

Stock Screening Based on Fuzzy Comprehensive Evaluation Model: A Case Study of the U.S. Financial Services Industry Banking under the COVID-19 pandemic

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Abstract. Faced with the strong impact of the epidemic, investment strategies also need to be optimized according to the actual situation. This paper analyzes the data of 282 stocks in the financial services industry and banking industry in the U.S. stock market from 2015-2021 through the fuzzy comprehensive analysis model, and selects a relatively appropriate intra industry portfolio according to the Sharpe ratio. In the process of research, based on the existing data and the social assessment of the covid-19 epidemic, a fuzzy comprehensive analysis model was initially constructed. This provides corresponding evaluation rules for each influencing factor, and determines its weight in a certain level of fuzzy comprehensive analysis model. Then, the experiment can screen out 29 high-quality stocks in the industry according to the total score. Then, the experiment classifies high-quality stocks according to their different characteristics, and selects the stocks with the highest scores in each category to participate in portfolio comparison. Finally, the experiment will focus on the Sharpe ratio and select a relatively good portfolio example at this stage after comprehensively evaluating the rationality of other values. At present, this example has strong investment value, and the investment strategy discussed in this paper may also have strong applicability in other industries after appropriate adjustment.

Keywords: COVID-19 epidemic; Investment strategy; Fuzzy comprehensive analysis model; Sharpe ratio.

1. Introduction

With the covid-19 pandemic at the end of 2019, the world's economic and social ecology has been extremely far-reaching, causing huge changes and widespread economic chaos. During this period, the United States has also made active efforts to combat the epidemic. However, by 2021, although the US Congress has proposed some bills, including *the coronavirus assistance, relief and Economic Security Act* and *the wage protection plan and health care Enhancement Act*, the deterioration of the economic ecology will inevitably have a great impact on the entire financial service industry, including banking, insurance and other sub industries [1]. For the banking sector, a lot of bank assets come from loans from households and businesses, while banks mostly derive their income from loan repayment inflows and fulfilling their due obligations to depositors [1]. If society's ability to repay loans suddenly drops sharply, banks will be in a bind. Similarly, the failure of banks will have a more severe impact on the financial system. It is precisely because of the pandemic that a large number of families have reduced orders due to disease, isolation and other possible economic factors, resulting in business declines or even disruptions everywhere, with a broad economic impact [1]. In addition, because the future trend of the economic situation is difficult to predict, the follow-up asset flow behavior of many enterprises has become more uncontrollable, and even greatly reduced the frequency of activities or other ways to reduce the risk of infection, which has further damaged the economic ecology [1]. This also proves that the economic impact of the epidemic is sustained and intense, which cannot be easily ignored. As far as the current situation is concerned, the covid-19 epidemic has caused irreversible economic chaos and brought immeasurable challenges and risks to the whole banking industry [1]. Therefore, this paper selects and analyzes the data of 282 stocks in the financial services industry banking industry of the U.S. stock market from 2015 to 2021 based on the fuzzy comprehensive evaluation model. In this context, it focuses on the stock selection strategies that investors can adopt in the face of banking stocks.

At this stage, although there have been more studies on the relationship between the epidemic and the development of the banking industry, the arguments of this paper are quite different. Now, the general research is limited to the resilience of the banking regulatory framework under the influence of the covid-19 epidemic and the relationship between banks and small and medium-sized enterprises in the context of the covid-19 epidemic to reflect the operating conditions of banks, but such research is only limited to the macro level, although it can better reflect the overall market, but the support for investment decision-making is slightly weak [2-4]. In addition, some studies have analyzed the market situation of banking investment markets, but this part of the research focuses only on the Islamic banking system, which is too narrow to help most investors [5]. Therefore, this paper mainly focuses on the financial services industry banking sector in the U.S. stock market, and focuses on exploring and evaluating the related attributes of each stock, such as pressure resistance and profitability, to reflect the development trend of each bank, so as to provide more reliable investment decision-making suggestions for larger investment groups. In terms of the selection of evaluation methods, because in the current research, fuzzy comprehensive analysis method has been widely used in quantitative risk assessment of Arctic oil spills, vulnerability assessment and influencing factor analysis of marine economic system and risk assessment of renewable energy investment, highlighting its good ability in quantitative risk assessment, Therefore, this paper selects the fuzzy comprehensive analysis model as the main evaluation model for scoring [6-8]. In the process of building the model, according to the existing comprehensive decision-making support system for stock investment decision-making and other evidence of venture capital around the world at this stage, the early evidence of banks and fintech stocks, and the existing data of banking systemic risk around covid-19, this paper objectively and comprehensively constructs the weight allocation scheme in the model [9-12]. Finally, this paper constructs the final appropriate stock investment decision through Sharpe ratio.

This paper analyzes the data of 282 stocks in the banking industry of financial services industry in the U.S. stock market from 2015 to 2021 through the fuzzy comprehensive analysis model, and selects a relatively appropriate intra industry portfolio based on the Sharpe ratio. In the process of research, the experiment first preliminarily constructs the fuzzy comprehensive analysis model based on the existing data and the social evaluation of the covid-19 epidemic. Then, the experiment can screen 29 high-quality stocks in the industry by virtue of the total score. Then, the experiment classifies the different characteristics of high-quality stocks, and selects the stocks with the highest scores in each category to participate in portfolio comparison. Finally, the experiment will focus on the Sharpe Ratio and, after evaluating the rationality of other values, choose an example of a portfolio that is relatively good for both short-term and long-term investments, with a higher Sharpe Ratio, which means they can generate a stable income at a lower risk than other investment strategies. In addition, for other similar industries that are seriously affected by the epidemic situation at this stage, the experimental model can also be well applied after the appropriate modification of the decision-making scheme in this paper according to the market conditions of specific industries, which provides a new idea for system analysis of various industries.

Based on the above strategies, the following paper will discuss and analyze 282 stocks in the financial service industry of the United States stock market through several steps, such as model building, experiment, and preliminary conclusion of experiment and in-depth analysis of experiment. Finally, based on the experimental results and combined with the special market environment of the current epidemic situation, it will give an objective and comprehensive market analysis and investment strategies with relative advantages.

2. Methodology and Data

2.1 Fuzzy Comprehensive Evaluation Model

Fuzzy comprehensive evaluation model is a widely used model in fuzzy mathematics. In the evaluation of a certain transaction, researchers often encounter such problems, because the evaluation

transaction is determined by many factors, so researchers should evaluate each factor; On the basis of making a separate comment on each factor, how to make a comprehensive comment considering all factors is a comprehensive evaluation problem. Therefore, when the boundary of many things is not very obvious, it is difficult to classify them in a certain category when evaluating them, so researchers first evaluate individual factors, and then conduct a comprehensive fuzzy evaluation of all factors to prevent the loss of any statistical information and information in the middle of the process, which helps to solve the problem of deviation from objective reality caused by deterministic evaluation such as "yes" or "no", which is the role of fuzzy comprehensive evaluation. In order to reflect the investment status carefully, this paper sets up a three-level comprehensive evaluation model, covering four aspects and many evaluation details.

Here is a brief description of the model. Because each stock has its own unique characteristics, this model is based on the data of 282 stocks in the banking industry of the US financial services industry from 2015 to 2021 obtained by the US stock market, and carefully analyses the performance of each stock from various dimensions. The first level model includes four aspects: valuation, growth, profitability and expenditure, which can more fully reflect the overall characteristics of each stock. The second-level model extends on the basis of the first-level model. The valuation module contains two characteristics: value and one-year return. The growth module contains four characteristics: earnings per share, profit before interest and tax depreciation and amortization, and their growth rate. The profitability module also contains four characteristics: GP/A, ROA, P/E and P/B. The payment module contains only one feature divided by the return rate. Such a detailed attribute division can make each stock more accurate positioning.

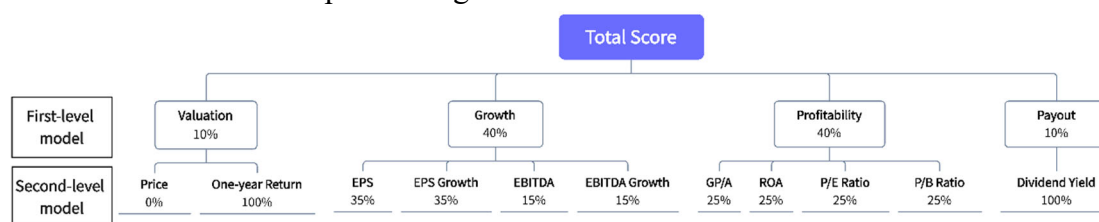


Figure1. The first two levels fuzzy comprehensive analysis model

The third level model is composed of the 2020, 2021 and 7-year average values of each characteristic in the second level model, which can objectively reflect the extent of each stock affected by the epidemic, its resilience in the post-epidemic era and its comprehensive development in the past seven years.

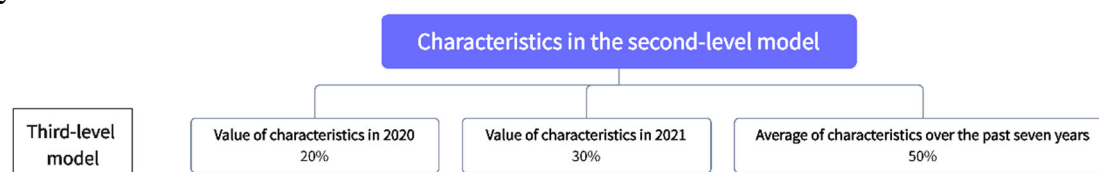


Figure2. The third level fuzzy comprehensive analysis model

2.2 Model Role

For most investors, hundreds of candidate stocks are huge, while a small number of stocks are relatively easy to choose. However, considering the extreme uncertainty of the market under the epidemic situation, it is a more comprehensive portfolio setting method to select some high-quality stocks by fuzzy comprehensive evaluation of a large number of stocks, and then conduct risk analysis through Sharpe ratio and industry portfolio.

3. Model Test

3.1 Model Scoring Rules

The experiment is carried out according to the above model. In each third level subdivision data set, the experiment sorts the set of data and divides it into ten small data sets according to the characteristics and size of the value. The higher the ranking of the data sets, the more scores are obtained. For example, the first group gets 10 points, the second group gets 9 points, and so on.

Table1. Corresponding table of ranking and score

Rank	1-29	30-57	58-85	86-113	114-141	142-169	170-197	198-225	226-253	254-282
Group	1	2	3	4	5	6	7	8	9	10
Score	10	9	8	7	6	5	4	3	2	1

For the ranking rules, other stock data adhere to the ranking from large to small. But P / E ratio and P / B ratio take a special approach. Because a lower positive P / E ratio means a shorter return period, less investment risk, and better stock investment value, while a lower positive P / B ratio means a higher output ratio. Therefore, the two data are sorted in ascending order in the positive interval first, and then in ascending order in the negative interval, so as to get the complete sequence.

3.2 Third Level Model

After obtaining the corresponding data scores through the third level model, the experiment first weighted the average within the scope of a single third level model. Considering the severe epidemic situation and unstable social environment at this stage, the resilience of each stock under extreme economic ecology and the resilience after impact should be paid enough attention to. Therefore, because the data values in 2020 and 2021 can reflect the resilience and resilience of the corresponding stocks from the side, their weights account for 20% and 30% respectively. In addition, the average value in recent years is also extremely important, which can better reflect the comprehensive growth capacity of the corresponding stocks, and also evaluate their position in the industry from the average value, so it accounts for 50% of the weight.

Characteristics in the second level model

$$= 0.2 \times \text{Value of characteristics in 2020} + 0.3 \times \text{Value of characteristics in 2021} \\ + 0.5 \times \text{Average of characteristics over the past seven years} \quad (1)$$

After completing the evaluation of the third level model, the experiment has obtained the corresponding scores for the data in the second level model, so that the weighted comprehensive evaluation process of the second level model can begin. In this stage, the experiment will analyze the second level model one by one.

3.3 Second Level Model

3.3.1 Valuation

In this section, the main subdivisions are price and one-year return. However, because the analysis of stock value alone cannot fully reflect the actual problems, one year return is the main judgment factor, with a weight of 100%.

$$\text{Valuation} = \text{One Year Return} \quad (2)$$

3.3.2 Growth

In this section, the main sub items are EPS, EBITDA and their growth rates. First, it is certain that EPS and EBITDA are the basis of the judgment. Because the growth rate is obtained after comparing with the previous data, which means that the growth rate will be more affected by the previous data, that is, a benchmark, so such an assessment is relatively more uncertain. In other words, stocks with lower base values, even if they have higher growth rates, cannot make up for the shortcomings of low benchmarks; Stocks with higher values, even if the growth rate is negative in some periods, have a

higher benchmark to make up for this defect. However, this does not mean that the basic values of EPS and EBITDA are dominant, and the growth rate can reflect the follow-up development of stocks to a certain extent, showing the development potential, which is also a very important basis. As a result, EPS and EBITDA each weigh 35%, while their growth rates each weigh 15%.

$$Growth = 0.35 \times EPS + 0.35 \times EBITDA + 0.15 \times EPS \text{ Growth} + 0.15 \times EBITDA \text{ Growth} \quad (3)$$

3.3.3 Profitability

In this section, the main subdivisions are GP / A, ROA, P / E ratio and P / B ratio. First of all, for GP / A and ROA, they can reflect the profitability of enterprises from different angles, show the level of income obtained by all assets of enterprises, comprehensively reflect the profitability and input and output status of enterprises, and infer whether enterprises can make full use of financial leverage to realize debt operation, so as to achieve more income. Through the in-depth analysis of this indicator, experiment can enhance the attention of all parties to the asset management of enterprises and promote enterprises to improve the income level of unit assets. P / E ratio is a very important indicator for individual stocks and class stocks, which can reflect the return period of investment, investment risk and stock investment value. P / B ratio can also show the proportion of unit input and output and risk, which will greatly affect investor's decisions. Therefore, because these four data mainly assess the two main directions of stock profitability, the four types of data will each account for 25% of the weight to meet the comprehensive judgment of stock profitability.

$$Profitability = 0.25 \times GP/A + 0.25 \times ROA + 0.25 \times P/E \text{ Ratio} + 0.25 \times P/B \text{ Ratio} \quad (4)$$

3.3.4 Payout

In this section, the main sub item is divided yield. Divide yield is a measure of how much dividends a company pays each year relative to its share price. Because the content of this part is relatively single, divide yield will have a 100% weight.

$$Payout = Dividend \text{ Yield} \quad (5)$$

3.4 First Level Model

After the weighting and calculation of various indicators in the second level model are completed, the first level model can make a final evaluation on the basis of the scores calculated by the above rules. The experiment will also further weight the four major categories in the first level model, valuation, growth, probability and payout.

Considering that the fundamental requirement for investors to choose a portfolio is to find stocks with better growth prospects and strong and stable profitability, growth and profitability should be the primary factors in evaluating stocks and occupy a dominant position in the comprehensive evaluation. Valuation and payout have fewer subdivisions. At the same time, one year return is more rigid, while a higher value of divide yield can magnify returns and bring more returns, but from another point of view, this may be at the expense of the company's potential growth, or the stock is experiencing a Sharpe decline. In addition, the type of dividend is also worth considering. In banking, the average dividend yield in the market will be relatively high. However, these are the yields of ordinary dividends, which are taxed as fixed income and capital gains, unlike eligible dividends. Therefore, after considering the role of various indicators, the weight of growth and profitability was set to 40%, while the weight of evaluation and payout was set to 10%.

$$Total \text{ Score} = 0.1 \times Valuation + 0.4 \times Growth + 0.4 \times Profitability + 0.1 \times Payout \quad (6)$$

4. Results

4.1 Preliminary Results

Through the above analysis, the experiment finally selected 29 stocks with the highest scores, namely NASB, BPOP, ECPG, PFSI, FBC, CFFI, WD, NRIM, HMST, HBCP, KB, SMBC, CUBI,

SASR, TSBK, COOP, CHMG, BAP, RF, PKBK, CMA, UBOH, QCRH, FSBW, LARK, SMMF, UNTY, CFG, FITB. The specific comprehensive evaluation scores are shown in the table.

Table 2. Premium Stocks Selected from Model

Tic	Comm	Currency	Valuation score	Growth score	Profitability score	Payout score	Total score
NASB	NASB FINANCIAL INC	USD	6.6	8.34	9.475	9.4	8.73
BPOP	POPULAR INC	USD	9.2	9.55	7.975	4.7	8.40
ECPG	ENCORE CAPITAL GROUP INC	USD	9.5	9.61	8.55	1	8.31
PFSI	PENNYMAC FINANCIAL SERVICES	USD	7.6	8.49	9.6	2.3	8.23
FBC	FLAGSTAR BANCORP INC	USD	7.4	8.58	9.3	1.5	8.04
CFFI	C&F FINANCIAL CORP	USD	4.5	8.08	8.8	7.2	7.92
WD	WALKER & DUNLOP INC	USD	10	8.34	8.1	3	7.88
NRIM	NORTHRIM BANCORP INC	USD	5.4	6.76	9.2	8.3	7.75
HMST	HOMESTREET INC	USD	9	8.38	8	2.8	7.73
HBCP	HOME BANCORP INC	USD	6.6	8.32	8.15	4.7	7.72
KB	KB FINANCIAL GROUP	USD	6.2	7.34	7.9	9.5	7.67
SMBC	SOUTHERN MISSOURI BANCORP INC	USD	8.4	7.73	8.4	3.2	7.61
CUBI	CUSTOMERS BANCORP INC	USD	8.8	9.5	7.025	1	7.59
SASR	SANDY SPRING BANCORP INC	USD	7.9	8.17	6.775	7.2	7.49
TSBK	TIMBERLAND BANCORP INC	USD	8.2	5.44	9.125	8	7.45
COOP	MR COOPER GROUP INC	USD	8.8	9.53	6.55	1	7.41
CHMG	CHEMUNG FINANCIAL CORP	USD	6.6	8.73	6.55	6.2	7.39
BAP	CREDICORP LTD	USD	3.6	9.46	6.575	6.1	7.38
RF	REGIONS FINANCIAL CORP	USD	8.2	6.98	7.675	7	7.38
PKBK	PARKE BANCORP INC	USD	6.3	6.59	8.5	6.9	7.36
CMA	COMERICA INC	USD	8	8.96	5.4	7.7	7.31
UBOH	UNITED BANCSHARES INC/OH	USD	6.2	6.32	9	4.8	7.23
QCRH	QCR HOLDINGS INC	USD	8.5	8.35	7	2	7.19
FSBW	FS BANCORP INC	USD	4.7	6.34	9.6	3.3	7.18
LARK	LANDMARK BANCORP INC/KS	USD	4.1	6.23	9.05	6.5	7.17
SMMF	SUMMIT FINANCIAL GROUP INC	USD	7.2	7	7.675	5.5	7.14
UNTY	UNITY BANCORP INC	USD	8	6.65	8.375	3	7.11
CFG	CITIZENS FINANCIAL GROUP INC	USD	7.2	8.32	5.8	7.2	7.09
FITB	FIFTH THIRD BANCORP	USD	8.8	6.38	7.35	6.9	7.06

4.2 Further Analysis

After the above experiments, the corresponding high-quality stocks have been obtained, and further matching will be carried out below. Considering that among the currently selected stocks, the correlation coefficient of valuation score and payout score is - 0.452, while the correlation coefficient of growth score and probability score is - 0.459, all high-quality stocks can be reclassified according to valuation score and growth score, payout score and probability score, and can be divided into value advantage stocks and growth advantage stocks.

After calculation, the median of the four values is 7.6, 8.32, 8.1 and 5.5 respectively. Considering the above classification, although the growth score of NASB is greater than the median of 0.02, it can be roughly classified as the low value category.

Through observation, the scoring indicators of the first two stocks can be found that the valuation score and growth score of NASB are relatively low. BPOP's profitability score and payout score are at relatively low levels. Such two stocks represent two completely different types, namely, value advantage and growth advantage. Therefore, these two stocks are enough to meet the analysis needs at this stage, so the experiment selected these three stocks for detailed analysis and calculated the Sharpe ratio.

$$\text{Sharpe_Ratio} = \frac{E(R_p) - R_f}{\sigma_p} \quad (7)$$

In the above formula, $E(R_p)$ represents the expected annual return of the portfolio, R_f represents the annualized risk-free interest rate, and σ_p represents the standard deviation of the annualized return of the portfolio.

Considering that there are obvious extreme fluctuations in the annual returns of some stocks in the high-quality range, in order to reduce the impact of extreme values, the upper and lower limits of 5% and 95% are set to replace extreme values (the upper and lower extreme values will become the corresponding values of stocks at 5% and 95% positions), so as to obtain a relatively reasonable annual return. However, although these two stocks are high-quality stocks in the previous fuzzy comprehensive evaluation model, because the two stock types are different, the weights of the two stocks in the portfolio are 25% + 75%, 50% + 50% and 75% + 25% respectively. For the risk-free interest rate, according to the analysis of existing market data, the yield of one-year treasury bonds has shown an upward trend in the recent stage, but it is currently roughly maintained at 3%. Therefore, the experiment takes 3% as the risk-free interest rate.

According to the above analysis method, the experiment calculated the Sharpe ratio for one year and the Sharpe ratio for three years, and the following data were obtained:

Table 3. Sharpe Ratio for One Year Cycle

One Year	25%+75%	50%+50%	75%+25%
Annualized return of investment portfolio	20.39%	18.34%	16.29%
Risk free rate	3%	3%	3%
Standard deviation of portfolio	0.2092	0.1389	0.0947
Sharpe Ratio	0.8312	1.1039	1.4034

Table 4. Sharpe Ratio for Three Year Cycle

Three Year	25%+75%	50%+50%	75%+25%
Annualized return of investment portfolio	55.73%	53.18%	50.63%
Risk free rate	3%	3%	3%
Standard deviation of portfolio	0.1553	0.1460	0.1465
Sharpe Ratio	3.3958	3.4364	3.2514

It can be observed that for short-term investment, the return on investment continues to decline with the increase in the proportion of value dominant stocks and the decrease in the proportion of growth dominant stocks, but the degree of risk decline is greater. As a result, the Sharpe ratio increases with the proportion of value advantage stocks. This reflects that under the influence of a more unstable social environment, short-term investment in the banking sector chooses more value advantage stocks, which is more conducive to avoiding risks and stabilizing returns, but the disadvantage is that returns may be less than the other two investment weight distributions. Therefore, in short-term investment, investors should pay more attention to investing in value advantage stocks.

For long-term investment, the return on investment also continues to decline with the increase in the proportion of value dominant stocks and the decrease in the proportion of growth dominant stocks, but the degree of risk decline is unstable. After analysis, the Sharpe ratio is higher when the average investment value advantage stocks and growth advantage stocks are invested. It reflects that in the face of long-term social instability and the normalization of the epidemic in some areas, the short-term investment choice of average investment value advantage stocks and growth advantage stocks in the banking sector can bring higher returns while controlling risks. Therefore, in long-term investment, investors should pay attention to two types of stocks at the same time.

5. Conclusion

At present, in the context of the global covid-19 epidemic, the deterioration of economic ecology and the turbulence of social environment, as a cyclical stock, the financial services industry banking

industry is undoubtedly one of the stock categories most affected by environmental factors, but in the future, if the economic trend is good, its rebound will be extremely huge. This paper brings the idea of mathematical modeling into the field of investment analysis, and uses fuzzy comprehensive analysis model to analyze the data of 282 stocks in the banking industry of financial services industry in the U.S. stock market from 2015 to 2021. Considering the social environment, this paper first relies on a three-level fuzzy comprehensive analysis model for comprehensive scoring, and then selects 29 high-quality stocks with excellent pressure resistance, strong resilience and adaptability from large to small to narrow the scope of evaluation. After that, the experiment reclassifies the identified high-quality stocks into value advantage stocks and growth advantage stocks, and makes a more detailed analysis of two excellent and characteristic stocks as the representatives of their categories. In this part, the experiment constructs three different types of weighted portfolios, and studies the short-term Sharpe ratio of one year and the long-term Sharpe ratio of three years to judge the relatively more comprehensive portfolio at this stage. Finally, the experimental study concludes that in a bad economic environment, short-term investment in the banking industry should pay more attention to value advantage stocks, but it is more reasonable to invest in value advantage and growth stocks on average in long-term investment

Although, at this stage, the model and conclusion proposed in this paper have a certain theoretical basis, and the portfolio obtained also has good performance. However, the strong subjectivity of the fuzzy comprehensive evaluation model still needs to be improved. At the same time, this paper's analysis is limited to the financial services industry and banking industry in the U.S. stock market. In the face of stocks with different characteristics in other countries or other industries, the universality and stability of the model in this paper still need to be verified.

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