Further Study on the Optimal Currency Structure of China’s Foreign Exchange Reserves

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Abstract: China maintained a rapid growth momentum for china’s foreign exchange reserves in recent years. China’s foreign exchange reserves amounted to 20088.8 trillion U.S. dollars\[1\] as of April 2009. It has become the focus of attention of How to prevent the risk of the huge foreign exchange reserves effectively. Given China’s background of excessive foreign reserves, it has become an important issue for foreign exchange reserves management of how to adjust foreign exchange reserve structure and improve the operational efficiency of foreign exchange reserves. This paper will focus on the analysis of the structure of foreign exchange reserve through combination of China’s current economic situation which is excessive foreign reserves, aimed at maximizing risk diversification and risk reducing. We find it is rational for china which euro accounts for 17.5%, U.S. dollar accounts for 60%, British Pound accounts for 60%, Japanese yen accounts for 14%.

Keywords: foreign exchange reserves, currency structure, risk control

1 Introduction

Guard against risks and increasing the value becomes the focus of attention because the increasing number of foreign exchange reserves in recent years in China. The analysis of existing literature is mainly from two aspects. They research of volume and structure of the foreign exchange reserves. In view of the special conditions of china. Adequate foreign exchange reserves are necessary, so we will focus on the analysis from the view of structure. And reasonable structure of foreign exchange reserve can reduce the risk effectively.

The analysis of the impact factor of foreign literature is valuable for the research of currency structure of china. National literature which is based on china’s specific circumstances and applying the traditional model to the research of the currency structure of China’s foreign exchange reserves, laid the foundation for further study. But the deficiency lies in the little studies on the actual situation in the face of China’s big volume current reserves and double excessive surplus situation. So it is not reference valuable for getting a reasonable currency structure. The establishment of any model should be based on a country’s actual conditions. Therefore, this paper, on the basis of previous studies, combined with China’s actual conditions of China’s foreign exchange reserve analyzes currency structure. First, we select the U.S. dollar, euro, pound and yen to analyze from the principles of economic strength, currency stability, trade matching principle.

2 Analysis of currency structure based on assets portfolio return ratio

From a portfolio return ratio, we analyze rate of return of the four currency first, process it using EXCEL software, then arrived at the expected return ratio and covariance matrix of rate of return.\[2\] \[3\]

<table>
<thead>
<tr>
<th>Month</th>
<th>euro</th>
<th>dollar</th>
<th>pound sterling</th>
<th>yen</th>
</tr>
</thead>
<tbody>
<tr>
<td>November, 2008</td>
<td>0.017</td>
<td>2.308</td>
<td>-4.252</td>
<td>3.803</td>
</tr>
<tr>
<td>December, 2008</td>
<td>10.146</td>
<td>2.118</td>
<td>0.835</td>
<td>7.176</td>
</tr>
<tr>
<td>January, 2009</td>
<td>1.089</td>
<td>0.367</td>
<td>-0.212</td>
<td>1.378</td>
</tr>
<tr>
<td>February, 2009</td>
<td>-2.304</td>
<td>0.401</td>
<td>0.324</td>
<td>-1.359</td>
</tr>
</tbody>
</table>
We analyze the four kinds of currency return ratio using the quadratic programming method to get a currency structure which is of the lowest risk according to different levels of expected return ratio. The ratio of the dollar and the pound was 4.7, which analyze the difference between assets according to the benefits and risk characteristics of the assets.

We analyze the four kinds of currency return ratio using the quadratic programming method to get a currency structure which is of the lowest risk according to different levels of expected return ratio. The ratio of the dollar and the pound was 4.7, which analyze the difference between assets according to the benefits and risk characteristics of the assets. Matlab programming

\[
H = \begin{bmatrix}
26.81079 & 2.200356 & 6.282166 & 13.82757 \\
2.200356 & 1.348329 & -2.92409 & 4.260853 \\
6.282166 & -2.92409 & 17.47599 & -1.92591 \\
13.82757 & 4.260853 & -1.92591 & 27.4639
\end{bmatrix}
\]

\[
f = [0; 0; 0; 0]
\]

\[
A = [0.0267682, 0.00919596, 0.00916583, 0.01094696]
\]

\[
b = [0.02]
\]

\[
aeq = [1 1 1 1]
\]

\[
beq = [1]
\]

\[
lb = [0; 0; 0; 0]
\]

\[
[x, fval, exitflag, output, lambda] = quadprog(H, f, A, b, aeq, beq, lb)
\]

3 Analysis based on the functions of reserve assets

We analyze the data from functions angle of reserve assets: they are impact of trade structure, the economic strength of the reserve currency countries, foreign direct investment and external debt respectively.

On the conditions of the trade structure only, China’s foreign exchange reserve currency structure should be: euro 0.17-0.27, dollar 0.57—0.67, pounds 0.02 around, yen 0.09—0.19. Through the analysis of data, we found the proportion of euro, dollar, pounds and Japanese yen is 0.220561, 0.619116, 0.022924, 0.137399 respectively.

3.1: Customs import and export volume tables of china with other countries and regions from January to June of 2009 (unit: thousands of U.S. dollars)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>euro</td>
<td>27,934,788</td>
<td>20,832,592</td>
<td>26,451,729</td>
<td>27,304,727</td>
<td>26,842,807</td>
<td>30,753,753</td>
</tr>
<tr>
<td>dollar</td>
<td>63,850,334</td>
<td>60630831</td>
<td>78,347,836</td>
<td>81,973,214</td>
<td>79,127,880</td>
<td>85,528,808</td>
</tr>
<tr>
<td>pounds</td>
<td>2,901,002</td>
<td>2,027,992</td>
<td>2,774,939</td>
<td>2,942,535</td>
<td>2,791,601</td>
<td>3,203,828</td>
</tr>
<tr>
<td>yen</td>
<td>14,499,691</td>
<td>14,047,088</td>
<td>17,520,859</td>
<td>18,446,875</td>
<td>15,875,194</td>
<td>19,357,493</td>
</tr>
<tr>
<td>total</td>
<td>109185815</td>
<td>97538503</td>
<td>125,095,363</td>
<td>130,667,351</td>
<td>124,637,482</td>
<td>138,843,882</td>
</tr>
</tbody>
</table>

Note: Data of Table 2 is got according to the data from information network of china’s customs
### 3.2: GDP table of major reserve country from 2004 to 2008

<table>
<thead>
<tr>
<th>Year/currency</th>
<th>euro</th>
<th>dollar</th>
<th>pound</th>
<th>yen</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>96810</td>
<td>116573</td>
<td>21540</td>
<td>46059</td>
</tr>
<tr>
<td>2005</td>
<td>100255</td>
<td>123979</td>
<td>22319</td>
<td>45491</td>
</tr>
<tr>
<td>2006</td>
<td>105744</td>
<td>131639</td>
<td>23770</td>
<td>43684</td>
</tr>
<tr>
<td>2007</td>
<td>121051</td>
<td>138112</td>
<td>27278</td>
<td>43767</td>
</tr>
<tr>
<td>2008</td>
<td>127611</td>
<td>142043</td>
<td>26455</td>
<td>49092</td>
</tr>
</tbody>
</table>

Note: data is got according to the net of the National Bureau of Statistics and the World Bank

From the perspective of foreign direct investment, we got a ratio of 8.75% for euro, 57.8% for dollar, 13.8% for pounds, and 20.7% for Japanese yen roughly.

From the impact of foreign debt, we got a currency structure of 6%, 68%, 14%, 12% for euro, dollar, pounds, and Japanese yen.

We make an analysis according to the data of the report of the international balance of payments, exports and imports of the goods trade are 1.4346 and 1.0739 trillion U.S. dollars. So the good trade surplus is 360.7 billion U.S. dollars. Income and expenditures of the services trade is about 147.1 and 158.9 billion U.S. dollars, result is 11.8 billion deficit. Foreign direct investment inflows is 160.9 billion U.S. dollars in 2008, the net inflow is about 147.8 billion U.S. dollars. China’s direct investment is 55.6 billion U.S. dollars, the net outflow is about 53.5 billion U.S. dollars. Direct investment balance is 94.3 billion U.S. dollars. Foreign debt of china stood at 374.7 billion U.S. dollars.

Song Tiebo (2001) consider we should make an assumption that the weight of trade structure and foreign debt is 0.4 in the analysis. And the weight of trade structure and foreign debt is the same.

Liu Zhixiong (2006) assumes that the weight of China’s foreign trade, China’s foreign direct investment, country’s economic strength and China’s external debt is about 0.25, 0.15, 0.2 and 0.2.

As a result, we consider the weight of China’s foreign trade 0.2 while the other three weight is adjusted according to the data of 2008. Through comprehensive consideration we give weight assumption: China’s foreign trade 0.34, country’s economic strength 0.2, China’s foreign direct investment 0.1, and China’s external debt 0.36.

We suppose:

Weight C,  
Then \( C = (C_1, C_2, C_3, C_4) = (0.34, 0.2, 0.1, 0.36) \)

Weight of currency in various factors is column vector which is Rij, where i=1, 2, 3, 4 stands for factors, j=1, 2, 3, 4 stands for reserve currency. A said the currency structure of foreign exchange reserves.

Then \( A = C \times Rij \).

We get the data into the formula.

\[
A = C \times \begin{pmatrix}
0.221, 0.619, 0.023, 0.137 \\
0.355, 0.419, 0.078, 0.147 \\
0.088, 0.578, 0.138, 0.207 \\
0.060, 0.680, 0.140, 0.120
\end{pmatrix}
\]

\[
= \begin{pmatrix}
0.17649 \\
0.59686 \\
0.08762 \\
0.13984
\end{pmatrix}
\]

China’s structure distribution of foreign exchange reserves is in table 4 according to these four kinds of factors.

### 3.4: Structure distribution of China’s foreign exchange reserves based on the functions of reserve assets

<table>
<thead>
<tr>
<th>Structure distribution</th>
<th>euro</th>
<th>dollar</th>
<th>pound</th>
<th>yen</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight</td>
<td>0.17649</td>
<td>0.59686</td>
<td>0.08762</td>
<td>0.13984</td>
</tr>
</tbody>
</table>

### 4 Analysis based on the excessive foreign reserves angle

We analyze from the point of view of the modest size of foreign exchange reserves with China’s actual
conditions first. Scholars and researchers of China suggest that it is excessive for China’s foreign exchange reserves in recent years.

Wang Yunxia (2009) consider that actual reserves of China is 2.4 times that the optimal reserve by the end of 2007, and the gap is still widening according to the trend. She analyze the volume of China’s foreign exchange reserves using expanded J-R model and calculate the optimal reserves of China from 1995 to 2007.

Zhang Bo (2008) analyze empirically the reserves using methods of demand of the foreign exchange reserves. After considering a variety of channels of foreign exchange reserves, he drew up an appropriate proportion of reference. Then calculate a model to measure and compare with the holding reserves to determine if it is appropriate. His conclusion is the appropriate scale of China’s foreign exchange reserves in 2007 is about 517.652 billion U.S. dollars. But China’s actual exchange reserves in 2007 are about 1.528249 trillion U.S. dollars which is significantly higher than the optimal size. (more than nearly 2 times)

Jiang Wei (2009) calculate a moderate interval of appropriate foreign exchange reserves from 1991 to 2008 through the use of Factor Analysis Methods, construct Egewoer Model. And put three aspects of transaction demand, precautionary demand and debt demand in to consideration. In 2008, China’s appropriate foreign exchange reserves is about 544 billion U.S. dollars, as the range scope is from lower limit of 416.8 billion U.S. dollars to the upper limit of 671.2 billion U.S. dollars. But by the end of 2008, China’s actual foreign exchange reserves had reached 1.94603 trillion U.S. dollars, exceeding the upper limit of the moderate range about twice.

Lu Xiaoli (2009) study China’s foreign exchange reserves using the Agarwal model empirically. She divided China’s appropriate foreign exchange reserves into five parts: transactional reserve R1, regulatory reserve R2, debt reserve R3, preventive reserve, FDI profit remittances reserves R5. Amend the Agarwal model and finally come to the modest size of foreign exchange reserves from 1990 to 2008. From the data from 2006 to 2008, a modest reserve were 486.087 billion U.S. dollars, 569.826 billion U.S. dollars, 704.105 billion U.S. dollars while the year’s actual foreign exchange reserves had reached 1.066300 trillion U.S. dollars, 1.528249 trillion U.S. dollars and 1.946049 trillion U.S. dollars. The foreign exchange reserves exceeded the amount of modest reserves 1.2419 trillion U.S. dollars in 2008, it is about 2.76 times than the appropriate scale.

Wang Lei (2009) adopted amending the Agerwal model, the estimated upper limit foreign exchange reserves were 448.9 billion U.S. dollars, 389.078 billion U.S. dollars, 473.159 billion U.S. dollars from 2006 to 2008. But China’s actual foreign exchange reserves reached 1.905585 trillion U.S. dollars in 2008, the ratio is 4.03.

The appropriate ratio of the out scale to in scale of China’s foreign exchange reserves is 2:1 through analysis by scholars in recent years. Therefore from the scale of foreign exchange reserves angle, the in scale of the reserves applied to the function angle, the out scale of the reserves applied to the minimizing the risk and maximizing the revenue of the foreign exchange reserves angle. Also because such consideration is based entirely from the theory, so adjustment should use the ratio of 4.7:1. We lock the ratio of euro and yen, re-allocate the ratio of the dollar and pound, then the ratio is 0.56373:0.11994.

4.1: The weight and ratio of the currency of China’s foreign exchange reserves based on excessive scale angle

<table>
<thead>
<tr>
<th>Currency structure</th>
<th>euro</th>
<th>dollar</th>
<th>pound</th>
<th>yen</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight: 0.33</td>
<td>0.17649</td>
<td>0.56373</td>
<td>0.08762</td>
<td>0.13984</td>
</tr>
<tr>
<td>weight: 0.67</td>
<td>0.17649</td>
<td>0.56373</td>
<td>0.11994</td>
<td>0.13984</td>
</tr>
</tbody>
</table>

Suppose weight C, then C= (C1, C2) = (0.33, 0.67). Suppose the weight of the currency reserves in the two factors the column vector, said Rij, where i=1, 2, 3, 4 said weight, j=1, 2, 3, 4 said reserve currency. A said the currency structure of the foreign exchange.

A=C×Rij
\[(0.33, 0.67) \times \begin{pmatrix} 0.17649, 0.59686, 0.08762, 0.13984 \\ 0.17649, 0.56373, 0.11994, 0.13984 \end{pmatrix} = (0.17649, 0.57466, 0.10927, 0.13984) \] (4.2)

Analysis revealed that the structure of currency reserves should be as follows:

4.3: The ratio of China's foreign exchange reserves based on excessive scale angle

<table>
<thead>
<tr>
<th>Currency structure</th>
<th>euro</th>
<th>dollar</th>
<th>pound</th>
<th>yen</th>
</tr>
</thead>
<tbody>
<tr>
<td>structure</td>
<td>0.17649</td>
<td>0.57466</td>
<td>0.10927</td>
<td>0.13984</td>
</tr>
</tbody>
</table>

5 Analysis based on the economic double excessive surplus angle

Analysis based on the source structure of reserves is of the same as analyzing the formation of claims. Foreign exchange reserves are formed with two parts: one is net inflows of current account of the international balance of payments, the other is net inflow of capital account. This two composed the sum of foreign exchange reserves. (This does not take into account errors and omissions item, because the number of projects is sometimes small, but the big variation has a significant impact on the increase and decrease of the reserves.) From the source of the capital and financial account it includes capital account, finance account and other investment. It includes direct investment, portfolio investment and other investment under financial account. These are mainly formed by foreign capital inflows, so it is not stable. It may cause the outflow of foreign capital which led to the loss of reserves if the international and domestic economic situation has undergone drastic changes such as the financial crisis, exchange rate and interest rate changes. Such sources are relatively stable if the foreign exchange reserves are mainly from net inflow of current account. First, current account include goods and services, income and current transfers. This kind of claims are got from domestic goods and services, foreign investment income and current transfer funds which is from foreign government to Chinese government and sectors. Therefore increases of the foreign exchange reserves due to the current account should apply based on the physical characteristics of the economic field. Capital and financial account surplus is from international investment and international credit. These are debt reserves because international investment demand repatriation of profits, international credit requires interest back. So these parts of debt reserves should be eventually repaid, it is unstable and easy to change. So it is analyzed based on the theory of portfolio, stressed the role of benefits and risks in arranging the structure of the foreign exchange reserves.

5.1: China's international balance of payments (simplified) unit: 100 million U.S. dollars

<table>
<thead>
<tr>
<th>Item</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Current Account</td>
<td>458</td>
<td>686</td>
<td>1608</td>
<td>2532</td>
<td>3718</td>
<td>4261</td>
</tr>
<tr>
<td>A. Goods and Services</td>
<td>360</td>
<td>492</td>
<td>1247</td>
<td>2089</td>
<td>3074</td>
<td>3488</td>
</tr>
<tr>
<td>a. Goods</td>
<td>446</td>
<td>589</td>
<td>1341</td>
<td>2177</td>
<td>3153</td>
<td>3606</td>
</tr>
<tr>
<td>b. Services</td>
<td>-85</td>
<td>-96</td>
<td>-93</td>
<td>-88</td>
<td>-79</td>
<td>-118</td>
</tr>
<tr>
<td>B. Income</td>
<td>-78</td>
<td>-35</td>
<td>106</td>
<td>151</td>
<td>256</td>
<td>314</td>
</tr>
<tr>
<td>C. Current Transfer</td>
<td>176</td>
<td>228</td>
<td>253</td>
<td>291</td>
<td>386</td>
<td>457</td>
</tr>
<tr>
<td>One. Capital and Financial Account</td>
<td>527</td>
<td>1106</td>
<td>629</td>
<td>66</td>
<td>735</td>
<td>189</td>
</tr>
<tr>
<td>A. Capital Account</td>
<td>- 0.48083</td>
<td>- 0.69345</td>
<td>41</td>
<td>40</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>B. Financial Account</td>
<td>527</td>
<td>1107</td>
<td>588</td>
<td>26</td>
<td>704</td>
<td>159</td>
</tr>
<tr>
<td>1. Direct Investment</td>
<td>472</td>
<td>531</td>
<td>678</td>
<td>56.9</td>
<td>1214</td>
<td>943</td>
</tr>
<tr>
<td>2. Portfolio Investment</td>
<td>114</td>
<td>196</td>
<td>-49</td>
<td>-675</td>
<td>186</td>
<td>426</td>
</tr>
<tr>
<td>3. Other Investment</td>
<td>-58</td>
<td>379</td>
<td>-40</td>
<td>132</td>
<td>-696</td>
<td>-1210</td>
</tr>
<tr>
<td>Four. Net Errors and Omissions</td>
<td>184</td>
<td>270</td>
<td>-167</td>
<td>-129</td>
<td>164</td>
<td>-260</td>
</tr>
</tbody>
</table>

Note: Data is got from the State Administration of Foreign Exchange Web
5.2: Structure of China’s international balance of payments unit: 100 million U.S. dollars

From the trend of source structure of foreign exchange reserves, we consider the data from 2006 to 2008 as a reference standard. The current account data in these three years period is about 350.36 billion U.S. dollars, the capital and financial account data in these three years period is about 33 billion U.S. dollars. So the current account is about 10.6 times than that asset and financial account. So the conclusion is current account ration 0.9138, capital and financial account ration 0.0861.

5.3: The ratio and weight of the structure of China's foreign exchange reserves based on the double excessive surplus situation

<table>
<thead>
<tr>
<th>Currency structure</th>
<th>euro</th>
<th>dollar</th>
<th>pound</th>
<th>yen</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight, 0.9139</td>
<td>0.17649</td>
<td>0.59686</td>
<td>0.08762</td>
<td>0.13984</td>
</tr>
<tr>
<td>weight, 0.0861</td>
<td>0.17649</td>
<td>0.56373</td>
<td>0.11994</td>
<td>0.13984</td>
</tr>
</tbody>
</table>

Application of the formula:
\[
A = C \times R_{ij} = \begin{pmatrix} 0.17649, 0.59686, 0.08762, 0.13984 \\ 0.17649, 0.56373, 0.11994, 0.13984 \end{pmatrix} \times \begin{pmatrix} 0.17649, 0.59400, 0.09040, 0.13984 \end{pmatrix}
\]

5.5: Structure distribution of China’s foreign exchange reserves based on the double excessive surplus situation

<table>
<thead>
<tr>
<th>Structure distribution</th>
<th>euro</th>
<th>dollar</th>
<th>pound</th>
<th>yen</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight</td>
<td>0.17649</td>
<td>0.59400</td>
<td>0.09040</td>
<td>0.13984</td>
</tr>
</tbody>
</table>

6 Conclusion

It is based on the China’s current situation where analysis is from the two kinds of perspective which is size of reserves assets and source structure of reserves. We find that the euro accounted for approximately 17.5%, the dollar accounted for approximately 60%, pound accounted for approximately 9%, Yen accounted for approximately 14%. It is more appropriate for the currency ratio of China’s foreign exchange reserves.

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ID number: 130402198301032429

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[1]. The State Administration of Foreign Exchange Site