THE USE OF DURATION IN ECONOMIC LOSS CASES

Harry M. Davis, Appalachian State University

Abstract

The purpose of this paper is to apply the concept of duration to legal cases involving economic loss. To determine the economic loss, future cash flow payments must be discounted at the rate on long-term bonds. Unfortunately, this rate does not eliminate the reinvestment risk associated with the different maturity structure of the long-term government bond and the time period of economic loss. The application of duration to the procedure of determining the value of economic loss will eliminate the distortion caused by reinvestment risk.

INTRODUCTION

Our legal system has long been asked to determine economic loss in personal injury and accidental death cases. Financial consultants have been used to estimate the earnings which would have been received in the future if an individual had lived or continued to pursue the same career. The victim's lost earnings have then been reduced to a present value figure and the proceeds have usually been distributed as a lump sum award at time of settlement.

In order to arrive at a lump sum, financial consultants have had to make certain assumptions with regard to the discount rate and the investment expertise of the victim or the victim's heirs. Consultants have facilitated between using the real and nominal discount rate. Similarly, consultants have not considered the problem of interest rate risk, or more specifically, reinvestment risk in a volatile interest rate environment.

The purpose of this paper is twofold. First, the paper will review the real versus nominal discount rate pole

mic. Second, the paper will show how the concept of duration can be applied to eliminate the reinvestment risk associated with the annuity payments from the lump sum settlement.

THE DISCOUNT RATE

The basic framework for determining the present value of future lost income in a lump sum form is as follows:

$$V_L = V_0 + \frac{V_1}{(1+r)^1} + \frac{V_2}{(1+r)^2} + \dots + \frac{V_n}{(1+r)^n}$$

$$V_L = \sum_{t=0}^n \frac{V_t}{(1+r)^t} \quad (1)$$

Where:

V_L = the present value of the lost income stream;

V_0 = the dollar lost for period t ($t = 1, 2, \dots, n$);

r = the discount rate;

n = the end of the loss horizon.

In order to use equation 1, certain assumptions must be made about future earnings as well as the discount rate. Typically, earnings are projected into the future utilizing historical data to determine growth rates. On the other hand, the discount rate does not usually involve average data. The discount rate chosen is the one which prevails at the time of settlement. The argument is that in a lump sum settlement the plaintiff will, in fact, invest the funds at today's rates.

In selecting the appropriate discount rate (r), the courts have recognized that the level of investment sophistication of plaintiffs should not be a consideration (see 1,2,9). The courts have taken the position that loss values should be computed independently of the level of expertise of the plaintiff. As a result, financial consultants have most often used the rate on federal government securities as an appropriate risk-free discount rate. By using government securities as a proxy for the discount rate, courts have held that the plaintiff should not need professional investment advice in managing the lump sum settlement.

In an exhaustive study, Ibbotson and Sinquefeld (I-S) examined the behavior of ex-post real rates of return for U.S. Treasury bills and long-term treasury bonds (see 5). From 1926 through 1981, the real rates averaged approximately zero for these securities. As a result of the variation in the expected real rates on Treasury bills, the appropriate real rates on these securities approximates two percent. This rate is the one most often used when the real rate is used as opposed to a nominal rate.

A damage award should be an accurate estimation of the earnings that a victim would have earned if the defendant's wrongful conduct had not occurred. In order for the estimate to be accurate, the effective inflation on wages and the discount rate must be

considered. Unfortunately, the treatment of inflation in the valuation framework is not that easy. If ex-post inflation is greater than ex-ante inflation rates employed in the earning series, than the amount of the award will not satisfy the amounts that will be needed each year to provide equitable recovery for the plaintiff. Likewise, if the investment is made at a time when the inflation rate implicit in the term structure of interest rates is higher than the ex-post inflation rates that ultimately prevail, than the realization of the settlement will not be equitable.(1)

Several solutions have been suggested to deal with inflation in the valuation framework. Because of the impact of inflation and the nominal versus real rate polemic, the four following approaches have been used for computing economic loss:

1. Discounting nominal flows at real rates,
2. Discounting real flows at nominal rates,
3. Discounting real flows at real rates,
4. Discounting nominal losses at nominal rates.

Approaches 1 and 2 are clearly inferior to 3 and 4. Approach 1 leads to a settlement value which is overstated and would benefit the plaintiff while approach 2 leads to an understated value. In either case, the inconsistency in rates leads to biased results.

Approach 3 is shown as equation 1 where V_0 and r are in real terms. The relationship between nominal and real interest rates was the central theme in Irving Fisher's Theory of Interest. According to Fisher, the rate of interest minus inflation is equal to the real rate which is determined by time preference and is, therefore, essentially constant over time. One approach is to assume that the growth in earnings and

the discount rate are composed of a real component and an inflation component. Therefore, earnings and the discount rate can be stated in real terms for computations using equation 1.

Approach 4 adjusts both the earnings stream and the discount rate by the rate of inflation. This approach is shown in equation 2 which follows:

$$V_L = V_0 + \frac{V_1(1+I)}{(1+r)(1+I)} + \frac{V_2(1+I)^2}{[(1+r)(1+I)]^2} + \dots + \frac{V_n(1+I)^n}{[(1+r)(1+I)]^n}$$

$$V_L = \sum_{t=0}^n \frac{V_t(1+I)^t}{[(1+r)(1+I)]^t} \quad (2)$$

Where I is the inflation rate from each period 1 through n , with the inflation rate based on the current price level. Equation 2 is based on the assumption that actual inflation equals expected inflation. In this form, it does not matter if inflation is constant, increasing, or decreasing since the effects in the numerator and denominator cancel out.

The resulting value of the lost income stream (V_L) using equation 1 with real terms would equal that of equation 2 since the loss flows and the discount rates have identical adjustments for inflation over the loss period. Both methods eliminate the problems inherent in attempting to compare two different rates adjusted for inflation. Additionally, the use of approaches 3 and 4 lead to the same economic loss regardless of the assumptions about inflation.

THE USE OF DURATION

While the courts have favored strategies which generally lead to low default risk, little has been said about the interest rate risk inherent in a

lump sum settlement. Obviously, the risk an investor assumes with the purchase of any government bond is related not just to security and other portfolio characteristics, but also to the investor's time horizon and the interest rate fluctuations that occur over that horizon. Annuity income produced by the portfolio must be reinvested over the time horizon. For fixed income securities, the periodic interest payments may become too low or too high at the original purchase price of the security relative to what currently issued securities offer in yield. The prices of the older securities rise and fall inversely to market rates. As a result, the investor not only faces the interest rate risk associated with the value of the portfolio, but also the reinvestment risk associated with the periodic payments.

A solution to the interest rate risk inherent in the portfolio is to immunize the portfolio through the use of duration. The concept of duration originated with Frederick R. Macaulay (see 7), who wanted an alternative to the term-to-maturity for measuring a bond's life. Instead of considering only the time of the last principal payment, duration incorporates the timing of all coupon and principal payments as well as the time value of money. Duration can be defined as the average term of all coupon and principal payments value-weighted by the importance of each payment to the total value of the bond.

The duration of a bond is computed by multiplying the present value of each coupon and principal repayment by the time it takes to receive the payment. Each of these products is summed up with the result divided by the price of the bond. The formula is as follows:

$$D = \frac{\sum_{t=1}^n \frac{C_t(1+i)^t}{(1+i)^t}}{\sum_{t=1}^n \frac{C_t(1+i)^t}{(1+i)^t} + \frac{V_n(1+i)^n}{(1+i)^n}} \quad (3)$$

Where:

D = duration;

C = annual income in dollars;

V = value of obligation at maturity;

i = interest rate per period.

For any fixed income security with a positive coupon rate, the duration will always be less than the term-to-maturity. For example, consider a bond with a coupon rate of 12 percent and a term-to-maturity of five years with a market interest rate of 12 percent. The duration of such a bond is four years, or one year less than the term-to-maturity. The difference is due to the fact that duration takes into account the weighted average present value of the coupon payments.

Duration will relate a change in interest rates to a change in the price of an asset. The approximate price change would equal the rate change multiplied by the duration and the present value of the asset concerned. The equation form is:

$$P = -d \times i \quad (4)$$

Where:

P = the percent change in price for the asset;

d = the duration;

i = the change in market yield for the financial instrument.(2)

The relationship between duration and term-to-maturity (N), the coupon rate (c) and the market rate of interest (i) is as follows:

$$D = f(N, c, i), \quad (3)$$

That is, a bond's duration is directly related to its term-to-maturity (N), inversely related to the coupon rate (c), and inversely related to the market rate of interest (i).

In a wrongful death or personal injury case, the lump sum settlement

should generate a earnings stream which approximates the lost income stream as a result of the wrongful act having been committed. The function of the valuation framework is to match these two streams.

In order for the streams to be matched, the periodic payments generated by the settlement amount must approximate the loss periodic income payments. For this match to take place, the settlement amount must be invested in securities of varying maturities to generate the appropriate stream. Unfortunately, if these securities are purchased on the basis of term-to-maturity, interest rate risk is introduced. As interest rates fluctuate over the life of these securities, the proceeds from the maturing of the securities will likewise fluctuate. This price fluctuation will result in a mismatch in the income and earnings streams.

Interest rate risk occurs as a result of assets having a longer or shorter duration than liabilities.(3) In terms of economic loss determination, assets would be equivalent to the portfolio obtained through the settlement and the liabilities would be equivalent to the foregone benefits or earnings. When the average duration of assets is set equal to the average duration of liabilities, the portfolio is immunized from the effects of a change in interest rates. That is, by matching durations on both sides of the balance sheet we insure that assets and liabilities are equally affected by changes in interest rates.

As shown in equation 1 earlier, either the nominal or real discount rate must be used to obtain the present value of the future stream of earnings and benefits. Since that rate is established at the settlement date, the court assumes that the portfolio will earn that return over the investment horizon of the plaintiff. Only by using duration and immunizing the portfolio can the plaintiff lock-in the rates at the settlement

date which will match the earnings flow with the loss income flow. Using duration and immunizing the portfolio maximizes the likelihood that a fixed rate of return will be achieved over a fixed time horizon.

While duration rather than term-to-maturity should be used to establish the time horizon of the settlement portfolio, the use of duration in no way violates the desire of the court that the individual not be required to have investment expertise.⁴ Since the n in equation 1 is always known in these types of cases, a portfolio with a proper duration can easily be obtained.

CONCLUSION

In legal cases involving economic loss determination, the court is interested in establishing true economic present value. In order to do so, either nominal benefits must be discount-

ed at a nominal discount rate or real benefits must be discounted at a real discount rate. Either method will yield the same result which does not attempt to determine purchasing power.

While the real or nominal discount rate can be used, the question of the correct rate does not consider the question of interest rate risk. Any settlement portfolio will be at the mercy of its inherent interest rate risk. That is, as interest rates rise or fall, the value of the periodic payments and principal will move inversely with the interest rate. In order to eliminate interest rate risk and insure a fixed rate at the settlement date, the settlement portfolio must be immunized. By using duration, the settlement portfolio can be immunized against the vicissitudes of interest rates. Only in this way can the court be sure that the plaintiff will, in fact, receive the fixed rate of return which was used to calculate the lump sum settlement amount.

FOOTNOTES

¹This problem is similar to the "tile effect" of inflation. That is, fixed rates today may carry an inflation premium which is unjustified over the life of an investment.

²Notice that the equation implies approximation as opposed to equality. For small changes in interest rates, the approximation is reasonably accurate. For large changes, however, the approximation is less accurate.

³This is the sense in which duration is used by financial institutions to reduce interest sensitivity.

⁴While duration for fixed income securities can easily be determined, the problem with its use will be to educate the courts.

REFERENCES

1. Abrahamson, Allen R., "Theoretical and Practical Considerations in the Choice of Discount Rate Methodology in Economic Loss Determination: A Hyeristic Essay," presented at the Financial Management Association Meetings, Atlanta, GA, 1983.
2. Bagby, John W., Norman G. Miller, and Michael E. Solt, "The Determination of Compensatory Damages: A Valuation Framework: *American Business Law Journal*, Spring 1984.
3. Bierwag, G. D., "Immunization, Duration, and the Term Structure of Interest Rates," *Journal of Financial and Quantitative Analysis*, December 1977.
4. Fischer, Irving, *The Theory of Interest*, New York: Macmillan, 1930.
5. Ibbotson, R. G. and R. A. Sinquefield, *Stocks, Bonds, Bills and Inflation: The Past and the Future*, Financial Analysts Research Foundation, Charlottesville, VA, 1982.
6. Khang, Chulsoon, "Bond Immunization When Short-Term Rates Fluctuate More Than Long-Term Rates," *Journal of Financial and Quantitative Analysis*, December 1979.
7. Macaulay, Frederick R., *The Movements of Interest Rates, Bond Yields and Stock Prices in the United States Since 1856*, New York: National Bureau of Economic Research, 1938.
8. Ott, Robert A., "Duration Analysis and Minimizing Interest Rate Risk," *Review*, Federal Home Loan Bank of Atlanta, December 1984.
9. Shannon, Martin J., "Management Consultants Find an expanding role as expert witnesses," *Wall Street Journal*, January 22, 1981.