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Measurement and Research on the Adequate Size of China's Foreign Exchange Reserves

Xiao Han

Business School, East China University of Political Science and Law, Shanghai, 201620, China

Abstract: *Moderate size of foreign exchange reserves is not only to maintain economic stability of one of the important backing, but also reflects a country's comprehensive strength of one of the important indicators, this paper aims to measure the size of China's foreign exchange reserves is moderate and give the optimization of China's foreign exchange reserves size of the proposal. This paper uses the ratio analysis method and the IMF model to analyze the moderate size of China's foreign exchange reserves and compare it with China's actual foreign exchange reserves. At the same time, this paper puts forward suggestions to optimize the size of foreign exchange reserves, including: the development of moderate foreign exchange reserve size target, optimize the allocation of foreign exchange reserve assets, promote the development of RMB internationalization, and improve the degree of market openness. These suggestions not only help to optimize the size of foreign exchange reserves, but also help to promote China's economic development and the internationalization of financial markets.*

Keywords: *foreign-exchange reserves, moderate scale, proportionality analysis*

1. Introduction

Foreign exchange reserves are the main indicator of a country's international reserves and one of the most important indicators of a country's comprehensive strength. Under the conditions of an open economy, the size of foreign exchange reserves is not only an important indicator of macroeconomic performance, but also a powerful tool for the State to exercise macroeconomic control over the economy. With the development of China's economy and the advancement of globalization, the scale of China's foreign exchange reserves has been increasing in order to maintain the balance of payments, stabilize the exchange rate of RMB, promote economic development and prevent external shocks and other needs. After years of accumulation, China's foreign exchange reserves have reached a huge level of over 3 trillion dollars. However, the corresponding problems and risks should not be ignored. The outside world for the scale of China's foreign exchange reserves have been questioned, that this excessive reserves may lead to China's economic growth slowdown, inflation and other negative effects. At the same time, China is facing external debt pressure as well as opening up and other pressures, and economic globalization has also brought new challenges. In this context, how to maintain the moderate size of foreign exchange reserves has become an urgent problem.

Therefore , this paper studies the moderate size of China's foreign exchange reserves through the proportion analysis method and IMF model analysis method two methods respectively, and compares them with China's actual foreign exchange reserves, trying to analyze whether the size of China's foreign exchange reserves is moderate. This paper also puts forward corresponding suggestions on the basis of summarizing the research results to contribute to the management of China's foreign exchange reserves.

2. Study on the Adequate Size of China's Foreign Exchange Reserves

2.1. Study on the Adequate Scale of Foreign Exchange Reserves Based on Proportional Analysis Approach

2.1.1. Ratio analysis based on foreign exchange reserves/imports

Proportion analysis method refers to the scale of foreign exchange reserves and reflect the demand factors of the ratio between the various economic indicators as the object of study, through the proportion of the reasonable definition to determine the appropriate size of foreign exchange reserves research method. American economist Triffin (R. Triffin, 1947) was the first to use proportional analysis to

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measure the moderate size of a country's foreign exchange reserves, he believes that a country's total imports to determine the size of the country's demand for foreign exchange reserves, the size of the demand for foreign exchange reserves will increase with the development of the country's import trade[1]. Therefore, he proposed that foreign exchange reserves and imports can be used to determine the proportionate relationship between the appropriate size. If this ratio reaches 40% of the optimal size of foreign exchange reserves; when this ratio is lower than 30%, the foreign exchange management authorities should take corresponding measures to regulate; the minimum limit of this ratio is 20%. If according to the annual foreign exchange reserves accounted for the proportion of imports to calculate, the proportion of the value should be up to 25% is appropriate, that is, a country's foreign exchange reserves should be able to meet the demand for three months of imports[2].

Table 1: Ratio of China's foreign exchange reserves to imports, 2000-2022

Year	Imports (billions of dollars)	Reasonable upper limit ($ billion)	Lower bound of reasonableness (billions of dollars)	Foreign exchange reserves (billions of dollars)	Foreign exchange reserve balance/reasonable ceiling	Foreign exchange reserve balance/reasonable lower bound
2000	2250.94	900.38	450.19	1655.74	1.84	3.68
2001	2435.53	974.21	487.11	2121.65	2.18	4.36
2002	2951.70	1180.68	590.34	2864.07	2.43	4.85
2003	4127.60	1651.04	825.52	4032.51	2.44	4.88
2004	5612.29	2244.92	1122.46	6099.32	2.72	5.43
2005	6599.53	2639.81	1319.91	8188.72	3.10	6.20
2006	7914.61	3165.84	1582.92	10663.44	3.37	6.74
2007	9561.15	3824.46	1912.23	15282.49	4.00	7.99
2008	11325.62	4530.25	2265.12	19460.30	4.30	8.59
2009	10059.23	4023.69	2011.85	23991.52	5.96	11.93
2010	13962.47	5584.99	2792.49	28473.38	5.10	10.20
2011	17434.84	6973.94	3486.97	31811.48	4.56	9.12
2012	18184.05	7273.62	3636.81	33115.89	4.55	9.11
2013	19499.89	7799.96	3899.98	38213.15	4.90	9.80
2014	19592.35	7836.94	3918.47	38430.18	4.90	9.81
2015	16795.64	6718.26	3359.13	33303.62	4.96	9.91
2016	15879.26	6351.70	3175.85	30105.17	4.74	9.48
2017	18437.93	7375.17	3687.59	31399.49	4.26	8.51
2018	21357.48	8542.99	4271.50	30727.12	3.60	7.19
2019	20784.09	8313.64	4156.82	31079.24	3.74	7.48
2020	20659.62	8263.85	4131.92	32165.22	3.89	7.78
2021	26867.30	10746.92	5373.46	32501.66	3.02	6.05
2022	27143.60	10857.44	5428.72	31276.91	2.88	5.76

As shown in Table 1, this paper first according to China's total imports, respectively, to calculate the reasonable upper limit of the reasonable size of foreign exchange reserves and reasonable lower limit, and then use the actual value of foreign exchange reserves with the reasonable size of the upper limit value and lower limit value of the comparative analysis. As can be seen from the table, since the beginning of 2000 China's foreign exchange reserves far more than based on the Triffin proportion method calculated the modest size of the interval, and showing a trend of continuous expansion. This ratio reached its peak in 2009 and then fell back to shrink. In particular, since the end of the reform of foreign exchange system in 2005, the size of China's foreign exchange reserves has greatly exceeded the normal value of the range, the highest more than the upper limit of its reasonable value of 4 ~ 5 times, in 2009, the size of China's foreign exchange reserves and even more than the lower limit of the value of 11 times more than the size of China's foreign exchange reserves in 2010 also exceeded the lower limit of the reasonable 10 times more than the size of China's foreign exchange reserves in 2009 as well as in 2010, the ratio of the size of foreign exchange reserves / imports. In 2009 and 2010, the size of foreign exchange reserves / imports ratio is too high may be due to the impact of the financial crisis in 2008, the financial crisis has led to a substantial decline in demand for China's exports, so based on imports to calculate the size of foreign exchange reserves reasonable range is small. However, despite this, the actual size of China's foreign exchange reserves far exceeds the reasonable range of foreign exchange reserves is a definite fact.

Triffin's theory of proportional analysis is based on a certain period of time. Riffin's theory of proportional analysis is based on the theory proposed in a certain period of time, when the main content of international trade is the import and export of commodity trade, and the international capital flow is relatively small, so it is reasonable to use the country's trade and import and export indicators to examine

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the international economic activities. However, with the development of economic globalization and trade liberalization, international capital flows have become increasingly intense and the scale of international capital flows has been increasing. Therefore, in the current context, the Triffin ratio analysis method, which measures the appropriate size of foreign exchange reserves only in terms of the amount of imports, has lost its practical value.

2.1.2. Ratio analysis based on foreign exchange reserves/short-term external debt

Triffin uses the ratio of foreign exchange reserves/imports to measure whether the foreign exchange reserves are in the optimal size, and some scholars use the foreign exchange reserves as a proportion of short-term external debt to measure whether the foreign exchange reserves are in the optimal size. This indicator can be used to measure whether a country's foreign exchange reserves are sufficient to support its ability to pay short-term external debt. Therefore, the proportion of foreign exchange reserves to short-term external debt should be above 100%[3]. If a country's foreign exchange reserves account for a low proportion of short-term external debt, it may be challenged by the international market because of a shortage of foreign exchange funds, resulting in damage to the country's credibility.

Table 2: Ratio of China's foreign exchange reserves to short-term external debt, 2000-2022

Year	Foreign exchange reserves (billions of dollars)	Short-term external debt (billions of dollars)	Foreign exchange reserves/short-term external debt
2000	1655.7	130.8	1265.8%
2001	2121.6	837.7	253.2%
2002	2864.0	870.8	328.9%
2003	4032.5	1027.7	392.3%
2004	6099.3	1387.1	439.7%
2005	8188.7	1716.4	477.0%
2006	10663.4	1992.3	535.2%
2007	15282.4	2356.8	648.4%
2008	19460.3	2262.8	860.0%
2009	23991.5	2592.6	925.3%
2010	28473.3	3757.0	757.8%
2011	31811.4	5009.0	635.0%
2012	33115.8	5409.3	612.2%
2013	38213.1	6766.3	564.7%
2014	38430.1	12982.0	296.0%
2015	33303.6	8874.1	375.2%
2016	30105.1	8660.4	347.6%
2017	31399.4	11452.4	274.1%
2018	30727.1	12891.5	238.3%
2019	31079.2	12188.4	254.9%
2020	32165.2	13163.7	244.3%
2021	32501.6	14462.3	224.7%
2022	31276.9	13379.7	233.7%

As can be seen from table 2, the balance of China's short-term external debt was only US$ 13.08 billion in 2000, but reached US$ 83.77 billion in 2001, a 5.4-fold increase in the balance of short-term external debt in one year's time. The reason behind this anomaly is that since 2001, China in accordance with the then international standards on the original external debt caliber adjustment, and the future maturity of one year in the medium and long term debt into the short-term external debt (the remaining period) statistics, so in 2001 China's short-term external debt appeared to be a sudden increase. 2001 foreign exchange reserves/short-term external debt ratio plummeted also because of the short-term external debt after 2002 China changed the caliber of the statistics. After 2001, China's foreign exchange reserves and short-term foreign debt ratio showed a first rise after the decline of the inverted U-shaped relationship, 2001 to 2009 this ratio rose and reached a peak of 9.25 in 2009, followed by this ratio declined, 2022 the end of this ratio is only 2.33. In summary, based on the foreign exchange reserves / short-term foreign debt ratio analysis method also shows that China's foreign exchange reserves have been greatly increased. The current size of foreign exchange reserves has greatly exceeded the reasonable level.

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2.1.3. Ratio analysis based on foreign exchange reserves/GDP

In addition to measuring the appropriateness of the size of foreign exchange reserves by calculating the ratio of foreign exchange reserves to imports and the ratio of foreign exchange reserves to short-term foreign debt, it can also be measured by calculating the ratio of foreign exchange reserves to gross domestic product (GDP). This indicator reflects the size of a country's economy on the demand for foreign exchange reserves, the indicator that the larger the size of the country's economy, the greater its demand for foreign exchange reserves. Western economic theory suggests that it is more reasonable for a country's foreign exchange reserves to account for no more than 20% of GDP[4].

Table 3: Ratio of China's foreign exchange reserves to GDP, 2000-2022

Year	Foreign exchange reserves (billions of dollars)	GDP (billions of dollars)	Foreign exchange reserves/GDP
2000	1655.7	12113.4	13.6%
2001	2121.6	13393.9	15.8%
2002	2864.0	14705.5	19.4%
2003	4032.5	16602.8	24.2%
2004	6099.3	19553.4	31.1%
2005	8188.7	22859.6	35.8%
2006	10663.4	27521.3	38.7%
2007	15282.4	35503.4	43.0%
2008	19460.3	45943.0	42.3%
2009	23991.5	51017.0	47.0%
2010	28473.3	60871.6	46.7%
2011	31811.4	75515.0	42.1%
2012	33115.8	85322.0	38.8%
2013	38213.1	95704.0	39.9%
2014	38430.1	104756.8	36.6%
2015	33303.6	110615.5	30.1%
2016	30105.1	112332.7	26.8%
2017	31399.4	123104.0	25.5%
2018	30727.1	138948.1	22.1%
2019	31079.2	142799.3	21.7%
2020	32165.2	146876.7	21.9%
2021	32501.6	177340.6	18.3%
2022	31276.9	171244.2	18.2%

As can be seen from Table 3, from 2000 to 2002, China's foreign exchange reserves and the ratio of GDP has been less than 20%, the size of foreign exchange reserves is moderate; from 2003 to 2020, China's foreign exchange reserves and the ratio of GDP are higher than 20%, the size of foreign exchange reserves is high; 2021 and 2022 foreign exchange reserves and the ratio of GDP to less than 20%, the size of foreign exchange reserves is moderate. At the same time, from 2003 to 2020, the ratio of foreign exchange reserves and GDP showed a first rise after the decline of the inverted U-shaped relationship, specifically for the period from 2003 to 2009, the ratio gradually rose and reached a peak of 47.03% in 2009, from 2009 to 2020, the ratio gradually declined, and tends to 20%.

The conclusion that China's current size of foreign exchange reserves is too large was reached above through three methods, respectively, based on the import ratio analysis method, based on the short-term debt ratio analysis method and based on the GDP ratio analysis method. At the same time, the inverted U-shaped relationship based on foreign exchange reserves / GDP method of measurement is similar to the inverted U-shaped relationship based on foreign exchange reserves / short-term foreign debt method of measurement. The ratio analysis method is based on the factors affecting foreign exchange reserves to establish the measurement index, which is simple to operate, easy to calculate, and convenient for statistics and comparison. At the same time, this method is not subject to national, geographical and industry restrictions, can be used to compare the size of foreign exchange reserves in different countries and regions, different industries, so until now this analysis method still has a great influence on the formulation of foreign exchange reserves policy in various countries.

The advantage of the proportional analysis method is that it is simple and easy to implement, and its disadvantage is precisely that the calculation is too simple. This method only takes into account a particular factor affecting the demand for foreign exchange reserves, and does not comprehensively

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reflect the demand factors affecting the moderate size of foreign exchange reserves, which has certain limitations. At the same time, different countries have different national conditions, trade structure, external debt structure and other factors, different countries apply the appropriate size of foreign exchange reserves are also different. Therefore, when judging whether the size of a country's foreign exchange reserves is moderate, it is necessary to analyze it in the context of the country's specific situation. At the same time, the proportional analysis method uses established facts and data to argue the size of foreign exchange reserves in the past, and cannot argue the future situation, nor can it comprehensively take into account the impact of the international economic and political environment, such as the financial market shocks, the new coronary pneumonia epidemic, etc., and the persuasive strength is poor[5]. Therefore, the following is a quantitative study based on the IMF model to draw conclusions related to the issue of the appropriate size of foreign exchange reserves.

2.2. Study on the Adequate Size of Foreign Exchange Reserves Based on the International Monetary Fund (IMF) Model

The International Monetary Fund (International Monetary Fund, referred to as the IMF) was founded in 1944, headquartered in Washington, D.C., the United States, is an international organization consisting of 189 member countries.The main functions of the IMF are to promote international monetary cooperation, promote international trade, stabilize the international financial, support member countries in the management of foreign exchange reserves and the establishment of global economic monitoring and early warning mechanisms.

In 2011, the International Monetary Fund (IMF) proposed a new model for measuring the adequacy of developing countries' stock of foreign exchange reserves in its empirical study Measuring the Adequacy of Foreign Exchange Reserves, referred to as the IMF model.Based on the experience of countries with currency or financial crises in the past, the IMF gives a certain risk weighting to the various foreign exchange outflow channels, and calculates the size of the potential foreign exchange capital outflow after the weighting of the risk. The model takes full account of the fact that the shocks faced by foreign exchange reserves may come from different sources, and is widely used in the IMF's analytical framework for the stability of member countries' external accounts. The method selects four variables as the main indicators, namely, the balance of portfolio investment liabilities, the balance of short-term external debt, the balance of broad money, and the annual export volume, and calculates the risk-weighted stock of liabilities under the fixed-exchange-rate system and the floating-exchange-rate system based on the probability distributions of foreign exchange losses corresponding to these four indicators and takes this value as the lower limit of the moderate size of foreign exchange reserves, and takes 1.5 times of the lower limit as the upper limit of the moderate size of foreign exchange reserves.

$$\text{fixed-exchange-rate system: } R_{min}=OPL*0.15+STD*0.3+M_2*0.1+X*0.1$$

$$\text{floating exchange rate system: } R_{min}=OPL*0.11+STD*0.3+M_2*0.05+X*0.05$$

Rmin denotes the lower limit of the moderate size of foreign exchange reserves, OPL denotes the balance of portfolio liabilities, STD denotes the balance of short-term external debt, M2 denotes the balance of broad money, and X denotes the annual export volume.

China is currently practicing a managed floating exchange rate system based on market supply and demand, adjusted by reference to a basket of currencies, so the risk weighting coefficients of the fixed exchange rate system are applied for calculation. Since the data on the balance of portfolio investment liabilities comes from the table of China's international investment position disclosed on the official website of the State Administration of Foreign Exchange (SAFE), which has been disclosing data to the public since 2004, the study interval is set from 2004 to 2022.

According to Table 4, in 2004, China's foreign exchange reserves were moderate in size; from 2005 to 2013, China's foreign exchange reserves were higher than the upper limit of the moderate size, the foreign exchange reserves were in excess, and gradually deviated from the moderate size of foreign exchange reserves; from 2014 to 2016, China once again entered into the phase of the moderate size of the foreign exchange reserves; from 2017 to 2022, China's foreign exchange reserves were lower than the lower limit of the moderate size , the size of foreign exchange reserves is insufficient. It is worth noting that from 2017, China's actual foreign exchange reserve size and the lower limit of the moderate size of the difference is getting bigger and bigger, in 2017 the difference is only 108.899 billion U.S. dollars, 2022 the difference reached 184.6351 billion U.S. dollars, China's current foreign exchange reserves in the state of insufficiency.

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Table 4: Adequate size of foreign exchange based on IMF model measurements, 2004-2022

Year	Portfolio balance (billions of dollars)	Short-term external debt (billions of dollars)	Broad money balance (billions of dollars)	Annual exports (billions of dollars)	Foreign exchange reserves (billions of dollars)	Lower limit of foreign exchange reserves	Foreign exchange reserve ceiling
2004	994.0	1387.1	30696.7	5933.2	6099.3	4228.1	6342.2
2005	1353.0	1716.4	36877.5	7619.5	8188.7	5167.6	7751.4
2006	2527.0	1992.3	43340.8	9689.7	10663.4	6279.7	9419.6
2007	4083.0	2356.8	53035.0	12200.6	15282.4	7843.0	11764.6
2008	2784.0	2262.8	68389.0	14306.9	19460.3	9366.01	14049.0
2009	3941.0	2592.6	89330.3	12016.1	23991.5	11503.5	17255.3
2010	4514.0	3757.0	107209.6	15777.5	28473.3	14102.8	21154.2
2011	4227.0	5009.0	131796.7	18983.8	31811.4	17214.8	25822.2
2012	5467.0	5409.3	154323.0	20487.1	33115.8	19923.7	29885.6
2013	5985.0	6766.3	178598.5	22090.0	38213.1	22996.5	34494.8
2014	8343.0	12982.0	199982.9	23422.9	38430.1	27486.5	41229.8
2015	8583.0	8874.1	223580.1	22734.6	33303.6	28581.2	42871.8
2016	8483.0	8660.4	233440.3	20976.3	30105.1	29312.2	43968.4
2017	11775.0	11452.4	250231.0	22633.4	31399.4	32488.4	48732.7
2018	11628.0	12891.5	276285.5	24866.9	30727.1	35726.9	53590.3
2019	14526.0	12188.4	288034.7	24994.8	31079.2	37138.3	55707.5
2020	19558.0	13163.7	316945.3	25899.5	32165.2	41167.3	61751.0
2021	21477.0	14462.3	369373.1	33571.4	32501.6	47854.7	71782.1
2022	17810.0	13379.7	396429.1	35921.4	31276.9	49920.4	74880.6

Compared with the proportional analysis method, the IMF model comprehensively considers the shocks that foreign exchange reserves may face. However, the applicability of the IMF model in analyzing the appropriate size of China's foreign exchange reserves is also lacking. First of all, the IMF model and the proportional analysis method also fail to take into account the specific situation of each country, and may be biased in the actual measurement and estimation. the IMF model uses the same risk-weighted probability for all developing countries, which is more applicable but less accurate. Although China is still a developing country, its economy is already quite strong and it is the largest manufacturing and commodity trading country in the world. Therefore, there may be a large error in measuring the moderate size of China's foreign exchange reserves by the general measure of developing countries.The MF model is also unable to predict the impact of future external contingencies that may have a significant impact on the size of each country's foreign exchange reserves.

2.3. Analysis and summary

There are many factors affecting foreign exchange reserves, generally speaking, the greater impact of the gross domestic product, imports and exports, external debt, capital inflows and outflows, broad money supply and exchange rate, etc. In order to make the measurement results more accurate, this paper uses the proportion of the analysis method as well as the IMF model of the two methods to measure China's foreign exchange reserves of the appropriate size.

First of all, this paper uses the three indicators of foreign exchange reserves/import volume, foreign exchange reserves/short-term external debt, and foreign exchange reserves/GDP in the ratio analysis method to measure. Three methods of measuring the moderate size of foreign exchange reserves in some years there are differences, but they all show that from 2004 to 2022, China's foreign exchange reserves / imports, foreign exchange reserves / short-term external debt, foreign exchange reserves / GDP three indicators show first rising and then declining inverted U relationship, and peaked in 2009 near the peak. China's foreign exchange reserve stock is much higher than the moderate size, but the gap between the actual foreign exchange reserve size and the moderate size has narrowed in recent years.

Although the previous paper used three different indicators in the proportional analysis method to measure the moderate size of foreign exchange reserves, the proportional analysis method only considers a single variable that affects foreign exchange reserves, and the precision is not high. Therefore, this paper uses the IMF model to measure the moderate size of China's foreign exchange reserves. The measurement results show that in 2004, China's foreign exchange reserves were moderate in size; from 2005 to 2013, China's foreign exchange reserves were higher than the upper limit of the moderate size, the foreign exchange reserves were in excess, and gradually deviated from the moderate size of the foreign exchange reserves; from 2014 to 2016, China once again entered the moderate stage of the size

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of the foreign exchange reserves; from 2017 to 2022, the size of China's foreign exchange reserves was lower than the moderate scale lower limit, the size of foreign exchange reserves is insufficient.The results measured by the IMF model differ from the results measured by the proportion analysis method, probably because this paper compares the measurement results with the base 20% when using the IMF model.

3. Conclusions

According to the proportion analysis method and the IMF model to measure the appropriate size of foreign exchange reserves, the formulation of reasonable foreign exchange reserves target. Specifically, in the formulation of a reasonable scale of foreign exchange reserves, we should adhere to the method of seeking truth from facts, fully consider the changes in the domestic and foreign economic environment as well as the characteristics of China's economy itself, and other factors, to fully reduce the scale of foreign exchange reserves to make it more robust, which is conducive to the prevention of financial risks and the protection of national economic security.

First, in the investment and management of foreign exchange reserve assets, attention should be paid to risk management, seeking more sources of return and actively exploring diversified asset allocation methods. For example, the proportion of investments in the capital market can be increased to increase the diversity and return capacity of the investment portfolio and further enhance the yield and value of reserve assets.At the same time, in the investment portfolio of foreign exchange reserve assets, the proportion of low-risk and sound investments, such as treasury bonds and money market funds, should be appropriately increased. These investments can not only ensure the safety of funds and reliable returns, but also help to reduce the risk of the investment portfolio. Therefore, the proportion occupied by these investments in the portfolio of foreign exchange reserves should be appropriately increased in order to achieve asset optimization and sustainable growth in investment.

In order to further increase the competitiveness and attractiveness of the market, the Government could expand market access, increase the transparency and degree of competition in the market, relax investment restrictions on foreign capital and improve the efficiency of resource allocation in the market. At the same time, the Government can promote the degree of facilitation of the cross-border use of the renminbi and attract more international investors to the renminbi market, so as to increase the international utilization of the renminbi and the demand for foreign exchange reserves.

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