FINAL REPORT

Course: EE590

Name: Huijie Qu

Student ID: 4825802065

Term: 2018 Summer

Project Title:

Date:

**Abstract**

Nowadays, a lot of stock investors are bewildered by how to choose stocks which could bring them reasonable and safe return. However, as the development of financial engineering and computation, there is not many useful and easy methods left for normal investors. Therefore, we could see that the number of investors losing money in the stock market soared up year by year. No need to say that it is vital for us investors to think up with new methods to evaluate stocks in the market.

In this research, I hope to use the most common data, fundamentals, and some unique calculations to build an indicator which could tell us whether the stock will bring us profits in the next year and if it is a bullish or bearish stock in the future. Then, I will test the effectiveness and usefulness of this indicator with back-testing for all stocks in S&P 500.

1. **Introduction**

Currently, for any investors, there is no doubt that the most challenging and difficult operation in the stock market is choosing the stocks which is profitable with enough certainty. However, as time goes by, more and more strategies has been exploited and become public. As we all know, any published approach will be useless since all investors will try to make money from it and no profit left then. Considering current condition, it is undoubtful that we need more techniques and mathematical skills in investment to profit. That is the reason why I decide to dig up an effective indicator which I could take advantage of to give some hints about whether I should hold the stocks or invest in the other stocks which, from my perspective, is somewhat profitable in the future.

To solve it, I initially have two ideas about it. First, I think we can analyze the most basic aspects of each stock, fundamentals. Since, for any good company, it will definitely show some bullish sign either in its financials or income statement. This method is easy to find data and reference, but the biggest problem in front of us is which information is important for us and how to combine all of the data we have chosen to generate a reliable index that enable us to uncover profitable stocks quickly and certainly. Then, I begin to think use historical data of tickers of each stock and derive a projection of future stock price based on its mean and standard deviation. However, the drawback of this method is apparent. We will mostly rely on our own subjective estimation to differentiate stocks and some recent change in a corporation will be dismissed because historical data will not tell anything about what has happened recently. Thus, not only is this method subjective, but also it will not by up-to-date. Based on my experience in investment, I believe latest changes in any firms is much more important as well as valuable for investors. Therefore, I decide to choose the first method for this research.

When using fundamentals to analyze stocks, what is most important to its equity holders is return on equity (ROE), since it directly determines how much money an investor will get from holding stocks. What’s more, ROE will also give us an insight into the performance of a company. For a good firm, since it operates well and outperform the its industry, it will definitely have higher ROE than most entities of the same type. By comparison, an unsatisfactory firm will require higher percent of net income for its operation and debt, thus, it undoubtedly cannot have the ability to generate enough return for its investors. As we can see here, in some situation, ROE could give us a basic idea about a company’s performance. However, as I said before, estimating a stock by simply using ROE will not have any effect on our investment since it is known by all. Thus, we need to figure out an approach which could indicate us when to but or sell a stock.

To solve it, I name a new variable, Alpha. The alpha is a function of ROE and is used to represent the change of stocks’ ROE between last and today. Besides, I then use Alpha to rank the stocks we need to analyze and want to invest in. From the result, we will choose the top 25% stocks to invest in from today and they should give investors higher return than the market. Moreover, to validate this method, I then use the back-testing approach for the all of stocks in the S&P 500 and compare the return of top 25% stocks with the market’s. The result shows that, in the year we choose, these stocks really give us higher return than the whole market, which means we make more profit than most of investors.

What’s more, this result, which shows that I will get higher profit than the market when using Alpha, helps us validate the effectiveness and generality of this method and it also indicates us that this approach can work properly in reality. If we use it in investment, it possibly can be helpful for investors who want to make much more money from investing in the stocks.

1. **Problem Statement**

As we all know, in today’s market, relying on candle chart, moving average convergence divergence (MACD) and other indicators solely cannot provide us with enough information about the future trend of specific stocks. And most investors often lose money when investing based on above data. The reason behind the loss is that today’s stock market is totally different from the past and what most of investors would do when choose stocks are their subjective feelings. Then, the question bewildering each investor till today might be what I should do in current stock market and how could I make money in the market. This is also a big headache for me. Then, I was wondering how I could use some practical but useful methods to give me a direct feeling about the badness or goodness of each stock. In my opinion, I believe all stocks will follow its own trends and it will outperform the market if it shows strong increase or development in the past year. Thus, I want to use each company’s fundamentals to roughly obtain their future trends. In other words, I plan to take advantage of various information as well as combine all of them to make a reasonable and technical prediction about the future price trend of a stock instead of guessing it in investment.

Therefore, the problem I am trying to solve in this research is how to choose stocks that are profitable and have the potential to increase in the price reasonably with some technical methods. To reach this goal, I will take advantage of some public information about a company and extract the useful contents to construct our indicator.

To begin with, as I said before, I will first use ROE to build this indictor since it is the most important information for all of investors. In detail, ROE represents how much money each of equity holders will obtain from the stock he invests in; therefore, all investors would pay much more attention to this index before choosing which stock to invest in. However, the stock market can disguise anything it does not want others to see. For example, a junk stock would show investors that it does not continue losing money this year by using some accounting approach. If any investor believes what the company says, there is no doubt that he or she may lose much more money than he expects from this trading. Thus, to avoid this problem as well as give all investors an initial judgment about the future trend of a stock, I come up with an indicator named Alpha, which is a function of ROE and will tell investors whether or not it is worth investing in a stock.

What’s more, I hope Alpha could give very useful data to investors, that’s to say, I plan to construct Alpha with data easy to obtain and result clear to understand. Then, investors investing in different industries could all use this indicator to make a predication of the stock they want to invest in and form an initial image of the future trend of the stock prices. However, I also want to make Alpha easy to calculate, which would not take too much time, like one day or even one month, to show the result to users. Finally, after back-testing, I hope this indicator, if it works well in any certain industry, can be effective in the whole market, which will compare all stocks in a stock market and tell investors which stocks in the whole market can be worth investing. This would give us more choices when all stocks in an industry become weak in development and worthless. Moreover, if it finally succeeds, we can also form a better view about the whole market and know if it is a bullish or bearish market now, which will help us more in making wise investment decision. And that also is the ultimate goal why I try to construct such an indicator.

1. **Data Collection**

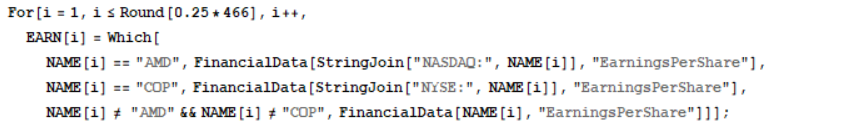
The data I will need to take advantage of and find is all stocks’ ROE of a specific industry in these two years and even the data of all stocks in the whole market, especially S&P 500. What’s more, the annual return of these companies is also needed to validate the effectiveness and usefulness of the indicator I will build later.

To find the data of the research, there are a lot of website and database we could take advantage of. When I deal with the situation for a certain industry, I would refer to the website Guru Focus to get the list of company in this industry and ROE, respectively. In the second step, that is back-testing, since the data we need to obtain is large, then I use the data of Intrinio to get all ROE of the companies in S&P 500. When it comes to the return of these companies mentioned, since Wolfram Alpha has its own embedded database in Mathematica, I just type some codes to use the data and get all the return data of all companies I need.

For the data from Guru Focus, it is not hard to process, we can just download a certain company’s date in the past years and download its Excel form file. To get the contents we need, we can just extract them from the form. Moreover, since we need to divide ROE of all these firms with twelve, what I have done is importing these data into Mathematica and using some codes to finish this work. For the data from Intrinio, the way I obtain the data is using the Excel add-in of this website. Since Intrinio’s database is abundant, the add-in does a big favor for me. To get the all the data I need, I can type in the Excel formula with the command shown in the picture 3.1 below.

C:\Users\quhui\AppData\Local\Temp\1526855530(1).pngpicture 3.1

To process these data, we could also work like what we have done for the data from Guru Focus with the help of Mathematica. For the last data I mentioned, it would be a little bit difficult to process, since we will get them from Wolfram Alpha, which means we will need to process all of them in Mathematica with some codes instead of our friend, Excel. Firstly, to obtain the return data of each company, I need the name of all the company which has become public since 2016. For this purpose, I will firstly delete any company which is not public until 2017, then I could extract the top 25% company after sorting the data left with Mathematica. Importantly, when I need to get the earnings per share (EPS) data of these company, I am going to need use the loop algorithm and a special code shown in the picture 3.2.



picture 3.2

Here, FinancialData function enables us to directly get the return data of each company we have determined to invest in. To process the data, I have put all of them into a list and then obtain the mean value of them with the Mean function in Mathematica. After these steps, the data has already shown in front of us. To make it more understandable, I have also put all the number into a chart which could give us a clear picture about the performance of the company which could work better and become profitable in the next year based on the predication of the indicator have shown. Till this point, all data we need to use has been processed and what we need to do last is comparing the return of our portfolio, that is the stocks whose Alpha is ranked top 25% in the market, with the market return. Then, we will understand if the indicator works or not and reach the conclusion.

1. **Method Used**

To complete the research, I will try to construct an indicator and use back-testing to verify that the effectiveness and usefulness of the indicator I have obtained. The following contents will detail the method I have used in this research.

First and foremost, I will need to get all the ROE data in a certain industry. In this research, I decide to choose the transportation industry as my example. However, to validate that the indicator we will obtain could be used in any existing market, I am going to extract the transportation companies in Dow Jones instead of S&P 500 as the sample. The transportation companies in Dow Jones are Air T Inc (AIRT), Air Transport Service Group Inc (ATSG), Atlas Air Worldwide Holdings Inc (AAWW), C.H. Robinson Worldwide Inc(CHRW), Diana Shipping Inc (DSX), Expeditors International of Washington Inc (EXPD), FedEx (FDX), Forward Air Corp (FWRD), Hub Group Inc (HUBG), Radiant Logistics Inc (RLGT), Roadrunner Transportation Systems Inc (RRTS), and UPS (UPS). The ROE data of these companies could be imported from my Excel, the one which has already contained TTM ROE as well as 2016 annual ROE obtained from Guru Focus. Since the number of each industry in the market is totally different from each other, it is required for me to make some changes toward these data. To make them uniform and generally useful, I decided to divide all ROE data by 12, the amount of transportation company in Dow Jones market. Then, I will need to deduct 2016 annual ROE from TTM ROE, which will present us how much each transportation company has increased or decreased till today compared with the last year’s situation. Here, the result of deduction is the Alpha we need to obtain in this research, the Alpha will represent a company’s performance compared with its past. If it has higher Alpha, that means it outperformed itself and indicates that this company will generate more money and profit than before, and its stock price will increase as well. In other words, we investors can make some money if investing in it.

After this step, the ROE change ranking can be seen, and we will also see the top 25% (Top 4) companies now. Then, I need to take advantage of the data I have obtained. Since in this research, I have made Alpha represent how a company’s performance is based on ROE when compared with the past. Thus, the change of companies’ ROE till today will hint us the development of the firms since the beginning of last fiscal year. Since the top 25% company means the ones have the best development in their industry, no one can deny that they will perform better than the stock market if only the industry they belong to is not hit hardly in the year we are going to make investment. Because of this reason, I will combine these four companies’ stock as a portfolio, and then, I would see whether their TTM ROE is truly higher than the whole market. To make this comparison come true, I can use the *Mean* function of Mathematica to get the average ROE of my portfolio and import the market’s TTM ROE from Yahoo! Finance. If the result is true, it is obvious that our portfolio outperforms the market and we will indeed make some money from this trading in this year. Nevertheless, if the result is totally reverse, it proves that I fail in building this indicator.

Lastly, what I need to do is verifying the effectiveness and generality of the Alpha. To complete this work, I will need to take advantage of back-testing for the indicator.

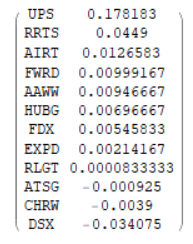
At the beginning, because I want to verify that this indicator could not only be effective in a specific industry in a specific market, but also would be used in various industries in all market, I randomly choose S&P 500 as my sample to proceed back-testing. At first, I need to obtain the ROE data of all stocks in S&P 500. To achieve it, I search all the ticker name of stocks in this stock market and import them into an Excel file. Then, I take advantage of the add-in in Excel named Intrinio to help me extract ROE data of all these companies in 2016 and 2017 as shown in picture 3.1. For these numbers, we will deal with them with the indicator, Alpha.

While handling these data with Alpha, the ROE data in 2016 and 2017 will first be divided by the number of stocks in the S&P 500 and the number of companies in S&P 500 is 506. However, in this process, it is notifiable that some companies we are researching is not publicly traded in 2016 or 2017. Therefore, we need to eliminate these companies from the list used for nest-step calculation. After this work, I will be able to get the Alpha of all companies. Then, ranking these companies is necessary for us to have an insight into which one will perform well, and which company will have the potential for increase in price and helping us making money. After ranking them, I will need to process them like what I have done for the twelve firms in transportation industry. For these S&P 500 companies, we need to take advantage of roughly 116 companies. The way I can extract the top 25% companies is using a loop algorithm and store them into an array named *RESULT*.

Finally, with the data in *RESULT*, I would use the *FinancialData* function (as shown in picture 3.2) built in Mathematica to obtain their EPS data. In this step, because of the drawback of Mathematica, it is noticeable that I also add two special condition for AMD (Advanced Micro Devices, Inc.) and COP (ConocoPhillips). The reason behind this work is that Mathematica cannot identify this company based on their ticker name without specifying which market they belong to. Therefore, for these two special companies, it is required for me to make some changes on the code for others. Fortunately, after this modification, I can successfully obtain these top 25% companies’ EPS data. Then, we just need to make all the numbers into an array before making further comparison. In the comparison, I will compare EPS of my portfolio with the whole market. It is not hard to obtain current EPS of S&P 500 from the internet, and it shows that the quantity is 109.88, which means, in the past twelve years, how much you can earn if you hold all the stocks in S&P 500. After this, what we need to do is using the *Sum* function to calculate how much the EPS of my own portfolio is. Here, If the result is that my portfolio’s EPS is higher than the market’s, that means all stocks I bought for my portfolio can generate more money per share than the whole market, and it also tells us that my strategy used for choosing stocks works as I predicted at first. However, if the result is that my portfolio’s EPS is lower than the market’s, that means we might miss some important factors when constructing the indicator, Alpha, or function embedded in the indicator has some errors. Which indicates us we need to make some revision on Alpha.

1. **Results**

In the first step, I was trying to construct the Alpha with the ROE of companies in transportation industry in Dow Jones Market. After getting all the data I need to use in this calculation and taking advantage of the method I mentioned, I got the ranking list of the twelve transportation companies’ Alpha which is shown in the picture 5.1.



picture 5.1

From this ranking list, we can see that, in transportation industry, the top 25% best companies are UPS, RRTS, AIRT, FWRD. By searching these companies’ TTM ROE in our Excel file, we can see the mean value of these four companies exceeds the average value of all the transportation companies. And this result also means that by using the indicator, Alpha, at least in transportation industry of Dow Jones, we could make comparatively higher profit by investing in these four firms.

Then, after constructing Alpha in transportation industry, it is necessary for me to validate the effectiveness and generality of this indicator. Therefore, I proceeded back-testing with the data from the market, S&P 500. For stocks used for back-testing, we also need to exclude companies which is not pubic traded before 2016 since I am going to use each companies’ ROE in 2016 and 2017 and their TTM earning per share (EPS) compared with that of S&P 500 to finish this work.

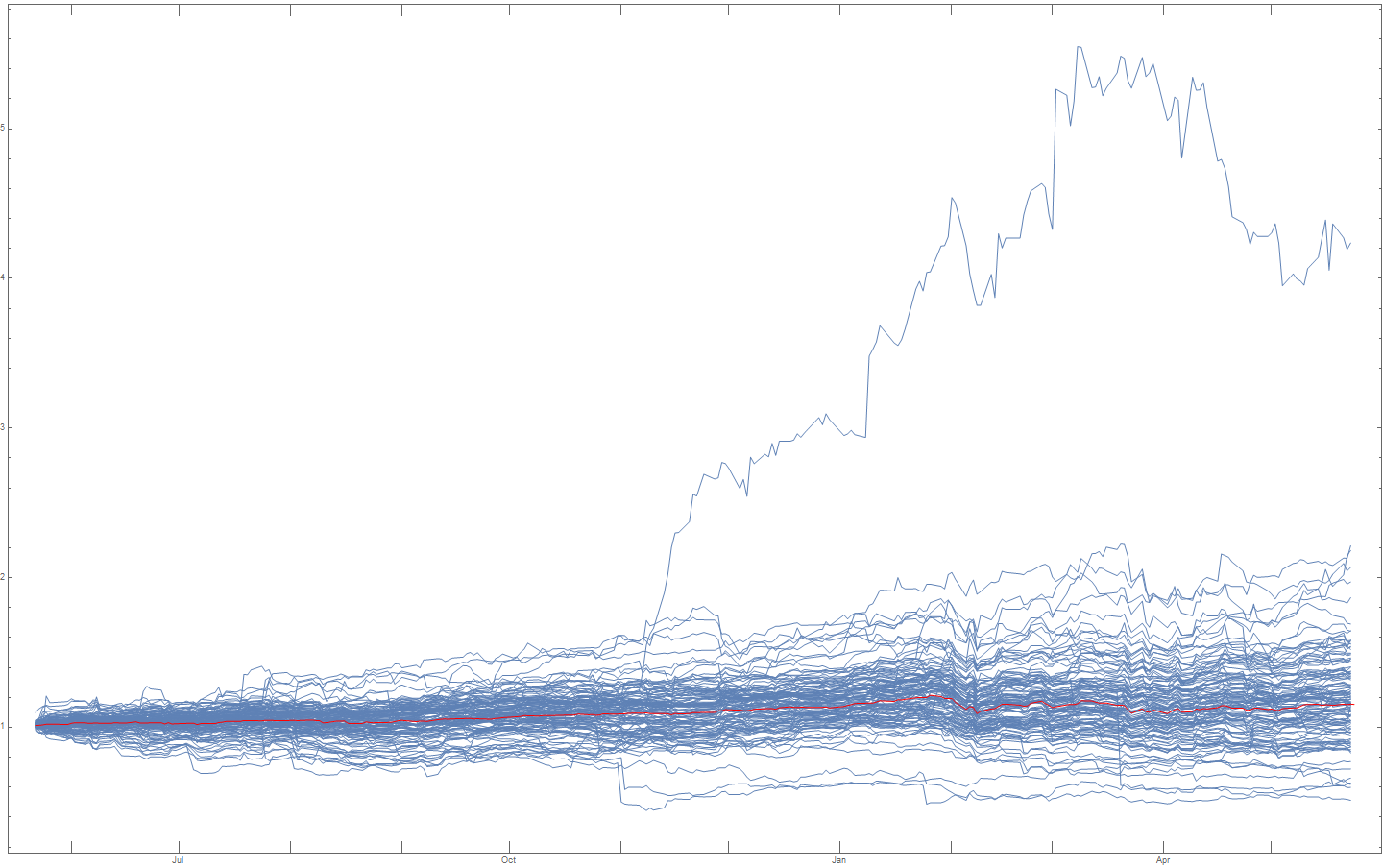
After using the method mentioned before, what I have done first is to calculate the total EPS of the top 25% companies and make a comparison between my portfolio and S&P 500. After loop calculation and extraction, Mathematica gives us the result shown in picture 5.2.

C:\Users\quhui\AppData\Local\Temp\1527199640(1).png

picture 5.2

Based on the result came from Mathematica and the data of S&P 500 collected from the internet, it shows that the portfolio I have built using Alpha can eventually generate higher EPS, which is around 607.9, compared with that of S&P 500, which is only 109.88, till May 2018. Thus, it is obvious that buying the portfolio which is constituted from all the stocks chose by using Alpha can bring us higher profit, which is around 6 times higher than the portfolio that simply includes all stocks in S&P 500. What’s more, back-testing method also helps us verify the reliance and generality of Alpha.

Besides, to show the usefulness and effectiveness of the indicator Alpha in detail, I also decided to put the cumulative fraction change of all the stocks in the portfolio, as well as S&P 500, into a chart like picture 5.3, and this chart can give us more insights into the reason why the stocks we have chosen can be more profitable.



picture 5.3

In this picture, the red line represents the TTM cumulative fraction change of S&P 500, the other blue lines are the data of all of stocks we have chosen for our portfolio based on the ranking of Alpha. It is not hard to spot that, in the past twelve months, even though most of the selected stocks change around the line of S&P 500, there are still more stocks moved above the red line, which implies that their price increased faster than S&P 500. Therefore, when combing all of the stocks, I could undoubtedly obtain more profits because of the larger increase in the stock prices.

As we can see above, when using Alpha in transportation industry of Dow Jones, we indeed earn more profits than the whole industry. Moreover, when we again use Alpha in S&P 500 stock market, Alpha also enables us to create a portfolio which could generate about 6 times profit than the whole market, which is a pretty attractive return. Also, from the beginning of building the indicator toward the back-testing, we finally obtain a satisfactory result, that is we could take the indicator, Alpha, as a factor for choosing stocks which could bring us more profit than the whole market. On the other hand, the result also verifies the presumption that ROE in the past year could somewhat indicate the trend of the stock.

1. **Conclusions**

From the result above, we have seen that, by using Alpha, not only can we obtain higher return in transportation industry, but also, we will make more money than the whole stock market. That means, the indicator, Alpha, indeed helps me find the stocks which have the potential for increase in price. Specifically speaking, since I can have a little bit higher return when using Alpha for transportation industry of Dow Jones and 6 times higher return when using it for the S&P 500 stock market, even though it is impossible to give investors accurate quantity of how much more money can they earn than the whole stock market, it is still safe to say, by using Alpha, investors can indeed choose the stocks which embrace the trend of increase in the next year based upon the past two years’ data. What’s more, the result above also shows the effectiveness and generality of this indicator.

On the one hand, since the generality of this indicator has been proved after using back-testing method for S&P 500 stock market. It means we will have more choice to use this indicator in each market around the world. For example, using this indicator, we can also derive the ranking list of stocks in Dow Jones, NYSE or other stock markets around the world, and the list also makes it possible for me to choose which stocks are worth investing in or profitable in the future. More importantly, if someone prefer a certain industry and believe this industry will probably outperform the whole market in the next year, the indicator can also help him or her to choose the top 25% stocks in this industry. Evidently, if someone could accurately spot the best industry in the market, this indicator becomes much more meaningful since the investors could earn more money from the most profitable industry, which also means they could get unexpected return in the next year. Therefore, as we can say, by using this indicator, it will assist each of investors to screen for some stocks which can generate more profit from thousands of stocks in the whole market and help investors obtain as many profits as possible when they have thorough understanding of the market.

On the other hand, this indicator also gives us more insights into the company’s fundamentals. As we use ROE of different periods to construct the indicator, Alpha, and make estimations on the future performance of a certain stock, it is obvious that, in some extent, the changes in ROE of each of companies can truly help us understand stock rules better. In other words, since return on equity means how much money the equity holder of a company can obtain from investing in one stock of a company, the value of it directly determine if this stock is attractive and profitable to potential investors. Moreover, using the change of this value is much more meaningful than merely taking advantage of a certain year’s data. As we all know, since ROE determines how much investors can earn, the change of it indicates whether the company will be able to keep its good performance, generate more revenues, or expand and develop itself quickly and healthily to become a better company in the future. Therefore, estimating a company’s development based upon the ROE of several years will help us gain more insights into this company and more understandings on the development process of the company. Then, undoubtedly, the data leads us to make more reasonable investment choice on stocks which has bright future and lots of momentum to develop. All in all, besides using Alpha to choose stocks, we can also rely on it to analyze the performance of a company, which is often more necessary for investors.

Besides the effectiveness of the indicator constructed in this research, it also gives analysts another perspective to analyze the stock market and find a profitable investment. Currently, programs like Python and R is used widely in financial world because the abundant package they have and easiness to master them. However, as is shown in the research, it also informs us the probability of using Mathematica as the analyzing tools for stock market in the future. No one can deny that Mathematica does not have as many packages as the other languages mentioned before, but with several years’ development, currently, it can already apply to different fields for different goals, like medication, construction and even art. As what I have done in this analysis, by using sorting and loop algorithm, Mathematica enables me to get the ranking list of stocks in either a certain industry or the stock market. Besides, the *FinancialData* command helps me to obtain any stock’s data I need from the database of Wolfram Alpha, which helps me save a bunch of time searching data from the internet and input them into Excel or Mathematica. Therefore, we can see that in some research, Mathematica could become a reliable assistance for us and it is also feasible that, one day, we could use Mathematica to proceed analysis for the stocks or even the whole world’ finance. However, I also want to say that as Mathematica is still a closed-source software, there are still some drawbacks inside it when compared with other languages. For instance, when I try to verify the trustworthiness and reliability of indicator Alpha, I must write more codes than Python or R which just require one or two lines to finish this job. What’s more, because of the lack of codes which can help me acquire some kinds of data, I have to use the other codes which is similar as the one I need in this model instead. But this operation will increase the risk of incorrectness in the result. However, I still believe that as the development of Mathematica, these problems could be solved soon and one day, Mathematica could be used widely in finance as Python and R.

But, each model has its own disadvantages, in this research, there is still some points we can refine later. Firstly, in the past few years, the stock market around the world all kept an increasing trend, which also causes most stocks increase in these periods. However, we can earn a lot of profit in these periods, it is still unknown whether we will still have such higher return or lose more money than the whole market in the downside situation. Thus, it seems necessary for me to test Alpha in some downside periods then. Secondly, running the program and getting the results takes me a lot of time. From my perspective, I think there are two reasons behind the low efficiency problem. The first reason is network speed. Because we need to extract a lot of financial data from the database of Wolfram Alpha, the connection status will depend how fast can we reach the result. The second reason is the program structure. As we can see from the code attached at the end of this paper, I used lots of loop algorithm in the program, which will make programs work less efficiently. Although Python will also meet this kind of problem, it has been increasingly solved with packages which changes the embedded algorithm and could enable it run faster. In this research, I cannot avoid using loop algorithm since we need to extract data of more than 100 stocks. However, if I can write codes for each of stocks instead of using loop or discover some better solutions from Mathematica in the future, I think this problem would not bewilder me for long time.

All in all, even though there indeed exist some drawbacks, the result is satisfying and Alpha eventually help me find a pretty profitable portfolio which enables me to earn six times more than the whole market in the past twelve months and help us have better understanding how to use each stock’s fundamentals to make reasonable investment.

1. **References**

[1] Stephen Wolfram. 2017. An Elementary Introduction to the Wolfram Alpha (Second Edition). Wolfram Media, Champaign. 339 pp.

[2] YCharts.com. S&P 500 Earnings Per Share TTM. 2018. [https://ycharts.com/indicators/sp\_500\_eps\_ttm. Accessed May 2018](https://ycharts.com/indicators/sp_500_eps_ttm.%20Accessed%20May%202018)

[3] Intrinio. Intrinio Excel Add-in Documentation. 2018. <http://docs.intrinio.com/excel-addin#intrinio-excel-functions>. Accessed May 2018.

[4] S. Ross, R. Westerfield, J. Jaffe, etc. 2015. Corporate Finance (11th edition). McGraw-Hill Education, New York. 1026pp.

1. **Software used**