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The Study on Structural Financial Products:

Take A-Type Financial Product as an Example

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Abstract

Equipped with complex design structure and a wide variety of hooked targets, SFP makes it difficult for investors to effectively measure their returns and risks. This paper uses a specific A-type SFP of a concrete bank as a research object for analysis. Firstly combing the research status and research ideas of domestic and foreign SFP based on domestic and foreign academic literature, the paper gives a brief introduction and preliminary analysis of the basic situation of A-type SFP. Subsequently based on *VaR* mode, the market risk analysis method , this paper analyzes the relevant data of A-type SFP, and uses the Monte Carlo simulation

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method to simulate the future price trend of the asset and calculate the corresponding expected return and *VaR* value. By evaluating and analyzing the expected return and *VaR* value, it proposes corresponding measures for the issuers and investors of the SFP, which will contribute to a certain reference for the healthy development of the bank's SFP.

Keywords: SFP; market risk; *VaR* ; Monte Carlo simulation method

1. Introduction

Structured financial product (Hereinafter referred to as SFP) are innovative financial products based on financial engineering technology that combines fixed income with derivative options. At present, the S&P Structured 500 Structured Index Bond (SPIN) is the world's first SFP recognized by academia, which is issued by Solomon Structured Brothers Investment Banking Corporation in 1986. The beginning of China's SFP can be traced back to 2003, such as Bank of China's "Huijubao". In recent years, the market share of the structured financial business increased significantly in China.

Despite the rapid development of China's structural financial products, many domestic researches indicate that there are still many problems. The development and investment of SFP started relatively late in China, which shows financial derivatives market is imperfect. The products are numerous and chaotic, and the market lacks development vitality and stamina(Zhihao Li 2019). Secondly, there is a cognitive bias between the the actual return and the expected maximum return in investor’s perception. The investors are attracted by the expected maximum return and capital preservation treaty, which has led to an irrational purchase behavior(Qian Zhang2011). Therefore, based on the structured financial business under the general environment of sustainable development, in-depth study of the problems faced by SFP and the offer of relevant solutions can provide reference for China's commercial banks to further develop competitive structured financial products. And it can also help investors screen financial structured products more effectively.

2. Review of Literature

The academic research of foreign SFP is ahead of China in terms of research content and research methods. In terms of research content, John D Finnerty (1993) conducted a pricing analysis study on Australian Index Growth Notes (SIGN). Wilkens (2005) conducted a large-scale data study on structured products in the German and found that most products are at a premium. In terms of research

methods, Chen.K.C and Sears. R.S (1990) first adopted split pricing method to analyse pricing of SPIN500. Wallmeier and Diethelm(2008) used a multi-fork tree model to perform pricing analysis on multi-asset bonds with embedded barrier options.

Domestic scholars' research on SFP mostly focuses on product development status and products' pricing. For example, Lihong Zhai and Xing Zhang(2009) believed that although China's SFP are developing rapidly, the development of SFP is still in the embryonic stage. Liang He(2012) used the Cholesky decomposition method to study the pricing of the bank of China's 09001A SFP. In recent years, the focus of domestic literature research has also turned to the analysis of market risk. Li Liu(2008) adopted value-at-risk to conduct empirical analysis on non-guaranteed floating income financial products.

Through the comparison of domestic and foreign literature research, there exists plenty of problems such as the immaturity of SFP market , the shortage of product R&D, which determines that SFP has considerable risks. Thus the paper selects a non-guaranteed floating return SFP, a concrete bank-A-type SFP. Based on the qualitative analysis of its current situation, the *VaR* value of the product is calculated by the *VaR* model and the quantitative analysis of the market risk is carried out. Finally, the paper provides optimization suggestions for the problems highlighted by the current situation of market risk management and empirical results.

3. Case Selection

3.1 Introduction of "A-type" SFP

The A-type SFP, linking to the closing price of CSI 300 Index, is 6-month structured RMB financial products with a single period of 181 days.

3.2 Selection Reasons of A-type SFP

There are two main reasons for Selecting the A-type SFP as the research object: Firstly, equipped with the typical characteristics of SFP, A-type SFP is representative that can be studied and analyzed. Secondly, it is feasible that A-type SFP possesses the structure of "fixed return + option income" like most standard SFP in the finance market, being convenient for measurement and analysis.

Table1. Basic information of A-type SFP

Product parameter structure	Exercise price: 100.00%, Barrier price: 110.00%, Participation rate 60.00% Expected minimum yield: 2.50%, Expected knockout yield: 5.00%
Calculation of product yield under different scenarios	(1)If the ratio of "the closing price of the CSI 300 Index to the closing price of the starting day" was greater than the barrier price during the observation period, then r = 5%; (2) If there is no (1) situation during the product observation period, it is as follows: ①When T <exercise price, r = 2.5%; ②When T> = exercise price, r = 2.5% + 0.6 × (T-1)

Notes: T = Closing price of the CSI 300 Index on the observation day / Closing price of the starting day.

4. Empirical analysis of A-type SFP

4.1 Sample Data Source and Processing

A total of 184 samples of historical data as a time series to estimate market factors, was selected from the CSI 300 Index daily closing price from May 10, 2019 to February 11, 2020, released by China Securities Index Co., Ltd. Choose the closing price and yield from the CSI 300 Index as explanatory variables of the sample data, and take the closing price of May 19, 2019 (P = 3730.4513) as the opening price, following daily closing price being used as the ending price. The paper takes the logarithmic yield of CSI 300 Index closing price. Defines it as:

$$r_t = \ln(P_t - P_{t-1} / P_{t-1}) = \ln(P_t / P_{t-1}) \quad (1)$$

r_t : logarithmic yield of CSI 300 Index closing price of the t period.

P_t : the closing price of the t period.

4.2 Normality Test of Data

Whether the logarithmic yield series of CSI 300 Index closing price conforms to the normal distribution, this paper selects the comparative analysis of the skewness and kurtosis of the sample data and the normal standard value. Compared with the normal standard value(skewness=0,kurtosis=3), the skewness and kurtosis values of the sample data are -1.872, 13.790 respectively, which

shows the distribution is left-biased and has the characteristics of sharp peaks and thick tails and the logarithmic yield of CSI 300 Index closing price does not follow a normal distribution.

Table 2. Statistical characteristics of sample data inspection

Number of valid samples	183
Minimum	-0.0820879
Maximum	0.0298467
Average	0.0003159
Median	0.0003448
Standard deviation	0.015553044
Skewness	-1.872
Kurtosis	13.790

4.3. Randomness Test of Data

If there is no correlation between the items of the sequence, it indicates that the sequence is irregular. Then the autocorrelation analysis chart of the logarithmic yield series of CSI 300 Index closing price generated by software Eviews is used to determine whether the returns of each period are relevant. Under 36 during the lag period, both the AC and the PAC are close to 0, which means that the items in the series are uncorrelated, so it can be considered that the logarithmic yield series of CSI 300 Index closing price is random.

4.4 Stability Test of Data

If the mean and variance of the logarithmic yield series of CSI 300 Index closing price change with time, and the periodic changes are strictly eliminated, and there is no systematic change, it means that it is a stable random process.

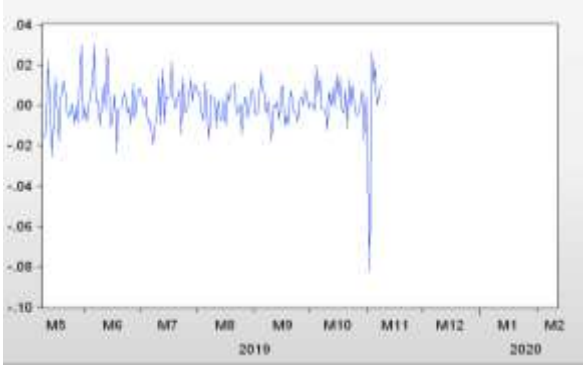

Figure 4. Time series of CSI 300 Index yield series

According to the Figure 4, the logarithmic yield series of CSI 300 Index closing price fluctuates around zero value and there is no obvious upward or downward trend, which can be considered that the sequence is stationary.

Table3. ADF Test of the logarithmic yield series of CSI 300 Index closing price

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.82221	0.0000
Test critical values:	1% level	-3.466377	
	5% level	-2.877274	
	10% level	-2.575236	

And the statistical value of the ADF test is -12.82221, far lower than the ADF test critical value of -3.466377 at the significant level of 1%, and the P value is 0 , indicating that the null hypothesis of unit root of this series is significantly rejected, and the logarithmic yield series of CSI 300 Index closing price is stable.

5.5 Theoretical Model Establishment

VaR , Value at Risk, is defined as a financial asset or its combination may suffer the maximum potential loss under a certain confidence level and holding period. Thus referring to J.P. Morgan (1996) and Philip Jorry (2000), the VaR function of SFP is:

$$Prob(\Delta P > VaR) = 1 - c \tag{1}$$

In equation (1)[2] ΔP and VaR respectively represent the loss of value during the asset holding period and the maximum loss value at the confidence level c . A high confidence level means that investors have a higher degree of risk aversion. Suppose that the return rate of the SFP is R , and initial value is the price P_0 , and that there is a minimum return value of the asset P^* at a certain confidence level c . According to the definition of VaR , there is:

$$VaR_R = E(P) - P^* \tag{2}$$

Equation (2) is the average VaR_R . If the initial value is defined as the benchmark, the absolute VaR_A is:

$$VaR_A = P_0 - P^* \tag{3}$$

Assuming that the probability density function of future return rate is $f(r)$,

[2] Equation (1) can also be expressed as Prob（△P<VaR）=C

for a certain confidence level c, the minimum asset value R^* is:

$$1-c=\int_{-\infty}^{R^*} f(r)dr \tag{4}$$

So far, the calculation of the VaR value of SFP is to find the probability density function and specific statistical distribution of the future return of the asset.

5.6 Empirical Analysis Based on VaR Model

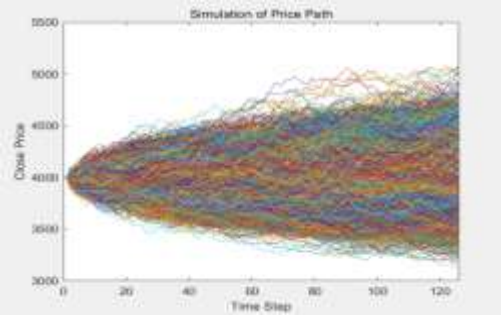

Figure 5. CSI 300 Index closing price simulation trend chart

The paper selects the closing price of the CSI 300 Index from May 10, 2019 to February 11, 2020 as historical data to estimate the parameter value. With the help of MATLAB programming, MC simulation succeeds to simulate the CSI 300 Index closing price of the 126 trading days 10000 times. Simulated by MATLAB, closing price trend of the CSI 300 Index in the next 126 trading days is shown in the figure5.

Based on the data, the simulated regularity of probability distribution for the expected return rate of the product is shown in the following table:

Table3. The simulated probability distribution of the expected return rate of product A-type SFP

Expected annual rate of return	2.5%	2.5%+0.6*（T-1）	5%
Simulated probability	47.63%	39.11%	13.26%

Notes: T = Closing price of the CSI 300 Index on the observation day / Closing price of the starting day.

According to the simulated random sample data, there is a 13.26% probability of being able to break the 110% barrier price, where the expected knockout rate of 5% will be obtained. If the future closing price falls continuously

below 100% exercise price, there is a 47.36% probability of obtaining a 2.5% expected minimum return rate. In addition, there is 39.11% probability of obtaining an expected return rate between 2.5% and 8.5%, in which the distribution is basically equal this income range. And with the help of computer, the average expected return rate is 5.64% . Thus expected return rate of simulation of A-type SFP: 39.11% × 5.64% + 47.36% × 2.5% + 13.26% × 5% = 4.053%. Assuming that the initial subscription amount is 1 million yuan, the probability distribution of simulated expected ending value of A-type SFP can be calculated at the following table:

Table 4. The probability distribution of simulated expected ending value of A-type SFP

Simulated expected ending value	Probability distributions
$P_H = 1000000 \times (1+5.64\% \times 181/365) = 1027968.22$	39.11%
$P_M = 1000000 \times (1+5\% \times 181/365) = 1024794.52$	13.26%
$P_L = 1000000 \times (1+2.5\% \times 181/365) = 1012397.26$	47.63%
Expected ending return: $E(P) = 1000000 \times (1+4.053\% \times 181/365) = 1020098.44$	

Obviously, under any given confidence level, the expected minimum ending value P_L is 1012397.23.The bank 's half-year fixed deposit interest rate is 1.55%, and the time cost of the initial investment can be calculated as: 1000000 (1 + 1.55% / 2) = 1007750. Therefore, based on the above data, we can calculate: $VaR_R = 7701.18$, $VaR_A = -4647.26$.

From the above calculation results, we can see that the risk of this financial structured product is relatively low, which is consistent with the bank's risk assessment results. In terms of expected return, the probability that the user obtains a guaranteed return is 47.63%, close to half. Although the simulation results show that it is only 13.26% probability that the product can touch the barrier price, there is nearby 40% probability that it can break the exercise price and obtain 5.5% of the simulated expected return. However, from the perspective of market risk, it is acceptable that the average loss value VaR_R is 7701.18, which means the investment of 1 million yuan may lose 7701.18 yuan. And the absolute loss value VaR_A indicates that compared with the semi-annual fixed deposit of the same period, the market risk loss value is 4647.26 yuan that is not too large.

5. Research Conclusions and Suggestions

5.1 Research Conclusion

Taking a bank's " A-type SFP" as the research object, we use the *VaR* model

to calculate the *VaR* value of the product and conduct a quantitative analysis of market risk. By selecting typical case to study the current situation of SFP market risk management , relevant optimization suggestions are given to predict and control product market risks. Whether it is the expected return from the simulation or the product *VaR* value, the design of the A-type financial product is generally reasonable.

The world is facing severe COVID-19 epidemic when this paper is being written, severely affecting the economy. Hence biasing the model analysis, the economic impact of COVID-19 epidemic is not taken into consideration when the paper conducts empirical study. However, the overall impact is not large, and it is a good way to use the *VaR* value to measure the benefits and risks of SFP.

5.2 Suggestions for Issuers

Above all, boost the risk management of SFP. In advance of product design, not only should product designer take account of the target customer group preferences and risk tolerance, but custom-made products with an innovative and pragmatic attitude. The second is to standardize the release of product information to enhance product information transparency. Thus purchaser can completely grasp the product risk return and operational direction, and base on their own risk preference to make a proper investment decision.

5.3 Suggestions for Investors

Firstly, choose products according to your risk preference and fully figure out what uncertain risks exist in financial products and their linked targets. Secondly, to check the product specification in detail, do not blindly follow the trend to choose products. Finally, to boost financial theory capacity, learn how to quickly and effectively distinguish the potential risks of SFP.

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