Mind the **curve**

Option pricing needs to evolve, says Kyriakos Attikouris

Despite the phenomenal growth in the use of FFAs over the past few years, activity in the freight options market still remains comparatively small. This is rather disappointing as options can serve a much wider range of trading or hedging strategies, apart from the standard long/short strategy of FFAs. Part of the problem can be attributed to the inherent complexity of these instruments and the lack of a commonly accepted option pricing model.

Initially, the industry started pricing options on freight using the so-called “Black-76” model. This represents an extension of the most famous option-pricing model, namely the Black-Scholes model. The general Black-Scholes framework assumes that the option is written on the spot price, whereas the Black-76 model assumes, instead, that the underlying of the option is the corresponding forward price.

However, there is one big problem with using the Black-76 model for pricing freight options. The Black-76 model assumes that the option payoff is a function of the underlying price at the time of option expiration, whereas the payoff of freight options depends on the average of the underlying price over a specified period.

The general class of options whose payoff is linked to the average value of the underlying asset on a specific set of dates during the life of the option is commonly referred to as “Asian” options. Let us examine a few facts about Asian options.

First of all, the name “Asian” option has no particular significance. It was originally used by David Spaughton and Mark Standish who were both working for Bankers Trust in 1987. They were in Tokyo on business when they developed the first commercially used pricing formula for options linked to the average price of crude oil. Because they were in Asia, they called the options “Asian options.”

Asian options are commonly used in currency and commodity markets. Options based on an average, such as Asian options, are of interest in markets with thinly traded assets, as they have a reduced incentive to manipulate the underlying price at expiration. Because the average value of an underlying price over an extended period of time tends to be less volatile than the underlying price itself, Asian options tend to be less expensive than comparable vanilla options.

Asian options are broadly segregated into two categories: arithmetic average Asians and geometric average Asians. Geometric Asian options are not commonly used in practice, so let us elaborate on the arithmetic averaging. This is seen as being the sum of the sampled asset prices divided by the number of sample points: (X1+X2+…+Xn)/n. Unfortunately, the arithmetic average has certain undesirable statistical properties under which an arithmetic average Asian cannot be priced analytically (i.e. by means of an exact “closed-form” solution). There are two possible ways to work out a solution to this problem: Either to use an analytic approximation (such as those proposed by Turnbull and Wakeman, Levy, or Curran) or to solve the problem numerically, typically by means of Monte-Carlo simulation.

Going back to how the industry prices options on freight, it appears that increasingly more people recognise – at last – that they should be treating freight options as Asians. We have been witnessing recently a conscious shift from the Black-76 model to the Asian class of models. Imarex is now publishing indicative option prices for its tanker routes using the Turnbull and Wakeman approximation. We even hear about some market participants being bold enough to use the Monte-Carlo simulation technique.

All of these changes are undeniably welcome and help us get closer to unveiling the “true” fair value of an option. However, the quest for the “correct” price is not over yet. Typically, all of the above models take as input the respective FFA price for the averaging period of the option. But this is just one price. One number which says what is the expected average price of the underlying index or route for the period in question. It tells nothing about whether the market is in contango or backwardation in that period and how steep that might be. But does it matter? How critical is it to know the shape of the forward curve as opposed to knowing just its average level?

Options are non-linear instruments with asymmetric payoffs. Either they have a positive payoff when they expire in-the-money (ITM) or a zero payoff when they expire out-of-the-money (OTM). There is subtle difference though. The positive payoff is directly proportional to how deep ITM the option expires, whereas the zero payoff is the same no matter how far OTM the option might expire. Asian options in particular are “path-dependent” options, which means that their payoff depends on the actual path of the underlying asset, by way of taking the average of the actual prices recorded on a specific set of dates during the life of the option. The presence of a forward curve provides a critical piece of information which is a forecast of that path, as implied from current FFA prices. So why would anyone attempt to price a path-dependent option without taking into consideration all the information that is available about that path?

Let us consider a simple example to illustrate the problem. Graph A displays two hypothetical forward curves over a period of 90 days. A forward curve is defined as the line chart which shows the implied spot rate at any given future date. Such a forward curve can be bootstrapped from current FFA quotations using certain interpolation techniques. Suppose that curve A represents the “real” forward curve, showing that the market is in steep backwardation with an average value of 100 (corresponding to the underlying FFA price for the same period).

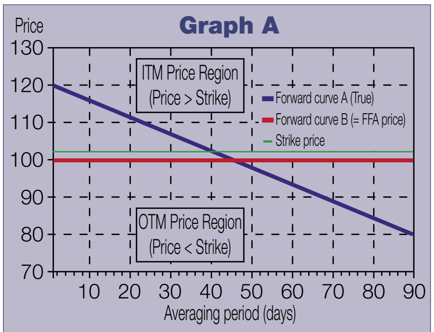
On the other hand, curve B is the type of curve which is implicit in the approximation models or in any other pricing model which takes as input a single FFA price and not the entire forward curve for the averaging period of the option. It is flat because these models have no way of knowing or reconstructing the shape of the “true” forward curve. So, although both curves are correct in the sense of having the same average value, matching the corresponding FFA price for the period in question, they differ in terms of their shape.

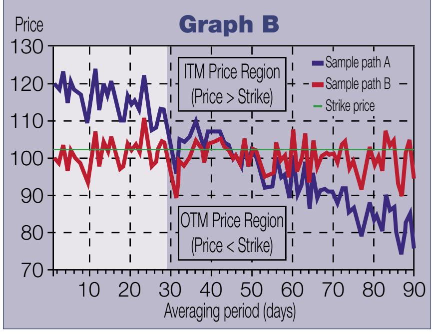
Let us assume now that we wish to price an arithmetic average call option for that period with monthly settlements and a strike price of 102. What stands out immediately is the fact that a substantial part of curve A lies within the ITM price region during the early part of the averaging period.

Graph B displays two sample paths centered around the two forward curves depicted in Graph A. Both paths have been generated by a Monte-Carlo simulation engine using the same set of random numbers. It is easy to see which path stays longer and deeper into the ITM region, leading to a higher positive payoff – at least for the first monthly settlement (shaded area in the graph). The same path goes deeper into the OTM region as well, but remember, the payoff for being OTM – irrespective of how much – is always restricted to zero. The price of the option is not reduced if the price of the underlying asset ends up further OTM.

This clearly shows why the shape of the forward curve does matter and why it is important to respect the path-dependent nature of the option. Any pricing model which does not take into account the full information off the entire forward curve is prone to producing errors – either overvaluing or undervaluing an option, depending on the level of the strike price relative to the underlying FFA price and whether it is a call or a put. Obviously, the steeper the forward curve and the longer the averaging period, the higher the potential for error.

So how do we price Asian options more accurately? The only method which is capable of incorporating the full forward curve is a





special variant of the Monte-Carlo simulation model. The technical details of such a model go beyond the scope of this article, but to give an indication, it relies on making the drift coefficients of the underlying stochastic process time-dependent. This is achieved by calibrating the drift coefficients to match the forward rates implied by the latest FFA prices so that the model is able to capture the current contango or backwardation in the forward market.

It is important to note that the above treatment is not specific to freight options. It is similar to how options are being priced in other markets with available forward curves, such as energy and interest-rate markets. As more participants make their entry into the freight options market and the level of financial sophistication rises, the ability to produce more accurate option prices will become increasingly important. The industry has already taken a long-needed step moving from Black-76 to the Asian class of models. Yet, there are more steps to take and more refinements to make before we reach a high level of confidence in how we price freight options. In the coming issues of *The Baltic* we will be discussing other interesting techniques relating to shipping derivatives and risk management, such as value-at-risk and counterparty risk measurement, amongst others.

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