

Applicability Analysis of Purchasing Power Parity to RMB Exchange Rate

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Abstract: This paper takes purchasing power parity (PPP) theory and RMB exchange rate as the research object. First, it uses policy analysis method, deviation degree method, real exchange rate method, and definition method to study the applicability of purchasing power parity theory in my country. Then, it selects monthly data from January 1994 to December 2022, and uses Johansen cointegration test method to test the multivariate cointegration relationship between the exchange rate of US dollar against RMB and the Sino-US price index. According to the research findings, a cointegration relationship exists among the three variables, but the experimental results are inconsistent with the theory. The final conclusion is that purchasing power parity still can't explain our country's exchange rate changes very well, but the feasibility of PPP in our country has been enhanced.

Keywords: RMB exchange rate system, Absolute purchasing power parity, Relative purchasing power parity, Johansen cointegration test.

1. Introduction

According to the statistics of the International Monetary Fund (IMF), using the International Project Comparison (ICP) method to compare the GDP of countries, China has surpassed the United States and ranked first since 2014. Despite its many flaws, PPP theory can explain exchange rate by explaining the purchasing power relationships of national currencies, using simple logic, and eliminating distortions caused by exchange rate mispricing. Analyzing the applicability of PPP theory in my country can provide strong support for analyzing RMB exchange rate issues using PPP, and also help to improve my country's exchange rate system with reference to the degree of deviation between PPP exchange rate and RMB exchange rate.

2. Literature Review

So far, there have been two main types of tests for PPPs. The first is through a unit root test of the real exchange rate. Most scholars use the traditional unit root test methods (such as ADF test, PP test, etc.) to generally conclude that there is a unit root in the real exchange rate [1], but gradually found that with the extension of the data period, different exchange rate systems will be involved, making the results unconvincing. Therefore, people use more panel data to solve problems. Sun Gang and Deng Liyang use four test methods of LL, IPS, SUR and Fisher P λ [2]; some scholars also use nonlinear models to solve the low power problem of unit root test, such as Ding Jianping and Chen Weixue use threshold autoregressive model [3].

The second is to test PPP by studying the relationship between the nominal exchange rate, China's price and US price. The most widely used test methods are the Johansen cointegration test [4] and EG test [5]. After the cointegration relationship is detected, the error correction model, impulse response and variance decomposition are carried out [6]. Some scholars also use nonlinear models to test, such as Liu Qing's LSTAR model [7].

In the study of whether PPP can explain the change of RMB

exchange rate, different empirical methods, different time samples, and different statistical indicators will be used, and different results will be produced. In terms of empirical methods, the cointegration test is the most widely used method. Hence, this study also employs the Johansen cointegration analysis technique and utilizes the most up-to-date data to examine whether the RMB exchange rate aligns with the long-term equilibrium relationship proposed by the PPP theory.

3. Purchasing Power Parity Theory

The theory of purchasing power parity is grounded on the principle of the law of one price and can be categorized into absolute PPP and relative PPP. The law of one price can be expressed as:

$$P = E \times P^* \quad (1)$$

Among these variables, E represents the nominal exchange rate based on the domestic direct pricing method, P denotes the domestic price level, and P* signifies the foreign price level (the same below).

Absolute PPP is a static analysis that relies on the exchange rate at a specific moment in time. The conditions for establishing absolute PPP are as follows: the law of one price holds for all tradable goods, and the price index calculation for both countries assigns equal weights to all tradable commodities.

Absolute PPP posits that the nominal exchange rate can be determined by the ratio of the price levels of the two countries, denoted as:

$$E = \frac{P}{P^*} \quad (2)$$

Relative PPP is obtained by relaxing the assumption of absolute PPP. Relative PPP takes into account transaction costs and acknowledges the variations in commodities and their corresponding weights when calculating the general price levels across different countries. Relative PPP

introduces a weight θ on the basis of formula (2), namely:

$$E = \theta \times \frac{P}{P^*} \quad (\theta \text{ is a constant}) \quad (3)$$

It can be concluded that:

$$E \approx \pi - \pi^* \quad (4)$$

Among them, π represents the domestic inflation rate, while π^* represents the foreign inflation rate.

Relative PPP is a dynamic analysis that studies exchange rate changes in a certain period of time, and changes from the relationship between exchange rate and price level to the relationship between exchange rate change and inflation rate.

4. Analyzing the Applicability of Purchasing Power Parity Based on China's Reality

4.1. Policy analysis

One of the prerequisites for the establishment of the PPP theory is the adoption of a floating exchange rate system. In this context, a floating exchange rate system refers to an exchange rate that is determined solely by the market's supply and demand for currency. In the process of continuous

improvement of my country's exchange rate system, it has already moved closer to the ideal floating exchange rate system. Affected by the COVID-19 epidemic in recent years, most countries cut interest rates in the early stage to stimulate market vitality, and then began to raise interest rates in order to curb inflation in the middle and late stages. my country's exchange rate has also been affected, but the RMB's independent trend characteristics have become more and more obvious, and the correlation with the US dollar has declined. Compared with the U.S. dollar, the real effective exchange rate index of RMB fluctuates less, which verifies the effectiveness of my country's floating exchange rate system and enhances the feasibility of PPP theory in my country.

4.2. Deviation degree method

By comparing the nominal exchange rate of the US dollar against the RMB and the PPP of the RMB, it is judged whether the RMB exchange rate conforms to the PPP theory. Figure 1 illustrates that the PPP exchange rate deviates significantly from the nominal exchange rate, but this deviation gradually decreases over time. This indicates that the current applicability of the PPP theory in my country is still limited. However, if the trend of reducing the degree of deviation is maintained in the future, the applicability of the PPP theory will gradually increase.

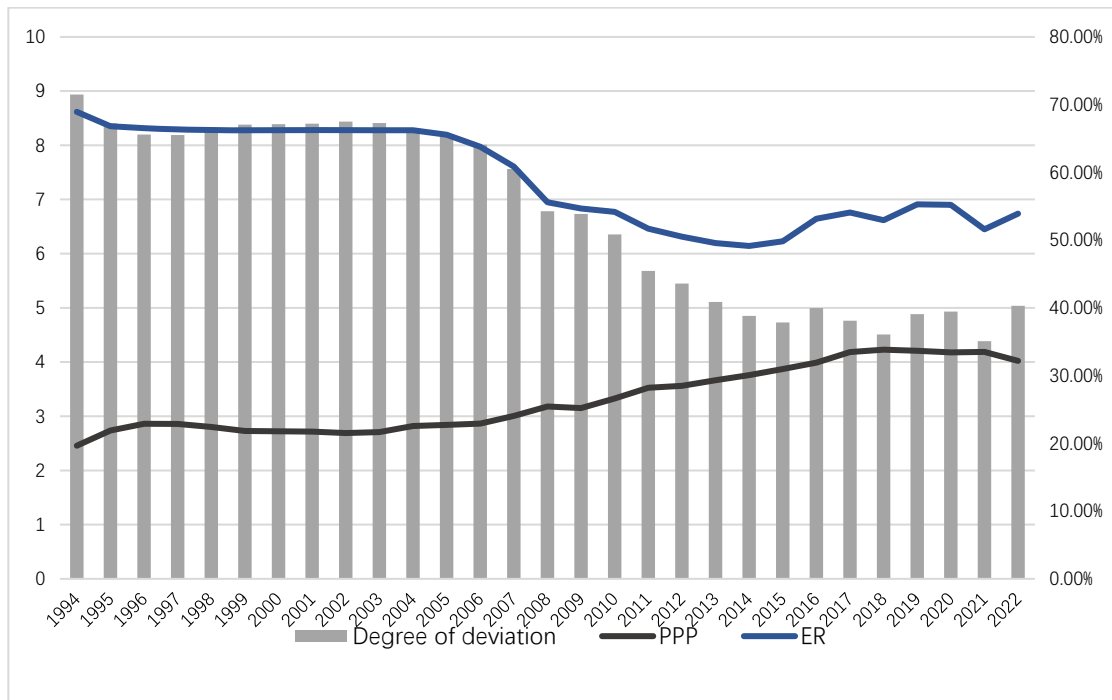


Figure 1. The degree of deviation between PPP and ER

4.3. Real exchange rate method

Using e to represent the real exchange rate, its expression is:

$$e = E \times \frac{P}{P^*} \quad (5)$$

The real exchange rate exists independently of the nominal

exchange rate and remains constant at all times. Nevertheless, figure 2 reveals a strong correlation between my country's real effective exchange rate index and the nominal effective exchange rate index, without a clear tendency to converge towards a specific equilibrium value in the long run. This suggests that the PPP theory is not applicable to the exchange rate of the RMB.

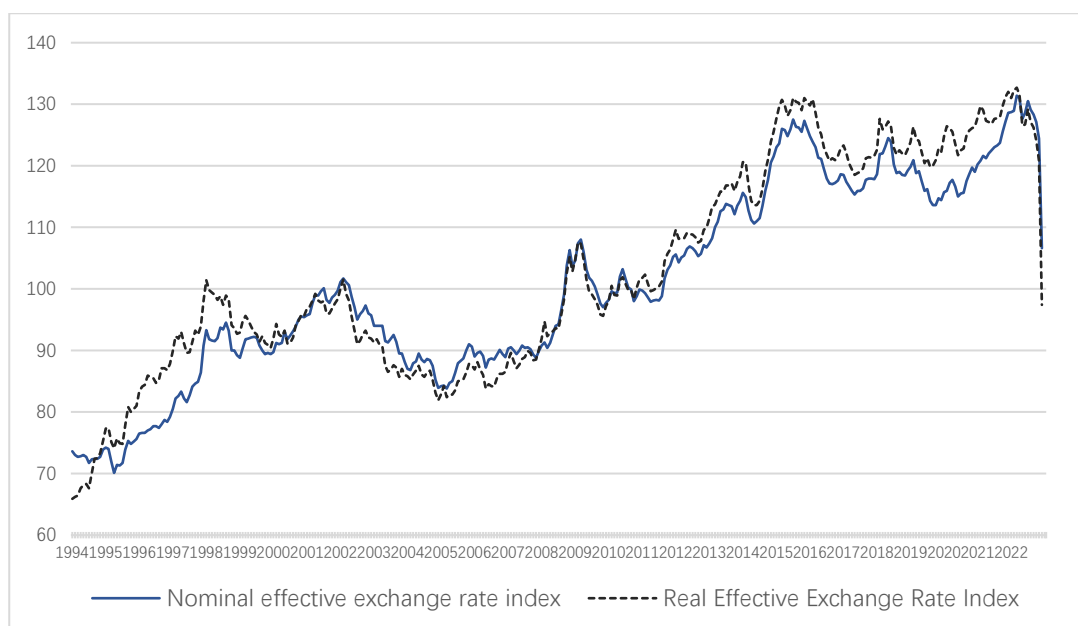


Figure 2. Comparison of nominal effective exchange rate index and real effective exchange rate index

4.4. Definition method

The inflation rate is represented by the change rate of CPI, and when the difference between the year-on-year change rate of CPI between China and the United States is reduced by the definition of relative purchasing power parity, the exchange rate of USD/RMB should rise. However, as can be seen from

Figure 3, the phenomenon in some periods is contrary to the theory. For example, the difference in the year-on-year change rate of CPI between China and the United States decreased significantly from 1994 to 1999, but the exchange rate basically did not change after a slight decline in 1995. This observation indicates that the PPP falls short in effectively explaining the trend of the RMB exchange rate.

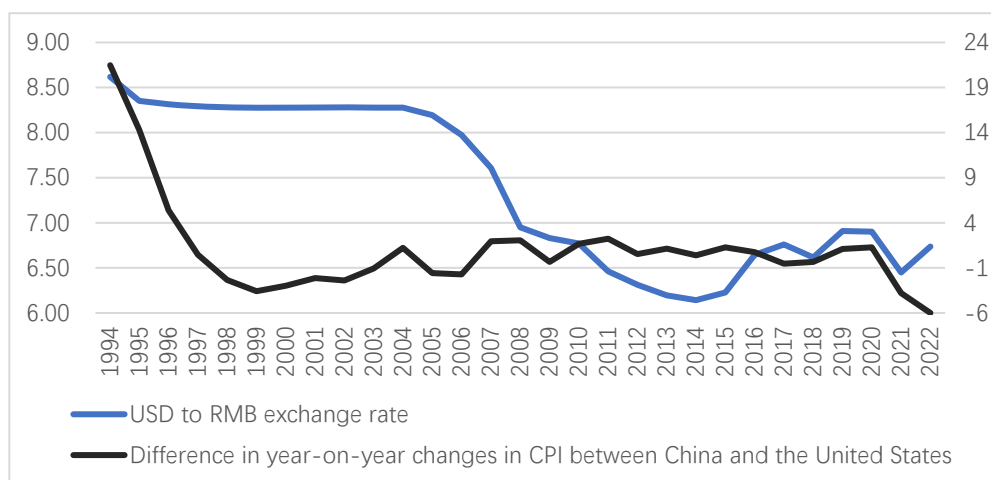


Figure 3. Definition method

5. Analysis of the Reasons for The Deviation of RMB Exchange Rate from Purchasing Power Parity

First, each country has different supply and demand for the same commodity. In certain periods, the price of a certain commodity may suddenly increase or fall based on its national conditions, thus deviating from the actual value of the commodity.

Second, as a major exporter, my country has a double surplus in the balance of payments all year round, and its foreign exchange reserves rank first in the world. However, excessive foreign exchange reserves are likely to cause inflationary pressure, and the international financial market is changing rapidly. The larger the foreign exchange reserves, the greater the risk. Our country needs foreign exchange

control to maintain the currency value and stabilize the exchange rate.

Third, it is difficult to keep consistent statistics on the inflation rate of the two countries. The indicators that can measure the price index include PPI, CPI, GDP deflator, etc., but the official statistical index is different. The commodities in the basket are inconsistent, and the proportion of each commodity is also inconsistent.

6. Empirical Analysis

6.1. Data Selection and Description

This paper selects monthly data from January 1994 to December 2022. The selected variables include American CPI Index (ACPI), China CPI Index (CCPI) and USD/RMB Exchange Rate (RATE), among which the CPI index

represents the inflation rate. The above variables were logarithmized to eliminate heteroscedasticity. The data used in the demonstration are all from the official website of OECD.

6.2. Unit root test

Using the ADF test, it can be concluded from Table 1 that at the 1% significance level, the three variables are all first-order integrated.

Table 1. Augmented Dickey-Fuller test

Variable	ADF	P-value	Conclusion
LNRATE	-1.204999	0.2091*	Unstable
D(LNRATE)	-10.69431	0*	Stable
LNUS CPI	-3.349094	0.0603*	Unstable
D(LNUS CPI)	-6.116607	0*	Stable
LNCN CPI	6.229865	1*	Unstable
D(LNCN CPI)	-11.41814	0*	Stable

Note: *** represents the rejection of the null hypothesis at the 1% significant level, ** represents the rejection of the null hypothesis at the 5% significant level, * represents the rejection of the null hypothesis at the 10% significant level. (the same below)

6.3. Model building

Construct a two-variable model, regard the difference between CPPI and ACPI as a variable, and study its linear relationship with RATE.

$$\text{LN RATE}_t = \lambda + \beta_0 (\text{LnCCPI} - \text{LnACPI}) + \xi_t \quad (6)$$

To construct a three-variable model, the inspection requirements are relatively loose, and proportionality and symmetry are not required.

$$\text{LN RATE}_t = \lambda + \beta_0 \text{LnCCPI} - \beta_1 \text{LnACPI} + \xi \quad (7)$$

Because the results of the two-variable model in most of the literature are not significant or the co-integration results are not consistent with the theory, so this experiment directly uses the three-variable model for testing.

6.4. Johansen cointegration test

First use the VAR model to determine the co-integration lag order, judge by the principle of the most asterisks, and after many experiments, as shown in Table 2 (due to space limitations, only part of the results are shown), the optimal subsequent order is 37, and at the same time pass the three criteria of LR, FPE, and AIC.

Table 2. Optimal lag order

Lag	LogL	LR	FPE	AIC	SC	HQ
35	3954.492	12.18142	1.19E-14	-23.63307	-19.81819	-22.10770
36	3972.983	24.01477	1.13E-14	-23.69470	-19.77083	-22.12575
37	4002.104	37.25225*	9.99E-15*	-23.82535*	-19.79249	-22.21283
38	4006.648	5.724007	1.04E-14	-23.79642	-19.65455	-22.14031
39	4016.700	12.46644	1.04E-14	-23.80325	-19.55238	-22.10356
40	4024.958	10.08148	1.06E-14	-23.79843	-19.43857	-22.05516

Then carry out the Johansen co-integration test, it can be seen from Table 3 that at the 5% significance level, there is a co-integration equation among the three variables:

$$\text{LNACPI}_{t-1} = 0.569162 - 1.025877 \text{LNCCPI}_{t-1} - 0.245763 \text{LN RATE}_{t-1} \quad (0.12831) \quad (0.21554)$$

Table 3. Johansen cointegration test results

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None*	0.087642	42.42913	29.79707	0.0011
At most 1	0.038138	13.90340	15.49471	0.0856
At most 2	0.005805	1.81047	3.841466	0.1785

According to the equation, assuming that the U.S. price index remains unchanged and the Chinese price index rises, the exchange rate of the dollar against the renminbi will fall according to the equation, which is inconsistent with the theory. Therefore, the equation does not hold, that is, in the three-variable model, there is no long-term equilibrium relationship between the US CPI index, China's CPI index, and the exchange rate of USD/RMB.

7. Conclusions and Recommendations

7.1. Conclusions

In the policy analysis method and the degree of deviation method, it can be found that the independence of the renminbi is increasing, the degree of deviation is shrinking, and the purchasing power of the renminbi is gradually approaching the market exchange rate, indicating that the feasibility of PPP in my country has increased.

In the real exchange rate method and the definition method,

it can be found that the PPP theory is contrary to the actual phenomenon. This contradiction suggests that the PPP theory is inadequate in explaining the dynamics of the RMB exchange rate.

From the empirical analysis of Johansen's cointegration test, it is concluded that there is no linear relationship between the three variables of the US dollar-RMB exchange rate and the Chinese and American consumer price indexes, so relative PPP cannot explain the exchange rate changes in my country. However, there may be errors in the empirical results. The reasons are: the selection of statistical indicators may not be optimal; the epidemic in recent years has caused large changes in exchange rates and prices, and the data is not stable enough.

To sum up, PPP is still not able to explain my country's exchange rate changes well, but the applicability of PPP in my country is gradually increasing.

7.2. Recommendations

First, the internationalization of RMB will help to enhance the feasibility of PPP in my country.

Second, effectively use the theory of PPP to guide the long-term decision of RMB exchange rate and its fluctuation.

Third, it is recommended to make appropriate adjustments to the RMB exchange rate system, aiming to steer it towards a direction that promotes the long-term development of our country's exchange rate while prioritizing marketization to the greatest extent possible.

Fourth, promote market competition, reduce transaction costs, and strengthen price liberalization to ensure that commodity prices can be adjusted freely.

Fifth, the government can optimize the cross-border trading

environment by reducing tariffs and non-tariff barriers, so that the actual commodity prices in different countries are closer.

Sixth, strengthen cooperation with other countries and international organizations to share information and data in order to more accurately estimate differences in commodity price levels across countries.

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