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An Empirical Analysis of the Influencing Factor of International Reserve

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Abstract: International reserve refers to the assets that a country 's monetary authority can use to intervene in the foreign exchange market and pay the balance of payments at any time. With the development of China 's foreign economy, China 's foreign exchange reserves have grown rapidly since 1995, reaching a peak of $ 3.84 trillion in 2014.For a long time, international reserves have become one of the important academic topics actively studied and discussed by many economists at home and abroad. The purpose of this paper is to study the impact of various macroeconomic indicators on the scale of international reserves, in order to find out the most significant indicators that affect the scale of international reserves, and to provide a theoretical basis for optimizing international reserve management. By using Eviews to conduct a regression analysis on the data of the China statistic yearbook from 1981 to 2021, this paper attempts to find out the factor that influences the international reserve and put forward advice for improving international reserve management. According to the investigation of international reserves, economic scale, average import tendency and exchange rate, the final conclusion is that the impact of economic scale and average import tendency on the scale of international reserves is significant.

Keywords: international reserve, foreign exchange reserve, exchange rate, economic scale, propensity to import

1. Introduction

After the Reform and Opening up in 1974, China’s economic system changed from a planned economic system to a market economic system. The majority of the international reserve is composed of foreign exchange reserves, the most important of which are US dollars (including bonds and other assets). And after China’s foreign exchange system reform in 1994, the foreign exchange reserve has been experiencing a period of rapid growth. According to the data from the central bank each year, China’s foreign exchange reserve breached one hundred billion in 1996, and has kept growing at a high speed ever since. In 2006, China’s foreign exchange reserve went over $1 billion. After that, China’s foreign exchange reserve continued to surpass that of Japan to become the largest in the world until this day. By the end of 2014, China had a volume of foreign exchange reserves of over $3.84 billion, larger than the sum of those of the rest of the world. However from 2015 on, the volume of China’s foreign exchange reserve started going down by a little until this day.

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Since the 1960s, economists have attached great importance to the study of the scale of foreign exchange reserves, and have proposed many models and analysis methods to evaluate whether the reserves are reasonable. For example, the proportion analysis method, which uses the ratio of reserves to some other economic variables to measure the appropriateness of reserves; the cost-benefit method, that is, to achieve profit maximization of reserves; regression analysis, that is, regression analysis of the variables affecting moderate reserves, the establishment of an econometric model on moderate reserves ; and ' wardrobe effect ' analysis and qualitative analysis and so on.

In 1983, Edwards introduced the disequilibrium of domestic money market into the dynamic process estimation of international reserve demand and analyzed the influence of a country's national income level, total import and export volume and international capital flow on international reserve demand [1]. In 1980, Suss introduced the exchange rate, domestic money supply and demand, national income and price level into the international reserve demand simulation equation system, trying to explain the changing rules of international reserves under this framework [2]. 1990 Elbadawi adopts local adjustment model and an error correction model in 1990 [3]. In 1991, Ben-Bassat and Gottlieb examined the influence of the opportunity cost of foreign exchange reserves on the demand for international reserves. They found that the opportunity cost of foreign exchange reserves has a stronger effect on the demand for international reserves [4]. The post-1980s literature also paid more attention to the international reserve needs of developing countries. Frenkel in 1974, Edwards in 1984 and Elbadawi in 1991 made an empirical analysis of the impact of factors such as the economic scale of developing countries on international reserve demand. The empirical analysis results are consistent with the theoretical analysis results [5]. Using data from 1991 to 2020, this study focuses on explanatory variables such as the exchange rate of RMB against the dollar, the ratio of total imports to GDP, the rate of national external debt repayment, foreign net assets, CPI, and dollar loan interest rate. The findings indicate that foreign net assets and CPI are the primary determinants of China's foreign exchange reserves among the various explanatory variables [6].

From the perspective of the world experience, both developing countries and developed countries maintain a certain amount of international reserves. The basic role of international reserves is to make up for the balance of payments deficit, maintain exchange rate stability, maintain a country's international credibility, and improve a country 's international competitiveness. Therefore, the amount of international reserves held by a country is an important manifestation of its ability to intervene in the foreign exchange market and maintain exchange rate stability. However, the excessive scale of international reserves will increase the domestic money supply, affect the domestic interest rate level, price level and consumption level, and cause inflationary pressure. Analyzing the influencing factors of international reserves is of great significance for optimizing the management of international reserves.

2. Data Collection and Processing

This paper focuses on four main variables: foreign exchange reserves, national income (measured by total GDP), import propensity (measured by the ratio of total imports to GDP), and exchange rate (measured by the annual average exchange rate of RMB against the US dollar). Since the focus of the study is on international reserves, foreign exchange reserves are chosen as a proxy for international reserves due to their overwhelming share (more than 95%) of the total value of international reserves in China. National income is used to capture the size of the economy, and is measured by total GDP. Import propensity is a variable used to measure the degree of international openness, and is calculated as the proportion of total imports to national income, hence the use of the ratio of total imports to GDP. The exchange rate is measured by the annual average exchange rate of RMB against the US dollar. The data used in the study is sourced from the National Bureau of Statistics and is presented in Table 1.

DOI: 10.54254/2754-1169/24/20230420

Table 1: Data from 1981-2021.

Year	Foreign exchange reserve (billion yuan)	GDP (billion yuan)	Average exchange rate	Average import tendency
1981	0.005	0.49	0.07	1.78
1982	0.013	0.54	0.06	1.92
1983	0.017	0.6	0.07	1.96
1984	0.018	0.73	0.08	2.20
1985	0.008	0.91	0.14	2.94
1986	0.007	1.04	0.14	3.45
1987	0.011	1.22	0.13	3.72
1988	0.013	1.52	0.13	3.72
1989	0.021	1.72	0.13	3.77
1990	0.053	1.89	0.13	4.78
1991	0.116	2.2	0.15	5.32
1992	0.107	2.72	0.16	5.51
1993	0.122	3.57	0.17	5.76
1994	0.445	4.86	0.21	8.62
1995	0.615	6.13	0.18	8.35
1996	0.873	7.18	0.16	8.31
1997	1.160	7.97	0.15	8.29
1998	1.200	8.52	0.14	8.28
1999	1.280	9.06	0.15	8.28
2000	1.371	10.03	0.19	8.28
2001	1.756	11.09	0.18	8.28
2002	2.371	12.17	0.20	8.28
2003	3.338	13.17	0.26	8.28
2004	5.048	16.18	0.29	8.28
2005	6.708	18.73	0.29	8.19
2006	8.501	21.94	0.29	7.97
2007	11.621	27.01	0.27	7.60
2008	13.515	31.92	0.25	6.95
2009	16.389	34.85	0.20	6.83
2010	19.275	41.21	0.23	6.77
2011	20.546	48.79	0.23	6.46
2012	20.896	53.86	0.21	6.31
2013	23.654	59.3	0.20	6.19
2014	23.596	64.36	0.19	6.14
2015	20.748	68.89	0.15	6.23
2016	19.990	74.64	0.14	6.64
2017	21.195	83.2	0.15	6.75
2018	20.341	91.93	0.15	6.62
2019	21.445	98.65	0.15	6.90
2020	22.194	101.36	0.14	6.90
2021	20.964	114.37	0.15	6.45

DOI: 10.54254/2754-1169/24/20230420

2.1. Unit Root Test

The analysis of time series data should be based on the condition of sequence stability. In the real economy, many economic variables are random time series. If the variables are not tested and directly regressed, errors may occur. Therefore, in this paper, the DF test method is used to test the unit root of each data. The results are as follows:

Table 2: DF test for X1.

Null Hypothesis: X1 has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=9)

		t-Statistic
Elliott-Rothenberg-Stock DF-GLS test statistic		-0.460705
Test critical values:	1% level	-2.630762
	5% level	-1.950394
	10% level	-1.611202

level *MacKinnon (1996)
DF-GLS Test Equation on GLS Detrended Residuals
Dependent Variable: D(GLSRESID)
Method: Least Squares

Table 3: DF test for X2.

Null Hypothesis: X2 has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=9)

		t-Statistic
Elliott-Rothenberg-Stock DF-GLS test statistic		-0.850864
Test critical values:	1% level	-2.624057
	5% level	-1.949319
	10% level	-1.611711

level *MacKinnon (1996)
DF-GLS Test Equation on GLS Detrended Residuals
Dependent Variable: D(GLSRESID)
Method: Least Squares

Table 4: F test for X3.

Null Hypothesis: X3 has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic based on SIC, MAXLAG=9)

		t-Statistic
Elliott-Rothenberg-Stock DF-GLS test statistic		-1.19417
Test critical values:	1% level	-2.624057
	5% level	-1.949319
	10% level	-1.611711

level *MacKinnon (1996)
DF-GLS Test Equation on GLS Detrended Residuals
Dependent Variable: D(GLSRESID)
Method: Least Squares

DOI: 10.54254/2754-1169/24/20230420

The DF test shows that there is no unit root in each data, which is a stable sequence and can be analyzed by OLS regression.

3. Empirical Analysis

3.1. Model Building

According to the above statistical data, this paper builds multiple regression model, and then uses the coefficient of independent variables to determine the size of the impact of various factors on international reserves. First of all, let Y be the dependent variable, representing the annual international reserves, with foreign exchange reserves, X1, X2, X3 represent economic scale, exchange rate, import tendency respectively, with GDP, the average exchange rate and the average import tendency respectively. A multivariate linear regression model is obtained:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \mu \quad (1)$$

Where μ is a random perturbation term and βi is the regression coefficient.

3.2. OLS Parameter Estimation

The data input Eviews software regression analysis, the initial model is:

Table 5: OLS regression analysis.

Dependent Variable: Y
Method: Least Squares
Sample: 1981 2021
Included observations: 41

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.33667	1.626999	-1.436184	0.1594
x1	0.261073	0.01481	17.6277	0
X2	-0.966816	0.336003	-2.877408	0.0066
X3	5243511	11.69978	4.481717	0.0001
R-squared	0.901727	Mean dependent var		8.086488
AdjustedR-squared	0.893759	S.D. dependent var		9.363685
S.E. of regression	3.052061	Akaike info criterion		5.161979
Sum squared resid	344.6579	Schwarz criterion		5.329157
Log likelihood	-101.8206	Hannan-Quinn criter.		5.222856
F-statistic	113.1673	Durbin-Wats on stat		0.319104
Prob(F-statistic)	0			

$$Y = -2.336670 + 0.261073X_1 - 0.966816X_2 + 52.43511X_3 \quad (2)$$

According to the results of parameter estimation, β1 and β3 are greater than zero, which means that with the expansion of economic scale and the increase of foreign dependence, the scale of international reserves also increases accordingly, which is in line with economic theory. The β2 is less than zero, indicating that the scale of international reserves decreases with the increase of the RMB exchange rate against the dollar, that is, when the RMB appreciates, the international reserves increase, which is also in line with economic theory.

DOI: 10.54254/2754-1169/24/20230420

3.3. Model Test

In the regression results, the coefficient of determination R2 reached 90%, relatively close to 1, and the adjusted coefficient of determination also reached 89%, it indicates that the goodness of fit is higher, and the model better explains the reality. The value of F statistic is 113.1673, and the value of Fα (k, n-k-1) is between 2.29 and 2.84 at a given significance level α=0.05, which is much smaller than the value of F statistic. Therefore, the model is significant on the whole.

The correlation coefficient matrix between the three variables calculated by Eviews is as Table 6:

Table 6: Correlation Matrix.

	X1	X2	X3
X1	1	0.239293	0.096616
X2	0.239293	1	0.703248
X3	0.096616	0.703248	1

It can be seen that among the three variables, only the correlation coefficient between X2 and X3 is greater than 50%, reaching 70%, and the other correlation coefficient are less than 25%. So there is little possibility of multicollinearity in this model.

Through Eviews regression results for white test, the results are shown as Table 7.

Table 7: White test.

Heteroskedasticity Test: White			
F-statistic	8.220484	Prob.F (9,31)	0
Obs*R-squared	24.89343	Prob. Chi-Square (9)	0.0007
Scaled explained SS	28.90866	Prob. Chi-Square (9)	0.0007

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample: 1981 2021
Included observations: 41

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.625724	11.86444	0.052739	0.9583
X1	1.629978	1.241906	1.312481	0.199
X1^2	0.008917	0.002366	3.768018	0.0007
X1*X2	-0.493119	0.14446	-3.413526	0.0018
X1*X3	6.393543	2.732194	2.340077	0.0259
X2	-4.890451	8.533412	-0.573095	0.5707
X2^2	0.51699	0.977927	0.528659	0.6008
X2*X3	5.274208	50.29522	0.104865	0.9172
X3	104.1056	266.9172	0.39003	0.6992
X3^2	-268.2768	1053.959	-0.254542	0.8008
R-squared	0.704718	Mean dependent var	8.406289	
Adjusted R-squared	0.618991	S.D. dependent var	13.34068	
S.E. of regression	8.234657	Akaike info criterion	7.262801	
Sum squared resid	2102.097	Schwarz criterion	7.680745	
Log likelihood	-138.8874	Hannan-Quinn criter.	7.414993	
F-statistic	8.220484	Durbin-Wats on stat	1.659478	
Prob(F-statistic)	0.000004			

DOI: 10.54254/2754-1169/24/20230420

The coefficient of determination of the auxiliary regression is 0.704718, and the test statistic is 24.89343. Given the significance level α= 0.05, X20.05 (10) = 25.1882 > 24.89343, so there is no heteroscedasticity in the model.

In the case of a given significance level of α= 0.05, the value of tα / 2 (n-k-1) is 2.0262, and β1 and β3 pass the t test, indicating that X1 and X3 significantly explain Y, while β2 does not pass the t test, indicating that X2 does not explain Y significantly. Therefore, the X2 variable is eliminated.

3.4. Model Correction

After deleting the X2 variable, the model is regressed again. The results are as in Table 8:

Table 8: OLS regression analysis.

Dependent Variable: Y
Method: Least Squares
Sample: 1981 2021
Included observations: 41

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.960524	1.665751	-2.377621	0.0226
x1	0.250754	0.015686	15.98613	0
X3	28.74261	9.0731	3.167893	0.003
R-squared	0.879736	Mean dependent var		8.086488
AdjustedR-squared	0.873407	S.D. dependent var		9.363685
S.E. of regression	3.331594	Akaike info criterion		5.315135
Sum squared resid	421.7818	Schwarz criterion		5.440518
Log likelihood	-105.9603	Hannan-Quinn criter.		5.360792
F-statistic	138 9863	Durbin-Wats on stat		0.195022
Prob(F-statistic)	0			

In this model, the coefficient of determination is reduced to 87 %, but has little effect on its correlation. The F test was performed on the regression equation, and the F statistic was 138.9863. The F (k, n-k-1) was between 3.32 and 3.23 when the significance level was 0.05, which was obviously smaller than the F statistic, so the variables in the model had a significant impact on the whole. In the t-test for each variable, for a given significance level α=0.05, tα / 2 (n-k-1) = 2.024394, both variables passed the t-test, indicating that their effects on Y are significant. Therefore, the final model equation is as follows:

$$Y = -3.960524 + 0.250754X_1 + 28.74261X_2 \quad (3)$$

By removing the variable of average exchange rate, two variables that have a significant impact on international reserves are finally identified and have economic significance.

4. Discussion

Thus the study concludes that for every one trillion yuan increase in GDP, the total international reserves will increase 0.250754 trillion yuan. For every unit increase in import propensity, the total international reserves will increase by 28.74261 trillion yuan. From the above theoretical and empirical analysis, it can be seen that China's international reserve demand is mainly determined by factors such as national income and import tendency. Among them, import tendency has a greater influence on international reserve demand, followed by national income, which fully reflects the

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current stage of China's international reserve. The characteristics of the regular trading function and the risk prevention function are more prominent.

In their study of 120 developed and developing nations from 1981 to 2010, Sula and Oguzoglu explored the correlation between international reserves and economic growth, and discovered that the former has a beneficial impact on the latter. However, the extent of this influence wanes as the expense of maintaining reserves increases [7]. Alberola et al. examine the function of international reserves as a means of stabilizing international capital flows. Their analysis shows that international reserves aid in the withdrawal of financial investments from foreign countries by residents, leading to a decrease in capital outflows [8]. Qian and Steiner conducted research on the impact of international reserves on the maturity structure of external debt. Their study found strong evidence that the presence of reserves increases the proportion of long-term debt in the total external debt, thereby enhancing financial stability [9]. There is an intrinsic link between international reserves, the balance of payments and the macroeconomic balance. Therefore, according to the needs of economic development, maintaining a moderate scale of international reserves for the adjustment of the balance of payments and even the coordinated development of the entire economy is very necessary. Whether a country 's international reserve scale is reasonable or not should be marked by the balanced use of optimal reserve stock and adjustment speed. Because in terms of reserve stocks and adjustment speed itself, they have advantages and disadvantages. Maintaining a sufficient stock of reserves can reduce the cost of adjustment, but it must be at the expense of giving up domestic investment and consumption. The higher adjustment speed can reduce the reserve stock and cost, but the adjustment cost will increase with the increase in adjustment speed. Therefore, when a country determines the scale of international reserves, the key is to improve the structural balance between the two. Schröder conducts an extensive empirical analysis to measure the contribution of "mercantilist" and "precautionary" motives to the accumulation of reserves in China between 1998Q4 and 2011Q4. The findings indicate that precautionary motives and other factors appear to be the primary drivers of the surge in China's international reserves [10].

4.1. Accelerate the Reform Process of Financial and Other Factor Markets

Under the premise of open, fair, transparent and effective monitoring, it is necessary to reduce the control of interest rate, exchange rate, investment, market access and other aspects in a timely and appropriate manner, strive for the early realization of the full convertibility of RMB in the capital account, focus on improving the investment environment, appropriately reduce the marginal tax rate of enterprise and personal income tax, vigorously introduce all kinds of foreign capital, especially the direct investment of Hong Kong, Macao and Taiwan compatriots, and strive to reduce the possibility of capital flight. And further clarify the comprehensive management functions of the People 's Bank of China and the State Administration of Foreign Rejection from the legislation, prevent the government from going out of its way, improve the debt registration system and repayment management system, and gradually establish a unified national debt repayment fund to avoid falling into a payment crisis.

4.2. Enhance the Ability of the Central Bank to Stabilize the Exchange Rate

The central bank in China controls the majority of the country's foreign exchange reserves, while commercial and private banks hold a relatively small amount. Therefore, China's foreign exchange reserves may not fully reflect the country's overall international reserves or its ability to stabilize the RMB exchange rate. In comparison to countries without compulsory exchange rate systems, the same level of international reserves in China may have a lower ability to stabilize exchange rates. To address this, it is important to accelerate financial system and foreign exchange management reforms

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in China. Specifically, it is recommended to eliminate the compulsory foreign exchange settlement system and increase the accumulation of foreign exchange assets by the people. Additionally, it is suggested to increase the proportion of non-dollar assets in new foreign exchange reserves and steadily reduce the concentration of dollar assets.

China's foreign exchange reserves are highly concentrated in one currency, making it significantly susceptible to fluctuations in the dollar exchange rate. To mitigate this risk, China should increase the proportion of non-dollar assets in its foreign exchange reserves, while also encouraging domestic enterprises to use strong settlement currencies such as the euro or yen through import and export policy guidance. In recent years, trade between China and Japan, as well as the EU, has grown, presenting an opportunity for China to diversify its currency holdings.

5. Conclusion

Based on the regression analysis method used in this study, it is clear that there are several key factors that influence the size of international reserves. The results of this study reveal that two key factors - GDP and average import tendency - play a significant role in determining the level of international reserves held by countries. These findings have important implications for policymakers and international organizations, highlighting the importance of promoting economic growth and trade openness in building and maintaining strong foreign exchange reserves. As the global economy continues to evolve and become increasingly interconnected, it will be critical for policymakers to remain vigilant in monitoring these and other factors that affect the stability and resilience of the international financial system. By doing so, we can work together to ensure that our economies remain strong and stable, both now and in the years to come.

This paper has limitations. For example, data limitation, collecting accurate and comprehensive data on international reserves and related economic factors can be challenging, and may limit the scope or accuracy of the analysis.

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