

Prediction and operation of local treasury bottom target balance

Weihong Zhang^{1, a}, Xin Wang^{1, b}, Runji Lv^{2, c} and Pan Song^{1, d}

¹School of Economic and Management, Xidian University, Xian 710071, China;

²Nanjing Finance Bureau, Nanjing 210005, China.

^aweihongzhang@mail.xidian.edu.cn, ^b1049484206@qq.com, ^c331015184@qq.com,

^d814004456@qq.com

Abstract

The management of the target balance for local treasury is of great significance for the solving the problem of idle funds and the improvement of the income of local treasury. Through the 2015 Nanjing National treasury deposit balance and the cash inflow outflow data, calculate the amount of operational funds and the target balance for local treasury of Nanjing City in 2015 by exploiting the Miller-Orr model. Calculate it through the operation tools of the time deposit for the commercial bank. Investigations show that the calculated is 10116.46 million Yuan, Confidence interval is [978924, 1077090]; the income of operational fund is 307 million Yuan, which is higher than the actual income of 160 million Yuan. The beneficial rate of the fund operates rather well.

Keywords

Treasury cash management; the bottom of the target balance; forecast; operation.

1. Introduction

With the advancement of China's treasury cash management system reform and the increase of fiscal revenue by years, the funds are concentrated into the single account system, which expands the scale of treasury cash deposits, and this creates realistic conditions for the smooth management of treasury cash. During 2011 to 2015, treasury cash income and inventory balance of Nanjing City showed an increasing trend, the treasury balance average annual growth rate is 18% at the end of the year. Due to the time difference between income and expenditure of the seasonal budget, the mismatching between the project budgetary revenue and expenditure and the progress of the local budgetary performance, the fluctuation range of the treasury deposit period is large and there is operable space for the treasury cash deposits balance.

The management of the bottom target balance mainly refers to the funds management of the part that more than "target balance" [1]. The amount of funds that can be operated is the difference between the treasury cash deposits balance and the bottom target balance. From 2006, China officially launched the operation of the central treasury cash, to the end of 2015, the central treasury totally implemented commercial banks' time deposits for 87 terms, with the scale of operation of more than 3600 billion Yuan, and a total interest income of 66.7 billion Yuan. Through treasury cash management by the central government, the efficiency of the use of funds has been effectively improved and the treasury income has increased. The successful operation of the central treasury cash management provides experiences for the local treasury management.

Therefore, through the analysis of Nanjing City's total stock of state treasury and fluctuation of the state treasury stock of from 2011 to 2015, the study finds that there is space for the management of bottom target balance. The operation mode of the local treasury cash management is explored by referring to the successful operation of the central treasury cash management. This paper will study the prediction and operation of the bottom target balance of the local treasury.

2. Literature Review

The prediction of the bottom target balance and the choice of the operation mode are the key issues for the management of the treasury bottom target balance. Scholars have borrowed the optimal cash flow prediction models for studies of the treasury bottom target balance prediction, which include the Baumol Model, the Miller-Orr Model the Cost Analysis Model and the Cash Turnover Model. Aronson, Maldonado et al. used the Baumol Model and the Miller-Orr Model to predict the treasury cash in the U.S.'s state. The results showed that although the balance of treasury funds in the U.S. local government has gradually declined since the late 1960s, it still was over the optimal level [2,3]. Andrew Kalotay pointed out that the Federal Reserve Bank treasury funds balance should be about \$5 billion. Referring to its recommendation, US Treasury decided the daily treasury funds balance as 5 billion dollars and according to the income and expenditure to adjust [4]. In China, Jia Kang et al raised a series of operational recommendations, which including to determine the minimum amount of treasury cash, the best control targets of regular inventory and the use of open market operation tools for the management of treasury funds [5]. Chen Jianqi et al. constructed the Baumol expansion model to estimate and evaluate the optimal cash balance of Chinese treasury [6]. Wang Junxia, Yuan Qinghai et al. constructed and improved the Miller-Orr Model to estimate and protest the best holding level of China treasury cash [7,8].

The prediction of the bottom target balance of the treasury provides the basis for the operation of the bottom fund. In the studies of treasury cash operation, Clement and Marries Wright determined the balance of treasury cash deposits based on the income and expenditure of the treasury cash flow, and then chose the US the forms of short-term treasury bonds to operate [9,10]. John Pareto uncovered the necessity of operating the balance of UK treasury deposits under existing conditions, arguing that the balance of treasury cash deposits only need 1 billion pounds [11]. Deng Xiaolan, Zhang Wen, Sun Lingyan made comparative analyses of the different operating tools in China's financial market and provided the basis for the choice of the operation mode of treasury idle funds [12,13].

Although there are a lot of literatures on optimal treasury cash, the research on the calculation method of the optimal treasury cash is not enough, especially the research on operation of the local treasury target balance is rarely. This study takes the prediction and operation of treasury bottom target balance of Nanjing City as an example, uses the random model to measure the balance of the bottom target balance, and calculates and analyzes the income of the operational funds based on the measured results. The study aims to explore a forecasting method of the treasury bottom target balance and improve the profitability of the local treasury cash management through the operation of the bottom target balance.

3. Research Design

3.1 Data Resources

The data of the study come from the 2011-2015 "Nanjing City fiscal revenue and expenditure budget monthly report from 2011 to 2015, 2015 "national inter-bank pledged market bond repurchase transactions table", the major bank deposit interest rates in 2015 and other statistical data from the People's Bank of China (see the website: <http://www.pbc.gov.cn>.)

3.2 The Calculation of Treasury Bottom Target Balance Based on the Random Model

3.2.1 The Introduction of the Random Model

The random model, also known as the Miller-Orr Model, is a method of predicting the optimal cash holdings when cash demand is unpredictable. In this mode, the determination of the treasury bottom target balance M is related to the lower limit L , the conversion cost E , the opportunity cost K , and the standard deviation σ . Therefore, in the case where the treasury cash deposit and the cash flow are known, assuming that the difference between the upper limit H and the lower limit L is $3Z$ units, then the random model is constructed as follow:

$$M = Z + L = \sqrt[3]{3E\sigma^2/4K} + L \quad (1)$$

$$Z = \sqrt[3]{3E\sigma^2/4K} \quad (2)$$

Where M is the best cash holding, L is the lower limit, E is the cost of converting the portfolio bond, K is the opportunity cost of holding cash, σ is the standard deviation of the daily net cash flow, Z is related to the lower limit L, conversion cost E, the opportunity cost K and the standard deviation σ .

Therefore, the random model for the predicted value of the treasury optimal cash holdings is determined by the upper limit H, the conversion cost E, the opportunity cost K and the net cash flow standard deviation σ .

3.2.2 The Determination of Parameter Values

The lower limit L: L is determined by the treasury cash management department comprehensively based on the demand of funds over a period of time, the risk degree of the shortage of funds, other expenditure factors, etc. It must both ensure the safety of treasury cash deposits and not be too conservative.

The conversion costs E: the conversion costs which bond converts to cash or cash converts to bond. In the local treasury cash management, it mainly refers to the local government invests treasury funds and recover the required cost.

The opportunity cost K: the cash opportunity cost calculated by day.

The standard deviation σ : the standard deviation of daily cash change.

The upper limit H: increases 3Z units on the basis of the lower limit L and that is the upper limit H value.

$$H = 3Z + L \quad (3)$$

3.2.3 The Evaluation of the Random Model

As an effective method to study the treasury bottom target balance, the random model has been adopted by some experts and scholars. Wang Junxia, Deng Xiaolan, Zhao Yusen, Yuan Qinghai et al. have used the random model to estimate and forecast the control range of the treasury cash balance and the optimal holding level based on the actual data of the central and local treasury cash, they verified the feasibility of this model prediction [7-8]. Thus, the study applies the model to forecast the treasury bottom target balance of Nanjing city, and hopes to provide some references for the treasury cash management of local government in Nanjing city.

In the course of the actual operation, the regulation of the treasury cash holdings may not be controlled at a precise base of the bottom target, so the cash holding is controlled within its optimal interval [L, H]. When the treasury cash deposit balance reaches the upper limit H, the 2Z amount of cash will be used for investment operation to decrease the balance of the treasury cash deposit; when the treasury cash deposit balance is lower than the lower limit L, the Z amount of cash invested in the investment operation will be withdrawn to increase treasury cash deposit and ensure the normal financial needs. In this way, the treasury bottom balance will tend to the bottom target balance M during the continuing adjustment.

3.3 The Operation based on the Time Deposit Methods of Commercial Banks

1. Calculating the operational funds

The amount of operational funds can be calculated according to the difference between the treasury cash deposits balance and the treasury bottom target balance. The formula can be expressed as:

The amount of operational = the treasury cash deposits balance - the treasury bottom target balance

The value of the treasury cash deposit balance can be known based on the financial revenue and expenditure budget report, the value of the treasury bottom target balance can be calculated by the random model which mentioned above, and the difference between these two is the amount of operational funds during this period.

2. The choice of the operating tools

Theoretically, the treasury cash deposit operation tools mainly have three types: deposits of the People's Bank of China, time deposits of commercial banks as well as short-term investment of monetary market. Based on the practices of treasury cash management in China, the central bank started the official operation of treasury cash deposits since 2006 and mainly used time deposits of commercial banks. Subsequently, Beijing, Shanghai and other cities have also started the local treasury cash deposit operation practice and the results have been rewarding. In the study of the operation practices of provincial treasury cash management, Scholars Chen Suling, Yang Zhihong and Zheng Yan [14,15] supported that time deposits of commercial banks are the most suitable tool for local operation because of its high security and good liquidity. Therefore, the study chooses time deposit of commercial banks to operate the treasury operational funds and calculates the income from it.

3. The steps to calculate the operating income of the funds

First, to determine the operational scale of the operational funds. According to the amount of operational funds in every period by calculated, the study identifies the amount of funds in corresponding period. Then, to determine the commercial banks participating in treasury cash operation and their assessment methods and distribution plans. Finally, to calculate the income of the operational funds. According to deposit distribution plans and deposit interest determined by each commercial banks at that year to calculate the operating income.

4. The Empirical Analysis

4.1 The Calculation of the Nanjing City's Treasury Bottom Target Balance

Combining the monthly data of the treasury cash deposit balance of Nanjing City in 2015, the study uses the random model to calculate the treasury bottom target balance. Based on the confirmation of the parameter value, the value of the treasury bottom target balance is calculated according to the formula (1).

4.1.1 The Confirmation of Parameter Values

The relevant variable, the lower limit L , the conversion cost E , the opportunity cost K and the standard deviation σ , are explained as follow:

Lower limit L : According to the "Nanjing City fiscal revenue and expenditure monthly report", from the perspective of net cash flow, the study minuses the treasury monthly cash outflow and cash inflows in 2015, then selects the largest net outflow as the lower limit. The calculation result showed that the lower limit of 2015 is 9789.24 million yuan, as shown in Table 1.

Table 1. The statement of treasury cash flow of Nanjing City in 2015 Unit: 10,000 yuan

Month	Cash inflow	Cash outflow	Net flow
1	912,744	401,625	511,119
2	491,673	816,124	-324,451
3	843,249	835,148	8,100
4	942,990	433,429	509,561
5	1,569,521	506,336	1,063,185
6	810,043	1,788,967	-978,924
7	991,884	714,901	276,983
8	641,857	756,905	-115,048
9	2,237,077	2,359,764	-122,687
10	605,127	791,738	-186,611
11	3,001,840	2,316,249	685,591
12	2,285,861	2,264,014	21,847

(Net inflow of funds is positive; net outflow of funds is negative)

The conversion cost E: refers to Yuan Qinghai, Du Jie, Wang Junxia et al. scholars' research based on the random model of the treasury cash management, select the pledged bond to repurchase this relatively safe financial instruments as the main model of Nanjing City research [7-8]. The study selects five trading varieties of the repurchase time is 1 day, 7 days, 14 days, 21 days and 1 month respectively to research. In the case of the highest frequency of transactions, the number of repurchases of the above-mentioned transaction varieties is 22 times, 4 times, 2 times, 1 time and 1 time respectively and a total of 30 times per month (assuming 22 working days a month). In accordance with the inter-bank single coupon single purchase repurchase transaction fee of 120 yuan, the conversion cost is the monthly repurchase transaction cost of 3600 yuan.

The opportunity cost K: since the calculation of the conversion cost E has used the model of pledge-style repo transactions between banks, the opportunity cost K is the annual interest rate of bank pledged bond repo. According to the statistics of the department of the People's Bank of China website survey data, 2015 "national inter-bank pledged market bond repurchases transactions table", the weighted average annual interest rate of various types of bonds in 2015 are available. On this basis, the weighted average annual interest rate is calculated based on the proportion of the bond transactions amount of each type, as shown in Table 2.

The weighted average monthly interest rate of the opportunity cost of 2015 is: $2.01 \div 12 = 0.17\%$

Table 2. The classified statistical table of the of national inter - bank market bond repurchase transaction in 2015

Repo term	Volume of transaction(hundred million)	Proportion(%)	Average interest rate(%)
1 day	3700895	85.93	1.84
7 days	461541	10.72	2.89
14 days	114361	2.66	3.61
21 days	11337	0.26	4.13
1month	18661	0.43	3.68
Total	4306793	1	2.01

(Data resource: People 's Bank of China Statistics and Analysis Department [http:// www. pbc. gov.cn/diaochatongjisi/](http://www.pbc.gov.cn/diaochatongjisi/))

The standard deviation σ : According to the treasury deposits balance from "Nanjing City financial revenue and expenditure monthly report" in 2015, the standard deviation σ of the monthly balance of treasury cash deposits in 2015 is 4696.81 million yuan.

4.1.2 The Confirmation of the Treasury Bottom Target Balance

Based on the calculated conversion cost E, the opportunity cost K, the standard deviation σ , and the correlation formulas of the random model to calculate the value of the treasury bottom target balance M. Then the confirmation process of 2015 Nanjing City treasury bottom target balance is as follows:

Substituting the values of the conversion cost E, the opportunity cost K, and the standard deviation σ into the formula (2) and the Z value is calculated as:

$$Z = \sqrt[3]{3 \times 0.36 \times (469681)^2 / (4 \times 0.17\%)} = 32722$$

Substituting the value of Z and the lower limit L into the formula (1) to calculate the treasury bottom target balance M:

$$M = Z + L = 32722 + 978924 = 1011646 \text{ (10,000 yuan)}$$

Substituting the value of Z and the lower limit L into the formula (3) to calculate the value of the upper limit H:

$$H = 3Z + L = 3 \times 32722 + 978924 = 1077090 \text{ (10,000 Yuan)}$$

The optimal interval for the treasury bottom target balance of Nanjing City Treasury in 2015 is [978924, 1077090]. The optimal interval of the treasury bottom target balance of NJ City Treasury in 2015 and related parameters are as shown in Table 3.

Table 3 The optimal interval table of the treasury bottom target balance of Nanjing City Treasury in 2015 Unit: 10,000 Yuan

Year	The lower limit L	Z	The treasury bottom target balance M	The upper limit H	The optimal interval
2015	978924	32722	1011646	1077090	978924-1077090

4.1.3 Model Evaluation

In the process of the actual operation, the treasury cash holdings may not be controlled at a precise bottom target balance base, thus the cash holdings are controlled within its optimal interval [L, H]. In the treasury cash management of Nanjing City in 2015, when the treasury cash deposit balance reaches the upper limit of 10770.9 million Yuan, 654.44 million Yuan cash will be used for investment operation to reduce the balance of treasury cash deposit. When the treasury cash deposit balance is lower than the lower limit of 9789.24 million Yuan, 327.22 million Yuan will be withdrawn from investment operation to increase the treasury cash deposits and ensure the normal financial needs. In this way, the treasury bottom balance will gradually tend to the bottom target balance of 10116.46 million Yuan.

4.2 The Treasury Funds Operation based on the Bottom Target Balance

4.2.1 The Calculation of the Operational Funds

Substitutes two values of the treasury bottom target balance based on the above calculation and the treasury cash deposits known from the "Nanjing City fiscal revenue and expenditure budget monthly report" into the formula (4), then the study gets Nanjing City's treasury operational funds of, as shown in Table 4. Hereinto, the monthly funds are continuous. If part of the funds was operated in January, then the operational funds of February would be reduced accordingly. The amounts of monthly operational funds are mutual restraint.

Table 4 The prediction of Nanjing City's treasury operational funds in 2015 Unit: 10,000 Yuan

Month	1	2	3	4	5	6
Amount	599,504	275,053	283,153	792,714	1,855,899	876,975
Month	7	8	9	10	11	12
Amount	1,153,959	1,038,911	916,224	729,614	1,415,204	1,437,051

4.2.2 The Calculation of the Funds Operating Income

Based on the actual operation of the treasury bottom funds of Nanjing City, the operation of the operational fund, which is calculated above, carries out by the method of the time deposit of commercial banks.

First of all, to determine the scale of operation. According to the amount of the operational fund of Nanjing in 2015 in Table 4, the study suggests the treasury cash management department deposit a deposit of 3 billion Yuan for 3 months at the end of January, deposit a deposit of 7 billion Yuan for 6 months at the end of April, and deposit a deposit of 1.7 billion Yuan for 3 months at the end of May.

Secondly, to determine commercial banks of Nanjing City participating in the treasury cash operation and the deposit distribution ratio. At present, Nanjing City determines the financial funds deposited banks based on commercial banks' contributions to Nanjing City's economic and the duration of cooperation with the financial, including Bank of Communications, Bank of Nanjing, Agricultural Bank of China, China Construction Bank, Industrial and Commercial Bank of China and China Ever Bright Bank as the representatives. It is assumed that the Nanjing municipal treasury funds to operate a total of five batches of time deposits, time deposits of 10 billion Yuan in 2015. According to the actual situation, on the base of a certain proportion, the funds is deposited in 12 banks separately, as shown in Table 5.

Finally, to calculate the capital incomes. According to current proportion of deposits the Nanjing City Finance Bureau assigning for the major banks, the amount of 11.7 billion Yuan of operational funds in 2015 to be allocated to the major banks, the interest incomes are calculated by the time deposit interest rates of those banks in 2015. Due to several times of cutting interest rates requirement in 2015 (respectively in 1/3/2015, 10/5/2015, 28/6/2015, 26/8/2015 and 24/10/2015), the deposit interest rates changed largely. The study calculates combined with the Nanjing City treasury deposit operating time of the relevant interest rate, therefore the incomes of 11.7 billion funds are:

Industrial and Commercial Bank of China:

$$117 \times 0.16 \times [(30/117) \times 2.6\% + (70/117) \times 2.55\% + (17/117) \times 2.1\%] = 0.4675 \text{ (10,000 Yuan)}$$

Similarly, to calculate the incomes based on other relevant banks' interest rates, as shown in Table 5.

As can be seen in Table 5, the above-mentioned calculated operational funds gain income of 30.7 million Yuan with the commercial bank time deposit means to operate. According to "Nanjing City financial budget monthly report", the actual operating income of Nanjing City at the end of 2015 is 16 million Yuan with the method of the time deposit of commercial banks. The funds operating income based on the bottom target balance prediction is 14.7 million Yuan higher than the actual operating income, which proves an effective operation.

Table 5 The incomes of Nanjing City's treasury cash operation in 2015

Participating banks	Deposit allocation			Bank interest rates (%)			Interest incomes (0.1 billion)
	Proportion	Time deposit	Non-fixed deposit	3 months		6 months	
				By 31/1/2015	By 31/5/2015	By 30/4/2015	
Industrial and Commercial Bank of China	0.16	18.72	0.3	2.6	2.1	2.55	0.4675
Bank of Communications	0.08	9.36	0.3	2.6	2.1	2.55	0.2338
China Construction Bank	0.17	19.89	0.3	2.6	2.15	2.7	0.51604
Agricultural Bank of China	0.07	8.19	0.3	2.6	2.1	2.55	0.2045
Bank of Nanjing	0.08	9.36	0.35	2.82	2.59	2.99	0.27034
Bank of China	0.12	14.04	0.3	2.6	2.1	2.55	0.3506
Bank of Jiangsu	0.17	19.89	0.35	2.6	2.52	2.99	0.56124
Shanghai Pudong Development Bank	0.02	2.34	0.3	2.6	2.25	2.75	0.0618
China Minsheng Bank	0.04	4.68	0.3	2.585	2.25	2.75	0.1233
China Merchants Bank	0.03	3.51	0.4	2.6	2.1	2.55	0.0877
Industrial Bank	0.03	3.51	0.4	2.585	2.3	2.76	0.09296
Zijin Rural Commercial Bank	0.03	3.51	0.35	2.73	2.55	2.99	0.10037
Total	1	117					3.07015

(Data resource: Hexun.com <http://data.bank.hexun.com/ll/ckll.aspx>)

5. Results and Inspirations

The study takes Nanjing City as an example and uses the random model to calculate its treasury bottom target balance, based on the known treasury cash deposit and the relationship between the treasury cash deposit balance. The difference between these two is the operational funds. The study also comparatively analyses the income of the operational funds based on the commercial bank time deposit method and the actual income, the results show that:

First, the study uses the random model to calculate 2015 Nanjing City treasury bottom target balance M is 10116.46 million Yuan, the optimal interval of the treasury bottom funds is [978924,1077090] (shown in Table 3). The difference between the treasury deposit balance and the bottom target balance is the operation treasury funds. This result provides a quantitative reference for the management and operation of treasury cash in government departments.

Second, the study applies the method of commercial banks' time deposits and operates the operational funds which predicted based on the bottom target balance, the result is effective and well operation. Based on the predicted operation treasury funds of Nanjing in 2015, the study operates it by time deposits of commercial bank and the income is 30.7 million Yuan, which is 14.7 million Yuan higher than the actual operating income of 2015 Nanjing City's treasury deposit. This management and operation method effectively improves the use efficiency of treasury funds and the benefits.

According to the above research results and existing problems in the management of the treasury bottom target balance, the study raises policy suggestions from three aspects:

First of all, to establish and improve the local treasury cash management system. The existing banking law, budget law and other relevant legal norms should be supplemented and amended to clearly define the local government treasury cash management authority, responsibilities and methods. On the basis of the requirements in "local treasury cash management pilot approach" which issued by the Ministry of Finance and the central bank, to normalize the prediction and operation of the bottom target balance and ensure the standardization and efficiency of local treasury cash management.

Secondly, to establish and complete the dynamic monitoring system of treasury bottom funds. The treasury cash flow database includes the treasury cash flow historical data, price index, interest rates and other economic and financial indexes which directly relating to tax revenue. A completed database is conducive to fully grasping the bottom funds flow, the traffic, the structure and the law of inventory changes. Through the data analyses of the treasury fund balance and capital structure to forecast the treasury bottom target balance. When the bottom target balance appears abnormal data, timely enabling of the emergency mechanism. For example, in the first half of 2016, due to the hot development of the real estate market, Nanjing City's treasury deposits balance had an explosive growth and it exceeded more than the normal annual normal trend. When the monitor found the rapid increasing of the land transfer payments and real estate tax revenue, they timely adjusted the time limit of deposits in commercial banks, then improved the current treasury funds operating income.

Thirdly, applying various operating tools to operate the treasury bottom operational funds. At present, most of the provinces and cities in practice are using the operating method of the commercial banks' time deposits. With the diversified development of monetary policy tools, on the premise of sticking with the commercial banks' time deposits as the main mode of operation, some short-term monetary market operating models should be trialed, such as advance repayment and bond repurchase, to improve the profit of financial funds.

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