

Ladder options

A ladder option is a call or put option on an index, which periodically resets when the underlying trades through specified trigger levels called “rungs”, at the same time, knocking in the profit between the old and new strike. At maturity, it pays the maximum of the index and the underlying itself minus the strike floored to zero for the call version (respectively the strike minus the minimum of the index and the underlying itself floored to zero for the put version). The name comes from the fact that the trigger strikes play the same role as rungs on a ladder. The ladder option can be structured to have its strikes reset in either one or both directions, allowing a great flexibility in the payoff. Exotic versions of the ladder option commonly traded encompass ladder on the return of an equity stock index over a specified inflation rate or a fixed income bond return, payment made in another currency (quanto ladder), Asian version of the index, compounded version of the index, capped version of the increase of the index.

OTHER NAMES

The terminology of ladder option is quite common in Foreign Exchange derivatives structuring. Ladder options are commonly called ratchet options in fixed income derivatives, exotic cliquet, lock-step, step-lock or lock-in in equity derivatives.

EXAMPLE

Suppose that a hedge fund is bullish on the USD (US Dollar) versus the Euro in the coming six months. It plans that USD/Euro may rise up from 1.0534 to around 1.20. The hedge fund wants to have a high leverage. A derivatives strategy would be quite appropriate, as the client will only pay a small premium for a high profit (see lambda of an option). The hedge fund may want to buy deep out-of-the money USD/Euro calls. European call (see European option) would have the disadvantage to give it the right to exercise the option only at the maturity date, while American call would left it with the additional burden to know when to exercise the option optimally. The structuring group (see structuring of derivatives) advising the hedge fund may offer it a ladder option (call version) with an initial strike of 1.10 and reset strikes (or “rungs”) going upwards in steps of 5 percents from 1.10 to a maximum of 1.25. Now every time USD/Euro triggers a new threshold level, the strike will reset to this new level and a 5 percent profit is locked in. So if during the lifetime of the deal, the fx rate USD/EURO reaches its high at 1.21975, the highest rung reached will be 1.20 and a profit of 10 percents (1.20-1.10) will be locked in. At expiry the fund will receive the greater of the closing spot less original strike and the highest rung reached less original strike. If in our example, the highest level was 1.21975 but the rate closes at 1.13, the fund will receive 10 percent.

PRICING AND HEDGING

Since a ladder option can be seen as a strip of knock-in call options, its pricing follows the same risk management rules. Denoting by α the ladder step, by I_T the index value at the date T , by T_1, \dots, T_n the observation dates, by I_{\min} , respectively I_{\max} the minimum (resp. maximum) rung the ladder can reach, the payoff of the option (in the vanilla case) can be written as:

$$\text{Max}\left(\text{Max}\left(S_{T_n}, I_{T_n}\right) - K\right) \quad (1.1),$$

where the index is defined successively at the observation dates T_1, \dots, T_n :

$$I_{T_{i+1}} = I_{T_i} + \sum_{j=1}^{(I_{\max} - I_{T_i})/\alpha} j \cdot \alpha \cdot 1_{\{S_{T_{i+1}} - I_{T_i} > j\alpha\}} \quad (1.2),$$

with the initial condition:

$$I_{T_1} = \text{Max}\left(K, I_{\min} 1_{\{S_{T_1} > I_{\min}\}}\right) + \sum_{j=1}^{(I_{\max} - I_{T_{\min}})/\alpha} j \cdot \alpha \cdot 1_{\{S_{T_1} - I_{\min} > j\alpha\}} \quad (1.3)$$

A ladder option can be viewed as a series of knock-in options each struck at a different ladder level. Ladder option bear an important risk in terms of forward volatility as each of the option can be seen as forward starting. Obviously, the ladder option is also sensitive to volatility at the various rungs, with appropriate modelling of the skew because of the digital risk. Hence efficient risk management of the ladder option has to account for the volatility smile.

Models like the deterministic local volatility models of Dupire (1993) or Derman Kani (1994) perform badly to produce realistic forward volatility term structures. One has to prefer to them combination of local volatility models and jumps (see jump diffusion), or stochastic volatility models (see stochastic

volatility modelling) and models with jumps. Theories about parabola and log contract are also useful to get a feeling of forward vol. (see forward volatility agreements). Because of the path dependence of this option, Monte Carlo techniques are very appropriate, enhanced by various variance reduction techniques. Ladder options can also be risk managed as discrete type of lookback option, using static replication based on reflexion principle. However the static replication is model dependent and can be quite inappropriate if the model assumptions are not very realistic. Correct delta hedging of the residuals is therefore crucial.

The target market of ladder options is risk averse option buyers as profits are progressively locked in without losing the option position. Compared to a standard option, the ladder options offer the safe and comfortable position to knock each time a rung is triggered, locking in the profit. This can be very attractive to investors who think that the underlying may rally before selling off hence benefiting from the rise without taking the risk of the market fall when close to maturity. Compared to American option, ladder options do not need constant monitoring of the underlying and the subsequent delicate decision to exercise the option. This is why this product is often seen as complex defensive.

Ladder option can also see as a discrete and cheaper version of lookback options. However, the price to pay for this less risky than traditional options structure can be quite substantial compared to normal options.

Entry category: options

Scope: step lock

Related articles: path dependent options, Infinite Ladder Option, Shout Option.

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