Impact of Macroeconomic Conditions on the US-Japanese Yen Exchange Rate

Chenguang Zhao[1,a,*]

[1]*Overseas Chinese College, Capital University of Economics and Business, Xincun street, Beijing, China*

a. ldttzj@buu.edu.cn

*corresponding author

Abstract: In 2024, the yen exchange rate is affected by Japan's exit from the eight-year negative interest rate policy and the possible interest rate cut in the United States, which is related to the global economy and financial market volatility. In this context, it is necessary to reassess the mechanisms that influence fluctuations in the US-yen exchange rate. This study examines the fluctuation of the US-yen exchange rate from 2010 to 2024, focusing on significant growth periods between 2012-2016 and 2020-2024, and a stable phase from 2016-2020. Utilizing the ADF test for stationarity, ACF, and PACF analysis for ARIMA parameter determination, data decomposition by using window and decompose function in R studio, the research reveals the influence of macro factors such as "Abenomics", QQE and YCC policies on exchange rate trends. The study finds that monetary policy, especially the differences between the United States and Japan, has a significant impact on exchange rates, with the depreciation of the yen and periods of economic stability attributed to the combined effects of global economic challenges and policy responses. The research provides valuable insights for investors and policymakers, emphasizing the importance of macroeconomic conditions on exchange rates in the context of a constantly changing global economy.

Keywords: Exchange Rate Fluctuations, ARIMA Model, Decompose Function, Monetary Policy Impact, Abenomics.

1. Introduction

1.1. Research Background and Motivation

In the current global economic landscape, characterized by the interconnectedness of financial markets, the US-yen exchange rate has exhibited notable volatility, particularly during the periods of 2012-2016 and 2020-2024, with a period of relative stability in between. This volatility is a critical area of interest due to its implications for international trade, investment, and the formulation of economic policies in an era of globalization. The study is motivated by the need to dissect the complex interplay of macroeconomic conditions, especially the divergent monetary policies of the US and Japan, and their profound influence on exchange rate dynamics. By examining the impact of policies such as "Abenomics," QQE, and YCC, this study aims to uncover the mechanisms behind exchange rate fluctuations and provide actionable insights for investors and policymakers. The analysis will delve into the use of advanced statistical methods such as the ADF test for stationarity, ACF and

PACF for ARIMA modeling, and data decomposition techniques in R, to offer a comprehensive understanding of the factors driving these economic movements and their broader economic significance.

1.2. Literature Review

It is known from existing studies that macro conditions will have a great impact on the exchange rate, taking RMB as an example, it is concluded that expansionary fiscal policy and expansionary monetary policy will exert depreciation pressure on RMB exchange rate through various factors affecting exchange rate changes, including inflation rate differences, interest rate differences, market expectations, etc. Under the floating exchange rate system, the local currency exchange rate will also decline [1]. And the main progress and challenges since China launched the reform of the RMB exchange rate formation mechanism on July 21, 2005. These reforms are aimed at restoring price elasticity in the foreign exchange market and correcting distortions in supply and demand. In 2007, the price range of the inter-bank foreign exchange market was widened and the market players diversified, which promoted the RMB exchange rate formation mechanism to mature. In the same year, the US subprime mortgage crisis broke out and quickly spread to the world, triggering financial and economic turmoil and having a major impact on the RMB exchange rate [2]. In recent years, the Japanese economy has undergone significant shifts in monetary policy, especially in 2024 when the Bank of Japan made a historic decision to end the eight-year era of negative interest rates, raising the benchmark interest rate to a range of 0% to 0.1%. This policy change was a response to the moderate recovery of the Japanese economy and the sustained moderate rise in inflation expectations. With the diversification of market participants and the maturation of the yen exchange rate formation mechanism, this decision by the Bank of Japan has also had a significant impact on the yen exchange rate.

At the same time, the outlook for US interest rate policy in 2024 indicates that the Federal Reserve may initiate a rate-cutting cycle. This policy shift, combined with the Bank of Japan's interest rate hike, could have profound implications for the yen exchange rate. In the context of global financial market and economic fluctuations, the patterns of yen exchange rate changes may have altered, necessitating a reexamination of the mechanisms governing the yen exchange rate.

Faced with severe turmoil in the international economic and financial environment, the mechanisms by which various macroeconomic factors affect the yen exchange rate have undergone significant changes, urgently requiring a new perspective to analyze the trend of US-yen exchange rate fluctuations. However, in current research on yen exchange rate fluctuations, single-factor analysis forecasts and purely technical methods still dominate, while comprehensive multi-factor research on the US dollar to yen exchange rate is relatively scarce. This study aims to fill this gap by deeply analyzing the intrinsic mechanisms of US dollar and yen exchange rate fluctuations, providing a new perspective for understanding exchange rate movements.

1.3. Research Significance

Understanding the fluctuation of the US-yen exchange rate is of great significance for forecasting economic trends, formulating investment strategies and macroeconomic policies. Especially in the context of globalization, exchange rate fluctuations have a profound impact on international trade and capital flows.

1.4. Research Methods

The core methodology of this study involves the construction of an ARIMA model to analyze and forecast the fluctuations in the US-yen exchange rate. Initially, the stationarity of the exchange rate

data was assessed using the Augmented Dickey-Fuller (ADF) test to ensure it met the fundamental prerequisites for the ARIMA model. Subsequently, an in-depth analysis of the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) was conducted to ascertain the precise parameters of the ARIMA model, delving into the data's autoregressive and partial autoregressive properties. Furthermore, leveraging R language's data decomposition capabilities, the study revealed trends in exchange rate movements across various time periods. Finally, by integrating policy analysis, key determinants of exchange rate changes were discussed, including the policies of "Abenomics," Quantitative and Qualitative Easing (QQE), and Yield Curve Control (YCC). This comprehensive approach not only provides a basis for understanding historical exchange rate movements but also offers a scientific model for predicting future trends.

2. Methodology

2.1. ARIMA Model

The ARIMA model is a method used for forecasting time series data, which combines autoregressive terms, differencing, and moving average terms to represent the observed values of a time series. It is denoted by the form ARIMA (p, d, q), where "p" represents the order of the autoregressive terms, "d" represents the degree of differencing, and "q" represents the order of the moving average terms [3]. By accurately determining these parameters, the ARIMA model can reveal the intrinsic structure of the time series and provide a reliable basis for future trend predictions.

Generally speaking, modeling with ARIMA involves the following four main steps: First, the stationarity test of the original trend data; second, model identification, which is determined by the autocorrelation and partial autocorrelation plots of the stationary data to decide the values of parameters p, q, P, and Q; according to practical parameter identification experience, it is rare for parameters p, q, P, and Q to be taken to higher orders above 3. Therefore, in practice, models can be built by iterating through orders 0 to 3, and the best fitting model can be selected using the minimum criterion of BIC or AIC, supplemented by residual white noise test and the significance of coefficients for a comprehensive judgment. Next, parameter estimation of the model. Finally, testing and optimization of the model [4].

The ARIMA model has a simple structure and has a certain reference value for predicting the trend of time series data. However, the effectiveness of the ARIMA model in practical applications depends on the quality of the data, the characteristics of the data, especially the stationarity of the time series data, and the rationality of the three parameters p, d, and q [5].

2.2. Data Selection and Sources

In order to generate a model that can better explain the overall data, this study analyzes a time series of the US-yen exchange rate based on average monthly prices. All the data is extracted form Yahoo Finance(https://hk.finance.yahoo.com), from January 2010 to August 2024.

The study's examination of the US-yen exchange rate from 2010 to 2024, as shown in Figure 1, highlighted significant increases in 2012-2016 and 2020-2024, with stability from 2016-2020. These trends sparked interest in the correlation between growth phases.
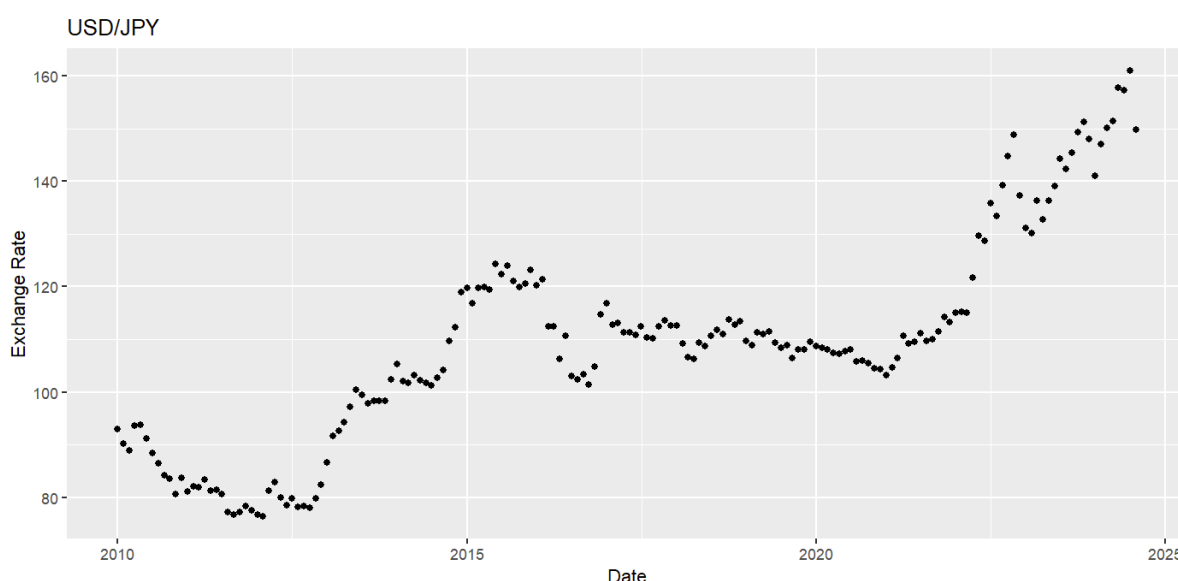
Figure 1: Trends in 2010–2024.

2.3. Stationarity Test

In the field of time series analysis, the ADF test is crucial for evaluating data stationarity. In table 1 the initial ADF test showed a P-value of 0.6357, indicating non-stationarity against the 0.05 threshold. To meet the ARIMA model requirement for stationarity, the data was differenced, resulting in a P-value of 0.01, suggesting stationarity akin to white noise within the 95% confidence interval.

Table 1: ADF test result.

Dickey-Fuller	P-value	Conclude
-1.8576	0.6357	Stationary

Note: Lag order=5

3. Empirical Analysis

3.1. Correlation Test

For ARIMA parameter determination, the paper deeply analyzed the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots, which indicated an AR(1) model due to the trailing ACF and truncated PACF, pointing to short-term autocorrelation decay. Selecting the AR(1) model provided a strong foundation for historical data analysis and future exchange rate forecasting, essential for accurate financial and economic predictions.

3.2. Decomposition Method Analysis

When it is found that the predicted value of exchange rate is different from the actual value, and it can be intuitively seen from Figure 1, that there is an obvious growth trend from 2012 to 2016 and from 2020 to 2024, while the trend from 2016 to 2020 is relatively flat. The window and decompose functions in R were then used to decompose and decompose data during this period, comparing trends between the three periods and exploring the reasons behind them. Figures 2-4 obtained by the decompose function show a more moderate increase from 2012 to 2016, followed by a sharper increase from 2020 to 2024, after a relatively flat increase from 2016 to 2020.
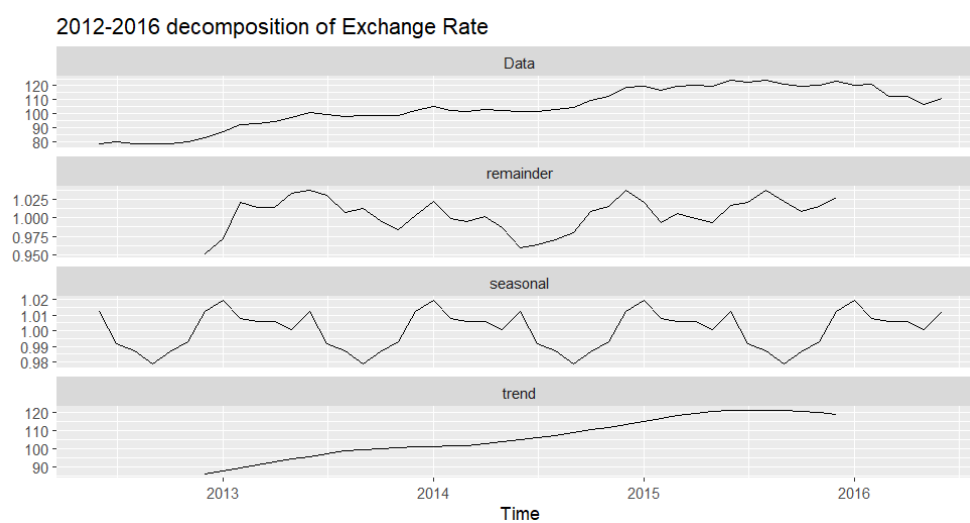
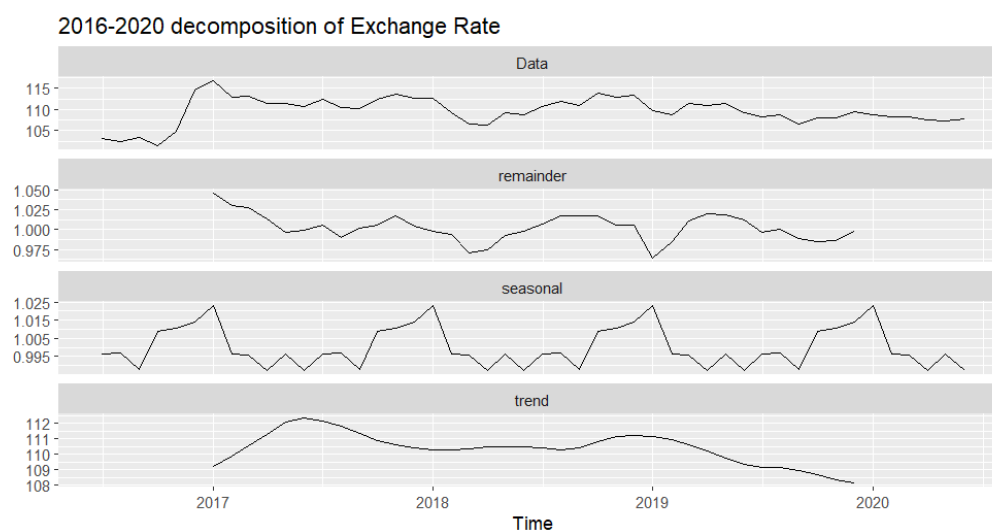Figure 2: 2012-2016 decomposition of exchange rate

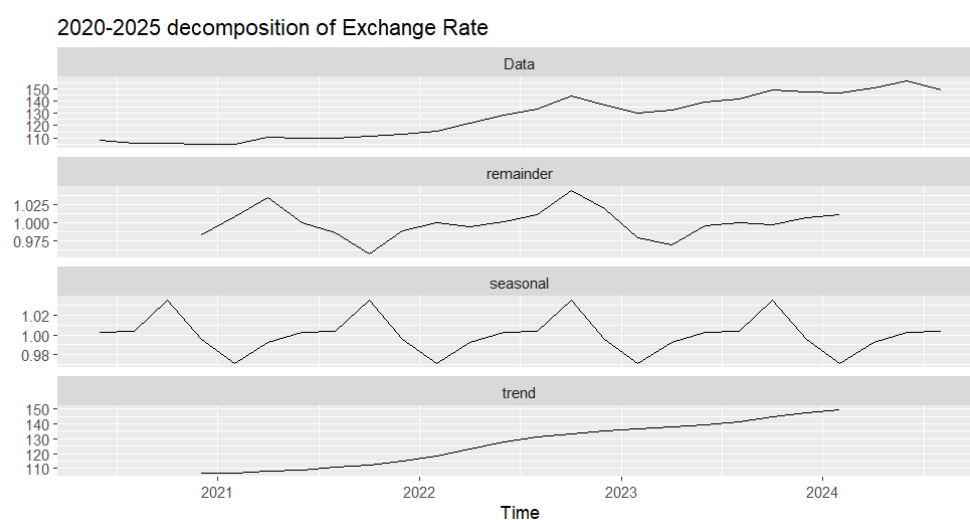Figure 3: 2016-2020 decomposition of exchange rate

Figure 4: 2020-2025 decomposition of exchange rate

4. Macroeconomic Factor Analysis

4.1. Trend Factor Analysis from 2012 to 2016

Analyzing the underlying reasons, it is found that the reason for the rise of US-yen exchange rate from 2012 to 2016 is related to the policies of Shinzo Abe after he took office. During this period, Japan implemented loose monetary policies, including continuous and stable negative interest rates and the depreciation of the yen, provided ample liquidity and flexibility for the Japanese market. To be specific, from September 28, 2012, the US dollar was worth 77.96 yen, which has been depreciated until June 5, 2015, when the US dollar was worth 125.64 yen, a depreciation of 61.16% [6]. In addition, his implementation of Abenomics is also an important reason for the appreciation of the exchange rate.

Abenomics refers to the series of stimulus policies that Shinzo Abe, Japan's 96th prime minister, has accelerated since he took office in late 2012, most notably monetary easing that has accelerated the depreciation of the yen [7].

The policy includes a bold monetary policy, flexible fiscal policy and a growth strategy to spur private investment, aimed at stimulating economic growth by increasing government spending and lowering interest rates. These policy measures have, to a certain extent, promoted Japan's economic recovery and development, also affected the exchange rate trend.

The impact of qualitative and quantitative monetary easing (QQE) in Abenomics on the Japanese exchange rate between 2012 and 2026 is significant. The implementation of the QQE policy, especially since 2013, marked a more aggressive monetary policy move by the Bank of Japan to combat chronic deflation and slow economic growth. These include large-scale purchases of government bonds and other risky assets, as well as the implementation of a negative interest rate policy that has flooded the market with liquidity. The initial implementation of the QQE policy put downward pressure on the yen, as the market expected that the BOJ's easing policy would increase the money supply, resulting in a decline in the yen's exchange rate against the US dollar.

Generally speaking, the appreciation of Japan's exchange rate between 2012 and 2016 was the result of a combination of factors, the loose monetary policy, the depreciation of the yen, and the "Abenomics" policy implemented by Shinzo Abe after he took office.

4.2. Trend Factor Analysis from 2016 to 2020

Continuing to explore why exchange rates are relatively flat between 2016 and 2020, between this period, the global economy faced multiple challenges, including Brexit, global trade tensions, and the outbreak of COVID-19. These factors may have had a dampening effect on fluctuations in the Japanese exchange rate.

The yen is often seen as a safe haven currency and may be bought by investors in times of increased economic uncertainty, thus supporting the yen's exchange rate.

Since 2016, although Japan has increased its quantitative easing monetary policy, the yen has appreciated significantly under the influence of negative interest rate policy and international hedging demand. Brexit may trigger a series of domino effects, global economic and financial risks will increase, and the yen as a safe haven currency will face greater appreciation pressure [8].

Another reason is that while the Federal Reserve gradually raised interest rates during this period, the Bank of Japan maintained a relatively loose monetary policy in order to support the domestic economy. This policy divergence usually leads to a depreciation of the yen relative to the dollar, but exchange rate movements may be limited by market expectations of policy effects and global economic uncertainty.

A Fed rate hike would hardly put downward pressure on the yen. On December 15, 2016, the Federal Reserve announced a 25-basis point interest rate hike, raising the federal benchmark interest rate to a range of 0.5% to 0.75%, and expected at least three more rate hikes in 2017. The impact of the rate hike on the yen can be predicted by referring to the trend of the US dollar against the yen after the Fed raised interest rates in 2004. At that time, after the Fed raised interest rates, the market expected depreciation trend of the yen did not occur, and the fluctuations of the exchange rate between the US dollar and the yen were relatively stable. Compared with the 2004 Federal Reserve interest rate hike, although the purpose of this Federal Reserve interest rate hike is different, it is still in the form of gradual interest rate hikes. Because of this, investors are more sensitive to the expectation of the first interest rate hike, and the number of international investment flows into the United States is relatively large, and the subsequent interest rate hike expectations will weaken, and the number of international investment flows into the United States will gradually decline. Therefore, after this rate hike, the fluctuation of the exchange rate between the US dollar and the yen is still difficult to expand, and the depreciation pressure of the yen will not offset its appreciation pressure, and the yen will still have an appreciation trend in the foreseeable period [9].

Japan's economic growth has been relatively stable during this period, despite some structural problems, but there has been no large-scale economic turbulence, which may help maintain the stability of the exchange rate.

4.3. Trend Factor Analysis from 2020 to 2024

The significant increase in the Japanese exchange rate between 2020 and 2024 may be influenced by a variety of factors, and the following is a specific analysis combined with relevant policies:

The Federal Reserve's monetary policy adjustment: The Federal Reserve began to raise interest rates in 2022 in response to high inflation, and successive rate hikes led to a widening of the Japanese interest-rate spread, which was the direct cause of the sharp depreciation of the yen against the dollar. The pace of the Fed's rate hikes and its actions to reduce its balance sheet usually lead to a stronger dollar.

Bank of Japan's ultra-loose monetary policy: The Bank of Japan maintains its ultra-loose monetary policy, including the Yield Curve Control (YCC) policy, which keeps short-term interest rates near -0.1% and 10-year rates near 0%.

Because the Bank of Japan has maintained an accommodative monetary policy for most of 2022, coupled with the Federal Reserve's successive sharp interest rate hikes, the monetary policy paths of Japan and the United States have diverged significantly, and the bond yields of the two countries have also widened, causing the yen to weaken sharply against the dollar [10].

This divergence from Fed policy has led investors to seek higher-yielding dollar assets, pushing up the value of the dollar against the yen.

Changes in global economic conditions: The COVID-19 outbreak in 2020 and the subsequent global economic recovery have had an impact on exchange rates. With the gradual opening of the economy and the resumption of trade activity, the market has increased demand for risk assets, which may have supported the strength of the dollar to some extent.

Japan's trade situation: Japan's successive trade deficits, especially the rising cost of energy imports, have increased demand for the US dollar, thereby putting pressure on the yen.

5. Conclusion

The rise in the yen exchange rate between 2012 and 2016 was closely related to the policies of Shinzo Abe, the loose monetary policies and QQE measures of his "Abenomics", which increased market liquidity, economic growth and stock market performance. The yen exchange rate was relatively

stable between 2016 and 2020, which may be related to global economic challenges, the difference in monetary policy between the United States and Japan, the safe-haven nature of the yen, and the steady growth of the Japanese economy. The significant depreciation of the yen against the US dollar between 2020 and 2025 is related to the Fed's rate hike policy, the Bank of Japan's ultra-loose monetary policy, changes in the global economic situation, and Japan's trade deficit, among other factors.

This study fills the gap in the analysis of exchange rate fluctuations in a specific period, and the research results provide an in-depth perspective for understanding exchange rate fluctuations, especially the direct impact of monetary policies on exchange rates. For investors, understanding the causes of exchange rate fluctuations is helpful to better assess risks and formulate investment strategies. For policymakers, research provides key factors to consider when formulating macroeconomic policies, especially in the context of globalization.

In future work, with the changing global economic environment, monetary policy will continue to be an important factor affecting exchange rates. Central banks are expected to continue adjusting their policies in response to economic volatility. Technological progress and the trend of globalization may bring about new economic models and trading methods, which may have a new impact on exchange rates. Considering the impact of political events and uncertainties on exchange rates, future studies can further explore how these non-economic factors interact with economic policies to jointly shape exchange rate trends. In summary, this study not only reveals the causes of past exchange rate movements, but also provides valuable insights for future economic analysis and policy making. As the global economy continues to develop and change, continuous monitoring and research on exchange rate dynamics will become increasingly important.

References

[1] Fu Hong-juan. (2001). macroeconomic policy: effects on exchange rate of rmb. Economic Theory and Business Management, (4), 11-17.
[2] Zhang Li. (2010). Analysis and Forecast of Influencing Factors of RMB Exchange Rate, Fuzhou University.
[3] Ma Guiyong. (2024). Stock Index Forecasting Research Based on the ARIMA-LSTM-BP Combined Model, Kashgar University. 2024.000203.
[4] Wang Yiliu. (2024). Research on RMB Exchange Rate Fluctuations Based on the ARIMA-GARCH Model. China Business Review, (11), 9-12.
[5] Li Lingling & Xin Hao. (2024). Application of ARIMA Time Series Model in Data Analysis. Fujian Computer, (04), 25-29.
[6] Liu Wei. (2015). Empirical Analysis of the Fluctuation of the US-Japan Exchange Rate and the Fluctuation of A-Share Stock Prices. Theoretical Exploration, (06), 100-104.
[7] Li Lu. (2015). Japan: Economic Recession Triggered by Abenomics. Business Culture, (36), 76-79.
[8] Lu Xinhong. (2017). Analysis and Prospects of the Japanese Economy. In International Economic Analysis and Prospects (2016-2017), edited by the Strategic Research Department of the China International Economic Exchange Center, 107-136.
[9] Li Xiao & Wang Han. (2017). The New Quantitative Easing Policy of the Bank of Japan: Characteristics, Background, and Challenges. International Economic Review, (03), 91-110+6-7.
[10] Liu Yanchunzi. (2023). The Bank of Japan Returns to the Global "Spotlight". Financial Times, 008.