

# Research on Pricing and Risk of Structured Wealth Management Products of "HuiYi ZhiXuan"

Yan-liang Zhang\*, Qing-chao Bai

School of Finance  
Shandong University of Finance and Economics  
Jinan, China

\*Corresponding Author: yan-liang Zhang  
E-mail: zhyanliang@sina.com

Le-ya Zhang

Stirling Management School  
University of Stirling  
Stirling Scotland United Kingdom

**Abstract**—The design terms of structured wealth management products are complex, and the variety of targets is linked, making it difficult for investors to grasp the true benefits and risk characteristics of the products. This paper selects "HuiYi ZhiXuan" series of structured wealth management products issued by HSBC as a case to study its pricing and risks. In terms of pricing, introducing time-varying volatility, using the GARCH(1,1) model to describe the price fluctuations of the underlying asset, and through the Monte Carlo simulation method on the basis of discounted cash flow, it is found that the product has a certain degree of pricing deviation; In terms of risk, the VaR method is used to quantify the market risk of the product and it is found that the product has higher risk, rational investors should choose carefully. Finally, based on the issuer and investor perspective, the corresponding countermeasures and suggestions are given.

**Keywords**—pricing; risk; structured wealth management products; Garch

## I. INTRODUCTION

The essence of structured wealth management products is an innovative financial investment product that integrates fixed-income bonds with financial derivatives based on financial engineering. The issuer invests most of the funds raised in risk-free assets and puts the remaining funds in high-risk, high-yield derivatives markets. This design structure allows investors to achieve higher returns based on risk tolerance. The financial derivatives of its connotation are often options that are linked to certain underlying assets such as stocks, stock indexes, interest rates, and foreign exchange. Compared with ordinary wealth management products, structural products have the characteristics of higher income level, more choices, more complicated structure and poor liquidity. Although China's structured wealth management products have developed rapidly in recent years, due to late start, whether in terms of pricing or risk management, core technologies still lag behind developed countries to some extent. At this time, it is of great theoretical and practical significance to deepen the pricing and risk research of emerging structural wealth management products.

## II. LITERATURE REVIEW ON STRUCTURED WEALTH MANAGEMENT PRODUCTS

### A. Pricing Research on Structured Wealth Management Products

The key to studying the pricing of structured wealth management products is the reasonable pricing of their embedded options. Fisher Black and Myron Scholes (1973)[1] proposed that stock price volatility obeys the geometric Brownian motion, the B-S model, and has made significant progress in the field of option pricing. Based on this research, Finnerty (1993)[2] splits the stock index growth notes linked to the S&P 500 into two parts, debt and options. The creditor's part is estimated by the present value of the zero-coupon bond, and the option part is priced using the B-S model, which is then widely used in structured product pricing. Domestic related research started late, but there are also a series of rich research results. Fu Yanxia (2011)[3] split the stock-linked wealth management products by pricing the two parts using the discounted cash flow method and the Monte Carlo simulation method to obtain the theoretical price of the product. Gu Qian, Cheng Xiang, Zhou Yong (2017)[4] took the interval stock-linked structured products as the research object, and proposed the pricing method of the products by Monte Carlo simulation method. Wang Youcao (2017)[5] under the hypothesis of risk neutrality and prospects, used the GARCH model to describe the price fluctuations of a structured financial product linked to gold, and used the Monte Carlo simulation to analyze the price.

### B. Risk Research on Structured Wealth Management Products

Foreign scholars have conducted in-depth research on structural product risk issues, especially after the 2008 financial crisis. Wilkens (2003)[6] selected a wealth management product linked to stocks for risk VAR measurement and compared it with five-year bonds and CDs. Wallmeier (2011)[7] analyzes the information disclosure of structured wealth management products, and uses the Leland model to analyze the benefits and risks of products, and intuitively reflects the benefits and risks of structured wealth management products. There are relatively few domestic studies on this aspect, mainly with the following results: Liu Nannan (2010)[8] believes that

the risks of structured wealth management products are mainly operational risks, market risks, legal risks and liquidity risks; Xing Bin (2010)[9] analyzed the risk measures of structural wealth management products based on B-S model, binary tree model and Monte Carlo simulation, and introduced VAR indicators; On the basis of fuzzy mathematics theory, Jiao Yujia (2018)[10] used the fuzzy evaluation method to quantitatively analyze the two structural wealth management products of China Merchants Bank. It is found that the risk factors affecting the product are not only the target market risk, but also the investor credit risk and interest rate risk

### III. CASE SELECTION

HSBC's structured wealth management products are mainly divided into six series, and "HuiYi ZhiXuan" series focuses on short and medium term, mainly linked to high-quality ETF funds, it is a non-guaranteed floating income product with a risk level of moderate risk. The case object selected in this paper is 3 months of bearish RMB structured investment products, 001 of "HuiYi ZhiXuan" series. The product is linked to the Southern FTSE China A50 ETF Trust Fund (2822 HK), and the level of earnings is determined by the price observed on the final valuation date. If the performance of the linked asset A50 ETF is equal to or lower than the trigger level of 97% on the final valuation date, the investor receives the principal and potential coupon, at which time the annual return is 12%; If the performance level on the final valuation date is higher than 97% but lower than or equal to 100%, the investor can get the full principal, and the annual return rate is 0%; If the performance level on the final valuation date is higher than 100%, the investment principal due for payment will be determined by the performance level, with a minimum of 97% of the investment principal.

This article selects this product as the research object, mainly based on the following reasons: 1. This product is a representative product in the linked ETF fund management products, and is also very representative in terms of complexity and benchmarking. 2. The product was released in September 2018 and is time-sensitive. 3. The product structure is clear, the relationship between the target and the revenue is direct, and the relevant data is easy to obtain, which is conducive to the establishment and simulation of the model.

### IV. EMPIRICAL STUDY ON THE PRICING OF "HUIYI ZHIXUAN" SERIES OF WEALTH MANAGEMENT PRODUCTS

This paper splits the selected products into fixed-income bonds and option contracts for pricing studies, finally, summarize it. For the fixed-income bond component, the cash flow discount method is used for pricing. For the pricing of option contracts, this paper introduces the GARCH model based on time-varying volatility. The Monte Carlo simulation method is used to perform 100,000 simulation operations on the established GARCH model to obtain the price of the underlying asset valuation date, then, the price of the option part is obtained, and finally the theoretical price of the product is summarized.

#### A. Data Selection

The final income of this product is linked to the closing price of the South China FTSE China A50 ETF (2822 HK) on December 12, 2018. Therefore, a simulation analysis of its closing price is required. It is usually necessary to take nearly two years of data processing when modeling the changing path of the underlying asset. Therefore, the historical data collected by this article is from September 12, 2016 to September 11, 2018, with a total of 495 data, mainly using its logarithmic rate of return.

#### B. Descriptive Statistics

Table I is a descriptive statistical indicator of logarithmic yield data. It can be seen that the skewness of the logarithmic yield is -0.2109211 and the kurtosis is 5.068309. This series of yields shows the characteristics of the general peak and thick tail of the financial time series.

TABLE I. DESCRIPTIVE STATISTICS

index	Numerical value
N	495
Mean	0.002272
Standard deviation	0.0114929
Variance	0.0001321
Skewness	-0.2109211
Kurtosis	5.068309

#### C. ARCH LM test

From the above descriptive statistics, we can find that there is a phenomenon of volatility aggregation in the logarithmic rate of return series, so that the existence of the ARCH effect can be preliminarily judged. Using (1), the ARCH LM test is performed on the first ten steps of the residual of the time series. The test results are shown in Table II.

$$R_t = C + \mu_t \quad (1)$$

TABLE II. ARCH-LM TEST

Lag(p)	chi2	df	Prob>chi2
1	4.969	1	0.0258
2	14.184	2	0.0008
3	42.194	3	0.0000
4	49.752	4	0.0000
5	49.896	5	0.0000
6	51.338	6	0.0000
7	51.320	7	0.0000
8	52.944	8	0.0000
9	55.979	9	0.0000
10	58.923	10	0.0000

It can be seen from Table 2 that the null hypothesis without ARCH effect is highly rejected from the second order, so we can consider using the GARCH model to fit the logarithmic rate of return of the southern A50 ETF fund.

#### D. Model Selection

According to the above conclusions, the GARCH model is designed, considering that there is no low-order autocorrelation in the time series, and thus the mean value equation is set as a white noise process, that is (2):

$$R_t = C + \sigma_t \epsilon_t \quad (2)$$

In this paper, the standard GARCH, GARCH-GED and TGARCH models are selected in the model selection to judge the degree of fitting of the time series, parameter estimation based on the maximum likelihood method, since the test results of the model selection are too large, they are not enumerated in detail. After Bayesian Information Criterion (BIC) screening, GARCH(1,1) is optimally fitted. And further obtain the GARCH model of the yield fluctuation as follows:

$$R_t = 0.0002272 + \sigma_t \epsilon_t \quad (3)$$

$$\mu_t = \sigma_t \epsilon_t \quad \epsilon \sim N(0,1) \quad (4)$$

$$\sigma_t^2 = 0.0007171 + 0.657016\mu_t^2 + 0.9225786\sigma_{t-1}^2 \quad (5)$$

The parameters of the standard GARCH (1,1) model are statistically significant, and the sum of the residual term and the GARCH coefficient in the equation is less than 1, it shows that the oscillating oscillation of the model is convergent, and the model is suitable to describe the change of the logarithmic rate of return of the A50ETF.

#### E. Monte Carlo Simulation Process Based on Standard GARCH(1,1) Model

Considering that there are 63 trading days in the duration of the product, the simulation step size of Monte Carlo is set to unit 1, with a total of 63 steps. In turn, to simulate the change in logarithmic yield and volatility during the product's lifetime, Using the matlab software to repeat the above simulation process 100,000 times, and get the 100,000 simulation price of the A50ETF. Table III is a probability distribution table in which the simulated price p falls within each expected interval:

TABLE III. INCOME DISTRIBUTION TABLE

Interval	Probability	Annualized rate of return
$P \leq P_0 * 0.97$	32.44%	12%
$P_0 * 0.97 \leq P \leq P_0$	7.98%	0%
$P_0 \leq P \leq P_0 * 1.03$	12.06%	$4 * (100\% - (\text{Final valuation date closing price} / \text{initial price}) )$
$P_0 * 1.03 \leq P$	47.52%	-12%

After integrating the 12060 simulated prices falling in the third interval, the average expected yield of the interval is -8.16%. Taking the principal amount of RMB 100,000 as an example, the weighted average value of the product value of each interval is 99301.576. The one-year Shanghai Interbank Offered Rate of 3.55% is selected as the risk-free rate to discount the value of the product, and the final value is 98425.59. That is, the theoretical value of the product with an investment unit of RMB 100,000 is 98425.59, which is lower than the value given by the product of 100,000. The product

has a 1.6% premium rate. This shows that HSBC's structured products still have many problems in pricing design, and it is necessary to further strengthen the pricing rationality of products.

#### V. EMPIRICAL STUDY ON THE RISK OF "HUIYI ZHIXUAN" SERIES OF WEALTH MANAGEMENT PRODUCTS

The risks faced by structured wealth management products generally include the risk of underlying price changes, interest rate and inflation risks, credit risk, liquidity risk, etc. Since the most critical risk of "HuiYi ZhiXuan" of structured wealth management products is the price change risk of the target, the risk measurement of this paper is mainly aimed at the risk of fund price changes. This paper selects the VaR risk measure method to measure the risk of fund price change, and continues to use Monte Carlo simulation method to simulate it. Different from the income distribution table of the products obtained above, in this chapter, based on the VaR value method, the quantile of the income distribution at a given confidence level, that is, the minimum value at the confidence level, is obtained, thereby obtaining the VAR value of different confidence levels of the product.

The product is a three-month period with a one-year Shanghai Interbank Offered Rate as a risk-free rate. According to the above-mentioned 100,000 Monte Carlo simulation results of the 63-day South FTSE A50 closing price, the VaR values of the confidence intervals of the "HuiYi ZhiXuan" wealth management products are shown in Table VI.

TABLE IV. VAR TABLE

Confidence interval	90%	95%	99%
VaR(absolute)	3000	3000	3000
VaR(relatively)	3887.5	3887.5	3887.5

As can be seen from Table 3 above, the probability of the best-case yield of 12% and the worst-case rate of return of -12% is 32.44% and 47.52%, there are obvious gains and risks that are not equal, and buyers have a higher risk of loss. It can be seen from Table 4 that the absolute VaR reaches 3000 in each confidence interval, and reaches 3887.5 with relatively to VaR. This shows that investing in the product will have a loss of 3887.5 compared with the time deposit with the same term structure, so the product is more risky and rational investors should choose carefully.

#### VI. CONCLUSIONS AND SUGGESTIONS

##### A. Research Conclusions

1. Through Monte Carlo simulation, it is found that the theoretical value of "HuiYi ZhiXuan" wealth management products is lower than the issue price. This shows that there are still some problems in the pricing design of HSBC's structured products, and it is very important to further strengthen the pricing rationality of products.

2. Through the risk measurement of the product, it can be concluded that the product yield and risk are not equal, In each confidence interval, the relative VaR reached 3887.5, which

shows that the product has higher risk. As a rational investor, it should be carefully chosen. As the issuer HSBC, the risk management of structured wealth management products should be strengthened.

## B. Suggestions

### 1) Advices for commercial banks

First, at present, China's structural wealth management market does not have a complete market risk management system. Domestic commercial banks should actively learn from the Western developed countries' experience in risk management of such products, and gradually establish a complete market risk management system based on the characteristics of structured wealth management products. And When investors purchase structured wealth management products, bank-related staff should provide professional and detailed guidance. Fully disclose information about risks and benefits, let investors fully understand the various income scenarios of the products and the specific conditions of the targets. Finally, before designing a structured wealth management product, a commercial bank must fully consider the customer's assets and risk-taking ability, Design a diverse range of products to meet a diverse customer base.

### 2) Advices for investors

Investors should choose their own wealth management products based on their own asset status and risk appetite, establish a correct investment concept, and make rational investments. And when purchasing structured wealth management products, investors should carefully analyze the specific terms of the product and its important matters. For example, the term of the product, whether it has redemption conditions, and the degree of protection of the principal. In

particular, it is necessary to fully understand the assets under the target, and must not pursue the highest rate of return given by the product promotion.

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