

Project Dissertation Report on

Investment Model to Rank

Companies

Submitted By

Aditya Chauhan

2K19/DMBA/06

Under the Guidance of

Mr. Chandan Sharma

Assistant Professor



DELHI SCHOOL OF MANAGEMENT

Delhi Technological University

Bawana Road Delhi 110042

CERTIFICATION

This is to certify that the work titled '**Investment Model to Rank Companies**' as part of the final year major Research Project submitted by Aditya in the 4th semester of MBA, Delhi School of Management, Delhi Technological University during January-May 2021 was conducted under my guidance and supervision.

This work is his original work to the best of my knowledge and has not been submitted anywhere else for the award/credit degree whatsoever.

The project is submitted to Delhi School of Management, Delhi Technological University in partial fulfilment of the requirement of the degree of Master of Business Administration.

Mr. Chandan Sharma

Assistant Professor

Delhi School of Management,

DECLARATION

I hereby declare that the report titled '**Investment Model to Rank Companies**' as part of my final year Major Research Project submitted by me in the 4th semester for the grade/credit purpose for partial fulfilment of MBA at Delhi School of Management, Delhi Technological University during January-May 2021 under the guidance of Mr. Chandan Sharma is my original work and has not been submitted anywhere else.

This report has been written by me in my own words and not copied from elsewhere. Anything that appears in this report which is not my original work has been duly and appropriately referred/cited/acknowledged.

Aditya Chauhan

2K19/DMBA/06

MBA(Finance & Marketing)

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Aditya Chauhan

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ABSTRACT

Purpose

With the exponential development of commercial operations in today's world, the presence of a performance evaluation mechanism in all organisations is a foregone conclusion. This requirement is so obvious that the absence of an evaluation mechanism is seen as a sign of the organization being unhealthy. Financial reviews motivate businesses to improve their results by displaying a company's actual financial status in comparison to other businesses by providing a favourable atmosphere.

These types of evaluations are also helpful in reforming and strengthening shortcomings by recognising the strengths of completed operations. In today's intensely competitive climate, financial results evaluation is a critical process for businesses. Company rating is a complicated mechanism that requires the consideration of several financial ratios at the same time. Furthermore, the task of selecting a suitable loan applicant firm has become more difficult, as financial professionals must evaluate a broad variety of options based on a collection of competing financial requirements

. As a result, all insiders and customers of a company benefit from establishing a specific and appropriate performance evaluation procedure. To assess financial results, we must consider a number of financial metrics that represent a company's competitiveness. To properly measure and rate the relative success of rival firms, multiple financial ratios must be considered simultaneously. To accomplish this goal, a systematic literature analysis and expert advice are used to identify the key requirements.

Method

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method was selected to solve the problem after a rigorous literature analysis. The TOPSIS method will determine the financial ratios' importance to the evaluation result and show how firms work differently on each financial ratio. This paper examines the

TOPSIS approach and offers an online website platform that anybody can use to rate US companies in various industries.

The created website takes data from a financial api and automatically executes calculations using the TOPSIS model. It gives us the names of all the companies, their tickers, and the rankings they have earned. Anyone in the world may use the website, which is used to rate firms in a specific industry in the US market.

Findings

The result of this research is a tool in the form of a website that can be used by various investors, analysts, traders and researchers to ascertain the ranking of companies in an industry according to the fundamental ratios. The ranking is based on only the ratios and it doesn't take into account other stock market factors such as sentiments, macroeconomics and political forces etc. Ignoring all these factors the model is a robust tool to rank companies and can be used in conjunction with other research that accounts for these other factors to provide fruitful results.

INTRODUCTION

Performance evaluation is seen as an important step toward developing a self-evaluation process and, as a result, increasing accountability capacity. Any academics believe that performance evaluation is a part of the larger and growing transparency trend. They agree that performance evaluation is one of the most effective tools for ensuring transparency. Performance evaluation necessitates the creation of certain indices on which to assess organisational performance. Performance evaluation indexes are, in effect, a road map from where you are now to where you want to go. Evaluating the success of businesses and factories will serve as a roadmap for potential expansion, growth, and, most significantly, control and supervision decisions. Companies ranking is a useful metric for identifying companies in trouble from others who are doing well. Companies' longevity is therefore ensured by their ranking. It is important to make a large amount of business decisions, such as investment decisions, loan approvals, and the formation of any business partnership in general.

The growth of stock exchanges and over-the-counter markets has resulted in the development and proliferation of financial services that provide investors with consultation services and rank companies and stock exchanges at various levels. Investors, administrators, creditors, and other stakeholders all use different metrics to evaluate a business unit's output. Organizational performance is a metric that assesses how well an organisation achieves its goals. Financial success is one of the most critical aspects of organisational efficiency. In today's dynamic world market, evaluating a firm's or industry's financial success is critical not only for management, borrowers, and current/potential customers, but also for firms in related industries. Financial analyses encompasses the evaluation of an organization's or a sector's results. Since the word "financial performance" has many uses, including "income," "productivity," "production," and "economic development," financial measures should be included throughout the performance evaluation phase by all businesses and associated industries. In this case, financial statement research could be a viable option for evaluating and rating businesses.

Rankings will expose a company's weaknesses and strengths, as well as opportunities and challenges. In reality, it's a full-length mirror that reflects their current situation. This method is extremely important in making trade, spending, and funding decisions for businesses. Different parameters, as well as specific metrics and rating systems, may be used to rate companies. Financial ratios derived from financial statements such as a balance sheet, income statement, and cash flow are used to evaluate a company's financial performance over time. These ratios provide financial institutions and commercial banks valuable knowledge about a company's financial success from different angles.

Without taking into account any of these contradictory financial ratios, the aggregate financial success of rival firms cannot be properly measured or rated. Financial analysis of firms, on the other hand, is a time-consuming mechanism that requires the consideration of several financial ratios at the same time. Financial analysts compile a financial performance report after an organisation uses the conventional financial analysis methodology. A financial statement analysis focusing on the computation of financial ratios is a standard method for measuring a company's financial results. A subjective review of the company's financial situation, when it concerns sales and expenditures, is used in a financial analysis article.

Financial ratios derived from income statement and balance sheet data are important measurement tools for determining a company's performance and financial assets. Various indexes and metrics have been adopted by a significant number of scholars in various studies relating to financial performance evaluation in recent years. "Many studies are generally considered in the financial performance review, describing the relationships among financial indexes as well as the effect of these indexes on the performance of companies, which will be listed in the literature review section". Because of its unrealistic expectations and reliance on an expert's individual judgement, this approach is no longer adequate in today's complex market climate. Furthermore, financial companies must devote time to doing a business report.

However, some experiments in the literature used financial ratios to construct credit models. For business ranking, "multivariate statistical and econometric analysis"

methods like the “linear likelihood model and the logit regression” model are used. The literature proposes detailed comparisons and reviews of credit score models, such as soft-computing techniques, non-parametric statistical methods, and parametric statistical methods. The biggest drawback of methodological methods used in company ranking is that a large percentage of businesses fail to meet the requirements. As a result, the predictive ability of the default functions calculated using these techniques is limited. We need to identify an appropriate and consistent structure based on previous studies and checked indexes and parameters in order to establish an effective financial performance assessment model. As a result, ranking and evaluating the index, as well as the companies, demanded a reliable quantitative methodology. MADM (multi-attribute decision making) approaches are commonly used in assessing financial results or conducting business rating analyses based on a range of competing parameters. MADM approaches are useful for comparing companies across industries, as well as evaluating various financial ratios. It will compare and rate rival firms based on their overall results. TOPSIS is an example of a MADM form. The main goal of this paper is to create an online tool that uses the TOPSIS method to automatically rate companies when given a market. This method is only for use in the United States.

DATA SOURCE

The screenshot displays the FMP API dashboard. At the top left is the 'FMP API' logo. The navigation menu includes 'HOME', 'DOCUMENTATION', 'PRICING', 'EXTRAS', 'TERMS', 'CONTACT', 'DASHBOARD', and 'LOGOUT'. The main heading reads 'Financial data for every needs.' Below this, a sub-heading states: 'Enhance your application with our data that goes up to 30 years back in history. Earnings calendar, financial statements, multiple exchanges and more!'. Two buttons are visible: 'DOCS' and 'GET STARTED'. The dashboard features three data visualization panels: a circular gauge chart, a line chart showing data from Jan to Jun, and a candlestick chart. A price indicator shows an upward arrow and '\$312.57'.

Our goal is to identify the rank among the alternatives. The initial step is to collect financial ratios of all the companies from a particular sector in the US market. Financialmodelingprep is great source of financial data. It is an API which makes very easy for us to retrieve financial data like historical prices, financial statements, financial ratios and so on. It offers a free tier for which we can make up to 250 requests free a day. However, for more advance requests a subscription is required. Equal weight is given to each ratio.

LIST OF RATIOS USED

Return on Equity

Return on equity (ROE) tells the stakeholders how efficiently is the company's management using the capital. It assesses a company's viability in comparison to its shareholders' money. The higher the return on equity, the better the managers are at achieving profits from its shareholders' funding.

The return on investment (ROI) is often used to equate a firm to its rivals and the general economy. When evaluating businesses in the same market, the model is particularly useful because it helps to provide precise indicators of which companies are running with greater financial performance, and it can be used to evaluate almost every organisation with mostly tangible rather than intangible properties.

$$ROE = \frac{\text{Net Income}}{\text{Shareholder Equity}}$$

A good way to look at it to have a ROE that is better than the competitors. Assume that a firm, ABC, has kept a consistent ROE of 21 percent over the last few years, relative to the 16 percent that is the average of competitors. An investor might believe that ABC's managers are good at generating income. ROE levels that are relatively high or low can differ greatly from one business segment or sector to the next. The analogy would be more important when used to compare one business to another related company. A typical investor shortcut is to regard a return on equity similar or greater than any index return of that country to be good.

Return on Assets

Return on assets (ROA) compares the return of the company to the assets invested in it. ROA tells the stakeholders how efficiently a company's managers are using its assets.

Companies are basically about using assets efficiently and getting best out of what they get.(at least the ones that survive). Though using income to sales becomes a valuable metric, comparing returns to the services an organisation used to earn them casts doubt on the business's viability.

$$\textit{Return on Assets} = \frac{\textit{Net Income}}{\textit{Total Assets}}$$

The return on assets (ROA) is determined by dividing a company's net profits by its total assets. ROA, in simple terms, tells you what earnings were made from invested capital (assets). The return on asset (ROA) for public corporations will differ significantly depending on the sector. This is why it's better to equate ROA to a company's previous ROA figures or a comparable company's ROA by using it as a comparison indicator.

The (ROA) figure informs investors of how much a firm converts its assets into income. The bigger the ROA, the better, as the organisation creates more profits with less spending.

Adding back the cost of interest to net profits by using the total assets in a given timeframe as the denominator, in other words, negates the effect of taking on additional debt. Since interest cost is not included in the income statement's taxable income, it is added.

Return on Capital Employed

The return on capital employed measures how efficiently is the business using its capital employed. It will help to ascertain how great an organisation is at generating profit from its resources when it is deployed.

$$\text{ROCE} = \frac{\text{EBIT}}{\text{Capital Employed}}$$

where:

EBIT = Earnings before interest and tax

Capital Employed = Total assets – Current liabilities

EBIT (earnings before interest and taxes), also known as net profits, indicates how much a business receives from its activities alone, without interest and taxes. EBIT is determined by deducting sales from cost of product sold and operating expenses.

The terms "money working" and "invested capital," which are both used in the ROIC equation, are somewhat similar. After subtracting existing liabilities from net assets, you will calculate capital invested, which equals shareholders' equity plus long-term debts. Rather than using capital employed at a random point in time, some analysts and investors would choose to measure ROCE using cumulative capital employed, which is the average of opening and closing capital employed over the time span in question.

Quick Ratio

It is the measure of the short-term liquidity of the company. It's also known as the acid test ratio because it shows a company's ability to pay off short term debt easily using assets that can be liquidated easily. A quick test designed to yield immediate results is referred to as a "acid test."

$$QR = \frac{CE + MS + AR}{CL}$$

where:

QR = Quick ratio

CE = Cash & equivalents

MS = Marketable securities

AR = Accounts receivable

CL = Current Liabilities

The quick ratio takes into consideration the quantity of net short term liquid assets available with the quantity of existing obligations of a firm. Those assets that can be quickly turned to cash are with no effect on the price acquired on the open market are current assets, while short term liabilities are company's debts that must be returned to creditors within a year.

Interest Coverage Ratio

The interest coverage ratio tells us how quickly a firm can earn its interest. To get interest coverage ratio we divide a company's earnings before interest and taxes (EBIT) by its interest expense for a fixed time period.

$$\text{Interest Coverage Ratio} = \frac{\text{EBIT}}{\text{Interest Expense}}$$

where:

EBIT = Earnings before interest and taxes

The lower the interest coverage level, the higher the debt and the risk of bankruptcy for the firm. Intuitively, a lesser ratio means that there is not much income that is required to cover debt costs, making the firm more affected to interest rate changes. A higher interest coverage ratio indicates that the corporation can cover its interest obligations and is financially better.

A high ratio, on the other hand, can mean that an organisation is missing opportunities to leverage its earnings. For businesses with consistent sales and cash flows, an ICR over 2 is hardly appropriate as a rule of thumb. Analysts would like to see an ICR of more than 3 in some situations. An ICR of less than one indicates that the corporation is in bad financial condition, as it indicates that it is unable to pay off its short-term interest commitments.

Gross Profit Margin

Stakeholders use gross profit margin to ascertain a company's stability by measuring the amount of income left over after subtracting the cost of goods sold. Gross profit margin is written in the form of percentage of revenue and is also called as the gross margin ratio.

$$\text{Gross Profit Margin} = \frac{\text{Net Sales} - \text{COGS}}{\text{Net Sales}}$$

For example, if a business wishes to automate such supply chain functions, the initial expenditure might be high, but the final cost of products may be lower due to lower labour costs as a result of the automation.

Gross margins can be affected by changes in product prices. For all other factors equal, a business with a higher profit margin prices its goods at a higher price. Although, this is a difficult balancing act as if a business raises the costs too high, less consumers will purchase the commodity, and the company will lose market share as a result.

Price to Book Ratio

The P/B ratio is a method of comparing a company's market capitalization to its book value. The book value of an asset is the same as its carrying value on the balance sheet, and firms measure it by subtracting the asset's accrued depreciation.

The tangible net asset value of a company is determined by subtracting gross assets from intangible assets (such as trademarks and goodwill) and liabilities. Book value may be net or total of liabilities such as trade payables, income taxes, and operating charges for the original outlay of an acquisition.

$$P/B \text{ Ratio} = \frac{\textit{Market Price per Share}}{\textit{Book Value per Share}}$$

Many claim that a business can benefit from using other stock valuation metrics in addition to or instead of the Price to Book ratio.

The market-to-book ratio is used to calculate if a company's asset valuation is equal to its stock market price. Comparing Market to Book ratios between firms of the same field is the easiest way to go.

Price to Sales Ratio

The price-to-sales (P/S) ratio is a measure that measures the share price of a business to its income. It's a measure of how much the capital markets value each dollar of a company's sales or revenues.

$$P/S \text{ Ratio} = \frac{MVS}{SPS}$$

where:

MVS = Market Value per Share

SPS = Sales per Share

For investors and analysts, the P/S ratio is an important analytical and valuation metric. The ratio indicates how much money consumers are able to pay for each dollar in revenue. It may be determined by dividing the company's market capitalization by overall revenue over a specified time span (usually twelve months) or by dividing the stock price by sales per share on a per-share basis. A sales multiple or income multiple is another name for the P/S ratio.

The P/S ratio, like all ratios, is most useful when comparing firms in the same industry. A low ratio indicates that the stock is undervalued, and a ratio that is slightly higher than the average indicates that the stock is overvalued.

The last four quarters or present financial year, is the standard 12-month cycle used for revenue in the P/S ratio (FY). A forward P/S ratio is one that is calculated using estimated revenue for the current year.

PEG ratio

The price/earnings to growth ratio (PEG ratio) is calculated by dividing a stock's price-to-earnings (P/E) ratio by the earnings growth rate for a given time frame.

The PEG ratio is used to calculate the valuation of a stock while still taking into account the company's projected earnings rise, and it is considered to offer a more complete image than the more traditional P/E ratio.

$$\text{PEG Ratio} = \frac{\text{Price/EPS}}{\text{EPS Growth}}$$

where:

EPS = The earnings per share

Every analyst considers that a PEG ratio of less than one is satisfactory as a general thumb rule.

A business's P/E and anticipated growth should be comparable, according to well-known investor Peter Lynch, indicating a reasonably priced firm and supporting a PEG ratio of 1.0.

A company's PEG is considered overvalued when it reaches 1.0, whereas a stock with a PEG of less than 1.0 is considered undervalued.

Price to Earnings Ratio

Price to earnings ratio (also known as P/E ratio) is calculated by dividing the price of the share by its earning. It is used by the analyst to determine the worth of the stock.

$$\text{P/E Ratio} = \frac{\text{Market value per share}}{\text{Earnings per share}}$$

If a company's P/E ratio is compared to the P/E ratios of other firms in the same industry, it becomes even more important. An energy corporation, for example, may have a high P/E ratio, but this may represent a industry norm rather than one exclusive to the business. If the whole market has high P/E ratios, for example, a single company's high P/E ratio will be less of a problem.

Furthermore, since a company's debt can influence both the valuation of its stock and its earnings, leverage can skew P/E ratios. Consider two businesses that are somewhat close but vary largely in the amount of debt they take on. The one with the most debt would almost certainly have a lower P/E ratio than the one with the least debt. If business is successful, though, the company with the most leverage is likely to benefit better because of the chances it has taken.

TOPSIS

Decision Making is the most effective method for selecting a superior option from a wide range of options. Since decision-making over general options is ubiquitous, almost all other problems have a large number of parameters. Such standards usually contradict one another, but there might be no way to meet any of them at the same time. The policy makers want to fix the MCDM dilemma in order to cope with those issues. MCDM problems can be solved in a variety of ways.

Hwang and Yoon proposed one of them in the form of a TOPSIS to solve the MCDM problem with several alternatives. The preferred alternative should have “the shortest geometrical distance from the PIS and the greatest geometrical distance from the NIS”, according to the central definition of this strategy.

This method is now used in a variety of areas, including energy medicine, industrial systems protection, and environmental fields such as chemical engineering and water resource studies. Chen and Hwang extended the TOPSIS method's concept and proposed a new TOPSIS model.

Zulqarnain created a graphical model of the TOPSIS system, which they used to choose a medical clinic for disease diagnosis. Chen has used the recently proposed approach for decision making to solve ambiguous data by extending TOPSIS for Group Decision Making in a Fuzzy Setting.

The value weights of multi-criteria and alternate ranking based on these criteria were analysed as linguistic variables by a panel of decision makers. For MCDM problems, several approaches have been developed.

Many scholars contributed to the TOPSIS approach, which has been used in medical diagnosis and decision-making in a variety of areas, according to the literature.

TOPSIS Method

The TOPSIS method, developed by Hwang and Yoon, is a method for resolving MCDM. They suggested the PIS and NIS to promote the shortest Euclidean distance, and each criterion must be maximised or reduced.

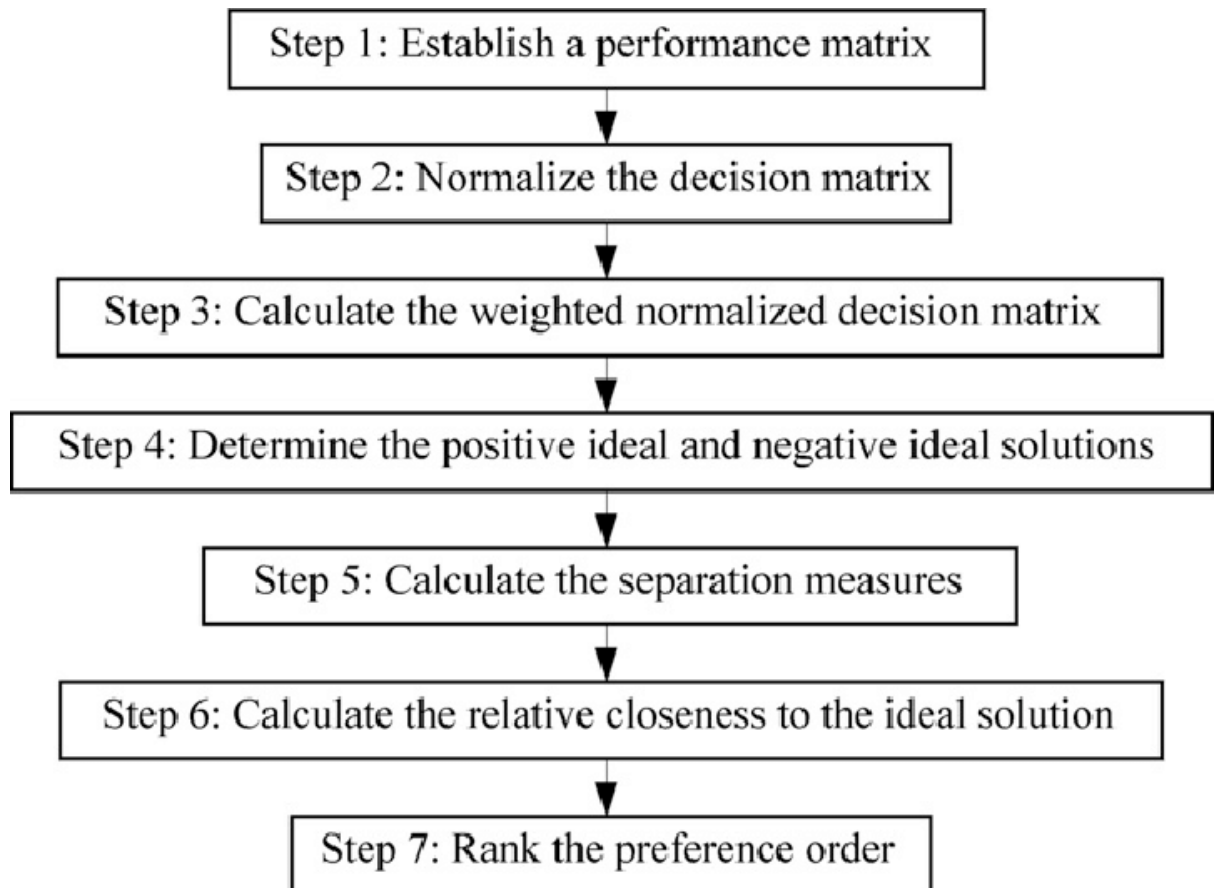
They believed that the TOPSIS approach aids in ranking alternative closeness based on the optimal ideal solution and obtaining the highest degree from available options. The best option has a rank of one, while the worst option has a rank of zero.

There is an intermediate ranking between the best solution extremes for each response. An equivalent collection of selection parameters allows for accurate weighting of relative disease, and therefore the best disease is troubling and requires care. The TOPSIS technique's steps are shown below.

An MCDM problem with m -alternatives is viewed by TOPSIS as a geometric structure with m points in n -dimensional space. The preferred alternative should have “the shortest geometrical distance from the PIS and the greatest geometrical distance from the NIS”, according to the central definition of this strategy.

A general idea when using TOPSIS is that criteria should be monotonically increasing or decreasing so that PIS and NIS can be easily distinguished.

Steps



Step 1

Create an evaluation matrix consisting of m alternatives and n criteria, with the intersection of each alternative and criteria given as x_{ij} , we therefore have a matrix $(x_{ij})_{m \times n}$.

Step 2

The matrix $(x_{ij})_{m \times n}$ is then normalised to form the matrix

$$R = (r_{ij})_{m \times n}, \text{ using the normalisation method}$$

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^m x_{kj}^2}}, \quad i = 1, 2, \dots, m, \quad j = 1, 2, \dots, n$$

Step 3

Calculate the weighted normalised decision matrix

$$t_{ij} = r_{ij} \cdot w_j, \quad i = 1, 2, \dots, m, \quad j = 1, 2, \dots, n$$

where $w_j = W_j / \sum_{k=1}^n W_k, j = 1, 2, \dots, n$ so that $\sum_{i=1}^n w_i = 1$, and W_j is the original weight given to the indicator $v_j, j = 1, 2, \dots, n$.

Step 4

Determine the worst alternative (A_w) and the best alternative (A_b):

$$A_w = \{ \langle \max(t_{ij} \mid i = 1, 2, \dots, m) \mid j \in J_- \rangle, \langle \min(t_{ij} \mid i = 1, 2, \dots, m) \mid j \in J_+ \rangle \} \equiv \{ t_{wj} \mid j = 1, 2, \dots, n \},$$

$$A_b = \{ \langle \min(t_{ij} \mid i = 1, 2, \dots, m) \mid j \in J_- \rangle, \langle \max(t_{ij} \mid i = 1, 2, \dots, m) \mid j \in J_+ \rangle \} \equiv \{ t_{bj} \mid j = 1, 2, \dots, n \},$$

where,

$J_+ = \{j = 1, 2, \dots, n \mid j\}$ associated with the criteria having a positive impact, and

$J_- = \{j = 1, 2, \dots, n \mid j\}$ associated with the criteria having a negative impact.

Step 5

Calculate the L^2 -distance between the target alternative i and the worst condition A_w

$$d_{iw} = \sqrt{\sum_{j=1}^n (t_{ij} - t_{wj})^2}, \quad i = 1, 2, \dots, m,$$

and the distance between the alternative i and the best condition A_b

$$d_{ib} = \sqrt{\sum_{j=1}^n (t_{ij} - t_{bj})^2}, \quad i = 1, 2, \dots, m$$

where d_{iw} and d_{ib} are L^2 -norm distances from the target alternative i to the worst and best conditions, respectively.

Step 6

Calculate the similarity to the worst condition:

$$s_{iw} = d_{ib} / (d_{iw} + d_{ib}), \quad 0 \leq s_{iw} \leq 1, \quad i = 1, 2, \dots, m.$$

$s_{iw} = 1$ if and only if the alternative solution has the best condition; and

$s_{iw} = 0$ if and only if the alternative solution has the worst condition.

Step 7

Rank the alternatives according to s_{iw} ($i = 1, 2, \dots, m$).

Backend Calculations

First of all the financial data is collected from the financialmodelingprep api. The following is the code in python used to extract the data.

```
#get the financial ratios
count = 0
for company in companies:
    try:
        if count < 5:
            count = count + 1
            fin_ratios = requests.get(
                f'https://financialmodelingprep.com/api/v3/ratios-ttm/{company}?apikey={api_key}'
            ).json()
            value_ratios[company] = {}
            value_ratios[company]['ROE'] = fin_ratios[0]['returnOnEquityTTM']
            value_ratios[company]['ROA'] = fin_ratios[0]['returnOnAssetsTTM']
            value_ratios[company]['ROCE'] = fin_ratios[0]['returnOnCapitalEmployedTTM']
            value_ratios[company]['Quick_Ratio'] = fin_ratios[0]['quickRatioTTM']
            value_ratios[company]['Interest_Coverage'] = fin_ratios[0]['interestCoverageTTM']
            value_ratios[company]['Gross_Profit_Margin'] = fin_ratios[0]['grossProfitMarginTTM']
            value_ratios[company]['PB'] = fin_ratios[0]['priceToBookRatioTTM']
            value_ratios[company]['PS'] = fin_ratios[0]['priceToSalesRatioTTM']
            value_ratios[company]['PEG'] = fin_ratios[0]['pegRatioTTM']
            value_ratios[company]['PE'] = fin_ratios[0]['peRatioTTM']
```

The data is then passed through a function specifically created to perform topsis calculations on the data.

```
def topsis(ratios):
    df = pd.DataFrame.from_dict(ratios,orient='index')
    df2 = np.sqrt(np.square(df).sum())
    df3 = df/df2
    columncount = df.shape[1]
    weights = np.empty([1,columncount])
    weights.fill(1/columncount)
    norm_weighted = df3 * weights
    positive_value_db = norm_weighted.iloc[:,6]
    negative_value_db = norm_weighted.iloc[:,6:10]
    positive_solution_1db = np.max(positive_value_db)
    positive_solution_2db = np.min(negative_value_db)
    positive_solution = pd.concat([positive_solution_1db, positive_solution_2db])
    positive_solution_1db = np.min(positive_value_db)
    positive_solution_2db = np.max(negative_value_db)
    negative_solution = pd.concat([positive_solution_1db, positive_solution_2db])
    final_positive_matrix = np.sqrt(np.sum(np.square(norm_weighted-positive_solution),1))
    final_negative_matrix = np.sqrt(np.sum(np.square(norm_weighted-negative_solution),1))
    relative_closeness = final_negative_matrix/(final_negative_matrix+final_positive_matrix)
    relative_closeness = relative_closeness.sort_values(ascending=False)
    relative_closeness = relative_closeness.to_frame()
    relative_closeness.reset_index(level=0, inplace=True)
    relative_closeness.rename(columns={0:'Score', 'index':'Ticker'},inplace=True)
    return relative_closeness
```

FRONTEND WEBSITE

Link - [investment_model · Streamlit \(topsis-company-ranking.herokuapp.com\)](https://investment_model.streamlit.io/topsis-company-ranking.herokuapp.com)

Ranking Companies with TOPSIS

TOPSIS, known as Technique for Order of Preference by Similarity to Ideal Solution, is a multi-criteria decision analysis method. It compares a set of alternatives based on a pre-specified criterion. The method is used in the business across various industries, every time we need to make an analytical decision based on collected data.

Here we are comparing several companies and finding out which one has the strongest financials. These companies are our alternatives set. To combine them together and decide which one is the strongest, we need to employ some reliable metrics. We are using indicators derived from financial statements like ROA (return on assets), ROE (return on equity), etc. These indicators will form our criteria set.

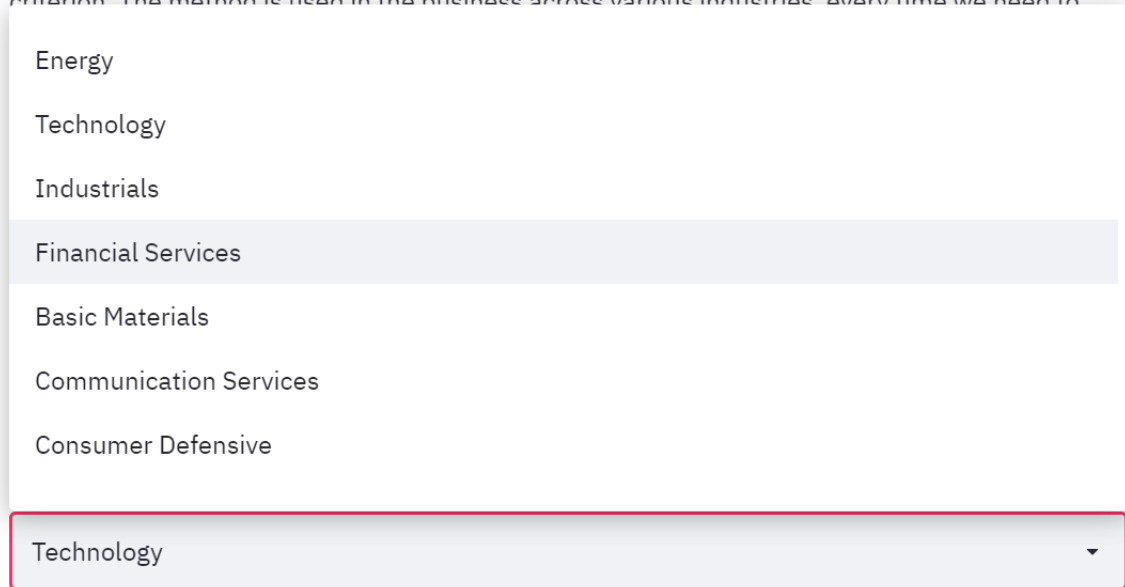
The logic of TOPSIS is based on the concept that the chosen alternative should have the shortest geometric distance from the best solution and the longest geometric distance from the worst solution.

Select a sector

This is the main page of the website. It explains the topsis method and gives the user an option to select the sector

Ranking Companies with TOPSIS

TOPSIS, known as Technique for Order of Preference by Similarity to Ideal Solution, is a multi-criteria decision analysis method. It compares a set of alternatives based on a pre-specified criterion. The method is used in the business across various industries every time we need to



Energy

Technology

Industrials

Financial Services

Basic Materials

Communication Services

Consumer Defensive

Technology

Search

The user can select any sector from the dropdown value and click “Search”

The website the automatically takes the latest data at that time and performs TOPSIS calculations on the data. Then the results are displayed in the form of a table.

The following table shows the results ranking the companies according to TOPSIS method.

Select a sector

Technology

Search

	Ticker	Score	Company Name
0	TXN	0.6452	Texas Instruments Incorporated
1	QCOM	0.6283	QUALCOMM Incorporated
2	AMAT	0.5496	Applied Materials, Inc.
3	AAPL	0.5266	Apple Inc.
4	NVDA	0.3191	NVIDIA Corporation

Select a sector

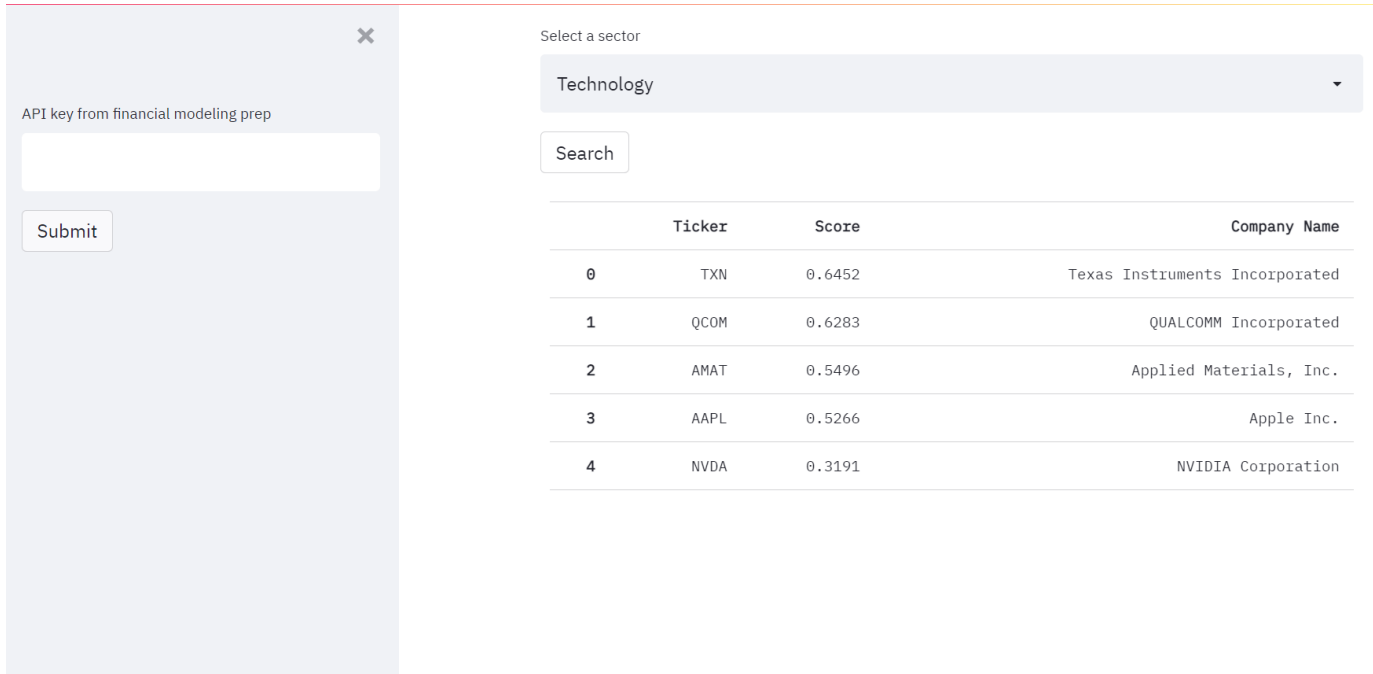
Energy

Search

	Ticker	Score	Company Name
0	VNOM	0.6572	Viper Energy Partners LP
1	CLNE	0.5897	Clean Energy Fuels Corp.
2	PDCE	0.5856	PDC Energy, Inc.
3	FANG	0.5734	Diamondback Energy, Inc.
4	PTEN	0.3758	Patterson-UTI Energy, Inc.

The website also provides an option to provide your own api that you can get from [Financial Modeling Prep - Home](#).

You can use your own api in case the free quota is finished in the default one.



The screenshot shows a web application interface. On the left, there is a modal window with a close button (X) in the top right corner. Inside the modal, there is a text input field labeled "API key from financial modeling prep" and a "Submit" button below it. On the right, there is a main interface with a "Select a sector" dropdown menu currently set to "Technology". Below the dropdown is a "Search" button. Underneath the search button is a table with the following data:

	Ticker	Score	Company Name
0	TXN	0.6452	Texas Instruments Incorporated
1	QCOM	0.6283	QUALCOMM Incorporated
2	AMAT	0.5496	Applied Materials, Inc.
3	AAPL	0.5266	Apple Inc.
4	NVDA	0.3191	NVIDIA Corporation

Just get paste your financial api and press "submit".

Link to the Website - [investment model · Streamlit \(topsis-company-ranking.herokuapp.com\)](#)

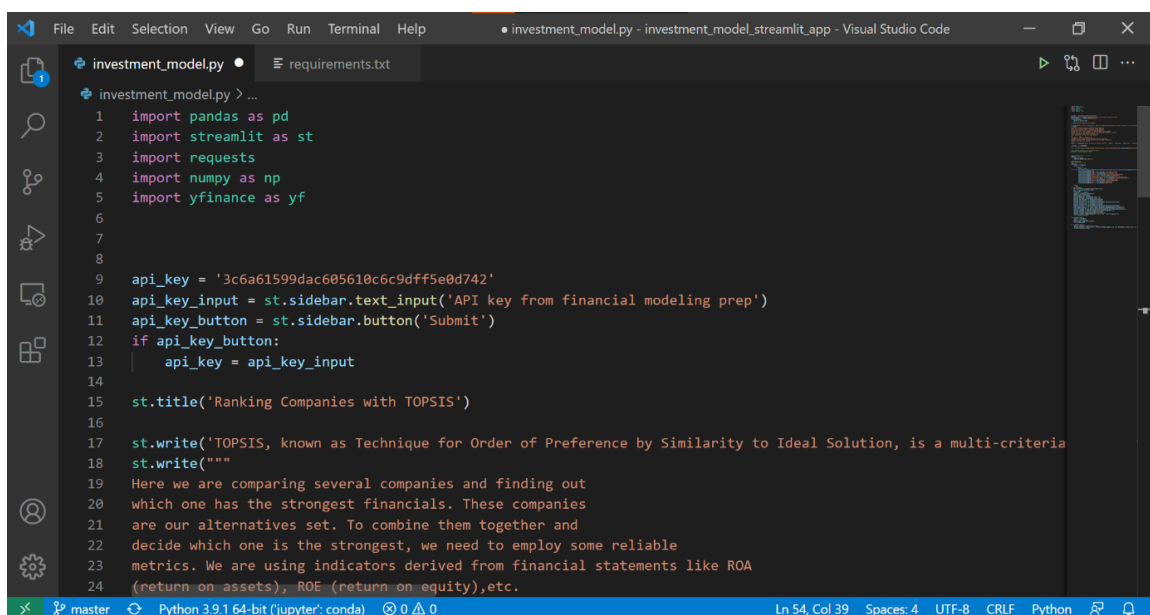
SERVICES AND TOOLS USED FOR DEPLOYING THE TOOL

Python



Python is an encoded high-level general-purpose programming language. The heavy use of indentation demonstrates Python's programming philosophy, which prioritises code readability. Its object-oriented design and language structures are targeted at assisting programmers in writing easy, logical code for both small and large-scale projects.

Python is dynamically typed and garbage-collected. Structured (especially procedural) programming, object-oriented programming, and functional programming are among the programming paradigms it supports. Python is often referred to as a "batteries included" language because of its large standard library.

A screenshot of a Visual Studio Code editor window. The title bar reads "investment_model.py - investment_model_streamlit_app - Visual Studio Code". The editor shows a Python file named "investment_model.py" with the following code:

```
1 import pandas as pd
2 import streamlit as st
3 import requests
4 import numpy as np
5 import yfinance as yf
6
7
8
9 api_key = '3c6a61599dac605610c6c9dff5e0d742'
10 api_key_input = st.sidebar.text_input('API key from financial modeling prep')
11 api_key_button = st.sidebar.button('Submit')
12 if api_key_button:
13     api_key = api_key_input
14
15 st.title('Ranking Companies with TOPSIS')
16
17 st.write('TOPSIS, known as Technique for Order of Preference by Similarity to Ideal Solution, is a multi-criteria
18 st.write("""
19 Here we are comparing several companies and finding out
20 which one has the strongest financials. These companies
21 are our alternatives set. To combine them together and
22 decide which one is the strongest, we need to employ some reliable
23 metrics. We are using indicators derived from financial statements like ROA
24 (return on assets), ROE (return on equity), etc.
```

The status bar at the bottom shows "master", "Python 3.9.1 64-bit (jupyter: conda)", "Ln 54, Col 39", "Spaces: 4", "UTF-8", "CRLF", "Python", and a search icon.

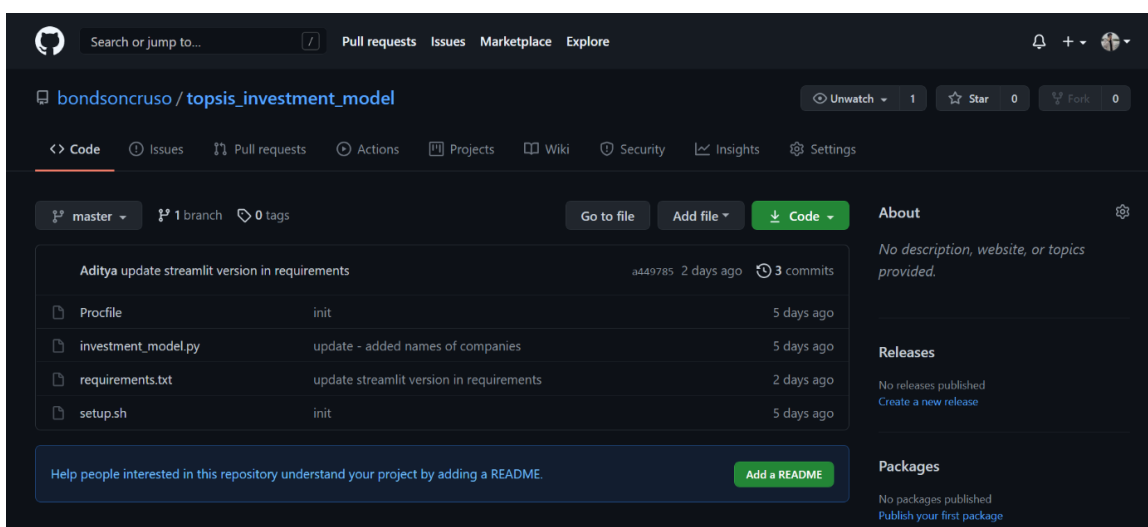
All the code performing the calculations and creating the website is written in python.

GitHub



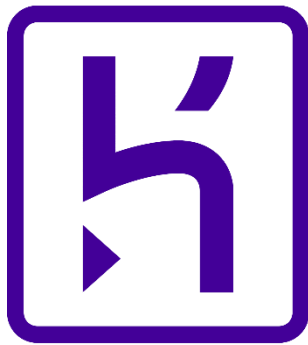
GitHub, Inc. is an Internet hosting firm that specialises in the development and version control of Git-based applications. It integrates Git's distributed version control and source code management (SCM) features with its own. Access control and collaboration tools, such as error reporting, feature requests, task management, continuous integration, and wikis, are used with every project. It has been a Microsoft partner since 2018. It is based in California.

The key features of GitHub are downloadable for download. For more specialised professional and business services, commercial providers are available. Free GitHub accounts are often used to host open-source software. As of January 2019, GitHub opens unregulated private repositories for all plans, including free accounts, but only three collaborators per repository. From April 15, 2020, the free plan would allow unregulated partners, but private repositories will be limited to 2,000 minutes of GitHub Action each month.



The code is hosted on GitHub.

Heroku



HEROKU

Heroku is a “cloud-based platform-as-a-service (PaaS) that supports a variety of programming languages”. Heroku, one of the first cloud services, has been in existence since June 2007, when it only supported Ruby. It also supports “Java, Node.js, Scala, Clojure, Python, PHP, and Go”. As a result, Heroku is referred to as a polyglot platform because it allows developers to “create, run, and scale” applications in a similar manner across a variety of languages.

A screenshot of the Heroku dashboard for a Salesforce Platform application. The dashboard shows the application name 'topsis-company-ranking', the GitHub repository 'bondsoncruso/topsis_investment_model', and the current branch 'master'. The main content area is divided into three sections: 'Installed add-ons' (showing \$0.00/month and no add-ons), 'Dyno formation' (showing \$0.00/month and free dynos), and 'Latest activity' (showing deployment and build logs).

Salesforce Platform

HEROKU Jump to Favorites, Apps, Pipelines, Spaces...

Personal > topsis-company-ranking ☆

GitHub bondsoncruso/topsis_investment_model master

Overview Resources Deploy Metrics Activity Access Settings

Installed add-ons **\$0.00/month** [Configure Add-ons](#)

There are no add-ons for this app
You can add add-ons to this app and they will show here. [Learn more](#)

Dyno formation **\$0.00/month** [Configure Dynos](#)

This app is using free dynos

```
web sh setup.sh && streamlit run investment_model.py
```

ON

Latest activity

- adi1097.ac@gmail.com: Deployed a449785b
May 9 at 10:15 PM · v5 · [Compare diff](#)
- adi1097.ac@gmail.com: Build succeeded
May 9 at 10:13 PM · [View build log](#)
- adi1097.ac@gmail.com: Deployed d58759e2
May 6 at 10:04 PM · v4 · [Compare diff](#)
- adi1097.ac@gmail.com: Build succeeded
May 6 at 10:03 PM · [View build log](#)

Our website is hosted on Heroku.

RESULTS

These are the results for technology sector

	Ticker	Score	Company Name
0	ADI	0.4913	Analog Devices, Inc.
1	LRCX	0.4781	Lam Research Corporation
2	MU	0.4518	Micron Technology, Inc.
3	QCOM	0.4274	QUALCOMM Incorporated
4	TXN	0.4219	Texas Instruments Incorporated
5	ADSK	0.4212	Autodesk, Inc.
6	AMD	0.4074	Advanced Micro Devices, Inc.
7	AMAT	0.3989	Applied Materials, Inc.
8	AAPL	0.3502	Apple Inc.
9	NVDA	0.3007	NVIDIA Corporation

Now let's analyse performance of the top 5 stocks in the above table

ADI



Analog Devices, Inc. is a company that creates, develops, manufactures, and sells integrated circuits (ICs). The company's products include instrumentation and measurement tools, wireless service services, energy storage systems, networking equipment, aerospace and defence electronics, optical systems, motorcycles, and mobile consumer devices. The company was founded in 1965 by Raymond P. Stata and Matthew Lorber and is headquartered in Wilmington, Massachusetts.

LRCX



Lam Research Corp. manufactures and services semiconductor fabrication devices for wafer production. The “United States, China, Europe, Japan, Korea, Southeast Asia, and Taiwan” are the regional divisions in which it works. Thin film deposition, plasma etch, photoresist strip, and wafer cleaning are all available. David Lam founded the company on January 21, 1980, and it is based in Fremont, California.

MU



Micron Technology, Inc. is a company that specializes in memory and storage technologies. “Compute and Networking Business Unit (CNBU), Mobile Business Unit (MBU), Storage Business Unit (SBU), and Embedded Business Unit (EBU) are the company's divisions (EBU)”. The Compute and Networking Business Unit division includes memory products marketed to the cloud service, enterprise, client, graphics, and networking industries. The Consumer Business Unit division markets memory devices in the smartphone and other mobile-device segments.

The Storage Business Unit division includes SSDs and part-level systems marketed to corporate and server, client, and commercial solid-state drive (SSD) markets, as well as other discrete storage units sold in component and wafer form to removable storage markets and sales of 3D XPoint memory. The Embedded Business Unit division includes memory and storage systems for the automotive, industrial, and residential markets. The organisation was founded on October 5, 1978, by Ward D. Parkinson, Joseph L. Parkinson, Dennis Wilson, and Doug Pitman, and is based in Boise, Idaho.

QCOM



QUALCOMM, Inc. is a wireless telecommunications company that develops, designs, and sells products and services. “Qualcomm CDMA Technologies (QCT), Qualcomm Technology Licensing (QTL), and Qualcomm Strategic Initiatives are the company's three divisions (QSI)”. The QCT division designs and manufactures integrated circuits and system applications for use in “voice and data communications, networking, device processing, graphics, and global positioning systems”.

The QTL division issues permits and rights to use parts of the company's intellectual property portfolio. The QSI division focuses on developing or creating new markets for its platforms, as well as assisting in the creation and launch of new voice and data communications devices and services.” Franklin P. Antonio, Adelia A. Coffman, Andrew Cohen, Klein Gilhousen, Irwin Mark Jacobs, Andrew J. Viterbi, and Harvey P”. White formed the organization in July 1985, and it is based in San Diego, California.

ANALYSIS

In the study we were able to determine a good ranking model to rank the companies. The TOPSIS method was able to take into account the ratios as inputs and rank the companies accordingly. We were also able to develop a website which offers users to use the TOPSIS method to get the rank of the companies daily.

We only provided the option of ranking across same sectors because comparing ratios across different industries is not meaningful. The main aim is to select stocks that are investable for long terms. As the strategy is to invest for long term, it is difficult to measure the performance in short amount of time. The ranking according to ratios determines that the top ranked companies are fundamentally strong. So the top ranked companies are good to invest and add to your portfolio of stocks.

A different way to measure can be found looking at the charts. All the companies have recently seen a price decline. This can be due to volatility in the market and in the long term the price may go up. Thus, making our portfolio profitable.

LIMITATIONS

Financial ratios have flaws that, if not understood, will lead to incorrect conclusions being taken from statistics. Financial ratios have a number of major disadvantages, which are discussed below.

A financial ratio is made up of a numerator and a denominator. If either the numerator or denominator are false, the financial ratio would be incorrect. A numerator or denominator error may occur due to human error. It's likely that an error was made while compiling the company's financial reporting results, for example. Alternatively, the firms may be manipulating the data through earnings management techniques (such as managing accruals).

Seasonal effects can also bias ratio analysis. The product turnover ratio for a food processor would be different if the balance sheet figure used for inventory was taken just before or just after the canning season.

This problem can be mitigated by using monthly averages for inventory when calculating percentages like turnover.

Inflation distorts a company's balance sheet dramatically, with recorded values often varying significantly from "true" values. Profits suffer, which has an effect on both depreciation expenses and production costs. As a consequence, a percentage analysis of a single firm over time or a quantitative analysis of multiple firms should be approached with care.

Another limitation is that it doesn't take into account the sentiments of the people. Judging and predicting the stock price just on the fundamental ratios is not feasible as there are many other forces at play in the stock market.

CONCLUSION

Financial conditions, which are usually measured by financial ratios, are one of the most significant comparative advantages of firms in the modern global economy. Financial ratios are a form of predictive financial data that can be used to analyze firms over time and within a specific industry.

We discovered that only standard financial ratios were used as inputs for our equations on our website after doing a thorough analysis of previous literature that used MCDM models. As a result, we are able to provide a valuable website that employs a well-researched investing strategy.

Long-term buyers should consider this website because they believe in holding securities for many years before sale. You must be confident in your ability to retain a stock pick for the next three to five years.

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