

Quantitative Analysis Based on Financial Macro Risk

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Abstract: Quantitative financial macro risk analysis typically involves multiple economic indicators, market data, and macroeconomic variables. In order to construct a quantitative model, it is first essential to determine which factors have a significant impact on financial macro risk. According to international standards, economic growth risk, inflation risk, unemployment risk, balance of payments risk, and financial market risk are commonly used as quantitative analysis indicators. Based on China's financial macro risk indicators in 2022, this paper uses the random forest model for quantitative analysis, and gives the corresponding strategies.

1. Introduction

The four major macroeconomic indicators include Gross Domestic Product (GDP), Inflation Rate (CPI), Unemployment Rate, and International Balance of Payments. Gross domestic product (GDP) refers to the final result of the production activities of all resident units of a country or region in a certain period calculated at market prices, which can reflect the economic strength and market size of a country or region. Inflation rate (CPI) is a macroeconomic indicator that reflects the changes in the price level of consumer goods and services related to residents' lives. It is mainly used for macroeconomic analysis and decision-making and national accounts indicators. The unemployment rate refers to the numerical ratio of unemployed labor force among the employed population who meet all employment conditions for a certain period of time. It is the main indicator reflecting the unemployment situation of a country or region. International balance of payments refers to all monetary payments incurred by a country during a certain period of time due to external economic transactions and the liquidation of external debts^[1]. It reflects the relationship between a country's external political and economic relations, and can also reflect the rise and fall of a country's position in the world economy.

2. Description of Quantitative Analysis of Random Forest Model

2.1 Data Sources

Data collection: Collect historical data on these key factors. These data can be obtained from institutions such as the National Bureau of Statistics, the World Bank, and the International Monetary Fund.

Data processing and standardization: Preprocess and standardize the collected data for subsequent analysis. This may include the processing of missing values, the detection and processing of outlier, and the standardization or normalization of data.

2.2 Index Design

Identify key factors: Firstly, we need to identify key factors that may affect financial macro risk. These factors may include: GDP growth rate, inflation rate, unemployment rate, interest rate, stock market index, credit spread, debt level (such as government debt, corporate debt, household debt, etc.), political risk, global economic risk (such as geopolitical risk, global trade environment, etc.).

2.3 Quantitative Analysis Method

The steps of quantitative analysis of financial macro risk using the random forest model are as follows:

(1) Data preparation: Collect and organize various macroeconomic indicators and financial market data, including GDP growth, inflation, unemployment rate, balance of payments, stock, bond, foreign exchange, real estate and other market prices and liquidity data.

(2) Feature selection: Based on the suggestions of domain experts and the results of feature importance analysis, select features that are highly correlated with financial macro risks, while removing redundant features.

(3) Data pre-processing: Data pre-processing operations such as missing value filling, outlier processing, and feature standardization are carried out to ensure data quality and model effect.

(4) Random forest model training: Divide the processed data set into training set and test set, use random forest algorithm to train the model, and conduct cross validation and parameter adjustment for the model to improve prediction accuracy.

(5) Model evaluation and result interpretation: Use evaluation indicators (such as accuracy, recall, F1 value, etc.) to evaluate the performance of the model, and explain the influencing factors of the model on financial macro risk based on variable importance analysis results.

(6) Risk quantification: Based on the trained model, calculate quantitative indicators of financial macro risks. This can be a comprehensive risk index or the contribution of various key factors to financial macro risk.

(7) Explanation of results and policy suggestions: Based on quantitative results, explain the sources of risks, potential impacts of risks, and possible risk prevention measures. Based on the analysis results, provide policy makers with responses to financial macro risks [2].

2.4 Model Code

The following is an example code for quantitative analysis of random forest model using Python language:

```
import pandas as pd
import numpy as np
from sklearn.ensemble import RandomForestRegressor
#Import Data
macro_data = pd.read_csv("macro_data.csv")
#Assuming the dataset contains the following five feature columns and one target column
features = ["GDP_growth", "inflation_rate", "unemployment_rate", "balance_of_payments",
"stock_index"]
target = "risk_level"
```

Next, we will divide the dataset into training and testing sets. 80% of the data is used to train the model, and 20% of the data is used to test the performance of the model.

```
#Randomly shuffle the dataset
macro_data = macro_data.sample(frac=1).reset_index(drop=True)
#Divide the dataset into training and testing sets
train_size = int(len(macro_data) * 0.8)
train_data = macro_data[:train_size]
test_data = macro_data[train_size:]
```

Then, we use the training set to train the random forest model. You can use the RandomForestRegressor class of the sklearn library to build a random forest regression model, which includes some hyperparameter, such as the number of trees, the maximum depth of each tree, the number of features to consider for each node, and so on.

```
#Build random forest regression model
rf=RandomForestRegressor(n_estimators=100,max_depth=8,max_features=2, random_state=42)
#Training model
rf.fit(train_data[features], train_data[target])
```

After the training is completed, we can use the test set to evaluate the performance of the model. We can use mean square error (MSE) and R-squared (R2) to evaluate the performance of the model.

```
#Evaluate model performance using test sets
test_predictions = rf.predict(test_data[features])
#Calculate MSE and R2
mse = np.mean((test_predictions - test_data[target]) ** 2)
r2 = rf.score(test_data[features], test_data[target])
print("MSE:", mse)
print("R2:", r2)
```

Finally, use the trained model to predict new data. Use a model to predict the macroeconomic risk level in 2023, assume we already know the five macroeconomic indicators for 2023:

```
#Assuming we already know the five macroeconomic indicators for 2023
new_data = pd.DataFrame({
    "GDP_growth": [2.8],
    "inflation_rate": [2.5],
    "unemployment_rate": [5.0],
    "balance_of_payments": [0.4],
    "stock_index": [3500]
})
#Using trained models for prediction
risk_level = rf.predict(new_data)[0]
print("The macro risk level for 2023 is:", risk_level)
```

3. Quantitative Analysis of Financial Macro Risk Based on Random Forest Model

3.1 Financial Macro Risk Situation in 2022

The following is a quantitative table of the financial macro risk situation in 2022. As shown in Tab. 1.

Table 1 Quantitative Table Of Financial Macro Risks in 2022

Risk type	Index	Situation in 2022	Note
Economic growth risks	GDP growth rate	3%	
Inflation risk	CPI increase	2%	
Employment Risk A	New urban employment (million people)	1206	
Employment Risk B	Surveyed jobless rate in urban areas	5.5%	
Balance of payments risk A	Goods surplus (100 million US dollars)	35.4%	
Balance of payments risk B	Foreign exchange reserves (100 million US dollars)	31277	
Financial Market Risk A	Increase in the Shanghai Composite Index	-15.1%	
Financial Market Risk B	Increase in the Shenzhen Composite Index	-25.9%	
Financial Market Risk C	Trading volume in the stock market (trillion yuan)	224.5	
Financial Market Risk D	Overseas custody balance in the bond market (trillion yuan)	3.5	

Through quantitative analysis of the above aspects, a comprehensive assessment of financial macro risks can be conducted. In addition, using statistical models, machine learning methods, and other technical means can further accurately measure the degree of correlation and mutual influence between various risk factors, providing targeted risk management recommendations for policy makers and investors.

3.2 Quantitative Analysis of Random Forest

Table 2 Summary of Basic Information of Random Forest Classification

Name	Item	Frequency	Percentage
Risk type	Balance of payments risk A	1	10.00%
	Balance of payments risk B	1	10.00%
	Employment risk B	1	10.00%
	Economic growth risks	1	10.00%
	Inflation risk	1	10.00%
	Financial market risk A	1	10.00%
	Financial market risk B	1	10.00%
	Financial market risk C	1	10.00%
Total	Total	10	100.00%
	Valid	10	100.00%
	Lack	0	0.00%
	Total	10	100.00%

The situation in 2022, indicator items as independent variables, and risk types as dependent variables are used for random forest modeling. From the table above, we can see that there are a total of 10 samples participating in the analysis. As shown in Tab. 2.

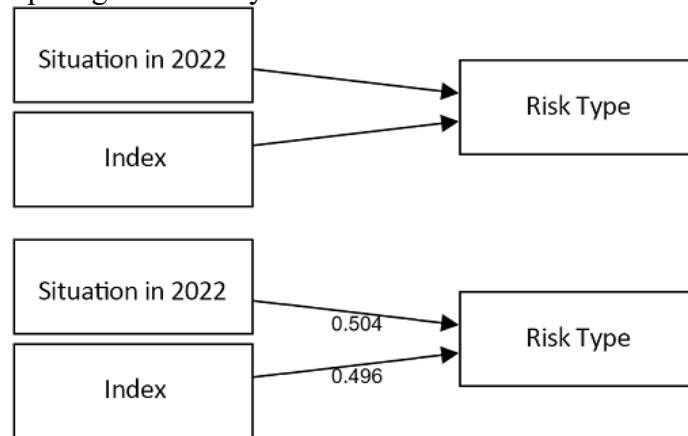


Fig.1 Weight Comparison

The feature weight shows the importance of each title's contribution to the model, with a sum of 1. From the table above, it can be seen that:

The proportion of the situation in 2022 is 50.36%, and this feature has the highest weight and plays a key role in model construction.

The proportion of indicators is 49.64%, followed by the importance of this feature, which plays an important role in model construction. As shown in Fig. 1.

Table 3 Training Set Model Evaluation Results

Item	Accuracy	Recall rate	f1-score	Number of samples
Balance of payments risk A	1.00	1.00	1.00	1
Balance of payments risk B	1.00	1.00	1.00	1
Employment risk B	0.00	0.00	0.00	0
Economic growth risks	1.00	1.00	1.00	1
Inflation risk	1.00	1.00	1.00	1
Financial market risk A	1.00	1.00	1.00	1
Financial market risk B	1.00	1.00	1.00	1
Financial market risk C	1.00	1.00	1.00	1
Accuracy			1.00	8
Average value	1.00	1.00	1.00	8
Average (comprehensive)	1.00	1.00	1.00	8
oobScore=1(Out-of-bag data testing)				

Table 4 Test Set Model Evaluation Results

Balance of payments risk A	Accuracy	Recall rate	f1-score	Number of samples
Balance of payments risk B	0.00	0.00	0.00	0
Employment risk B	0.00	0.00	0.00	0
Economic growth risks	0.00	0.00	0.00	1
Inflation risk	0.00	0.00	0.00	0
Financial market risk A	0.00	0.00	0.00	0
Financial market risk B	0.00	0.00	0.00	0
Financial market risk C	0.00	0.00	0.00	0
Accuracy	0.00	0.00	0.00	0
Average value			0.00	2
Average (comprehensive)	0.00	0.00	0.00	2
Balance of payments risk A	0.00	0.00	0.00	2

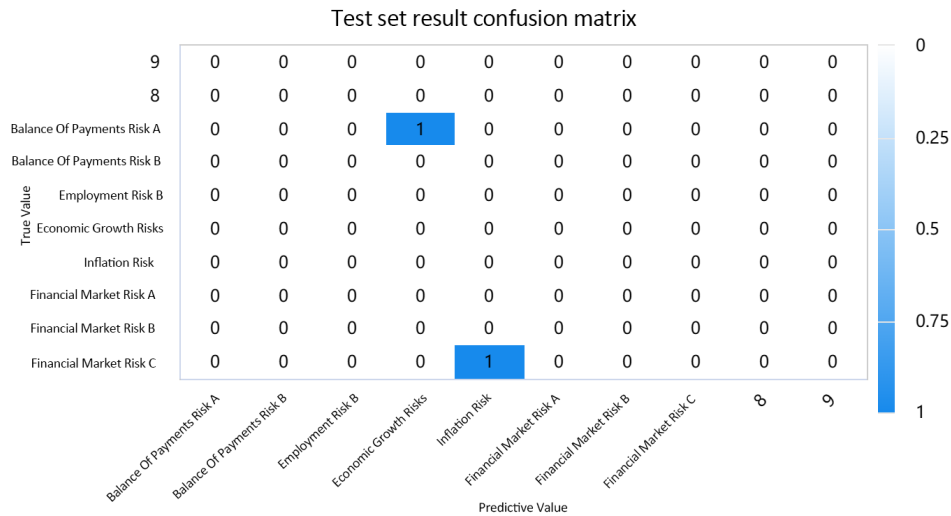


Fig.2 Test Set Result Confusion Matrix

Table 5 Model Summary Table

Name	Parameter name	Parameter value
Model settings	Data preprocessing	None
	Training set proportion	0.8
	Number of decision trees	100
	Node splitting criteria	gini
	Minimum number of samples for node splitting	2
	Minimum number of samples for leaf nodes	1
	Maximum depth of the tree	no limit
	Maximum number of features limit	auto
	Is there a return sampling	Yes
	Whether to conduct out-of-bag data testing	Yes
Model evaluation effect	Accuracy	0.00%
	Accuracy (comprehensive)	0.00%
	Recall rate (comprehensive)	0.00%
	f1-score	0.00

It can be concluded that the situation in 2022, the index item as the independent variable, and the risk type as the dependent variable, the training set proportion is set to 0.8, the number of decision trees is 100, the node splitting standard is gini, the maximum depth of the tree is not limited, and random forest modeling is carried out. As shown in Fig. 2.

From the table above, it can be seen that the accuracy of the final model obtained on the test set is 0.00%, the accuracy (comprehensive) is 0.00%, the recall (comprehensive) is 0.00%, and the f1 score (comprehensive) is 0.00. The model effect is relatively poor. As shown in Tab. 3. Tab. 4. Tab.

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4. Prevention and Strategies Based on Quantitative Analysis of Financial Macro Risks

4.1 Prevention and Analysis

This article predicts and analyzes the financial macro risks in 2023, based solely on existing data and information, and does not represent any authoritative or accurate viewpoint. It can be used as a reference:

(1) Economic growth risk: According to the World Bank's report¹, China's economy will be affected by the COVID-19 epidemic in 2022, and the growth rate will slow to 4.3%, lower than expected. 2023 may face more internal and external challenges, such as supply chain disruptions, energy shortages, real estate market adjustments, financial risks, and geopolitical tensions. Therefore, the risk of economic growth is high, and it is essential to strengthen macroeconomic regulation and structural reform to enhance economic resilience and potential.

(2) Inflation risk: According to a report by the World Bank, China's inflation will remain around 2% in 2022, below the government's target. In 2023, inflation pressure may increase due to factors such as rising international commodity prices, increasing domestic production costs, and tightening monetary policy. Therefore, the inflation risk is relatively moderate, and it is necessary to balance the goals of stable growth and stable prices, flexibly use monetary policy tools, and maintain basic stability of the overall price level.

(3) Employment risk: According to the table you provided, the new urban employment in China will reach 12.06 million in 2022, exceeding the government's target. The urban survey unemployment rate is 5.5%, slightly higher than the government target. In 2023, it may be affected by factors such as slowing economic growth, structural unemployment, and aging population, which will lead to increased employment pressure. Therefore, the employment risk is relatively moderate, and it is necessary to strengthen employment policy support, promote the flexibility and adaptability of the labor market, and improve the quality and efficiency of employment.

(4) International balance of payments risk: According to the table provided, China's goods surplus reached a high of 35.4% in 2022, reflecting strong export competitiveness. Foreign exchange reserves have also remained at a level of 3127.7 billion US dollars, reflecting a basic balance between supply and demand in the foreign exchange market. In 2023, there may be fluctuations in the international balance of payments due to factors such as changes in the global trade environment, exchange rate fluctuations, and capital flows. Therefore, the risk of international balance of payments is relatively low, and it is necessary to continue promoting opening-up and multilateral cooperation to maintain stability in the foreign trade and foreign exchange markets^[2].

(5) Financial market risk: According to the table provided, the Chinese stock market performed poorly in 2022, with the Shanghai Composite Index and Shenzhen Composite Index falling 15.1% and 25.9% respectively, reflecting a lack of market confidence. The transaction volume of the stock market is 224.5 trillion yuan, reflecting average market activity^[3]. The balance of overseas custody in the bond market is 3.5 trillion yuan, and the balance of overseas custody in the bond market is 3.5 trillion yuan, reflecting the increased openness of China's bond market and attracting more international investors. In 2023, the financial market may fluctuate due to the impact of strengthened financial supervision, risk exposure of financial institutions, development of financial innovation and other factors. Therefore, financial market risks are relatively high, and it is essential to strengthen financial regulatory coordination, prevent and resolve financial risks, and promote the healthy development of the financial market^[4].

4.2 Strategy

Based on the quantitative analysis of 2022, propose corresponding response strategies for financial macro risks in 2023:

(1) Economic growth risks. In 2023, the global economy is facing the risk of recession, which will put pressure on China's exports. The Chinese economy also faces downward pressure and

needs to implement measures to stabilize growth. Response strategy: Fiscal policies should increase support for key industries and enterprises, increase tax reduction efforts, maintain a stable and neutral monetary policy, timely increase re lending and innovate the use of monetary policy tools to meet market liquidity needs, expand openness, make good use of regional cooperation platforms, and explore emerging and overseas markets^[5].

(2) Inflation risk. Inflation levels are heating up globally, and China's CPI may continue to rise in 2023. Response strategy: Monetary policy should adjust the funding level based on price changes as a monetary policy tool, guiding the market to form stable inflation expectations. The pricing department should strengthen price monitoring and warning to avoid obvious price runaway.

(3) Employment risk. In 2023, the employment pressure will still be large, and the structural unemployment problem will be prominent. Response strategy: Fiscal policies should increase support for employment groups, accelerate the transformation of training simple workers through labor policies and encourage flexible employment, improve the social security system and expand the coverage of unemployment insurance.

(4) Balance of payments risk. The global trade situation remains severe in 2023, and trade frictions between the United States and China may continue to escalate. Response strategy: Promote high-quality the Belt and Road construction and expand emerging markets, promote the development of service trade, increase the diversification of export structure, moderately relax market access and expand the opening up of the financial industry^[6].

(5) Financial market risk. In 2023, global financial market volatility continued to increase, and institutional investor confidence remained low. Response strategy: Use various monetary policy tools to ensure reasonable and sufficient liquidity in the banking system, accelerate capital market reform and expand the entry of foreign institutional investors, strictly monitor systemic risks and avoid financial crises.

5. Conclusion

In 2023, macroeconomic financial policies need to focus on both stable growth and risk prevention. Through comprehensive measures such as monetary policy, fiscal policy, and structural reform, we will promote high-quality economic development, prevent and control the accumulation of various risks, and maintain the stability of the financial system.

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