**1. Bond Pricing in C++**

**(a)** The results are shown below:

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The highest price is the first price, which is about 97.561. That’s reasonable because the seller has less time to repay the value, and the difference between face value and price should be minimal.

**(b)** The results are shown below:

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From the information we can tell that the bond prices and the bond yields are negative connected.

**(c)** The results are shown below:

图片包含 电脑, 标志

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It’s easy to conclude that the first four bonds price are above $100 and the last two prices are below $100. Think about the time value of assets, the coupon would be less and less valuable as time going on.

**(d)** The results are shown below:

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The zero-coupon bonds have higher duration. Since zero-coupon bonds have no pays before maturity, they might be more sensible to the change in bond yield. In other word, they take more risk because they wouldn’t obtain any repay during maturity.

**(e)** The results are shown below:

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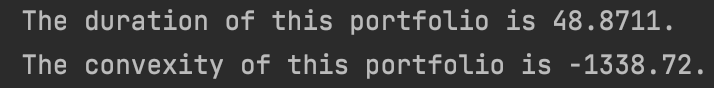
These second derivatives are positive.

**(f)** The value of this portfolio is about -0.112522

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**(g)** The results are shown below:



Obviously, the duration is bigger, but consider about the absolute value, the convexity is bigger.

**(h)** the adjusted portfolio number is about: 1.9703

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**(i)**When the rates sell off by 100 basis points, the adjusted portfolio would increase by 0.00821638.



**(j)** When the rates rally off by 100 basis points, the adjusted portfolio would increase by 0.00871623.



No matter the yield rises or falls by 100 basis points, the value of the portfolio always increases. Therefore, this portfolio is what I want to own. Furthermore, because of the eternal positive value, we can say that there’s no risk in the rates side. However, since the whole initial portfolio value is negative, which means we borrow money from markets. The only risk is whether we could repay it or not at the maturity. If we fail to pay for that, we’ll lose all the payoff we expect.

**(k)** the cashflows of 5 years are about 23, 22.4, 21.8, 21.2, 20.6.



**(l)** the price of the amortizing bond is about 100, and duration of the amortizing bond is about 2.80195

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The price of its zero coupon is about 86.26 and the duration is about 4.85; the price of its coupon equivalents is about 100 and the duration is about 4.57.

The prices of amortizing bond is higher than its zero coupon since it repays much more than zero coupon in the process, and this also lead to the lower duration since the holder takes less risk on it. Then, this amortizing bond has the same price as its coupon equivalents, because in this condition, the coupon equivalents rates is the same as the ytm. Similarly, since the amortizing bond pays its value more quickly, the duration of coupon equivalents is higher than its.