Research on the Risk of Structural Wealth Management Products Based on VaR

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Abstract. In recent years, with the rapid development of the domestic economy, the wealth management products of Chinese banks have become increasingly mature and strong, with a history of 17 years since their development in 2003. Especially with the implementation of the "New Asset Regulations" in 2018, breakeven wealth management officially became history, and the wealth management market underwent continuous changes. Under the influence of this new regulation, major financial institutions have transformed one after another, and banks are attempting to break the shackles of traditional bank wealth management products and launch innovative products. Among them, structured wealth management products, with their advantages of controllable returns and risks, have increasingly become the new darling of the bank wealth management industry. This article analyzes a structured wealth management product called "Golden Key · Ruyi", which is issued by the Agricultural Bank of China. This article takes relevant theories as the starting point, analyzes the internal aspects of the product, and ultimately proposes relevant safeguard measures based on the problems identified in the analysis.

Keywords: Financial products; Risk; Optimal design

1 Introduction

The "Golden Key·Ruyi" series of structured wealth management products have been issued by Agricultural Bank of China, one of the state-owned commercial banks under the issuer's jurisdiction, since October 2013. The products have the characteristics of fluctuating returns and do not promise to fully repay the principal at the end of the period. This product is linked to the Shanghai and Shenzhen 300 Index[1].

This article selects the 43rd issue of the "Golden Key·Ruyi" series of structured financial products issued by Agricultural Bank of China in 2019, which is bullish on the Shanghai and Shenzhen 300 Index RMB financial products. The reason for choosing this product for research is because it has representativeness and can be used as a reference for linked targets. According to the basic information of the product, it can be seen that the duration of the product is 90 days, and it does not guarantee the principal situation, and the return can fluctuate up and down, linked to the closing price of the Shanghai and Shenzhen 300 Index.

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2 Main risks of the product

For this product - the "Golden Key Ruyi" stock linked structured wealth management product, during its issuance process, for the issuer, while selling the product to investors, it is equivalent to linking their own income with the value of the product. For investors, if they want to obtain their expected returns from the products they purchase, they must have a clear understanding of the future returns of the products in the early stages of product selection, have a certain level of risk tolerance, and be prepared for potential losses[2]. Therefore, it is necessary to carry out risk management. Based on the characteristics of the product, this section mainly divides the risks that the product may encounter into four categories: market risk, liquidity risk, credit risk, and legal risk. The specific classification is as follows.

2.1 Market risk

For the products analyzed in this article, the main market risks they face are systemic risk and the price fluctuation risk of the Shanghai and Shenzhen 300 Index to which they are linked. The Shanghai and Shenzhen 300 Index to some extent reflects the basic situation of China's two major securities markets, Shanghai and Shenzhen, and has strong representativeness[3]. And this index is selected from two major securities market entities, the Shanghai Stock Exchange and the Shenzhen Stock Exchange, whose positions in the securities market are self-evident. Therefore, from an overall perspective, this index can accurately reflect the returns of market investors when investing. Another important aspect is interest rate risk. When investors choose to purchase a certain product, they will consider future interest rate changes, which can cause changes in the discount rate or have an impact on short-term market instruments. If interest rates decline, the cost that issuers need to bear increases, which is detrimental to the interests of issuers.

2.2 Liquidity risk

Liquidity risk refers to the inability of investors to redeem products at any time during their lifespan, resulting in investors not having the opportunity to negate their decisions even if they find that the current economic situation is not favorable to them. This puts investors in a disadvantageous position; For issuers, due to various reasons, they may have the ability to repay but cannot monetize their assets at a satisfactory price to obtain liquid funds. In addition, for investors, they also need to bear a certain opportunity cost when handing over their funds to banks to purchase wealth management products.

For both issuers and investors, there is still an issue of information asymmetry between the two. Many do not have professional guidance or blindly follow the trend, only purchasing products that most people tend to buy, which may cause unexpected losses. Once there is a loss, some investors with weak psychological resilience may lose trust in the bank. For issuers, if early redemption clauses are added to give investors the opportunity to "turn around", it will invisibly cause losses to the issuer. If investors all redeem their previously purchased products, it will be uncontrollable for the issuer and unable to save their chaotic situation.

2.3 Credit risk

For structured wealth management products, although they have become a relatively mature standardized financial derivative, there is still a possibility of default on the counterparty of the issuer's investment in the product. Because options are a product that has both buyers and sellers, once a default occurs, regardless of whether it causes economic losses to investors or not, the reputation and even credit rating of the issuer or bank will be affected. In other words, there will be a significant loss to the possibility of a group of banks who originally intended to hand over their funds to their trusted banks. If a default occurs, the issuer will do its best to allocate the net value of the product to investors. Therefore, in order to avoid such losses for issuers, it is required that issuers carefully investigate and study the credit situation of counterparties when selecting them, and choose counterparties with certain financial strength. Strict credit ratings can be applied to counterparties, and based on the results of credit ratings, counterparties with high credit ratings can be selected for cooperation.

3 Product risk measurement

3.1 Data processing

This article uses the 135 day closing price data of the Shanghai and Shenzhen 300 Index from September 21, 2018 to April 17, 2019. The closing price on September 21, 2018 is used as the opening price, and the closing price on each subsequent day is used as the closing price. And calculate the daily return rate for 134 days from September 22, 2018 to April 17, 2019 for empirical testing. Firstly, the data is preprocessed by taking logarithms,see equation (1)for an example. The reason for this is that on the one hand, it can reduce the absolute value of the data, and on the other hand, the correlation between the data will not change. Most importantly, it can make the data run more smoothly.

$$R_t = \ln(P_t / P_{t-1}) = \ln(P_t) - \ln(P_{t-1}) \tag{1}$$

Among them, Pt represents the closing price of period t, and Rt represents the yield. The daily return of the Shanghai and Shenzhen 300 Index is calculated based on the raw data during the sample period, and sorted by time. The results are shown in Table 1.

Table 1. Daily yield of CSI 300 index

Trading Day	closing price	Yield	Serial Number
2018-9-21	3410.4856	-	1
2018-9-25	3379.8043	-0.009036877	2
2018-9-26	3417.2413	0.01101578	3
2018-9-27	3403.5902	-0.004002772	4
2018-9-28	3438.8649	0.01031063	5
2018-10-8	3290.8988	-0.043980727	6
2018-10-9	3288.6906	-0.000671227	7
2018-10-10	3281.5978	-0.002159054	8
2018-10-11	3124.1139	-0.049179747	9
2018-10-12	3170.7262	0.014809956	10
2018-10-15	3126.4516	-0.014061959	11

2018-10-16	3100.9738	-0.008182496	12
2018-10-17	3118.2463	0.005554569	13
2018-10-18	3044.3918	-0.023969617	14
...	...	...	...
2019-3-28	3728.3953	-0.004013104	122
2019-3-29	3872.3412	0.037881359	123
2019-4-1	3973.928	0.025895741	124
2019-4-2	3971.2852	-0.000665256	125
2019-4-3	4022.1566	0.012728456	126
2019-4-4	4062.2309	0.009914079	127
2019-4-8	4057.2286	-0.001232176	128
2019-4-9	4075.4301	0.004476157	129
2019-4-10	4085.847	0.002552764	130
2019-4-11	3997.5778	-0.021840423	131
2019-4-12	3988.6168	-0.002244124	132
2019-4-15	3975.5244	-0.00328784	133
2019-4-16	4085.7891	0.027358216	134
2019-4-17	4087.2398	0.000354997	135

3.2 Historical simulation method for calculating VaR

The historical simulation method refers to the assumption that the current asset yield of a product will change along the past path. This method uses numerical values calculated from historical data to simulate the current value change. The calculation method of historical simulation method is relatively simple. It only needs to calculate historical data and does not require the data to meet a normal distribution. Only historical data can be used to analyze patterns.

Based on this, the relevant assumptions of the VaR model are as follows: H_1: return on assets follows normal distribution; H_2: the peak and thick tail characteristics exist.

Given a portfolio,see equation (2) for an example.W_0 isthe initial value of the portfolio,W is the final value, and R is the investment return rate of the portfolio during a certain holding period.Give the definition: μ is the expected value of R, σ is the standard deviation of the investment return rate, α is the confidence level.This then exists:

$$W = W_0(1+R) \tag{2}$$

Therefore, it can be concluded that the value performance of this portfolio is at least $W^* = W_0(1+R^*)$. At the same time, the VaR can be specifically divided into two categories: relative loss and absolute loss.Among them, the relative loss is the amount of the difference from the mean value, which is expressed by the formula(3):

$$VaR = E(W) - W^* = W_0\mu - W_0R^* = -W_0(R^* - \mu) \tag{3}$$

The absolute loss is the loss relative to the initial value, which is expressed by the formula(4):

$$VaR(0) = W_0 - W^* = -W_0R^* \tag{4}$$

For VaR in the parametric distribution, $R \sim N(\mu,\sigma^2)$ is satisfied if the portfolio yield R follows a normal distribution.Order $A=\frac{R-\mu}{\sigma}$, then it has A follows the standard normal distribution, namely A~N（0,1）, let $\varphi(a)$ is the probability density function of A, then it has equation (5):

$$\int_{W^*}^{x} f(w)dw = \int_{R^*}^{\infty} f(r)dr = \int_{A^*}^{\infty} \varphi(a)da = C \tag{5}$$

Among them,there is $A^*=\frac{R^*-\mu}{\sigma}$,Then find A^* and find R^* and then find the VaR, namely equation (6) and (7):

$$VaR(average) = -W_0 A^* \sigma \tag{6}$$

$$VaR(zero) = -W_0(A^*\sigma + \mu) \tag{7}$$

Table 2. Daily yield margin of CSI 300 index

Serial Number	Trading Day	closing price	Yield	Yield Spreads	Sorted Yield Difference	REORDER
1	2018-9-21	3410.4856	-	-	-	-
2	2018-9-25	3379.8043	-0.009036877	-	-	-
3	2018-9-26	3417.2413	0.01101578	0.020052657	-0.069857374	133
4	2018-9-27	3403.5902	-0.004002772	-0.015018552	-0.069177387	132
5	2018-9-28	3438.8649	0.01031063	0.014313403	-0.054291357	131
6	2018-10-8	3290.8988	-0.043980727	-0.054291357	-0.047020693	130
7	2018-10-9	3288.6906	-0.000671227	0.0433095	-0.04337989	129
8	2018-10-10	3281.5978	-0.002159054	-0.001487826	-0.034671418	128
9	2018-10-11	3124.1139	-0.049179747	-0.047020693	-0.033339786	127
10	2018-10-12	3170.7262	0.014809956	0.063989703	-0.032732249	126
11	2018-10-15	3126.4516	-0.014061959	-0.028871915	-0.03220709	125
12	2018-10-16	3100.9738	-0.008182496	0.005879463	-0.030276003	124
13	2018-10-17	3118.2463	0.005554569	0.013737065	-0.029524186	123
14	2018-10-18	3044.3918	-0.023969617	-0.029524186	-0.028871915	122
15	2018-10-19	3134.9455	0.029310646	0.053280262	-0.027003219	121
...	...	...	...	...	...	...
121	2019-3-27	3743.3878	0.011539623	0.022928943	0.025257313	15
122	2019-3-28	3728.3953	-0.004013104	-0.015552727	0.025907716	14
123	2019-3-29	3872.3412	0.037881359	0.041894462	0.026040601	13
124	2019-4-1	3973.928	0.025895741	-0.011985618	0.027681688	12
125	2019-4-2	3971.2852	-0.000665256	-0.026560997	0.028195714	11
126	2019-4-3	4022.1566	0.012728456	0.013393712	0.028414825	10
127	2019-4-4	4062.2309	0.009914079	-0.002814377	0.030646056	9
128	2019-4-8	4057.2286	-0.001232176	-0.011146255	0.035538182	8
129	2019-4-9	4075.4301	0.004476157	0.005708333	0.041746125	7
130	2019-4-10	4085.847	0.002552764	-0.001923394	0.041894462	6
131	2019-4-11	3997.5778	-0.021840423	-0.024393187	0.0433095	5
132	2019-4-12	3988.6168	-0.002244124	0.019596299	0.050378977	4
133	2019-4-15	3975.5244	-0.00328784	-0.001043717	0.053280262	3
134	2019-4-16	4085.7891	0.027358216	0.030646056	0.060120383	2
135	2019-4-17	4087.2398	0.000354997	-0.027003219	0.063989703	1

When calculating the VaR value of this product, 135 sample data from September 21, 2018 to April 17, 2019 were preprocessed in chronological order. The returns on each adjacent trading day were subtracted. After calculating the difference, the calculated difference was arranged in

ascending order. This difference can represent the possible fluctuations during this period, as shown in Table 2. In Table 2, at a 95% confidence level, find the difference value corresponding to the quantile, with a confidence upper limit of 133×95%=126.35≈126. So the absolute difference in the yield difference in row 126 of column 5 is the VaR value of the obtained product, which is 2.8415%. This value represents a maximum volatility of 2.8415% for the next stage of the closing price. According to the analysis of this product in this article, it can be seen that the option embedded in the product is a call option, so the maximum loss calculated by the historical simulation method for this product is -3.2732%.

3.3 Monte Carlo simulation method for calculating VaR

The article introduced the historical simulation method and applied it for relevant calculations. However, in terms of historical simulation method itself, this method is only a path estimated for a certain length of time in the future based on the historical changes in product returns. The Monte Carlo simulation law simulates the random change path of the market based on its historical changes, and obtains the VaR value of the product by simulating a large number of change paths.

Therefore, this section uses Monte Carlo simulation to calculate the value at risk of the product. Firstly, it is assumed that the Shanghai and Shenzhen 300 index prices of the linked targets of the product are independently distributed, and historical price fluctuations can replace future price fluctuations of the linked targets. The price fluctuations of the stock index follow the Brownian motion. Afterwards, the stock index price was simulated, and as the number of simulations continued to increase, it approximated the actual price trajectory. The closing price of the Shanghai and Shenzhen 300 Index on April 25, 2019 is still used as the opening price S0=3941.82, and the risk-free interest rate is 2.625% of the 3M interest rate value on the product's maturity date of July 24, 2019, with a standard deviation of 0.25174. Using Matlab software for Monte Carlo simulation, simulate the changes in the CSI 300 index over 90 days and repeat the simulation 10000 times to obtain the price curve as of July 24, 2019, as shown in Figure 1.

Due to the different closing prices of the linked products, the corresponding final yield also varies. According to the results of Monte Carlo simulation, the opening price S0=3941.82, and the probability of the Shanghai and Shenzhen 300 Index being lower than its execution price at maturity is 29.0412%, which is converted into a percentage change of 3.0163%.

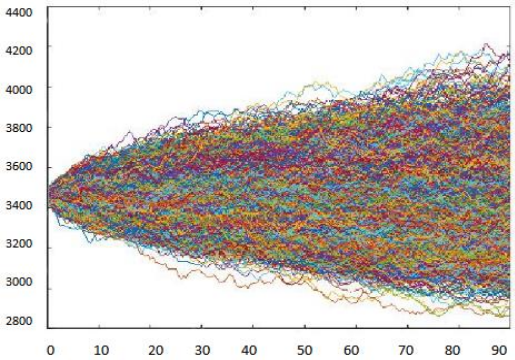

Figure.1.Price trend of CSI 300 index

3.4 Comparison of VaR values under two calculation methods

Based on the results of the historical simulation method and Monte Carlo simulation method used earlier, the VaR values calculated by the two methods are compared as shown in Table 3:

Table 3. Comparison of VaR values under the two calculation methods

method of calculation	VaR value	Opening price
Historical simulation method	3.2732%	3941.82
Monte Carlo simulation	3.0163%	3941.82

From Table 3, it can be seen that the VaR values calculated using historical simulation and Monte Carlo methods are both within the range of 3.0% -3.3%. Among them, the expected loss calculated by the historical simulation method is the largest, with an expected loss of 31.978 yuan, and the corresponding VaR value at this time is 3.2732%. By comparing the results of the two methods, it can be found that the calculation results under the two methods are relatively similar. Compared with the historical simulation method, the Monte Carlo method is based on past historical data for calculation, which may have some deviation. In contrast, the Monte Carlo method can better reflect the risk level of this product. However, the deviation between the two methods in terms of results is very small, and the results of Monte Carlo method are slightly smaller, which to some extent will more accurately reflect the true situation of the product's risk.

4 Product guarantee measures

4.1 Government aspects

Due to the special nature of the products studied in this article being linked to financial derivatives, their risks are more hidden, and risk transmission is more complex compared to other traditional wealth management products[4]. Furthermore, this series of products has higher returns compared to traditional products, which will to some extent attract some investors with higher risk tendencies to choose this type of product. This particularity suggests that relevant government regulatory departments should increase their regulatory efforts in relevant fields, prevent the occurrence of arbitrage through regulatory loopholes, and recognize the existence of product market risks. While strengthening regulatory efforts, attention should also be paid to financial innovation to better play a role in the development of the real economy.

4.2 Commercial banks

When designing the product, the actual needs of investors should be taken into account.For investors, different investors have different needs, which requires commercial banks to accurately classify the range of customers targeted for the product at the early stage of product design[5]. In the process of product design, it is different from person to person. After all, different investors have different needs.For example, for investors around the age of 60, they have reached the retirement age and have a stable income every month[6]. Often, their children have a stable job or have a family, and their children do not need their parents' investment.For

such investor groups, commercial banks can fully consider that they are more likely to be unwilling to bear the risk of the losses possibly caused by investment in financial products[7]. Therefore, this important factor should be fully considered in the design of products targeting these investors.

4.3 Investors

When choosing a wealth management product, first of all, you should carefully read the product manual in your hand, consult the staff in a timely manner if you don't understand anything, and inquire in detail about the relevant issues of your wealth management advisor's product, such as whether the product can be redeemed in advance, the linked target of the product, and the investment period of the product[8]. Having a detailed understanding of the financial products one is about to purchase can help avoid feeling confused when choosing financial products[9][10].

5 Conclusions

This article analyzes a structured wealth management product called "Golden Key·Ruyi", which is issued by the Agricultural Bank of China. The risk of the product is analyzed from the qualitative and quantitative parts respectively, and the Monte-Carlo simulation method and historical simulation method are used in the quantitative analysis respectively. By comparing the results, we can see that Monte Carlo method is more suitable for the risk analysis of the product. Finally, from the government, commercial banks, investors three aspects of product protection measures

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