12.8 %	9.44 %	36.8 %

Your portfolio value compared to the index:

	1 Years	2 Years	3 Years	4 Years	5 Years	6 Years	7 Years	8 Years	9 Years	10 Years	11 Years	12 Years
Your Portfolio Value	100.05	100.17	99.84	99.76	99.63	99.75	99.89	100.13	100.28	100.38	100.47	100.84
Index Value		115.82	137.78	121.4	112.78	113.11	123.46	150.21	157.06	153.92	134.22	146.89	200.95

In the first table:

Column "x years ago/x year": shows the growth rates of each fund.

Column "Current Allocation(%)": shows how the player just allocated his or her portfolio.

Column "Fund value": shows the 25 funds' values in that year, and all the initial values are set to be 100.

Column "Last three years gain": shows the average growth rates the last three years of each fund.

Column "New Allocation(%)": the place for the player to put numbers ranging from 0 to 100. These numbers represent the percentage of how the player chooses to allocate his

or her portfolio. For example, if the player put 50 in the row of "Fund 10" and "Fund 16", that means he or she allocates 50% of the portfolio to fund 10 and the other 50% to fund 16. Since the sum of the percentage cannot exceed 100% here, the sum of number cannot exceed 100. The entries that are left to blank represents 0% allocations.

In the second table:

Column "Since inception": shows three funds with the highest average growth rate so far.

Column "Last 3 years": shows three funds with the highest average growth rate in the last three years.

In the third table:

Row "Your gain": shows the player's gain in the year shown in the column name. The initial value of this is 100.

Row "Index gain": shows the market return in the year shown in the column name. The initial value of this is also 100.

In the fourth table:

Row "Your Portfolio Value": shows the player's cumulative portfolio value until the year shown in the column name.

Row "Index Value": shows the cumulative value of the stock market index until the year shown in the column name.

In each run of the game, the good fund varies. For each run, the player needs to input the percentage of how he or she allocates the portfolio in that year, and then clicks on the button "Simulate next year results" to get the data of the funds for the next year. This procedure continues for 12 years. At the end of the run, the number of the good fund is shown on the screen in red (see the picture above), and it also tells the player whether he or she beats the market, which is given by comparing his or her cumulative

portfolio value with the cumulative market index (comparing the two entries in the "12 years" column of the fourth table).

5. Methods

Some investors might think that they could have some strategies to find better performance funds. In order to find a good strategy that can beat the market index, different allocations were applied to specific funds that satisfied some desired conditions in a year. The game was repeated for 100 times, and after each game, the final "Your Portfolio value" and final "Index Value" were recorded and compared. For each of the strategies discussed below, two different ranks were used for allocating the portfolio: the rank calculated based on the funds growth rates since inception (from the beginning) and that of the last three years. The rank calculated since inception was chosen because getting more information about the growth rates can lead to more reliable predictions on the performance of the funds in the future years. The rank calculated based on the last three years data was chosen since, in reality, the most recent growth rates of funds provide more insight into the future growth. For example, if the stocks in a fund are related to machine learning or artificial intelligence, then as new technology being developed in these years, there is a higher chance that these stocks will increase.

6. Results and Discussion

In order to have good visualization of the strategies results, two plots were made for each strategy. In these plots, the y-axis represents "Your Portfolio value" minus the "Index Value", so a more positive y value means the player beats the market for a larger amount. The x-axis represents the comparison result for each game (run) with total 100 games. The strategy based on the "rank since inception" is in green (called "all years" method), and the strategy based on the rank of last three years rates is in blue (called "last three years" method).

The winning rate is defined as the chance that a player beat the market index. If the winning rate is higher than 50%, then it is reasonable to say that the corresponding strategy generally performs better than the market index.

6.1 Strategy 1: Invest 100% on the Rank 1 fund in each year

If the player invests 100% in the best-so-far fund each year, the winning rate for using the best-so-far fund (47%) is higher than just using the best fund in last three years (26%), but it is still lower than 50%. Therefore, if only one fund can be chosen at a time, using all the growth rates information of the funds in the previous years can increase the winning rate. Nevertheless, it is also a higher risk for using "all years" method since the player can get many extreme values: wins more than 300 and lose more than 200 (Figure 1).

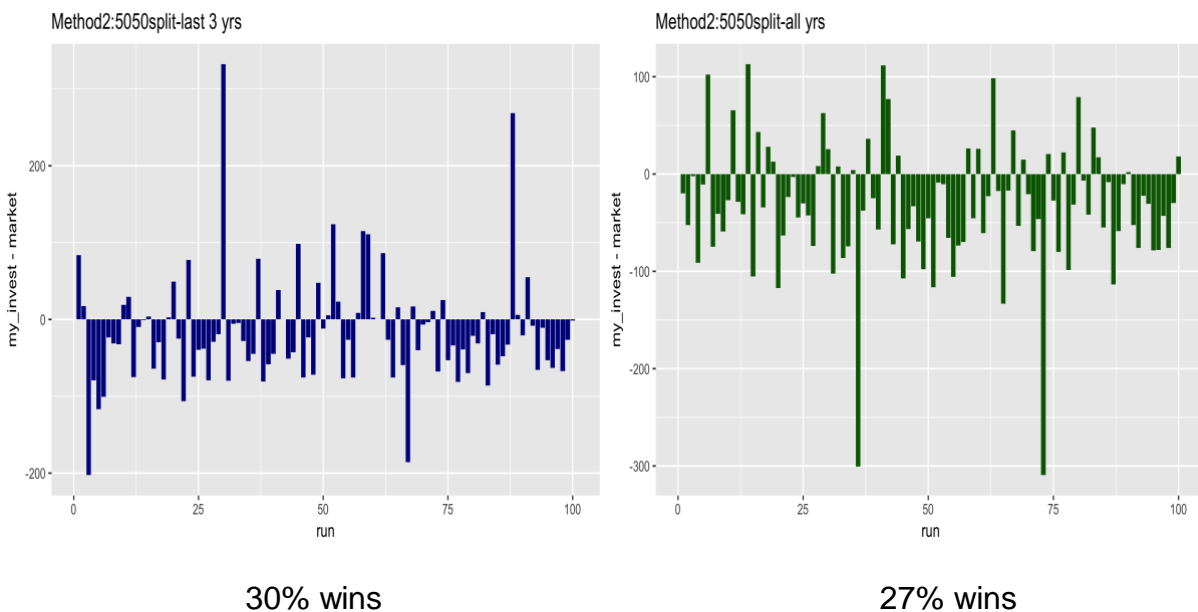| 26% wins | 47% wins |
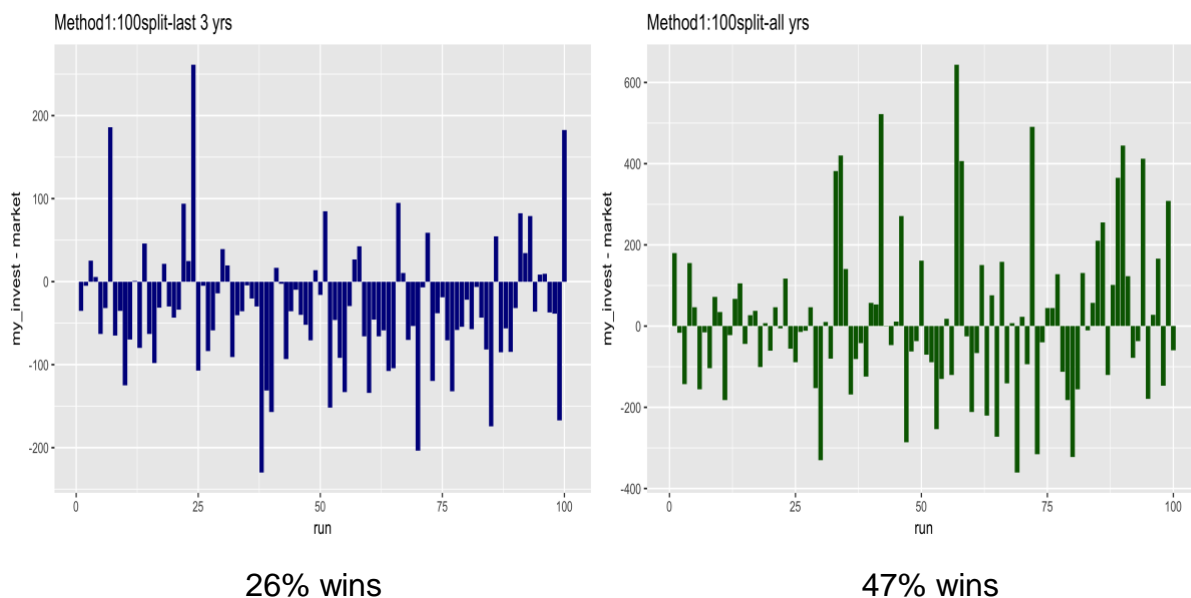
Figure 1: Profit comparison for investing 100% on the rank 1 fund in each year based on rank for last three years (left) and rank since reception (right).

6.2 Strategy 2: Invest 50% evenly on the Rank 1 & Rank 2 fund in each year

If the player thinks there is no much difference between the top two ranks funds, which means whichever of these two funds becomes the first is just by chance, then the player may want to invest equally in them. Although the winning rates for both of them are similar, there are two large positive values (over 200) for "last three years" and two large negative values (around 300) for "all years" (Figure 2). This indicates that for this 50% evenly split strategy, it is better to use the "last three years" method since the player tends to get more large positive values and less large negative values.

Method2:5050split-last 3 yrs   Method2:5050split-all yrs

30% wins   27% wins

Figure 2: Profit comparison for investing 50% evenly on the Rank 1 & Rank 2 fund in each year based on the rank of last three years (left) and rank since reception (right).

6.3 Strategy 3: Invest 50% on Rank 1, 30% on Rank 2, and 20% on Rank 3 fund in each year

If the portfolio is split across a decreasing percentage of the top three good performance funds, then the condition is that the player thinks the top-three-rank funds do have differences and the higher the rank, the better the fund will perform in the future. In this case, using the "all years" method has a winning rate which is 12% higher than that of the "last three years" method. Besides, the spreads of both methods are similar, which means players basically will not get extreme values (big wins or big loses) in both methods (Figure 3).

| 30% wins | 42% wins |
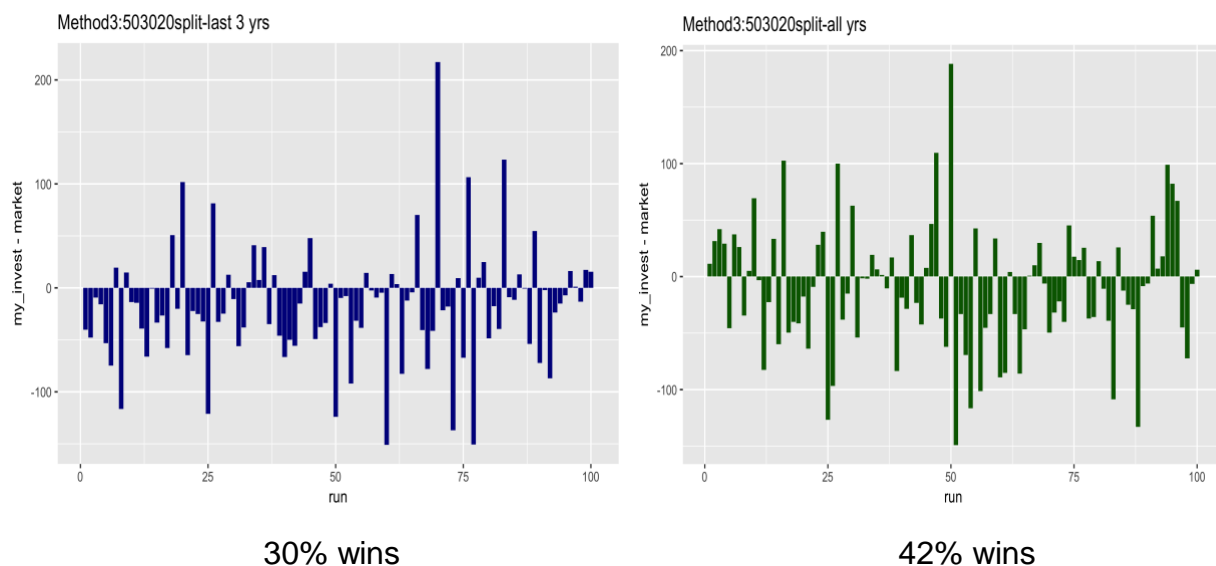
Figure 3: Profit comparison for investing 50% on Rank 1, 30% on Rank 2, and 20% on Rank 3 fund in each year based on the rank for last three years (left) and rank since reception (right).

6.4 Strategy 4: Invest 100% on a randomly picked fund each year

This simulates the situation that the players do not use any information from the previous years' growth rates of the funds. Instead, they choose one fund at random and keep for all 12 years. Only 1 out of 25 funds has an average growth rate higher than the market, so theoretically the chance that the players beat the market is 1/25 = 4%.

However, the empirical results show a 39% winning rate, which is much higher than the theory. One possible reason may be the high standard deviation that the funds have, which makes the funds vary a lot around the mean, so some funds can at times perform better than the "good fund". This phenomenon can be verified by noticing that after each game, the "good fund" has a higher chance that it does not appear in the top-three-rank funds, actually, the chance that it appears is around 66% (Table 1). Besides, more large positive values are observed in this method (Figure 4).

39% wins
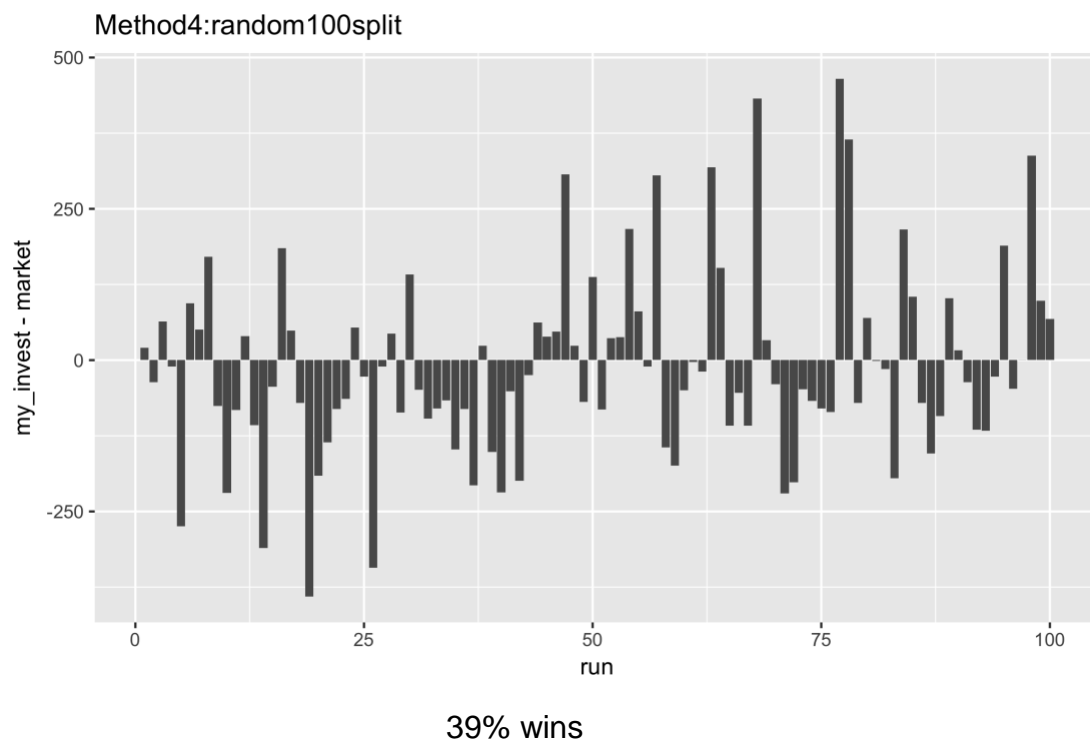
Figure 4: Profit comparison for investing 100% in a randomly picked fund and keeping investing in this fund in each year throughout each run.

	Rank 1 Fund	Rank 2 Fund	Rank 3 Fund	Top-three-rank Funds
Same as the "good fund"	12%	11%	11%	34%

number for a game				

Table 1: The chance that the method of choosing the top-three-rank funds includes the "good fund" based on the "rank since reception" at the end of the game (of total 100 games).

6.5 Strategy 5: Invest 50% on Rank 25, 30% on Rank 24, and 20% on Rank 23 fund in each year

In order to find out whether investing in the top-three-rank funds has a profit difference than investing in the bottom-three-rank funds, the portfolio is split in a decreasing order for the bottom-three-rank funds. Interestingly, from Figure 5, the player can still beat the market, yet with a lower winning rate.
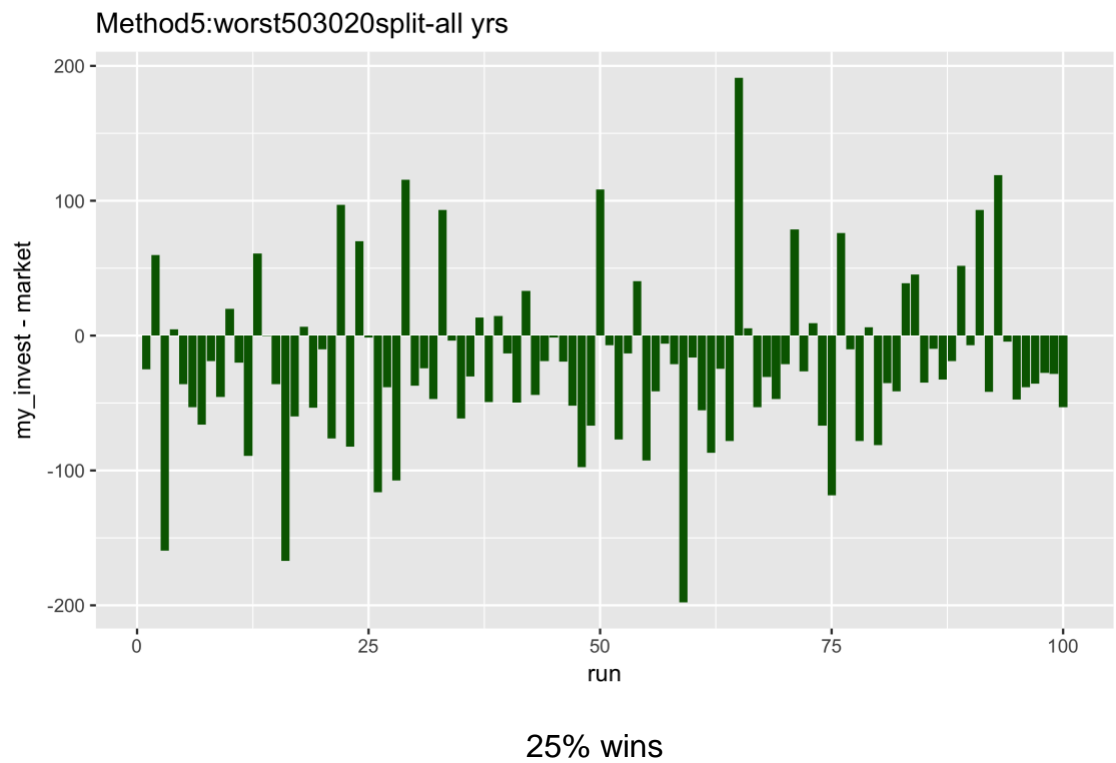

25% wins

Figure 5: Profit comparison for investing 50% on Rank 25, 30% on Rank 24, and 20% on Rank 23 fund in each year based on the rank since reception.

6.6 Comparison of all strategies

Relying on the rank information is like the investors collect the profit information of some funds, and then buying several good performance funds so far or that of in the last three years. Randomly selecting is like the condition that investors do not use any prior knowledge to make decisions for buying funds. If the strategies work, then the randomly selecting method should have a smaller percentage of beating the market than using these strategies. However, in this simulation, the result of the randomly selecting method does not show an obvious difference, comparing with the results of the strategies. From Figure 6, "all years" methods generally have higher winning rates than "last three years" methods. This makes sense because each year's growth rates are independent of all the other years and the parameters of the normal distribution of each fund in a game stay the same, so using "last three years" data is not sufficient to determine which one is the "good fund". Instead, the data of growth rates from the beginning of the game can give more insight into how the funds will perform. The best strategy is investing 100% on the Rank 1 fund based on the "all years" method, and the worst strategy is investing in the bottom-three-rank funds. This result is reasonable. Imagining the game is played for 100 years instead of 12 years, the Rank 1 fund will be more and more approaching the "good fund" in a long run. Therefore, if the player identifies which one is the "good fund", investing 100% in that fund can greatly increase the winning rate. Similarly, investing in the bottom-three-funds will be more likely to avoid the "good fund", so this decreases the winning rate.
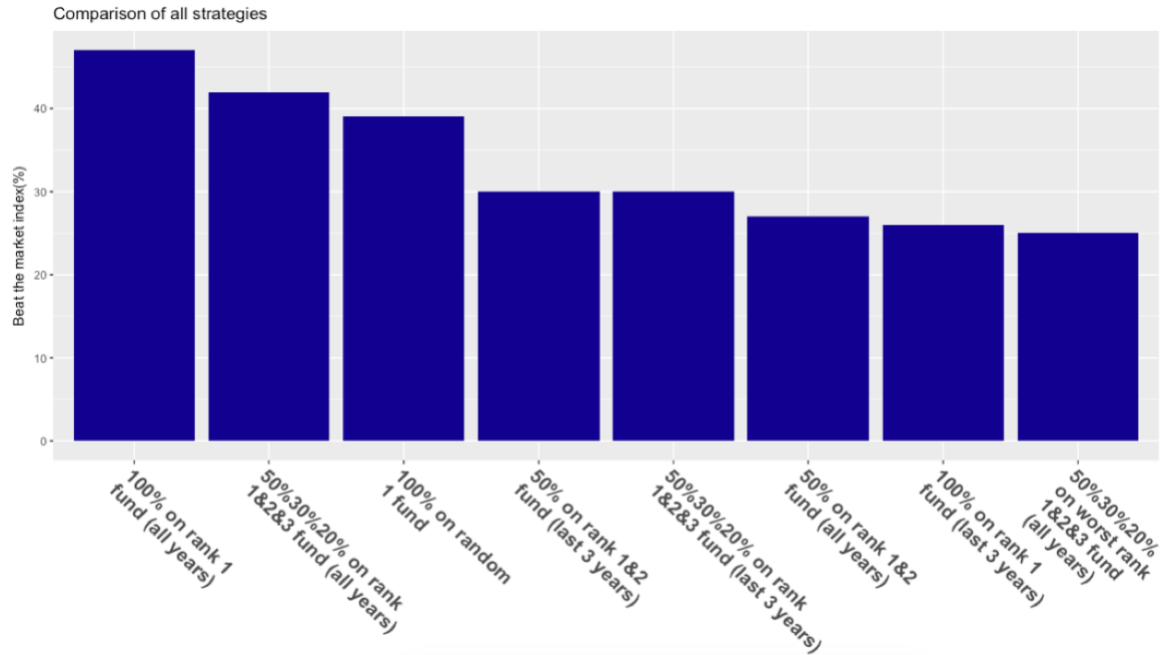
Figure 6: Winning rates comparison for all strategies.

7. Conclusion

None of the strategies discussed beat the market index. Therefore, as the claim stated in Buttonwood's article, it is hard for the market investors to find better performance funds, even though they might have some strategies for choosing funds. In the game, by investing in the funds that provided by the strategies, the player actively manages the funds, but this does not result in higher profits. This is also corresponding to what the company S&P Dow Jones Indices says: "In the past 10 years, less than 20% of actively managed blue-chip stock funds have outperformed the S&P 500 index of blue-chip stocks while fewer than 15% of small-company stock funds have beaten the Russell 2000 index of small-cap shares" ("Index Funds").

Some improvements can be made to fit the game closer to the real market. For example, in the game, the market index growth rate is fixed from year to year. It can be varied based on overall economic development in each year.

8. Work cited

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