Bond Term Structure and Duration to Reduce Risk

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Abstract. In the investment market, investors face various risks every day. However, rare investors fully understand how to diversify by DCF methods and duration methods. Everyone is risk-averse, in order to reduce the risk, investors need to diversify their portfolio, in which bonds is a hully important part. The paper will show us how to use DCF methods and duration method to hedge the risk by balancing proper weight of each certain of bond. In order to make the method more convincing and easier to understand, argument process shows how adopt a specific method to analyze two bonds- "Bright Diary" and " Huatai Securities Co., Ltd." in a specific situation and show how to use this method to avoid risks. The conclusion shows by purchasing specific share of different bond, the portfolio will be less affected by interest rate. In other words, the risk has been hedged and this will greatly help the investors to make their future investing strategies.

Keywords: bond; Duration; investment decision-making; fixed-income investment; interest rate risk.

1 Introduction

Investors encounter both debt and equity investments in the financial market. When considering equity investments, they offer high returns but also come with high risk. The essence of equity investment lies in the tradeoff associated with ownership. Equity investors hold shares in a company, giving them a say in decision-making processes while also obliging them to bear losses when the company underperforms.

In contrast, debt investments are characterized by a promise of payment, typically associated with lower returns and lower risk. In this context, investors take on the role of lenders. Debt investors are usually prioritized for repayment in the event of a project's failure, ensuring they are compensated before equity investors. This distinction highlights the fundamental differences in risk and return profiles between equity and debt investments, guiding investors in their decision-making processes based on their risk tolerance and investment objectives.

Moreover, equity investments are generally more suitable for individuals with longer-term investment goals due to their potential for significant capital gains and dividends over time. In contrast, debt investments are typically favored for short-term financial objectives. Equity investors receive returns through capital gains and dividends, reflecting the company's performance and profitability. On the other hand, debt

investors are compensated through the repayment of principal and the receipt of interest payments.

Although equity investments often offer higher returns, the majority of investors tend to be risk-averse, leading to a preference for debt investments due to their lower risk profile. To mitigate risks associated with debt investments, particularly those linked to interest rate fluctuations, investors frequently utilize the concepts of term structure and duration. These methods are instrumental in managing and reducing the risks inherent in bond investments, thereby providing a more stable and predictable investment outcome.

This research aims to demonstrate the application of term structure and bond duration in reducing investment risk, utilizing Huatai Securities Co., Ltd. and Bright Dairy as case studies. Huatai Securities' diverse business portfolio encompasses equity investment, quantitative investment, fixed-income investment, alternative investment, asset securitization, and capital market activities. In a recent fiscal period, Huatai Securities achieved a net profit of 12.209 billion and an operating income of 32.032 billion. Bright Dairy, on the other hand, specializes in the development, processing, and production of milk and dairy products, ice cream, non-carbonated beverages, and drinking water. In 2022, Bright Dairy reported an operating income of 27.841 billion and a net profit of 145.454 million. Notably, Bright Dairy operates with minimal credit risk, further enhancing its attractiveness as a subject for this research.

By examining these companies, this research will elucidate how the strategic use of term structure and bond duration can effectively mitigate investment risks, providing valuable insights for investors and financial managers. [2].This research will provide a method for investors to use duration and term structure to reduce risk. The two new methods will contribute to the investors' risk management strategies throughout the research.

The rest of this paper is structured as follows. Section 2 will introduce the methodology of this analysis, followed by the analysis and discussion in Section 3. A detailed analysis is represented in Section 4.

2   Methodology

2.1   Bond Valuation - DCF method

Bond valuation is a comprehensive method utilized to hypothetically determine the value of a specific bond. This method encompasses various financial metrics, including the present value, anticipated cash flows, and the bond's face value. [3] The concept of present value pertains to the current worth of a sum of money that is expected to be received in the future, which is adjusted by a specified rate of return to account for the time value of money. [4] This adjustment reflects the principle that a given amount of money today is worth more than the same amount in the future due to its potential earning capacity. The formula is Equation (1).

$$V = \frac{F}{(1+r)^T} + \sum_{t=1}^{T} \frac{C}{(1+r)^t} \qquad (1)$$

F= Face Value
C=Value of each Coupon paid
r= YTM
T=Time until Maturity

2.2   Duration

Duration refers to the time required to receive all cash flows from a bond. The calculation method involves taking the product of the discounted value of future cash flows and the number of years until each cash flow is received, and then dividing this product by the sum of the discounted values of all future cash flows. [5] This measure provides insight into the bond's sensitivity to changes in interest rates and helps investors assess the bond's risk and potential return. The formula of Duration is Equation (2).

$$D = \sum_t \frac{tPV(CFt)}{P} \tag{2}$$

D is Duration;
PV is the present value
CFt is cashflow in time t
P is the principle of the bond

2.3   Discounted Cash Flow

The discounted future cash inflow is a critical concept in bond valuation, as it represents the present value of expected future cash payments from a bond, adjusted for the time value of money. The primary purpose of duration is to quantify a bond's interest rate risk by considering various factors such as the bond's maturity, yield, coupon rate, and call features. Duration, therefore, serves as a key indicator of how sensitive a bond's price is to changes in interest rates. [6]

Additionally, other term structure measures examine the relationship between interest rates, bond yields, and various terms to maturity. The term structure can be expressed mathematically, where represented in Equation (3).

$$P(\tau, r) = e^{-r\tau} \tag{3}$$

This indicating the price of a zero-coupon bond maturing at time τ\tauτ given a constant interest rate rrr. The price of a bond maturing at time TTT is denoted as $P(T - t, r)$, where T is the maturity date and t is the current time. The return on a bond can be described as the relative change in its price, represented by $\frac{dP}{P}$, where dP is the change in price and P is the initial price. This return calculation is essential for evaluating the bond's performance over time [7].

2.4   Term Structure

Term structure measures bond yields over time and is used to predict changes in economic growth [8]. Practically, investors could use the spot rates to determine future

prices and choose to make an exchange right now or not by knowing the current rate. For a settled day, the forward rate is the exchange rate on that day. Forward rates are calculated using two zero-coupon bonds whose maturities differ by the period needed for the forward rate. The face value minus the purchase price is the total discount applied to the bond's face value.

The bond's price is calculated using a formula, applying the PV of cash flows in future in the form of coupon payments and the principal.

Duration to reduce the interest rate risk. When a bond's duration is shorter, it will be less volatile. With the exact change in the interest rate risk, the bonds with shorter Duration are more likely to lose less. Investors prefer bonds with shorter bond duration to reduce the interest rate risk.

3   Analysis and Discussion

3.1   Background of Investment

Introduce the Bonds Selected. The first bond - Huatai Securities Co., Ltd. will publicly issue corporate bonds (the fourth phase) to professional investors in 2021 (Variety 1). Issuer: Huatai Securities Co., Ltd. Bond code- 188134, Bond abbreviation - 21 Huatai G5. Bond type: Publicly issued corporate bonds (including corporate bonds). The issuance volume (100 million yuan) is 40.0000. The total number listed on the Shanghai Stock Exchange is (billion yuan) 40.0000. Issuance start date 2021-05-21 Issuance end date 2021-05-24Value date 2021-05-24 Expiration date 2024-05-24, Listing date 2021-05-27. Interest calculation method Fixed interest Interest payment method Annual interest paymentCoupon rate (%) 3.28 Bond term (year) 3. Base rate (%) - Floating spread (%) -. Standard bond conversion rate 0.92 Bond valuation (yuan) rating AAA Subject rating AAA .Is it non-guaranteed? [9].

There is another bond. Bond code 115169 Bond abbreviation 23Guangming01. Issuer: Bright Food (Group) Co., Ltd. Bond expansion abbreviation 23 Guangming 01. Full name of the bond: Bright Food (Group) Co., Ltd. will publicly issue corporate bonds (first phase) to professional institutional investors in 2023. Bond type Publicly issued corporate bonds (including corporate bonds). Issuance volume (100 million yuan) 30.0000 Total number listed on Shanghai Stock Exchange. (billion yuan) 30.0000. Issuance start date 2022-04-04 Issuance end date 2022-04-06. Value date 2022-04-06 Expiration date 2026-04-06. Listing date 2022-04-11 Interbank code -. Interest calculation method Fixed interest Interest payment method Annual interest payment. Coupon interest rate (%) 3.1 Bond term (year) 3. Base rate (%) - Floating spread (%) -. Standard bond conversion rate 0.92 Bond valuation (yuan) -. Issuance type Small public offering Transaction method. Meanwhile, it is unguaranteed. [6]

This analysis will calculate the bond between China Railway Construction and Bright Diary by duration and term structure.

Duration is calculated according to Equation (2).

The Goal of Diversification. Investors utilize diversification strategies to mitigate risk, understanding that spreading investments across various assets can lower overall portfolio risk. Bonds hold a significant position in the financial market due to their relatively low-risk nature. As a result, investors often include bonds in their portfolios to effectively reduce investment risk. By incorporating bonds, which offer more stable and predictable returns compared to other asset classes, investors can achieve a more balanced and less volatile portfolio.

Assume the AB corporation seeks guidance on hedging against interest rate risk. In 2.91 years from 2022, AB will need to make a bullet payment of 10,000 and is seeking advice on how to invest cash in bonds, Hua Tai securities, and Bright Diary.

As the data showed in the introduction. It is known that the face value is 100, the coupon rate is 3.28%, and the latest turnover is 100.22. Table 1 calculates the Duration of the bond issued by Huatai Securities Co., Ltd.

Table 1. Duration of Bond issued by Huatai Securities Co., Ltd.

t	CF	PV(CF)	tPV(CF)
1	3.28	3.18	3.18
2	3.28	3.18	6.36
3	103.28	100.22	300.66
Total		106.58	310.2

Duration is D = 310.2/106.58 =2.900

Then, the Bright Diary. As the data showed in the introduction. It is known that the face value is 100, the coupon rate is 3.1%, and the latest turnover is 101.29. (Table 2)

Table 2. Duration of Bond issued by Bright Diary

t	CF	PV(CF)	tPV(CF)
1	3.1	3.05	3.05
2	3.1	3.05	6.1
3	103.1	101.29	303.87
Total		107.39	313.02

Duration is D = 313.02/107.39 =2.915

The next part of the analysis calculates how to allocate money to these two selected bonds. Assume x be the portfolio share of bond Hua Tai securities and (1-x) be the share of bond Bright Diary.

x*2.900+(1-x)*2.915=2.910

x=33.33%

The present value of 10,000= 10000/(1.017)^2.91=9521.3

This implies that the portfolio needs to consist of 33.33%*9521.3= 3173.4 of Hua Tai securities and 6347.9 of another bond. To invest in 3173.4 of Hua Tai securities,

AB Co. needs to buy 3173.4/100 = 31.734 units of it. To invest in 6347.9 of Bright Diary, AB needs to buy 6347.9/100 = 63.479 units.

So, AB CO. should buy 32 units of A and 63 units of B.

4   Conclusion

This research presented a method for utilizing Duration to mitigate the interest rate risk resulting from potential future interest rate fluctuations. Initially, the discounted cash flow method was introduced to calculate the present value of a bond, followed by the computation of duration and the analysis of the bond's term structure. Subsequently, the research focused on constructing a portfolio to hedge against the uncertainties of future interest rate payments, specifically selecting Hua Tai Securities and the fixed-income securities issued by Bright Dairy for this purpose.

The findings of this research hold significant practical implications for both investors and financial managers. Investors can leverage fixed-income securities to minimize the risk in their portfolios by applying duration and portfolio theory. Financial managers, on the other hand, can use bonds to reduce the risk associated with future payments, thereby enhancing their companies' profitability. Consequently, this research provides valuable insights and strategies for effectively managing interest rate risk in the financial markets.

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