Valuation of interest rate swaps

Paul Williams looks at rising demand for contractual agreements between two parties to exchange a range of interest rate payments without exchanging the underlying debt instrument

In light of the increasing demand of interest rate swaps by companies in recent years for cash flow management, risk management, portfolio management and speculation, many industry commentators have expressed alarm over the rapid growth and size of the interest rate swaps market, arguing that they and other derivative instruments may threaten the stability of global financial markets.

In an ordinary interest rate swap, each party agrees to pay the counterparty a fixed or floating interest rate denominated in a particular currency.

Purposes

- **Hedge:** A financial market participant holding financial assets or liabilities with interest rate exposure can use interest rate swaps to hedge against its exposure and risk. For example, a non-redeemable float-bond issuer might wish to enter into an interest rate swap as a fixed payer to hedge its interest risk exposure in an expected rising interest rate cycle.

- **Speculation:** A risk-taking investor may wish to profit from speculation of interest rate movements using interest rate swaps. Thus, a speculator expecting interest rates to rise may gain interest rate exposure by entering an interest rate swap as a fixed-rate payer.

Types

The principal types of interest rate swaps are as follows:

- **Float-for-fixed:** One party pays a floating interest indexed to a reference index A to receive a swap rate on a given notional amount at an initial exchange rate for a given number of years. This is one of the most commonly seen interest rate swaps in the market, used by market participants to alter their exposure according to their expectation of floating interest rate movements. Arbitrage opportunities may exist due to varying levels of credit-worthiness and the existence of quality-spread differences between companies.

- **Float-for-float:** One party pays a floating interest indexed to a reference index A to receive floating rate interest indexed to a reference index B, on a given notional amount, for a given number of years. Likewise, float-for-float swaps with the same index, but for differing maturities are also common swaps available. Float-for-float interest rate swaps, also known as basis swaps, are normally used to hedge against or speculate on the spread between the two indexes widening or narrowing.

- **Cross-currency feature:** The above float-for-fixed and float-for-float swaps can also be created using different currencies. With the cross-currency feature embedded, an additional complexity of exchange rate fluctuation is introduced because the initial exchange rate is likely to change at each reset date. Therefore, extra care is needed in valuing cross-currency swaps.

Valuation of swaps

Although a number of interest rate resets and cash flow exchanges between parties may occur before the expiration date of the instrument, the valuation of an interest rate swap is not as complex as one may imagine. A plain vanilla interest rate swap can actually be seen as a combination of bonds (i.e. a fixed-rate bond vs. a floating-rate bond): a fixed interest rate payer can gain equivalent exposure by investing in a floating-rate bond while issuing a fixed-coupon bond with the same expiration and payment dates, and vice versa.

In general, the values recognized by the fixed-rate payer and the floating-rate payer are both zero at inception; otherwise, an arbitrage opportunity would arise. Therefore, the interest rate paid by the fixed-rate payer, which is known as the swap rate, will be set based on the market yield curve, to equalize the value to both parties in the interest rate swaps.

Zero-sum game

The value of the interest rate swaps could deviate from zero based on any shift or twist of the yield curve or floating rate changes over the life of the interest rate swaps. The parties to the instrument could then recognize a positive or negative value prior to maturity of the interest rate swaps. However the interest rate swaps arrangement between the two parties will remain a zero-sum game at any time, i.e. one party's gain is the other party's loss. The interest rate swaps can therefore be valued on either side as follows:

$$V_{fixed} = V_{float}$$

V_{fixed} = interest rate swaps value to the fixed rate payer
V_{float} = interest rate swaps value to the floating rate payer

Pricing of swap at inception

At inception of the instrument, the present value of the fixed interest rate payments is set to be equal to the floating rate payments in order to calculate the swap rate. Assuming there are T periods of payments in the interest rate swaps, and the maturity of the interest rate swaps is at time T, then:

Summary of sample swap payoff pattern

Perspective	Option equivalence	Payoff pattern
Fixed-rate payer	Long call + short put	Gain when interest rate rises
Fixed-rate receiver	Short call + long put	Gain when interest rate falls
Callable swap by fixed-rate receiver	Long call + short put + early termination right	Gain when interest rate rises with loss cap at strike rate

At inception t = 0,

$$V_{fixed} = PV_{floating} - PV_{fixed}$$

&

$$V_{fixed} = 0$$

Therefore,

$$PV_{fixed}(0) = PV_{floating}(0)$$

V_{fixed} = the value of the interest rate swaps to the fixed rate payer

$PV_{fixed}(0)$ = the present value of the fixed rate payment at inception, t=0

$PV_{float}(0)$ = the present value of the floating rate payment at inception, t=0

Subsequent valuation of swap

As mentioned above, the subsequent valuation at any time beyond the inception can be performed by treating the interest rate swaps as a bond portfolio. Under this method, the fixed-rate bond and the floating-rate bond are valued individually and the value of the interest rate swaps is the net value of the two bonds. From the fixed-rate payer's perspective, the value of the interest rate swaps at time k can be presented in the following equation:

$$V_{fixed}(k) = PV_{floating}(k) - PV_{fixed}(k)$$

The above method provides a quick and convenient way for the market participant to estimate the fair value of the interest rate swap through two simple bond valuations, which are performed using a conventional discounted cash flow method. This common methodology can be readily applied in the market for general valuation practice.

Valuation complexity

Beyond the basic valuation steps detailed above, other complexities may need to be reflected as follows:

- **Financial intermediary:** For large swap arrangements, a financial intermediary may be used to match counterparties on a given instrument. When a financial intermediary is involved, a spread will be earned by the financial intermediary, which will need to be incorporated in the valuation. The financial intermediary earns the spread by party-sourcing and matching, anonymous identity keeping, valuation, swap administration, and sometimes by offering a payment guarantee.

- **Credit risk:** Credit risk represents the likelihood of default on the given payments by the counterparty. A party in a swap arrangement is only exposed to credit risk when the swap is profitable. Therefore, credit risk on a swap is generally a function of the joint likelihood of financial distress of the counterparty and a favourable movement of the underlying variable of the swap.

  To manage and assess the credit risk of a swap position, the investment manager will monitor both the current credit exposure (effectively the current replacement value of the swap to the party) and the potential credit exposure of the swap, which is generally a range of estimated future replacement values of the swap based on confidence intervals over the remaining term of the instrument. The current credit exposure measures the credit loss if the counterparty defaults today, while the potential credit exposure provides an overview of future credit risk profile of the position as time passes.

  Depending on the arrangement, the potential credit exposure of an interest rate swaps is usually highest at around the middle of the term, as the underlying interest rate moves from its initial value (also known as the diffusion effect), which is offset by the fewer number of cash flow exchanges in the remaining term as time passes, perceived as the amortization effect. In contrast, the highest level of potential credit exposure of a currency swap tends to shift towards the end of the swap term, with an upward-sloping time-to-exposure profile, as its principal is exchanged at maturity and the amortization effect is, therefore, less material in this case.

  The complexity of the counterparty risk assessment is likely to further increase with exchange rate movement, when currency exchange is also involved as part of the swap term. It is also worthwhile to note that any payment guarantee may not be part of the contractual service even when a financial intermediary is involved. Nevertheless, credit default swaps can be incorporated if credit default protection is desired, especially if there is no financial intermediary and deemed counterparty credit risk.

- **Duration:** Duration of a fixed income portfolio can be managed via an interest rate swap instrument to modify the duration to a desirable target level (i.e. lowering a long-term bond's duration by using a float-for-fixed interest rate swaps; or matching the duration of the asset and long-term liability). An interest rate swap is a frequently used financial derivative to adjust the portfolio's duration flexibly at a reasonable cost. Flexibility and cost effectiveness can be achieved due to the fact that an interest rate swap can be set up with customized terms such as a reference index, reset date frequency and basis spread agreed without excessive upfront cost.

Conclusion

Interest rate swaps are widely used in global financial markets. For non-complex swap arrangements, this can be valued relatively by simply using discounted cash flow techniques. However, for a given portfolio to satisfy an overall hedging or speculation strategy, more complex features can be incorporated in a swap arrangement, which will require additional valuation considerations.

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