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Options with Interest Rates

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This article explains the basics of interest rate options and its usefulness for market participants. The topic has gained importance in the light of issue government securities with embedded derivatives in July 2002.

First, we use the textbook definition of an option contract: *a contract between two parties that permits one party, the buyer of the option, to buy or sell an underlying asset at a pre-fixed price on or before a pre-fixed date*. The counterparty is the option seller or writer. The option buyer pays a premium up front for obtaining the right to buy or sell the asset during a specific period of time. If the option is used to buy or sell the underlying asset, it is said to be exercised. An option granting the right to buy is referred to as a call whereas an option granting the right to sell is referred to as a put. An option that can be exercised any time prior to expiration is referred to as an American option while an option that can be exercised only at expiration is referred to as a European option.

When we use interest rate options, unlike options on stocks the underlying is not an asset but an interest rate. The underlying should actually be thought of as an interest payment or a cash flow. Hence one can define an interest rate call option as an option that grants the holder the right to make a fixed or known interest payment and receive a variable or unknown interest payment while an interest rate put option is an option that grants the holder the right to make a variable or unknown interest payment and receive a fixed or known interest payment.

Interest rate options are, by definition, cash settled because the underlying is an interest payment. When the option buyer exercises the option, the option seller makes a net payment to the option buyer. The option buyer will never exercise his option when he has to make a net cash payment to the option seller.

Options using FIMMDA-NSE MIBOR

Let us take a look at how interest rate option works with an example. Consider a call option in which the underlying is the rate on 3-month MIBOR and the option expires in 30 days from now. The buyer of the option designates an exercise price, which is in the form of an interest

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rate and commonly known as the strike rate or strike. Suppose the exercise rate is 6% and the notional principal INR10 million. This option grants the holder the right to make a 6% interest payment on INR10 million and receive an interest payment to be determined by the rate on 3-month MIBOR in 30 days. Suppose it is now 30 days later. The table below indicates the payoffs of the option based on a range of possible values of MIBOR at expiration of the option:

MIBOR (%) 30 days later	Pay off (Rs.)
4	0
5	0
6	0
7	25,000
8	50,000

In general, the payoff of an interest rate call is determined by the formula:-

(Notional Principal) Max (0, MIBOR-Strike) $(\frac{days}{360})$

So in this case, the payoff will be

$$(10{,}000{,}000)Max(0, MIBOR - 0.06)(\frac{90}{360})$$

So in all cases where MIBOR is below 6%, the payoff is zero. In the case where MIBOR is 7%, the payoff is

$$(10{,}000{,}000)Max(0{,}0.07 - 0.06)(\frac{90}{360}) = 25000$$

As long as the MIBOR is higher than the strike rate, the option will be exercised by the buyer of the call option because there will be positive cash flow in his favour. Interest rate put options grant the right to receive the strike rate and pay MIBOR. And as long as the MIBOR is lower than the strike rate, the option will be exercised by the buyer of the put option because there will be positive cash flow in his favour.

In general the payoff of an interest rate put is

$$(Notional\ \mathrm{Pr}incipal)Max(0, Strike - MIBOR)(\frac{days}{360})$$

Thus, an interest rate put will pay off when MIBOR at the expiration of the option is below the strike rate. The following table summarises the action in case of interest rate options:

Option Type	Principle	Action by Option Buyer
Call	Strike Rate < Variable Rate	Exercise
Put	Strike Rate > Variable Rate	Exercise

Applications of Interest Rate Options

Interest rate options permit the buyer of the option to pay a premium up front and obtain insurance against either rising or falling interest rates. For example a company plans to borrow INR10 million in 30 days at 3-month MIBOR plus 200 basis points. Thus, in 30 days, the firm will borrow at the 3-month MIBOR on that day plus 200 basis points. For example if on 30th day, the 3-month MIBOR is 7.16%, the company will borrow money at 9.16% that need to be repaid with principal 3 months later. The firm is exposed to the risk associated with the movement of MIBOR in next 30 days. Even though it is concerned about higher interest rates as the borrowings would be costlier, it would also like to benefit from the falling interest rates, in case such situation arises. Thus, it should be willing to pay a premium to obtain protection from rising rates while enabling it to benefit from falling rates. Let us say it selects a strike of 6% and pays a premium of 50 basis points. The actual amount of the premium is computed as the quoted premium times the notional principal times days/360, or whatever day count convention is being used for the calculation. That means it will pay

$$10{,}000{,}000(0.005)(\frac{90}{360}) = 12500$$

as the option premium up front to the option seller to get protection for upward movement of MIBOR.

In 30 days time the firm borrows at whatever MIBOR is on that day plus 200 basis points. Thus, 3 months later it will owe

$$10{,}000{,}000(1 + (MIBOR + 0.2)(\frac{90}{360}))$$

The option expires when the loan is taken out and pays off

$$10{,}000{,}000Max(0, MIBOR - 0.06)(\frac{90}{360})$$

3 months later.

Thus, 3 months after taking out the loan, the firm will pay the difference, which will be

$$10{,}000{,}000(1 + (Min(MIBOR, 0.06) + 0.02)(\frac{90}{360}))$$

In other words, the firm will pay 2% plus either MIBOR or 6%, whichever is smaller. However, we have not taken into account the fact that the firm had to pay a premium of 12,500

up front at the time of buying the option. Let us assume that the firm could have invested the same at Repo rate of 5.75%. So if it pays INR12,500 up front to buy the option, it is equivalent to paying 12,500(0.0575(30/360)) = INR12,560 at the time the loan is taken out. This increases the cost of the loan in that the firm receives only INR10 million minus the equivalent of 12,560.

Firms that lend money at a floating rate are concerned about the possibility of falling rates. Therefore, a firm that plans to lend at a future date would consider the possibility of buying an interest rate put. A put would pay off when MIBOR at expiration is below the strike rate. The payoff formula would be

$$(National\ \text{Pr}incipal)Max(0, Strike - MIBOR)(\frac{days}{360})$$

The firm would have to pay the option premium up front, which reduces the effective rate on the loan, but would be compensated when MIBOR falls below the strike rate. It would benefit when MIBOR rises above the strike rate, as the option expires with no value but the loan rate is higher.

Interest Rate Caps and Floors

In the examples we have seen so far, there was but a single interest rate to be set for the life of the loan. In international markets many types of loans involve multiple rate resets at various time intervals. For example, firms often borrow floating rate loans, in which each 3 months or 6 months the rate is reset. The principal is paid back at the maturity date of the loan. For each loan reset date a borrower or lender firm is exposed to interest rate risk depending on the direction of interest rate movement. Therefore, to manage that risk the firm might choose to purchase options expiring on each of the reset dates. Because of the heavy demand for these combinations of options, derivatives dealers offer them in the form of packages of instruments referred to as caps and floors. A cap is a combination of interest rate call options. A floor is a combination of interest rate put options. The component options are called *caplets* and *floorlets*. Each component option is independent of the other options. The option buyer has the right to exercise all or any of the components. That is, whether one option is exercised is not affected by whether another option is exercised. Each option is designed to compensate the borrower or lender for the exposure to the underlying rate on the designated rate reset date.

Example with Caps & Floors

Consider a firm that takes out a two-year loan of INR20 million. The loan rate is set every three months. Interest then accrues for three months and is paid. Then the rate is reset. The underlying rate will be 3-month MIBOR plus 100 basis points. On the day the firm takes out the loan, the rate is set for the first three months. There is no way to hedge that rate. The firm is

exposed to the rate reset in 3 months, 6 months, 9 months, 12 months, 15 months, 18 months and 21months. Let us say it purchases a cap consisting of component caplets that expire on the dates on which the rates will be reset. An exercise rate of 5% is selected, and the notional principal is set at the face amount of the loan of INR20 million. Let M_0 be MIBOR on the day the loan is taken.

In 3 months, the firm will owe

$$20{,}000{,}000(Mo + 0.01)(\frac{90}{360})$$

At this time, we observe a new value for 3-month MIBOR, which is denoted as M_{3m}. This means that the new interest rate will be M_{3m} + .01. At this time, however, a caplet is expiring and will pay

$$20{,}000{,}000Max(0, M_{3m} - 0.05)(\frac{90}{360})$$

Thus, 3 months later when the interest is paid, the amount the firm will owe is

$$20{,}000{,}000(Min(M_{3m}, 0.05) + 0.01)(\frac{90}{360})$$

In other words, it will owe 1% at a minimum and either 5% or MIBOR, whichever is lower. This continues for two more rate resets. In each case, the firm will owe interest at 1% plus either 5% or MIBOR on the rate reset date, whichever is lower. An interest rate floor works in a similar manner, but the payoff is that of an interest rate put, as discussed earlier. Interest rate floors are used by lenders to protect against falling rates, while leaving the opportunity to benefit from rising rates. For both caps and floors, a premium must be paid up front as it provides risk protection to the buyer. The premium will be the sum of the prices of the component caplets or floorlets.

Interest Rate Derivatives in India

Deregulation of interest rate exposed market participants to a wide variety of risks. To manage and control these risks and to deepen money market, scheduled commercial banks, primary dealers and all India financial institutions have been permitted to undertake forward rate agreements (FRAs) and interest rate swaps (IRAs).

Scheduled commercial banks (excluding Regional Rural Banks), primary dealers (PDs) and all-India financial institutions (FIs) undertake FRAs/ IRSs as a product for their own balance sheet management or for market making. Banks/FIs/PDS offer these products to corporates for hedging their (corporates) own balance sheet exposures.

Banks / PDs/ FIs can undertake different types of plain vanilla FRAs/ IRS. Swaps having explicit/ implicit option features such as caps/floors/collars are not permitted. The parties are free to use any domestic money or debt market rate as benchmark rate for entering into FRAs/ IRS, provided methodology of computing the rate is objective, transparent and mutually acceptable to counterparties. The interest rates implied in the foreign exchange forward market can also used as a benchmark for undertaking FRAs/IRSs. There are no restrictions on the minimum or maximum size of 'notional principal' amounts of FRAs/ IRSs. There are also no restrictions on the minimum or maximum tenor of the FRAs/ IRSs.

An IRS market (as well as interest rate options market) in India has the following obstacles:

IRS for trading: RBI restricts use of these derivative contracts by market participants to hedging the risk in their respective balance sheets only. To come out of the contract, reverse contracts need to be executed by the same parties or they have to wait till the expiry date. Therefore, the participants can not trade in these contracts. On the contrary, in an exchange traded contract, counterparties can come out of the contract by entering into reverse trades with any counter party at any point of time before the life of the contract. This facility increases the liquidity of the contracts and thereby reduces impact cost of trading and hence serves the purpose of risk management better. To provide depth to this market, market participants may be allowed to trade in these contracts.

Acceptable benchmark rate: We have a well accepted Overnight MIBOR that can be used as a bench-mark for very short period. But there is no term money market as such and hence the reference rates for 14-day, 1-month and 3-month MIBOR may not really serve the purpose of an acceptable benchmark rate. If the term money market has liquidity, more acceptable benchmark rates like 3-month MIBOR and 6-month MIBOR would evolve and be widely accepted. The present structure of the money market is also another cause. Two-way quotes are a fundamental necessity for a proper reference rate to be established. Banks can't offer two-way quotes in a call money market since the borrowing in the call is primarily driven by requirements of meeting CRR. Another problem is that while foreign banks and some of the new banks are perennial borrowers in the interbank market, several nationalised banks and institutions are perennial lenders. This gives rise to uni-directional players who are averse to two-way quotes. This polarisation impedes the development of a benchmark rate around which a term-money market can evolve.

Floating rate loans: At least one leg of IRS has to be a floating rate, development of floating rate loan market is essential. A primary reason for non-evolution of floating rate loans is the

common perception of the interest rate movements in India. Over the years, RBI has played a dominant role to moderate interest rate. Till recently, as the RBI had a major role in determining interest rates on the sovereign papers, there was very little volatility in the credit market. Floating rate loans would become popular when diverse views emerge among different players in the market for these rates. As lending rates for the companies are built on the bond yields of the similar tenors, the floating rates were not very different from the fixed rate loans, and not considered to be worth the risk. However, today bond yields are increasingly determined by market participants. And hence the consequent likely volatility in lending rates would help create market for floating rate loans and consequently, interest rate swaps and options.

Acceptable yield curves: The yield curve is required for effectively pricing any derivative contract and therefore, the lack of a reliable one hinders the development of derivatives. However, NSEIL has taken initiative to provide a reliable spot curve (ZCYC) to the market participants. Emergence of a proper yield curve would correctly reflect the spread between retail deposit and interbank rates or the credit spread for prime borrowers over the interbank rate. Moreover forward interest rates can be derived from such a yield curve. Developing a model to estimate the credit spread would go a long way to providing the required benchmarks.

Liquidity in bond market: Another reason for absence of an interest rate options market has been the illiquidity in the domestic bond market. Looking at the bond market we see major papers are illiquid, though situation has dramatically changed over last few years. However the average daily traded value remains at a low level of about 1% of the total outstanding value of sovereign papers in the market.

Awareness: The very concept of swaps is new to India. There is very limited knowledge about these instruments even among the active participants in Indian markets specifically the PSU banks. Moreover, the institutions which carry out the swaps on daily basis do not publish these data through any media and hence it is extremely difficult to develop a swap curve which will be used for the options as well as by other market participants.

Other reasons: During last one year or so (at least up to April 2002), we have seen a southward movement of interest rate and hence in this circumstances there would be few deals on interest rate products as there will be very few who would possibly take opposite view. But today the market is little different and interest rate has become a bit volatile over last 3 months or so giving rise to the justification of higher volumes in IRS market as well as introduction of options on interest rate.