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Pricing of principal-protected funds in China: are the guarantee fees too high?

Abstract

This paper focuses on the pricing of guarantees for principal-protected funds under the constant proportion portfolio insurance (CPPI) strategy and investigates how the CPPI parameters may affect guarantee prices. In addition, it assesses the fairness of the guarantee fees charged to the current principal-protected funds in China. Our research indicates that some of the funds are charged higher premiums than what our model predicts. The results highlight the major issues of the current pricing method used by the Chinese guarantee funds.

Keywords: CPPI, principal-protected funds, guarantee fee.
JEL Classification: G11, G13.

Introduction

With the rapid growth of Chinese economy over the past three decades, the financial markets in China have dramatically exploded. To meet the huge demand for exploring investment opportunities and to hedge against financial risk inherently involved in these investments, more and more new financial products have been introduced, and they are now actively traded in the Chinese markets. As an integrated part of the markets, mutual and insurance funds are also growing at an unprecedented pace. In the midst of a bear stock market in 2003, the first principal-protected fund in China was created. In contrast to the significant expansion of the general mutual fund industry in recent years, the segment of principal-protected funds has lagged far behind: the total number of such funds in China is a mere eight, as of February 2009.

Principal-protected mutual funds guarantee the investors, at any time, a pre-specified percentage of the initial amount of principal, particularly in falling markets. As with other similar guaranteed investment contracts, these provide investors with a valuable vehicle to hedge against a portfolio's downside risk, while still allowing them to achieve a higher return in favorable markets.

Currently, the value of guarantees on these funds is determined based on experiential pricing approaches in China (see, Chen, Han, and She, 2005). An obvious drawback of this treatment is that it provides a value without explaining why guarantees should be priced as such. If the guarantee fee is priced too high, the management expense ratio will be forced to increase, thereby deterring mutual fund companies from launching principal-protected funds. If the guarantee fee is priced too low, financial institutions providing this service will be exposed to excessive risk, leading to the lack of guarantors. The reasons for the stagnation of funds with guarantees in the Chinese financial markets are diverse; pricing concern is one of them. Therefore, it is crucial to value these guarantees fairly, in order to foster the development of principal-protected funds as well as other innovative financial products with guarantee-related clauses in China.

Guarantees have been extensively studied in existing literature with focuses on deposit insurance and loan guarantees, and multi-period rate of return guarantees embedded in life insurance policies and pension plan contracts. Merton (1977) first demonstrates that deposit insurance and loan guarantees are isomorphic to common stock put options and then, employs the option pricing theory to derive a closed formula for evaluating the guarantee cost. Marcus and Shaked (1984) follow the paradigm of Merton (1977) to estimate proper premium levels that should be charged to banks for the deposit insurance mandated by the Federal Deposit Insurance Corporation (FDIC) in the U.S., and their findings indicate that FDIC has charged a far greater premium than the fair value predicted by the Black-Scholes option-pricing model. With the introduction of various life insurance products with certain guarantee clauses, considerable research has been conducted to price equity linked life insurance policies (see, Brennan and Schwartz, 1976; Boyle and Schwartz, 1977; and Persson and Aase, 1997, among others). Another main arena is that of guarantees on pension plans. Previously, research in this area primarily focuses on defined benefit pension plans as this type of plans was prevalent (see, e.g. Pennacchi and Lewis, 1994). Recent reforms of pension plans have resulted in numerous

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switches from defined benefit to defined contribution plans, exposing pensioners to risks that were nonexistent before. To make the transition smooth, governments usually provide certain guarantee mechanisms to mitigate participants' investment risk. Owing to this new trend, more research has been carried out to provide valuation models for guarantees on defined contribution pension plans (Pennacchi, 1999; and Lachance, Mitchell, and Smetters, 2003). Furthermore, it has been recognized that guarantees embedded in many life insurance and pension plans are not maturity guarantees (Miltersen and Persson, 1999). Instead, a guarantee is provided for each period. For this type of multi-period guarantee, some closed-form formulae have been obtained (Lindset, 2003) and numerical simulations are also proposed to address additional complications caused by stochastic interest rates (Bakken, Lindset, and Olson, 2006). In China, as the financial guarantee industry is still at its inceptive stage, a limited variety of financial products are offered with guarantee policies. Subsequently, existing research on guarantees in China has been confined largely to the valuation of loan guarantees to small and medium businesses (see, Chen, Han, and She, 2005; Yang and Han, 2006; and Chen and Shen, 2004, among others).

As far as the authors know, current guarantee valuation research does not seem to consider the impact of different investment strategies employed to construct the underlying portfolio. Currently, a wide variety of portfolio selection strategies (Perold and Sharpe, 1988), reflecting diverse investment philosophies, are available to allocate funds among different assets. For instance, the constant proportion portfolio insurance (CPPI) method (Black and Jones, 1987) is a widely used investment strategy which has two controllable parameters (a floor and a multiple) to dynamically rebalance the portfolio's exposures to riskless and risky assets, such that the portfolio value will never fall below the floor. It is understandable that different investment strategies will lead to distinct asset allocation schemes and portfolio values, thereby affecting the pricing of associated guarantees. In the Chinese financial markets, due to the lack of other available hedging instruments, the CPPI investment strategy has been adopted by all existing principal-protected funds. Consequently, it is necessary to include this investment strategy to determine the price of guarantees for principal-protected funds.

This paper applies the Black-Scholes option pricing formula to the valuation of the guarantees for principal-protected funds under the CPPI strategy and illustrates the impacts of the CPPI parameters on the pricing of guarantees. Furthermore, we evaluate the current approach adopted by the Chinese guaranteed funds using the market data. The analysis highlights the problems with the experiential pricing approach. Some funds are charged higher/lower premiums than fair values predicted by the model. This partially explains the relatively slow growth of the guaranteed fund industry in China. Our results are of particular interest to practitioners as well as academics, given the fact that CPPI is one of the most important asset allocation strategies employed by guaranteed funds.

The rest of the paper is organized as follows. Section 1 describes the assumptions for our model and analyzes the structure of principal-protected funds to derive its basic properties. Section 2 examines the valuation of guarantees under the CPPI strategy and how it may be affected by different CPPI parameters. Section 3 provides an analysis of the guarantee pricing for the current principal-protected funds in China. The paper concludes in the last section.

1. Model assumptions and guarantee analysis for principal-protected funds

We consider maturity guarantees in this paper. The funds are offered for purchase during a fixed subscription period and are subsequently closed for any new subscriptions. These funds are then locked in for a pre-determined period of time. If an initial investment is held throughout the lock-in period, the investor is guaranteed to receive at least a certain percentage of the principal, which may be more or less than 100% depending on the lock-in period. Any early redemption is not guaranteed and is usually subject to certain penalties; hence, an investor may lose money if the fund falls since his/her purchase. Given these features of principal-protected funds, the following assumptions are introduced for the sake of tractability:

1. The fund is closed for new sales after the subscription period and no early redemption is allowed. This assumption indicates that the principal-protected fund considered here is similar to a closed-end fund.
2. There is no cash dividend to subscribers during the guarantee period. Dividends, if any, will be reinvested in the fund. Usually, a guarantee contract is honored if accumulated dividends plus the redeemed value at maturity are greater than or equal to the guaranteed amount. Therefore, even if there are indeed cash distributions during the guarantee period, the difference from our assumption here is simply the time value of subsequent return of distributions, which is generally negligible.
3. The management expense of the fund is omitted.
4. The riskless interest rate is a constant.

5. The market is frictionless and perfect. No taxes or transaction costs are charged to the fund and securities can be continuously traded in any fractional shares. No information asymmetry exists in the market.

Now, we can analyze the guarantee for principal-protected funds under the aforementioned assumptions. Suppose that the initial public offering collects an amount of V_0 from subscribers, and investors are guaranteed to redeem at least G at maturity. Usually, $G < V_0 \exp(rT)$, where r is the riskless interest rate and T is the guarantee period.

Let V_T be the terminal value of the fund assets at maturity. As per the fund contract, if $V_T \geq G$, investors redeem the full value of the fund portfolio and the guarantor does not have any financial liability. However, if $V_T < G$, guarantee clauses ensure that investors receive an amount of G and the guarantor is required to make up the difference $G - V_T$. Therefore, the payoff for the guarantor at maturity is given by

$$X = \max(0, G - V_T). \quad (1)$$

It is clear that Equation (1) is the same as the payoff of a European put option on the fund portfolio with a strike price of G. As a result, the no-arbitrage option pricing theory can be applied to the valuation of such guarantees.

2. Guarantee pricing based on the CPPI strategy

2.1. Dynamic process of the CPPI portfolio value. Suppose that two asset groups, riskless and risky assets, are considered for constructing a portfolio for the fund. This portfolio is then dynamically rebalanced as per the CPPI strategy to ensure that the portfolio value stays above the floor. In general, the value of the riskless asset B_t follows

$$dB_t = rB_t dt, \quad (2)$$

where r is the riskless interest rate. The dynamics of the risky asset S_t is determined by a classic diffusion process:

$$dS_t = S_t(\mu dt + \sigma dWt), \quad (3)$$

where μ is the expected return of the risky asset and $\mu > r$, σ measures its volatility, and W_i is a standard Brownian motion.

For a principal-protected fund with an initial amount of V_0 adopting the CPPI strategy, denote its initial floor and multiple by F_0 and m, respectively. Here we assume that the floor grows at the riskless interest rate and m is a constant. The cushion, C_t, at time t is defined as the difference between the portfolio value V_t and the floor value F_t; namely, $C_t = V_t - F_t$. The CPPI strategy requires investing $e_t = mC_t$ in the risky asset and $B_t = V_t - e_t$ in the riskless asset. The value of this portfolio of B_t and e_t is then governed by

$$dV_t = V_t\left(\alpha_t \frac{de_t}{e_t} + (1-\alpha_t)\frac{dB_t}{B_t}\right), \quad (4)$$

where $\alpha_t = \frac{m(V_t - F_t)}{V_t}$, representing the exposure percentage to the risky asset.

Bertrand and Prigent (2005) show that the dynamic process of the cushion of the CPPI strategy is given by

$$d(V_t - F_t) = (V_t - F_t)\{(m(\mu - r) + r)dt + m\sigma dW_t\}. \quad (5)$$

They also demonstrate that the value of the portfolio under the CPPI strategy is as follows:

$$V_t = F_t + (V_0 - F_0)\exp\{(m(\mu - r) + r - \tfrac{1}{2}m^2\sigma^2)t + m\sigma W_t\},$$
$$\forall t \in (0, T]. \quad (6)$$

2.2. Guarantee pricing. Now, we can use the formula in Equation (5) to determine the fair value of the guarantee. Two cases may arise: the trivial case of $F_T \geq G$ and the nontrivial case of $F_T < G$.

In the trivial case, as $V_0 - F_0 > 0$ (otherwise, all funds will be placed in riskless assets), Equation (6) indicates that $V_T \geq F_T \geq G$. According to (1), $X \equiv 0$, corresponding to a zero value for the guarantee. Intuitively, if our initial floor F_0 is set high enough, its riskless growth will automatically cover the terminal guaranteed financial liability at maturity. In the following discussions, we focus on the nontrivial case.

In this case, as $F_T < G$, there is a positive probability such that $V_T < G$, hence, $\Pr\{X > 0\} > 0$. According to our earlier discussions, the value of the guarantee is equivalent to the price of a European put option with the cushion as its underlying portfolio and $G - F_T$ as its strike, so long as the parameters of the CPPI are such designed that $F_T < G$. The price of the guarantee P_0 is given by the Black-Scholes (1973) formula:

$$P_0 = (G - F_T)\exp(-rT)N(-d_2) - (V_0 - F_0)N(-d_1), \quad (7)$$

where $d_1 = \frac{\ln\left(\frac{V_0 - F_0}{G - F_T}\right) + (r + 0.5m^2\sigma^2)T}{m\sigma\sqrt{T}}$, and

$d_2 = d_1 - m\sigma\sqrt{T}$, $N(\cdot)$ is the cumulative normal density function.

This result clearly indicates that the value of the guarantee depends on the user-set parameters in the CPPI strategy: the initial floor and the multiple. The choice of both parameters reflects the investor's risk tolerance and entails important consequences for the investment strategy and guarantee pricing. In particular, a more risk-averse investor will set higher floor and lower multiple levels, which implies a less risky portfolio. Contrary to option pricing, the guarantee value is greatly affected by the investment strategy, as well as the investor's degree of risk aversion.

Alternatively, the guarantee price can be expressed as a percentage of the initial total asset value as follows:

$$p_0 = \frac{P_0}{V_0} = (a - f_T)\exp(-rT)N(-d_2') - (1 - f_0)N(-d_1') \quad (8)$$

where $a = \frac{G}{V_0}$ is the guaranteed terminal percentage, $f_0 = \frac{F_0}{V_0}$ is the initial floor ratio, $f_T = \frac{F_T}{V_0}$ denotes the floor proportion at maturity, $d_1' = \frac{\ln\left(\frac{1-f_0}{a-f_T}\right) + (r + 0.5m^2\sigma^2)T}{m\sigma\sqrt{T}}$, and $d_2' = d_1' - m\sigma\sqrt{T}$.

We use an example to illustrate how the CPPI parameters affect the guarantee price. To this end, the Shanghai Stock Exchange Composite Index (SSECI) is selected as the risky asset, and the one-year guaranteed investment certificate (GIC) interest rate is used as a proxy for the risk-free rate. The SSECI is for the period from January 2, 2004 to December 31, 2004, which is obtained from the China Stock Market & Accounting Research (CSMAR) database. There are 243 observations in total and the average daily return is -0.00064 with a standard deviation of 0.013675. Therefore, the annual volatility of the risky asset is estimated as $\sigma = 0.013675 \times \sqrt{243} = 0.213172$. In 2004, the one-year GIC rate is r = 1.98%.

As the lock-in period for the principal-protected funds in China is three years with a terminal percentage of 100%, we convert this value to an equivalent one-year guaranteed percentage as

$$a = 100\% \times \exp(-1.98\% \times 2) = 96.12\%.$$

Given this input information, we calculate the guarantee prices for multiples ranging from 1 to 8 with an increment of 1 and floor ratios varying from 60% to 90% with an increment of 5%. Results are displayed in Table 1.

Table 1 illustrates that for a given floor ratio f_0 the guarantee price increases as the multiple m increases. Conversely, with a fixed multiple m, the guarantee price decreases when the floor ratio f_0 increases. Intuitively, the guarantee fee is essentially the expected cost of hedging the risk that the terminal portfolio value falls below a certain level. While the other parameters are kept unchanged, an increase in f_0 results in a decrease in the cushion and hence, a reduction in the exposure to the risky asset. Consequently, the risk of the portfolio is reduced, leading to a lower guarantee fee. On the other hand, given that the other parameters remain the same, an increase in the multiple augments the portfolio's exposure to the risky asset, thereby boosting the hedging cost or the guarantee fee.

Table 1. Guarantee prices (%) for different parameter profiles

	f_0 = 60%	f_0 = 65%	f_0 = 70%	f_0 = 75%	f_0 = 80%	f_0 = 85%	f_0 = 90%
m = 1	1.07	0.75	0.48	0.25	0.08	0.01	0.00
m = 2	3.79	3.01	2.25	1.52	0.86	0.31	0.02
m = 3	6.69	5.48	4.28	3.11	1.98	0.94	0.17
m = 4	9.56	7.94	6.33	4.74	3.18	1.70	0.43
m = 5	12.33	10.32	8.32	6.34	4.38	2.48	0.76
m = 6	14.95	12.58	10.22	7.87	5.54	3.25	1.11
m = 7	17.41	14.71	12.00	9.31	6.63	3.99	1.47
m = 8	19.69	16.67	13.65	10.65	7.65	4.69	1.82

Notes: This table presents the guarantee prices for different multiples and initial floor ratios. The risky asset is the Shanghai Stock Exchange Composite Index (SSECI) and the sample period is from January 2, 2004 to December 31, 2004.

3. An analysis of the guarantee fees in China

In this section we apply the method described in section 2 to assess the fairness of the current guarantee fees charged to the existing principal-protected funds in the Chinese financial markets. We focus on five guarantee funds in the Chinese markets: the Nanfang hedging fund, the Guotai, Yinhua, Tiantong and Jiashi principal-protected funds[1]. Nanfang

[1] There are three other principal-protected funds that were issued after June 2007: Jinyuan, Guotai Jinlu, and Jiaoyin. They are not included in this study due to limited data availability. The Jiashi fund is also not studied in this paper, as its data are not available.

was initiated in June, 2003, and all others in 2004. The guarantee period for all of them is three years and the guarantee amount at the terminal date is equal to the initial investment, i.e. the guarantee percentage is 100%. The guarantee funds in China do not provide the information about how the initial floor and multiple are determined. According to Li's (2005) study, the initial floor ratio is generally estimated around 90% for all Chinese guarantee funds. However, the multiple levels vary greatly from fund to fund, indicating that fund managers may have quite different degrees of risk-aversion. As per the CPPI strategy, the multiple is a constant and the floor grows at the risk-free rate over time. In practice, fund managers may adjust the multiple frequently to reflect changes in market conditions. Table 2 summarizes the investment strategies adopted by each fund and the restrictions on asset allocation. This information is collected from the recruitment prospectus of each guarantee fund.

Table 2. A summary of Chinese guarantee funds

Funds	Date created	Investment strategy	Maximum proportion in stocks	Lock-in period
Nanfang	June, 2003	CPPI	35%	3 years
Guotai	November, 2004	CPPI, OBPI	30%	3 years
Yinhua	March, 2004	CPPI	15%	3 years
Tiantong	September, 2004	CPPI	20%	3 years

Note: This table reports the investment strategies adopted by guarantee funds in China and the maximum percentage of the portfolio invested in risky assets. CPPI stands for the constant proportion portfolio insurance strategy and OBPI stands for the option-based portfolio insurance strategy. Jiashi is not included in this table.

Since all of the guarantee funds adopt the CPPI strategy as the asset allocation method, it is appropriate for us to assess whether the guarantees are fairly priced in China using Equation (8). For this purpose, the daily data of portfolio values for each fund from January 4, 2005 to June 29, 2007 are downloaded from the Security Star website, as the data for the risky asset in the funds are not available. The GIC rate is used as the risk-free rate for the analysis, which is obtained from the People's Bank of China website.

For an initial floor percentage, the volatility for the cushion of each fund is implied. Since the cushion volatility is the product of the multiple and the volatility of the risky asset, the price of the guarantee can be computed without the estimate of the multiple as long as the initial floor ratio is given.

The testing procedure is similar to the one adopted by An and Suo (2008), and is described as follows.

1. Starting from the beginning of the sample period, the price of a guarantee with a guarantee period of one year is calculated based on the estimated value of cushion volatility for each fund for a given floor level.
2. The above exercise is repeated every 3 months within the sample period. Thus, the prices of several different guarantees with overlapped guarantee periods are obtained.
3. The average prices are calculated and are used for our analysis.

The final results are reported in Table 3. These results indicate that for Nanfang, the average guarantee fee is 0.25% if the initial floor is 90% and 0.17% if the initial floor is 91%. If the initial floor is 85%, the fee could be as high as 0.68%. As the actual guarantee fee is only 0.20% (Liu, 2007), this charge seems to be reasonable given the predictions of our model.

Table 3. Model prices and actual fees charged by Chinese guarantee funds

Funds	Guarantee fees for different initial floors			Actual fees charged
	f_0 = 85%	f_0 = 90%	f_0 = 91%	
Nanfang	0.68%	0.25%	0.17%	0.2%
Guotai	1.25%	0.73%	0.67%	0.2%
Yinhua	0.16%	0.05%	0.03%	0.2%
Tiantong	0.22%	0.005%	0.002%	0.4%

Note: This table reports the estimated guarantee fees for the Chinese guarantee funds based on the model. The sample period is from January 4, 2005 to June 29, 2007.

For the Guotai principal-protected fund, a hybrid investment strategy of CPPI and the option-based portfolio insurance (OBPI) is adopted. As the essence of OBPI in the Chinese financial market is to diversify some assets to convertible bonds, this hybrid investment strategy can be treated as a variation of CPPI. Therefore, here we still use our model to assess the fairness of the guarantee fee charged by the guarantor. As the model predicts a guarantee fee of 0.60% to 0.70% for an approximately 90% initial floor, it seems that the current guarantee charge of 0.20% is pretty low.

For Yinhua and Tiantong principal-protected funds, their corresponding guarantee fees should be no more than 0.05% and 0.005%, respectively. However, their actual charges are 0.2% and 0.4% (Li, 2005), respectively, far greater than the fair levels determined by our research.

Due to data limitation, it is impossible for us to conduct further in-depth analysis. Nevertheless, our research findings demonstrate that two of the four funds considered are charging much higher guarantee premiums than the fair estimates provided by our model. Higher guarantee fees result in higher management expense ratios, thereby deterring fund companies from launching new funds. This research furnishes a reasonable account for the lagging development of principal-protected funds in China.

Conclusions

This paper examines the pricing of guarantees for principal-protected funds under the CPPI strategy. It distinguishes itself from the general guarantee valuation literature by explicitly considering the impact of the underlying investment strategy. The Black-Scholes (1973) formula is applied to the valuation of guarantee given some crucial parameters, such as the multiple, the floor, and the volatility of the underlying asset. It is then used to estimate guarantee fees charged by four principal-protected funds in China by using the market data.

Our findings indicate that some funds are charged much higher guarantee premiums than those predicted by the model. This research sheds some insights into the stagnation in the development of the principal-protected fund segment in contrast to the exploding growth of the general capital market in China.

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