

# The strategy construction of major asset allocation based on macroeconomic cycle

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**Abstract.** Nowadays, in the investment market, the investment method with major asset allocation as the core has become the mainstream of various industries. This paper studies the data of various macroeconomic indicators, screens these indicators and observes their changing trends, so as to divide the economic cycle, and uses time series analysis and calculation of the relevant characteristics of risk and return, so as to maximize the benefits of asset allocation. According to the Merrill Lynch "investment clock" theory, select four economic indicators, observe the general change trend of these four indicators in one, and divide them into five different stages of economic status. The APIMA time series model was used to calculate the changing trend of macroeconomic environment. Through mathematical statistics, economics and other relevant principles to calculate the risk and return characteristics of the five stages, presented by the correlation coefficient heat map. This paper analyzes the impact of monetary policy on the return of major assets at different stages of the economic cycle, which is conducive to improving the investment ability of various asset management companies, promoting the effectiveness of asset allocation, improving the annual return rate of asset allocation portfolio, and thus increasing economic benefits.

**Keywords:** Category Asset Allocation, Macroeconomic Indicators, Merrill Lynch "Investment Clock" Theory, APIMA Time Series Model, Risk-return Characteristics.

## 1. Introduction

Gary P. Brinson, the father of global asset allocation, has shown that over 90% of investment returns come from successful asset allocation in the long run. Category asset allocation is an investment decision-making system that organically combines quantitative and qualitative elements. "Allocation" is to allocate investment funds to different asset classes according to investment needs. The basic idea is to construct a portfolio containing multiple classes of assets, which can improve the return and risk characteristics of the portfolio. The broad category asset index is an intuitive demonstration of the practical broad category asset allocation theory[1], but currently the core of the dynamic adjustment of broad category asset allocation lies in the judgment of the future macro economy and the prediction of broad category assets. Only when the future economic situation and asset performance can be accurately predicted, can we identify asset classes with investment value. At home and abroad in the broad category of asset index have a lot of practice cases, in foreign aspects, in 2016, in the increase of the number of assets and the United States assets risk exposure, adjust the risk budget on the basis of the launch of MOZAIC II index. In 2019, UBS and South East Eng jointly launched the UBS South East Eng Global Asset Trend Allocation Index covering six global markets. Domestically, Guotai Junan Securities and other securities companies have actively launched their own major asset index family. From the performance of the index in the past ten years, the annual return is between 4% and 13%, the annual volatility is between 1.5% and 16%, and the Sharpe ratio is between 0.74 and 2.53. There are indexes with high return and high volatility, and there are also stable indexes with relatively low return, all of which achieve long-term stable return under the premise of better control of volatility. The validity of the asset allocation theory is also verified[2].

However, currently, China's investment environment lacks a set of forecasting models suitable for its own macroeconomic and major asset categories, so it is necessary to establish an asset allocation model suitable for China to simulate China's macroeconomic operating state[3], and deduce different investment portfolios according to state characteristics. This is what this article will address.

In this paper, two high-frequency and effective macroeconomic indicators are selected to divide the domestic macroeconomic operation status from 2001 to 2021 into different economic states, and the macroeconomic environment such as economic growth, inflation and interest rate in China in the next five years is analyzed by establishing a macroeconomic model. In this paper, expected return, standard deviation of return and Sharpe ratio are used to predict the risk-return characteristics of major asset indexes in various economic states, as well as the correlation among various asset indexes. Through the established ARIMA time series forecasting model, the domestic economic state in the next five years is predicted, as well as the risk-return characteristics of investment portfolio.

The basic structure of ARIMA time series model is as follows:

$$\begin{cases} \varphi(B)\nabla^d x_t = \theta(B)\varepsilon_t \\ E(\varepsilon_t) = 0, \text{Var}(\varepsilon_t) = \sigma_\varepsilon^2, E(\varepsilon_t \varepsilon_s) = 0, s \neq t \\ E x_s \varepsilon_t = 0, \forall s < t \end{cases} \quad (1)$$

Among them  $\nabla^d = (1 - B)^d$ ,  $\alpha(B) = 1 - \beta_1 B - \dots - \beta_p B^p$  is the auto regressive coefficient polynomial of the stationary and reversible model,  $\vartheta(B) = 1 - \epsilon_1 B - \dots - \epsilon_q B^q$  is the moving average coefficient polynomial of a stationary and reversible model[4].

## 2. Problem analysis and procedure

### 2.1. Categorization of economic status

Because it is necessary to find multiple indicators that can represent the national macroeconomic environment to accurately reflect the state of national economic development, the theory of "investment clock" of Merrill Lynch has reference value for this problem. According to the theory of "investment clock" model of Merrill Lynch, In this paper, two high-frequency and effective macroeconomic indicators are selected to divide the domestic macroeconomic operation status from 2001 to 2021 into different economic states, and a broken line chart is drawn to observe the change trend of the economic status.

### 2.2. The state of China's economy over the next five years

By constructing ARIMA time series model to simulate the four macro-economic environments of GDP, inflation rate (CPI), excess reserve ratio and employment rate of China in the next five years, the white noise of the model was tested according to the P value of Q statistic ( $P > 0.05$ ), and the model formula was obtained and combined with the time series analysis chart for comprehensive analysis. To predict the state of China's economy over the next five years.

### 2.3. The correlation between broad asset indices

In this paper, expected return, standard deviation of rate of return and Sharpe ratio are used to conduct correlation analysis, and the major asset indexes are selected. The correlation coefficient table and correlation coefficient heat map are obtained to predict the risk and return characteristics of the major asset indexes under various economic conditions.

### 2.4. Risk-return characteristics of a portfolio

The ARIMA time series analysis is performed again on the selected broad asset indexes based on the phases of the Merrill Lynch "investment clock" economic cycle[5]. The best difference series diagram and time series diagram are obtained respectively to predict the expected returns of the four

indexes in the next five years. Then, the standard deviation of return rate and Sharpe ratio are calculated through python to predict the risk-return characteristics of the investment portfolio.

### 3. Model assumption

1) It is assumed that the selected macroeconomic indicators will not be affected by the data change trend of other unselected macroeconomic indicators.

2) When the ARIMA model is used to predict its economic status and risk-return characteristics, it is assumed that the data series of variables used are differentially stable, and the residuals are independent identically distributed sequences.

3) In the process of analysis, the difference of time interval in the data needed for all problems is ignored, and it is believed that such difference will not cause significant influence.

4) It is assumed that there is no information difference between the data fitted at the previous time point and the next time point in the forecast time range when the economic state and risk return characteristics are forecast.

5) The distribution of strict stationary representation does not change with time; The expectation of white noise is 0 and the variance is 1.

### 4. Establishment and solution of the model

#### 4.1. Symbol specification

The symbols used in this article are explained as shown in Table.1.

**Table 1.** Symbol interpretation

symbol	meaning
$p$	Autoregressive order
$q$	Moving average order
$\varepsilon_t$	White noise sequence
$t$	time
$y(t)$	Predicted value
$a_{ij}$	Factor load
$\varepsilon$	Special factor
$F_j$	Factor score

#### 4.2. Establishment and solution of partition economic state model

The domestic macroeconomic operation status from 2001 to 2021 is divided into different economic states, according to the phases of the four business cycles in Merrill's "investment clock"[6], Consumer price index (CPI), employment rate, bank excess reserve ratio these four indicators as macroeconomic indicators.

In order to better describe the changing trend of GDP during 2001-2021, the data of expenditure method will be used to calculate its GDP quarter-on-quarter. The second is CPI, which also uses month-on-month data to describe the change trend of CPI and makes it correspond to month-on-month GDP. In addition, the CPI data is counted on a monthly basis, corresponding to the time of GDP quarter-on-quarter. The average of CPI quarter-on-month data in 12 months within a year will be used as the month-on-month CPI of that year. The employment rate between 2001 and 2021 can be obtained through the data of the employed population and the economically active population, and the average of the data of four quarters in one year can be used to represent the excess deposit reserve ratio of financial institutions in that year. The Line chart is shown in Figure 1.

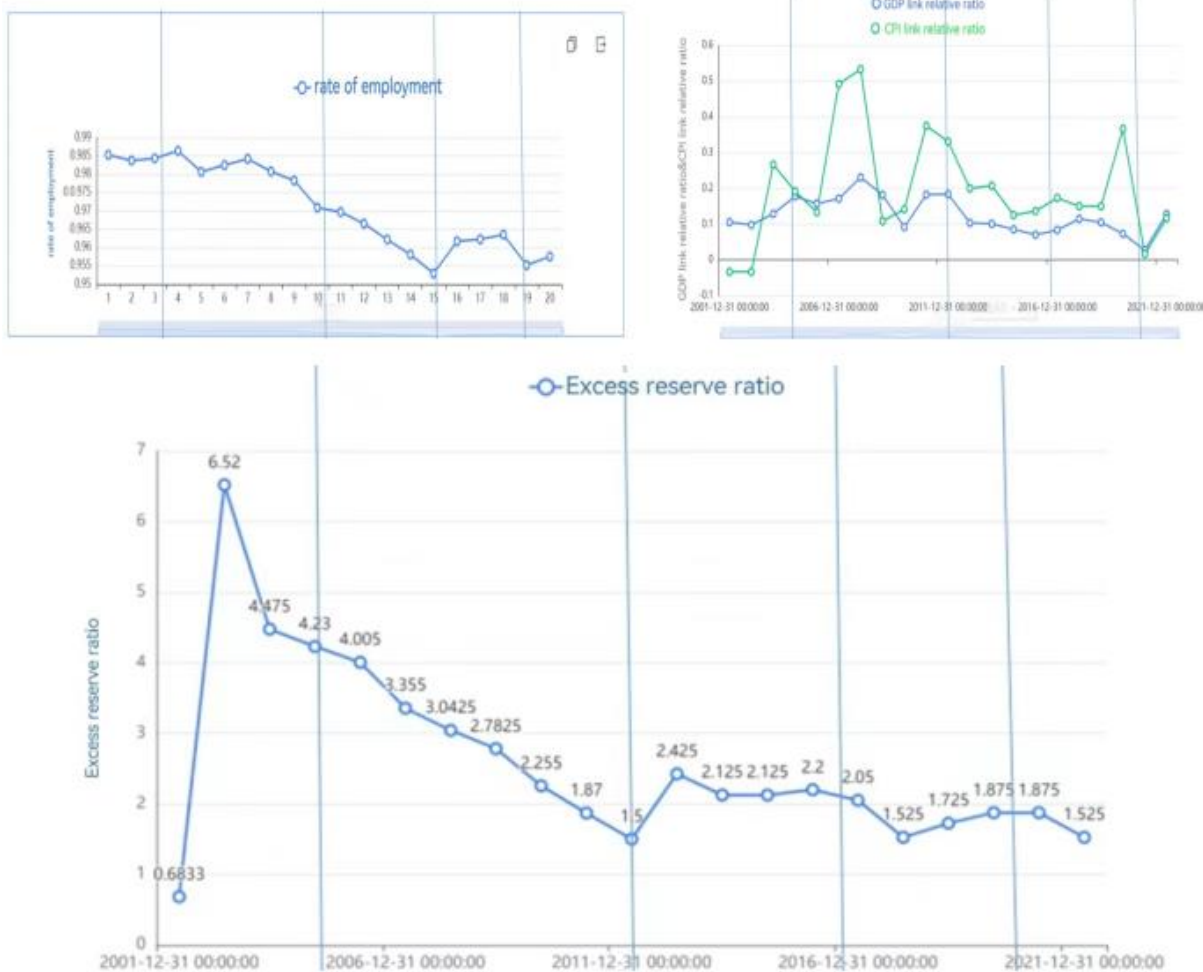


Figure 1. Line chart

According to the trend of the line chart, the economic cycle is divided according to the Merrill Lynch "investment clock" indicator of the state of the economy as shown in Table.2.

Table 2. Economic state

year	Line chart trend	Economic state
2001-01-01— 2005-6-30	The quarter-on-quarter GDP was higher than the CPI at the beginning but gradually exceeded the CPI. The employment rate was at a high and stable level. The excess reserve ratio rapidly increased and then fell rapidly.	Stage 1: The "developed" state of social development
2005-07-01— 2012-6-30	The employment rate showed a gradual downward trend, the excess reserve ratio fell rapidly to underestimation, and the CPI was much higher than GDP in the middle of this period.	Stage 2: Social development "downhill" state
2012-07-01— 2017-03-31	The employment rate has declined to its lowest point, the excess reserve ratio has stabilized, the CPI has declined but is slightly higher than GDP, and the GDP trend is relatively stable.	Stage 3: The "depressed" state of social development
2017-04-01— 2020-12-31	The employment rate rose slightly and became stable, the excess reserve ratio fell slightly to become stable, the GDP was stable, and the difference between CPI and GDP was small in the early period and CPI suddenly increased in the late period.	Stage 4: The "improved" state of social development
2021-01-01— 2021-12-31	Employment rose slightly, excess reserve ratio fell slightly, GDP exceeded CPI, but the difference between the two is not big.	Stage 5: The "recovery" state of social development

### 4.3. The establishment and solution of the model for predicting the future economic state

To predict China's macroeconomic environment in the next five years through the time series model, the following is a detailed explanation of the analysis steps.

(1) Before the simulation and prediction of the change trend of the data, the data is normalized [7].The normalization treatment is as follows:

$$x' = \frac{x-x_{min}}{x_{max}-x_{min}} \tag{2}$$

(2) The ARIMA time series model was used to fit the data and forecast the GDP, CPI, employment rate and excess reserve ratio in the next five years.

The general form of the model can be expressed as:

$$x_t = \varphi_0 + \varphi_1 X_{t-1} + \dots + \varphi_p X_{t-p} + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \dots - \theta_q \varepsilon_{t-q} \tag{3}$$

{ $\varepsilon_t$ } is the white noise sequence, AR and MA model are [8] special ARMA(p, q) models, when p=0, ARMA (0, q) is MA(q); When q=0, ARMA(p, 0) is AR(p).

#### 4.3.1. Time series model results

Model check table as shown in Table.3.

**Table 3.** Model parameter table

Model parameter table						
	coefficient	Standard deviation	t	P> t	0.025	0.975
ma.L1.CPI link relative ratio	0.54	0.236	2.287	0.022	0.077	1.002
ar.L1.D.Excess reserve ratio	-0.896	0.144	-6.22	0	-1.178	-0.613
ar.L1.GDP link relative ratio	0.495	0.181	2.732	0.006	0.14	0.849

The above table is the data whose model results are the test table of ARIMA model (1,0,0) and based on 0 difference. It is the model based on the sequential (year) GDP, excess reserve ratio (year) and CPI sequential (year) variables.

To sum up, according to the trend of forecast data in the Merrill Lynch "investment clock" economic state, the economic state that China will face in the next five years is in the "depressed" state of the economic state divided by the first question.

### 4.4. Establishment and solution of correlation model

#### 4.4.1. Establishment of model

Let's say I have n samples, p variables  $X = (X_1, X_2, \dots, X_p)^T$  is a random vector, The principal factor is  $F = (F_1, F_2, \dots, F_m)^T$ , then the factor analysis model is:

$$\begin{cases} X_1 = a_{11}F_1 + a_{12}F_2 + \dots + a_{1m}F_m + \varepsilon_1 \\ X_2 = a_{21}F_1 + a_{22}F_2 + \dots + a_{2m}F_m + \varepsilon_2 \\ X_p = a_{p1}F_1 + a_{p2}F_2 + \dots + a_{pm}F_m + \varepsilon_p \end{cases} \tag{4}$$

In the above formula,  $a_{ij}$  is called factor loading, matrix  $A = (a_{ij})$  is the factor load matrix, is a special factor [9].The factor scoring function is derived from the factor analysis model:

$$F_j = a_{j1}X_1 + a_{j2}X_2 + \dots + a_{jp}X_p \tag{5}$$

In the above formula: j=1, 2, ..., m, the factor score is calculated by the factor score function.

Test KMO and Bartlett first[10], Determine whether factor analysis can be performed. Secondly, for the Bartlett test, if the null hypothesis is not rejected, it means that these variables may provide some information independently, which is not suitable for factor analysis.

#### 4.4.2. Results of the model

Results of the model as shown in Table.4.

**Table 4.** Factor load coefficient table

Table of factor load coefficients after rotation		
	Factor load coefficient after rotation	Common degree (variance of common factor)
	factor	
SSE 300	0.998	0.996
CSI 300	0.999	0.997
CSI 500	0.994	0.989
CSI 1000	0.994	0.989
NHCI	0.997	0.994
S&P GSCI	0.932	0.868
China Debt Composite Wealth Index of less than 1 year	0.999	0.997
China Debt Composite Wealth 3-5 Year Index	0.999	0.997
China Debt Composite Wealth 7-10 Year Index	0.999	0.997
AMF	0.998	0.996

It can be seen from the above table that  $SSE\ 300 > CSI\ 300 > CSI\ 500 = CSI\ 1000$ ;  $NHCI > S\&P\ GSCI$  in the loading coefficient of commodities; In the bond load coefficient, the three bonds have the same index, but by analyzing the composite score table,  $China\ Debt\ Composite\ Wealth\ 7-10\ Year\ Index > China\ Debt\ Composite\ Wealth\ Index\ of\ less\ than\ 1\ year > China\ Debt\ Composite\ Wealth\ 3-5\ Year\ Index$ ; There are only money funds among cash and its equivalents, it's the only choice.

To sum up, the four indexes selected are SSE 300, NHCI, China Debt Composite Wealth 7-10 Year Index and AMF.

The expected rate of return and standard deviation of rate of return of these four types of assets in different economic states can be obtained by descriptive statistics of rate of return data.

Since annualized risk-free interest rate is required to solve the Sharpe ratio, combined with the existing data, the risk of national debt is the lowest compared with other assets. Therefore, the average interest rate of bonds from 2001 to 2021 is used to represent the annualized risk-free interest rate, so as to solve the Sharpe ratio[11].

#### 4.5. Establishment and solution of risk - return characteristic model

##### 4.5.1. Establishment of model

Four indexes have been selected above: SSE 300 (representing stocks), NHCI (representing commodities), China Debt Composite Wealth 7-10 Year Index (representing bonds) and AMF (representing cash and its equivalents), and the yields of these four asset classes at different points in time have been calculated. Based on the economic status of the next five years, the ARIMA model is used to obtain the model formula combined with the time series analysis chart for comprehensive analysis, and the order results of backward prediction are obtained.

##### 4.5.2. Results of the model

Since the time of the returns of the four types of assets described above has been accurate to the day, the average of all the returns of the assets in a given year will be used to represent the annual

return of that year[12], Time series analysis (ARIMA model) is used to predict the returns of these four asset classes over the next five years.

The annual returns of the four asset classes over the next five years as shown in Table.5.

**Table 5.** Annual return rate

time	stock	bulk commodity	bond	cash and its equivalents
2022	0.000979659	0.000752277	6.06275E-05	9.73714E-05
2023	0.000570582	0.000940236	0.000211021	0.000102015
2024	0.000279608	0.001002142	0.00024117	0.000106658
2025	0.00063249	0.001131273	0.00016694	0.000111301
2026	0.000364551	0.001238384	0.00016694	0.000115943

The relative risk-return characteristics of four asset classes in the next five years as shown in Table.6.

**Table 6.** Relevant risk-return characteristics

	stock	bulk commodity	bond	cash and its equivalents
Expected rate of return	0.000565	0.001013	0.000169	0.000107
Standard deviation of return	0.000273	0.000186	0.000068	0.000007
Sharpe ratio	1.481140	4.583365	0.121882	-7.402388

## 5. Conclusion

In this paper, all future indicators are forecasted based on time series analysis (ARIMA model). The biggest advantage of this model is that it only needs endogenous variables instead of other exogenous variables, so it is very convenient and fast to use this model to solve problems. The search for the index representing the broad category of assets is based on the whole data to achieve, in the aspect of data deviation has been considered more comprehensively. The risk assessment of the investment portfolio is still based on the expected return, the standard difference of rate of return and other related indicators, avoiding other related economic indicators which are more complex in calculation.

However, when choosing macroeconomic indicators to classify different economic states in a period of time, even if relevant data are consulted, the selection mainly relies on subjective consciousness, which makes the economic states divided incomplete. When processing or converting related data, some processed data or converted results are inconsistent with the expected value, which will cause deviation to the results obtained by using the model later. For the calculation of risk-return characteristics, a relatively simple calculation method is adopted, and there is a certain deviation from the real risk return index.

For the selection of macroeconomic indicators, more and more practical literature can be consulted as the basis for selection to reduce the impact brought by subjective judgment. When establishing the broad category asset index to build a portfolio, it is necessary to refer to relevant economic knowledge when observing and analyzing the predicted data, which is more conducive to improving the rationality of establishing the broad category asset index.

Through the establishment of macroeconomic models, this paper can analyze the future economic environment such as economic growth, inflation and interest rate, and predict the risk and return characteristics of major asset indexes in various economic states, as well as the correlation between major asset indexes. In addition, the established ARIMA time series model can predict the future economic state. And the risk-return characteristics of the portfolio.

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