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Finance - Bond Valuation and Interest Rate Risk

Given and Introduction

Analyzing the bond market, three types of bonds need evaluation:

1. Government bond with a coupon rate of 0.75%, 10 years to maturity, semiannual payments.
2. Corporate bond with a coupon rate of 3%, 30 years to maturity, annual payments.
3. High-yield bond with a coupon rate of 8%, 2 years to maturity, semiannual payments.

Data:

- Nominal value (\(F \)) = $1000
- Effective annual interest rate (\(r \)) = 1.5%

Required:

1. Price of each bond.
2. New price if the interest rate increases to 2.5%.
3. Bond with the highest interest rate risk.

A. Bond Prices Calculation

Formula:

```
P = ∑(t=1 to N) [ C / (1 + r/n)^(nt) ] + [ F / (1 + r/n)^(nN) ]
```

Where:

- \(P \) = Price of the bond
- \(C \) = Coupon payment
- \(F \) = Face value ($1000)
- \(r \) = Annual effective interest rate (1.5%)
- \(n \) = Number of compounding periods per year
- \(N \) = Number of years until maturity

1. Government Bond

- Coupon Rate: 0.75%
- Maturity: 10 years
- Payment Frequency: Semiannual
- \(n = 2 \)

Calculation:

Coupon payment (\(C \)): \(0.75\% \times 1000 = \$7.50 \)
Semiannual interest rate: \(0.015/2 = 0.0075 \)

```
P = ∑(t=1 to 20) [ 7.50 / (1 + 0.0075)^(t) ] + [ 1000 / (1 + 0.0075)^(20) ]
```

```
P ≈ ∑(t=1 to 20) [ 7.50 / 1.0075^t ] + [ 1000 / 1.0075^(20) ]
```

The total price is the sum of the present value of the 20 semiannual coupon payments plus the present value of the face value.

2. Corporate Bond

- Coupon Rate: 3%
- Maturity: 30 years
- Payment Frequency: Annual
- $n = 1$

Calculation:

Coupon payment (C): $3\% \times 1000 = \$30$
Annual interest rate: 0.015

```
P = ∑(t=1 to 30) [ 30 / (1 + 0.015)^(t) ] + [ 1000 / (1 + 0.015)^(30) ]
```

The total price is the sum of the present value of the 30 annual coupon payments plus the present value of the face value.

3. High-Yield Bond

- Coupon Rate: 8%
- Maturity: 2 years
- Payment Frequency: Semiannual
- $n = 2$

Calculation:

Coupon payment (C): $8\% \times 1000 = \$80$
Semiannual interest rate: $0.015/2 = 0.0075$

```
P = ∑(t=1 to 4) [ 40 / (1 + 0.0075)^(t) ] + [ 1000 / (1 + 0.0075)^(4) ]
```

The total price is the sum of the present value of the 4 semiannual coupon payments plus the present value of the face value.

B. New Prices with Interest Rate Increase

New effective annual interest rate = 2.5%

1. Government Bond

New semiannual interest rate: $0.025/2 = 0.0125$

```
P_new = ∑(t=1 to 20) [ 7.50 / (1 + 0.0125)^(t) ] + [ 1000 / (1 + 0.0125)^(20) ]
```

The price needs recalculating for 20 periods with the new semiannual rate.

2. Corporate Bond

New annual interest rate: 0.025

```
P_new = ∑(t=1 to 30) [ 30 / (1 + 0.025)^(t) ] + [ 1000 / (1 + 0.025)^(30) ]
```

The price needs recalculating for 30 periods with the new annual rate.

3. High-Yield Bond

New semiannual interest rate: $0.025/2 = 0.0125$

```
P_new = ∑(t=1 to 4) [ 40 / (1 + 0.0125)^(t) ] + [ 1000 / (1 + 0.0125)^(4) ]
```

The price needs recalculating for 4 periods with the new semiannual rate.

C. Interest Rate Risk Evaluation

High-yield bond presents the lowest interest rate risk because of its short maturity period of 2 years. The government and corporate bonds have higher interest rate risks due to longer maturities.

Final Solution:

1. Prices are calculated using present value formulas.
2. Prices are recalculated with increased interest rates.
3. The bond with the highest interest rate risk is the one with the longest maturity period.