Universitat de les Illes Balears

MASTER'S THESIS

USING FINANCIAL TECHNICAL ANALYSIS STRATEGIES TO SELECT THE MOST SHORT-TERM PROFITABLE COMPANIES FROM THE S&P500

Josep Roman Cardell

Master's Degree in Big Data Analysis in Economics and Business

(Specialisation in *Computing Technologies for Massive Data Management*)

Centre for Postgraduate Studies

Academic Year 2021-22

USING FINANCIAL TECHNICAL ANALYSIS STRATEGIES TO SELECT THE MOST SHORT-TERM PROFITABLE COMPANIES FROM THE S&P500

Josep Roman Cardell

Master's Thesis

Centre for Postgraduate Studies

University of the Balearic Islands

Academic Year 2021-22

Key words:

Index Fund, Momentum, Lambda Function, Docker

Thesis Supervisor's Name Isaac Lera Castro

Abstract

In this work, we present a study about the use of technical financial indicators to predict a reduced set of companies with a significant short-term profit. The companies are selected from a market index, and this same index is used as a benchmark to compare our profits. We have design five different strategies focusing on several indicators based on the moving average, prices momentum, market volatility... We have selected a set of companies in a weekly bases, from the first of January 2022 till August 2022. So far, the majority of the strategies are outperforming the index profit. However, the results show that there are some periods where the index is still better than the companies selected strategically.

The aim of this work is to use a market index to develop a strategy that consist in selecting a reduced subset of companies with higher or equal short-term profit than the index itself. The idea behind it, is that when you reduce the amount of companies you invest in, the risk you take is lower. Hence, even if the subset of companies have the same profit as the index, the portfolio is already better than investing directly in an index fund.

1 Introduction

Nowadays, the technology gives us access to a world of data and information. Thanks to that, investing never has been easier and faster. There are many platforms where we can invest in multiple assets, commodities, shares, cryptocurrrencies, and so on. At the same time, we deal with the challenge of immense volumes and vast sources of information, which deliver news continuously. Increasing the difficulty of filtering all this input we receive to only keep what is reliable and actually useful. Hence, it requires an enormous amount of time and research to properly invest our money.

We think that index funds are an interesting option to take advantage of growing economies or stay ahead of inflation. It consist of a portfolio that replicates the behavior of a market index, being an option that requires less management and delivers lower risk due to diversification.

The aim of this project is to get a reduced set, of ten companies, which can return a short-term profit, equal or higher than the financial index. This work is based on the development of five different strategies, which are focused on indicators and techniques used now a days in the financial market technical analysis. With this strategies we want to select the most profitable companies from the Standard Poor's 500. Then, we compute the percentage of change of the closing value of a share against the same value after a period of time. In this case we have defined a trading period of 4 weeks. This percentage represents how much would change your investment to those companies, or index, if you invest for that period of time. Thus, with the rate we compare the profit of the selected companies with the index profit over the trading period.

This project has two parts. The first one is the description of the background knowledge and the development of the approach. The second one contains the implementation of the idea using the cloud paradigm. The cloud architecture enables some technical advantatges such as: the automatization of the execution, and the scalability in terms of strategies and indicators. In addition, the cloud technologies also open the door to further analysis of our data, or the deployment of a visualization platform and monitoring tools.

2 Background Knowledge

This section covers the knowledge background and concepts required to understand the strategies. Firstly, we explain the concept of a financial index and describe the indicators that we use in our strategies. Finally, we introduce the strategies used in this project.

2.1 A Market Index

A market index is a hypothetical portfolio of investment holdings that represents a segment of the financial market [12]. An index is a set of companies that can be focused on different sectors of the economy, and distinct geographical areas. Thus, investors use them to follow the financial markets. Each index has its own formula, which usually is a weighted average of the companies price or market capitalization. For example, the *Ibex 35* is composed of the 35 companies with more liquidity of Spain [11]. Another example is the *Nasdaq Index*, which is mainly formed by companies on the technology industry.

An **index fund** is a portfolio that replicates the composition and the performance of an index. It offers a way of passive investing, which requires less managing and fees, lower risks through diversification, and strong long-term returns. The trade-off is its vulnerability to market swings and crashes, lack of human element and limited gains [7].

The most popular index funds track the Standard Poor's 500 (S&P500), which is composed by the largest traded corporations in the United States. The S&P500 is a market-capitalization-weighted index[1] containing 500 companies, over 11 different industries. Some of them are Disney, Google and Johnson & Johnson [9].

2.2 Financial Indicators

We can divide the indicators in two types: individual and combined. The first group only require single operations; thus are

[1] The effect of the individual companies in the index, depends on the capitalization of the company. Higher market cap, higher weighting.

easier to understand and apply to finances. The latter, are the combination of individual indicators, resulting in more complex interpretations.

The following is a description of the individual indicators used in this proposal.

2.2.1 Moving Average

The first indicator is the moving average(**MA**). Fixing a subset size, the MA is a series of means from all the subsets that form your data set. In each iteration a mean is calculated, and the subset is shifted one number forward. This method is used in time series to smooth out short-term fluctuations. In our experimentation, we choose a two windows sizes: a 5 days and 200 days. One MA of 5(5MA) days provides a smooth trend of the fluctuations of the value. Moreover, a period of 5 days also represents a trading week since the financial markets close during the weekend. While a 200-size window in MA(200MA), provides a long-term trend of the market analysis. One of the keys of MA is that depending on the size of he window, the MA will keep information from different periods of time. A short window represents the recent past, while a wider one still represents older events. Hence, there is a popular strategy that consist of identifying the intersections between the 200MA with the 50MA. After the intersection, if the 50MA is greater than the 200MA is a sign of the prices going up, whereas the other way around indicates a bearish market [10].

To calculate the following indicators, we use the 5MA instead of using the daily closing value of the companies. The main reason is that it maintain a smoother trend, avoiding outliers and aggressive short-term oscillations.

2.2.2 Rate of Change

The rate of change, is known as **ROC**. The ROC measures the rate at which the price has changed over a fixed period of time. It gives insight on how fast the price is falling or rising. This rate is calculated as a percentage:

$$ROC = [(x - x_n)/(x_n)] * 100 \tag{1}$$

Where x is the current value and x_n is the value n-periods ago. As a rate of change, the value zero acts as a center line. The ROC compares values of a past period against the current market, thus, to make it simple, a $ROC > 0$ means a positive market while below zero indicates a bearish market [2] [1]. Regarding the period, we use the next rates: 1, 3, 6, and 9 months(ROC1, ROC3, ROC6, ROC9). We do the average with the last 3 periods(AVGROC).

We use either the ROC3 or the AVGROC in the last step of all the strategies to define a ranking of the companies. At the top of the ranking we find the companies with highest rate of change over the three last trimesters.

[2]Known as when the market prices are going down

2.2.3 Standard Deviation

We use the standard deviation (STD) to measure the market variability. The STD measures how distant are the values from its average. In finances, it is used to measure market volatility. Indicates how the stock price swings from the average. The market volatility is commonly used in trading strategies to define a rate between the returns and the variability. This rate allows you to add the risk factor to your strategy. Another way to use the STD in technical analysis, is using the percentiles. For example, we could filter the companies keeping only the 25% with lower STD, and then apply another indicator to the remaining ones. Investors also use STD to asses the traders sentiment, which can be a predictor of how the market will behave [2].

The following is a description of the combined indicators used in this work.

2.2.4 The Dual Momentum

The momentum consists in the homogeneity of returns, which can be trending up or down. Hence, when the stock price has a momentum, it tends to keep going upwards -or downwards- for a period. To identify the companies with the strongest momentum, the dual momentum ranks them combining the price rate of change and variability. We use this indicator based on the experience of J.Alfayete presented on his book, [*Quantonomics*]. He exposes an interesting way to use the Dual Momentum. Given a fixed period of time and a number of companies(n), he uses the indicator to rank up the companies of one or more index funds. Then, for each period he compares the top n companies with his current portfolio to keep the repeated companies, and sell the ones that no longer appear in the ranking. As he explains, when companies have similar dual momentum, the ones that gain the momentum more recently will have stronger momentum, so better keep those. An alternative to the ranking, is to define buy and sell thresholds. Then, the rest of the approach is similar to the previous one, the idea is to keep your portfolio updated using the Dual Momentum. As the author explains, a longer period can contribute to more variability to your portfolio than a shorter one, as the probability to switch momentum increases over time. He also highlights the importance of fixing the number of companies you want in your portfolio. The larger the size, the higher the cost of keeping track them. Also there are higher chances of introducing smaller companies with lower liquidity which adds more risk to your portfolio [8].

Based on his approach, in our experimentation we combine the AVGROC and the 9 months STD:

$$IA = \frac{(ROC3 + ROC6 + ROC9)/3}{STD9} \tag{2}$$

This gives us an understanding of the price behavior for a long period of time. The AVGROC contribute with the rate of change over the previous months, while the STD reduces the rate significantly when the price oscillates aggressively.

2.2.5 The Relative Strength Index

The Relative Strength Index (**RSI**), is another momentum indicator used in financial technical analysis. It measures the speed and magnitude of the recent price changes. The RSI uses the Exponential Moving Average (EMA) which places more weight on the most recent values. This indicator provides information on when a security is being overbought or undervalued. The RSI compares a companies average gain on days when prices go up to its average loss on days when prices go down. The RSI is defined by the formula:

$$RSI = 100 - \frac{100}{1 + (EMA_{Gain}/EMA_{Loss})} \tag{3}$$

The results go from 0 to 100. When the gain is much higher than the loss the RSI value is smaller, and vice versa. Usually, the RSI only nears 100 or zero in a strongly trending market. The values 70 and 30, are mainly used as thresholds. On the one hand, the asset is considered to be overbought when the RSI is above 70.

An interesting application of this indicator is the divergence. When the RSI and the price are moving in different directions, it shows that the current price trend is weakening and could soon reverse [6].

2.2.6 Moving Average Convergence Divergence

The Moving Average Convergence Divergence(**MACD**) is also a momentum indicator. The MACD is calculated by subtracting a longer EMA from a shorter EMA:

$$MACD = 12EMA - 26EMA \tag{4}$$

Usually, the long window is considered to have 26 periods, while the short one is 12 periods. Continuing with the MACD terminology, a 9 periods moving average from the MACD line is called the signal. Finally, the distance between the MACD and its signal is known as the histogram. This set of indicators can be interpreted in several ways, although the most common ones are crossovers and divergences. The MACD is positive while the shorter window EMA is above the 26-period, which signals that the most recent price trend is raising stronger. A negative value, means that the price is going down. The more distant the MACD is above or below its baseline indicates that the distance between the two EMAs is growing. Regarding the histogram, it compares the MACD current value with it's trend from the signal. If the MACD is above the signal line, the histogram will be above 0, otherwise it will be bellow. The histogram is commonly used to point out when bullish or bearish momentum is high [5]. We define an indicator based on the histogram, named **crossup**. It is a boolean with the value *True* when the current histogram is positive and 5 periods ago was negative, else is *False*. The crossup identifies the companies which are starting to trend up.

All these indicators are based on the price value. However, there are some common indicators in financial technical analysis which focus on volume analysis. Being a unit of volume a transaction between a buy and a seller. Generally the volume analysis outcomes results in lower profits than technical analysis indicators based on price values. Hence, these two classes of indicators are usually complementary. In this project, we decide to focus on the price value, not volume.

2.3 Strategies

We use a similar approach to the one explained in *Quantonomics* by J.Alfayete. He explains multiple strategies to invest using financial technical analysis. He applys the strategies to the companies that compose different financial indexes, such as the NASDAQ, to obtain a reduced set of companies which adds to his portfolio. Then, after a period the companies are updated with the new results. That way he constantly have an updated portfolio.

Thus, in our study, in a weekly bases we check the list of companies of the S&P500. The list of companies forming the index changes by 20 out of 500 companies every year, so the companies are mainly the same every week. Then, we apply the strategies to the initial set of companies to select 10 of them. After 4 weeks, we calculate the rate of change of these companies.

In the following, we describe the six strategies proposed:

Our first strategy consist on the intersection of the 200MA and 50MA. We only keep the companies that meet a rising trend criteria, $50MA > 200MA$. We rank up the remaining companies by the 3ROC and select the top 10 companies. We use the 3 months ROC instead of the 6 o 9 months to get the companies with stronger upward momentum. We include a second filter to control volatility. This second criterion rules out high values of variability. Thus, we only keep the first we only keep the first quartile [3] of companies with lower STD. To that 25% we sort the companies by the 3ROC and select the top 10.

The second strategy also takes into account the ROC and the variability factor. In this case we use the Dual Momentum indicator. This is a rate between the momentum and the volatility of the values. In this case we rank up all the companies by it's rate and select the top 10 companies.

The third strategy is based on the RSI indicator. We switch the MA for the EMA, giving more importance to the most recent values. To smooth out the RSI values, we do a moving average with a 7 points window. The first selection consist on

[3] That is the lowest 25% of the values in the dataset

keeping the companies which 7MA of the RSI is not higher than the threshold of 70 (out of 100), to avoid companies that are more probable to be currently overbought. The next condition is to keep only the companies which current RSI is greater than the 7MA of the RSI. Finally, we rank the companies with the mean of the ROC of 3, 6 and 9 months, and select the top 10. The second variation of the third strategy consists on performing a second selection in parallel, where we get the first percentile of the companies with lower STD. Then, we merge both selections of companies, the first 25% with the two RSI conditions mentioned before. With the remaining companies, we select the 10 companies with higher ROC.

The fourth strategy also has two variations. The process is similar to the third strategy, yet using the MACD indicator instead. We have developed the **crossup** metric which indicated the companies that have a current positive histogram, and 30 periods ago it was negative. This way we not only keep the companies with upwards momentum, but also we pretend to get the ones that recently started raising, aiming for stronger momentum. Then we rank these companies with the ROC and keep the top 10. Th second strategy involving the MACD, follows the same steps, adding the merge between the crossup companies and the first quartile with lower STD.

The fifth strategy combines the two momentum indicators, RSI and MACD. First we select the companies that pass the crossup criteria. From those, we keep only the ones with a 7MA of its RSI lower or equal than 70. Finally, we sort by the ROC and select the top 10 companies with higher rate of change.

3 Implementation

We present a brief description of the key steps followed to implement the strategies. Broadly speaking, the proposed process follows the following steps. Firstly, we gather the companies daily data. We apply the financial indicators previously explained to the companies closing values. We execute the strategies, resulting in a subset of companies each one. Finally, after a trading period(i.e. four weeks) is time to calculate the returns of the companies, and compare the profit obtained with each strategy as well as the returns of the index it self.

Most of the companies listed in the S&P500 stay for a long period of time, yet there are some variations over time as some of them are replaced by others. Hence, its necessary to control the current companies of the index. We use the yahoo finance API [4] to retrieve the ticker name of the current 500 companies. Afterwards, we request to the same API the closing value of the listed companies for a period of one year, the last one, with a daily frequency. With the closing values for over a year, we calculate the mentioned indicators for each of the companies. Then, we store all this data in a single data frame, where the index is a timestamp and the columns are all the different indicators applied to all the companies. At the end of our experimentation, the size of this structure is about 50-60 rows and 8552 columns, that is 16x503[5]. Some of the indicators need data from a fixed period of time, such as the 9 months moving average. That is why, starting from a year of data, the indicator's outputs are roughly the last two months of data. This is totally fine for the purpose of this project, at this point we only need the value on the last day of data.

With the stored data, the next step is to apply the chosen strategies to the values on the last day of the data. We are looking for a short-term profitability. Thus, the values of the metrics for the most recent day are going to give us the most recent behavior of the companies. From the five strategies, we obtain a list of 10 companies for each strategy. Then, we store the subsets of companies in a sheet with some metadata such as the current date and strategy applied.

For this project, we define a trading period of four weeks. When the trading period has elapsed, we calculate the return the companies, and the return of the index it self. With the profit of each company, we compute the average profit of each strategy. We use this result to compare the strategies among them, as well as with the S&P500. We use the following formula to compute the return of the trading period as the percentage of change of the period:

$$return = (c_2/c_1 - 1) * 100 \tag{5}$$

Where c_2 is the closing value of the last day and c_1 is the closing value at the beginning of the trading period.

Once we have the returns of each company, the average profit of the strategies, and the return of the S&P500 for the same period of time, we store both values in the corresponding spreadsheet.

In the implementation of this project, we use the Google platform to store the spreadsheets, and performed weekly backup copies of the computed data. These backup files are stored in AWS S3. Some of the advantages of keeping this objects in the bucket are: with *S3 select* we can query data from a .csv file without servers or databases. In addition, in a future we can use the files to scale the app and create a database with the results.

This process is performed in a weekly bases since June 2022. In order to gather a larger set of results to compare the strategies we have simulated this process for the whole year 2022, till the present day. To do that, we have defined a loop

[4]The yahoo finance API: https://finance.yahoo.com/quotes/API,Documentation/view/v1/

[5]A few companies issue more than one class of stock, that is why there are more than 500 stocks

to simulate the execution of the previously explained process, for every Sunday from January to the current day.

4 Deployment on the Cloud Architecture

The second part of the this project consists of leveraging cloud services to automatize the execution of the implementation. The three most well-known cloud providers are: Google's Cloud Platform, Azure(Microsoft) and Amazon Web Services. The three of them cover the same basic necessities in terms of cloud computation, file storage, databases, security, etc. Each platform have different names for their services and there can be some nuances between them.

We use AWS due to its wide selection of free tier services that offers during the first year of subscription. Some of this free tier capabilities are still free afterwards. Specifically, combining three services it is enough to upload the code with all the required dependencies (*Elastic Container Registry*), configure a severless compute service to run the package (*Lambda Function*), and finally define a trigger to execute the application on a given time frequency (*Event Bridge*).

4.1 Lambda Functions

As a computer service is necessary for the execution of our scripts we choose an architecture model based on Lambda functions [6]. A lambda function is a serverless event-base computation service that allows you to execute your code without the need of managing servers or clusters. Lambda supports two types of deployment packages: container images and a .zip files. Among the advantages of the container option, it's easier to test the image on your local machine so is much faster to upload the final version and update it. Moreover, the size allowed by AWS for Docker apps is about 10GB while the .zip has a limited memory space. In addition to the container's flexibility, we believe it is an interesting tool to learn now a days as it has gained a lot of popularity over the last years.

4.2 Container

Docker is an open-source software designed to simplify the development of application. It is a PaaS (Platform as a Service) that creates isolated virtualized environments for building, deploying, and testing applications [3]. The first step to build the application is to define the environment. It starts with a docker file, which is the script of instructions that define how to build the docker image. Images are templates that contain the source code, dependencies such as the libraries, files required for the application ... Then, the image is used as the base to create a container, that is the virtualized runtime environment where you can isolate the application from the underlying system. At this point, you can launch the container to run the application.

We want the application to be executed by the lambda function, thus, we use an AWS base image which is specifically compatible with the Lambda service [4]. These base images are preloaded with a language runtime and other components that are required to run the image on Lambda. Hence, the first instruction in our dockerfile is to import the AWS's specific base image for executing Python code, i.e python:3.8 from public.ecr.aws/lambda. To this script we add a series of instructions required to configure the application environment. Right after importing the base image, the next instructions is to copy the main code, as well as another script with secondary functions. Then we copy a file that contains all the python libraries used in the main script, and install them. We also need to copy the file containing the credentials to login our google sheets. Finally, the last instruction executes the main code.

Before creating the lambda functions, we need to upload the container to the ECR. Amazon Elastic Container Registry [7] is a fully managed container registry, offering high-performance hosting, perfect to deploy our application image. So first, we create a new repository. Afterwards, to upload an image to this registry we have to retrieve the authentication token and authenticate our Docker client in our repository. Then, we build the Docker image using the ***docker build*** command. After the build completes, we tag the image with the same name as the repository. Finally, we push the image to our AWS new service.

Now that our image is uploaded to the cloud, we can create the Lambda function from the container image.

4.3 Event Bridge

The last service required to automatize the execution of our application is the trigger. Amazon Event Bridge [8] is a serverless event bus that makes it easier to build event-driven applications at scale using events generated from your applications, integrated Software-as-a-Service (SaaS) applications, and AWS services. First, we define a rule by which the trigger is activated at a specific moment of the day, and repeated in a given frequency, which in our case is our trading period. Finally, we add this newly defined trigger to the lambda function.

[6] Lambda Functions

[7] Elastic Container Registry

[8] Event Bridge

4.4 Amazon S3

Amazon Simple Storage Service [9], is an object storage service, build to store and retrieve any amount of data. We have created a bucket to store one .csv file with the results of each strategy. This service is commonly used as the first stage of a datalake, to back up and restore important data or simply archive data at low cost, and to run cloud-native applications. Hence, we can keep track of all results even though the google sheets become inaccessible or are deleted Also, in case we want to scale the project, with S3 we can easily connect to data analytic services or to a datalake.

5 Results

To properly visualize the results, we have connected the google spread sheets to a PowerBI report [10]. We have defined a series of dynamic visualizations to better understand the results of our strategies and whether we can obtain higher profit than a financial index or not.

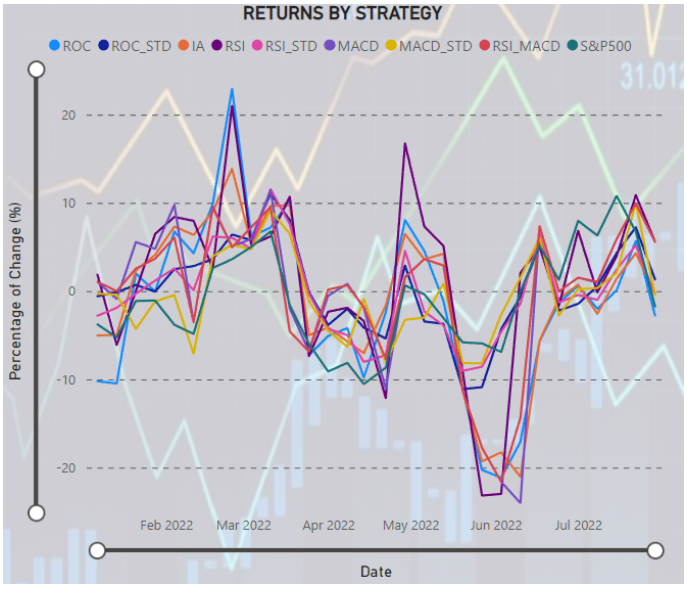
To recap, the results of analysis are the rate of change of the closing values of the company's share, for a period of time of four weeks. We use this value as a way of measuring how the value of the company has changed over time. The results are presented in %, not in any currency.

The first page of the report shows an overview of the results over the whole period. Taking a look into the roverview, currently from 01/01/2022 to 29/07/2022, 7 out of the 8 approaches have higher total profit than the S&P500. Being the first strategy, ROC, the only one with lower results with a -43.49% of return. While 7 of the strategies yield higher profits than the -30.84% of the S&P500, only two of them have positive overall result. These are the strategy *1.b ROC STD*, with a 8.64% and the *3.a RSI* with a 43.52%. In descending order of the results, the next strategy is the RSI STD and RSI MACD, -4.11% and -4.65% respectively, followed by the MACD and MACD STD with a -8.05 and 12.42 percentage of change. Close to the index's profit we find the IA strategy with a -24.11%.

The second page of the report shows the evolution of the results. Tracking the evolution we can visualize the extreme values, average and variability previously mentioned. In general the year 2022 began with a raising trend of the profits. This trend ended around March with the higher profits on the majority of the strategies. A general downward movement continued till mid-April. A pick of the returns at the end of April, end up with the lowest values at the end of May and begging of June. The last period tracked shows a general recovery of the profits, being all the returns positive.

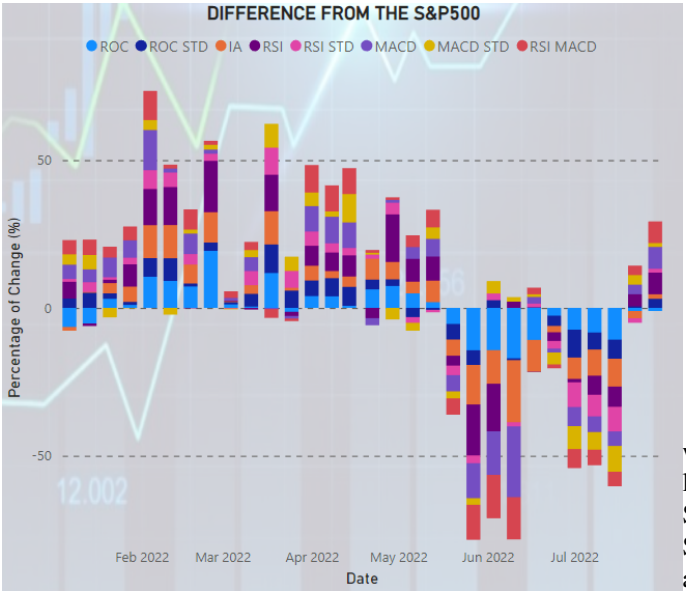
Ranking	Strategy	Return
1	RSI	43.28
2	ROC STD	6.95
3	RSI MACD	-0.75
4	RSI STD	-3.43
5	MACD	-4.65
6	MACD STD	-11.74
7	IA	-23.64
8	S&P500	-36.17
9	ROC	-47.67

Table 1: Ranking of total returns



Focusing on the distance of the index's returns and the strategies ones, we observe that the during the best performing periods of time, the strategies show much more profit than our benchmark. However, during the losing periods, the distance grows too, being the index more conservative than the majority of the strategies.

[9] Amazon Simple Storage Service
[10] To access the report, click here.



The third page of the report, gathers diverse statistics on the results. Ranking up the different approaches by the total return we confirm that the strategies in which the standard deviation was used to keep only the companies with lower variation, are the ones with lower accumulation of negative returns. However, these are also the strategies with lower positive returns. An interesting fact to point out is that from the strategies with that take the std into account, two of them have higher positive returns than the index. Moreover, all of them have lower negative returns compared to the S&P500. The worst performing strategy is the first one, the ROC, with mid-table positive returns and the worst level of negative returns.

Ranking	Strategy	Return
1	RSI	133.87
2	MACD	96.77
3	IA	88.98
4	RSI MACD	88.75
5	ROC	88.54
6	ROC STD	62.62
7	RSI STD	59.36
8	S&P500	56.85
9	MACD STD	51.32

Table 2: Ranking of total positive returns

It's interesting to point out that, on the one hand the strategy with higher profit *Table 1*, has the highest accumulation of positive returns, but also a relatively high accumulation of negative returns. On the other hand, the second strategy with higher returns, has only the third highest accumulation of positive returns, yet it has the lowest accumulation of loss.

From the extreme values we have that the majority of the strategies have a positive pick, higher than the 10.79% of the index. The MACD STD and RSI MACD have the lowest picks with 9.96% of profit at its best period. Similar thing happens

Ranking	Strategy	Return
1	ROC STD	-55.67
2	RSI STD	-62.80
3	MACD STD	-63.06
4	RSI MACD	-89.50
5	RSI	-90.58
6	S&P500	-93.02
7	MACD	-101.42
8	IA	-112.62
9	ROC	-136.21

Table 3: Ranking of total negative returns

with the worst returns. Only two strategies have better worst losses than the -10.53% of our benchmark. These are the RSI STD and MACD STD with a -9.03% and -8.19% respectively. Summarizing the returns to the average, we see that although all the strategies have similar average profit, only the best performing ones have positive averages. Finally, evaluating the standard deviation of the returns, the strategies with the std filter have lower variability while all the other have higher one compared to the index.

The last page of the report shows the current selection of companies per strategy, along with the return on the last investing period. From the last selection of each strategy we can tell that the strategies with the more strict conditions (i.e. MACD, MACD STD and RSI MACD) are not always able to keep the minimum 10 companies.

6 Conclusion

All in all, we can state that the strategies we have defined, from January till August of 2022, have better results in terms of short-term profit than a financial index, in this case the S&P500, which was the aim of the project. Clearly we have developed different kinds of strategies with different levels of risk. The strategies with the STD criteria are more conservative. Hence, these strategies accumulate less loss overtime, yet concentrate less profit too. Compared to the index, the conservative strategies have better results in terms of lower levels of negative returns, and even higher profit. These low risk strategies, could represent a functional investment approach. On the other hand, the more aggressive strategies clearly accumulate more positive returns than the index. However, in some cases the returns are highly volatile generating extreme levels of loss. Among these strategies, the RSI, MACD and the combination of both, managed to keep a more stable level of loss similar to the S&P500. Then, for an approach that tolerates more risk, these three strategies are an interesting solution too.

The use of the cloud services have facilitate the whole work

cycle. Starting with the scheduling of the script's execution, to the storage of the results to keep a registry, concluding with the development of the application to visualize and share the results. In addition, the further development of this project will be easier thanks to the flexibility and scalability the cloud services offer. Also, it opnes the door to collaborations with interested fellows.

The strategies have only been evaluated over the context of the 2022. For further analysis, these same strategies could be evaluated over previous years. It would be interesting to pick specific years, such as a past year which has been more like an average year, then a year where the stock market yield higher profits, and then a crisis period. It would be interesting to analyze the results of the strategies over the 2020 with the COVID context. Another future work to improve the strategies would be to compare them with different combinations of values of the parameters, such as the STD percentile to filter the companies on the conservative strategies.

bibliografia

References

[1] AVATRADE. *ROC Trading Strategies*. URL: https://www.avatrade.com/education/technical-analysis-indicators-strategies/roc-indicator-strategies.

[2] Brian Beer. *How Is Standard Deviation Used to Determine Risk?* URL: https://www.investopedia.com/ask/answers/021915/how-standard-deviation-used-determine-risk.asp.

[3] AWS Documentation. *Creating Lambda container images*. URL: https://docs.aws.amazon.com/lambda/latest/dg/images-create.html.

[4] AWS Documentation. *Deploy Python Lambda functions with container images*. URL: https://docs.aws.amazon.com/lambda/latest/dg/python-image.html.

[5] Jason Fernando. *MACD Indicator Explained With Formula, Examples, and Limitations*. URL: https://www.investopedia.com/terms/m/macd.asp.

[6] Jason Fernando. *Relative Strength Index (RSI) Indicator Explained With Formula*. URL: https://www.investopedia.com/terms/r/rsi.asp.

[7] Jason Fernando. *What Are Index Funds?* URL: https://www.investopedia.com/terms/i/indexfund.asp.

[8] J. Alfayate Gallardo. *Quantonomics*. Seven volumes planned. Punto Rojo Libros, 2020.

[9] Will Kenton. *What is the SP500 Index?* URL: https://www.investopedia.com/terms/s/sp500.asp.

[10] J.B. MAVERICK. *What Is the 200-Day Simple Moving Average?* URL: https://www.investopedia.com/ask/answers/013015/why-200-simple-moving-average-sma-so-common-traders-and-analysts.asp.

[11] Rankia. *Todo sobre el Ibex 35: Qué es, cómo se forma y empresas que lo integran*. URL: https://www.rankia.com/blog/bolsa-desde-cero/1982349-todo-ibex-35-que-como-forma-empresas-integran.

[12] Julie Young. *Market Index*. URL: https://www.investopedia.com/terms/m/marketindex.asp#citation-3.