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| Valuing Asian Options using Curran Approximation  Mälardalen University: UKK 2009  Sampid Marius Galabe, Kigha Nubitgha Franklin, Gyasi Hayford , & Kamta Celestin |

Abstract

In this paper, we discussed Asian options and show how the Curran approximation can be

use to calculate the value of the option based on the geometric conditioning approach.

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Introduction

Asian options can be defined as options whereby the underlying variable is the average price over a period of time. That is, “…the payoff depends on the average price of the underlying asset during at least some part of the life of the option” [Hull: 2008, pp564].

They are in some sense special type of option contracts because:

Their payoffs are determined by their average underlying price over some pre-set period of time,

They have lower volatility, which makes them cheaper as compared to the plain vanilla options. Furthermore, Asian options have complex payoffs; key values often depend on outside factors which vary over time such as exchange rate.

Because of their complex nature, Asian options are often traded on OTC rather than on exchange.

**Materials used and Limitation:**

Concerning the materials, we have used materials from the internet, the course literature, notes from class lectures and other financial text books which were not quite easy to read and understand.

It was not that easy either to have access to any materials that treats the Curran model explicitly. All the material we have found had very limited information about the Curran model or approximation.

**Types of Asian Options**

Two types of Asian options exist:

If the strike price depends on a fixed quantity, then the option is referred to as a fixed strike Asian option or an average price or rate option. Here the option at expiry pays the difference between the strike and an average of the underlying price achieved during a specified averaging period in the options term. The payoff from an average price *call* and *put* are respectively:

max(0, K) for *Call*  and

max(0, K) for *Put*

On the other hand, if the strike price is proportional to the asset price itself, then it is referred to as floating strike Asian option or average strike option. Here the option at expiry pays the difference between this strike and the underlying market price. The strike of the option is an average of the underlying price over the specified averaging period. The payoffs from an average strike options for *call* and *put* are respectively are respectively:

max(0, ) for *Call*  and

max(0, ) for *Put*

Further differences between the options can be made based on the nature of the average. That is either geometric or arithmetic, both with possible varying weights for previous observations.

If the nature of the average is geometric (geometric average price option), then the option can be treated as a regular option if the volatility is set equal to and the dividend yield equal to . This is because “In the risk-neutral world, it can be shown that the probability distribution of the geometric average of an asset price over a certain period is the same as that of the asset price at the end of the period if the asset’s expected growth rate is set equal to

rather than and volatility set equal to rather than [Hull: 2008, pp564].

Also, if the nature of the option is arithmetic, as explained by Hull, (pp565), we have to calculate the first two moments of the probability distribution of the arithmetic average in the risk-neutral world exactly and then fit a lognormal distribution to the moments. This is because the distribution of the arithmetic average of a set of lognormal distribution does not have analytically tractable properties. The first two moments are respectively:

= (the forward price) and

The proof of and can be found in the book of Hull Seventh edition.

If we then assume that the average asset price is lognormal or approximately lognormal, then we can use Black-Sholes formula for valuing future options to obtain the value of the option. That is,

,

And =

The Curran Model

Curran in 1992 to 94 came up with a model known as the Curran’s approximation for pricing Asian options based on a geometric conditioning approach in which he claimed is the most accurate approach of valuing Asian options than other closed-form approximations presented earlier.

For a *call* option, we have

Where

[]

Where *S* = initial asset price,

*X*= Strike price of option

b = Cost of carry

r = Risk-free interest rate

*T* = Time to expiration in years

= Time to averaging point

= Time between averaging points

n = Number of averaging points

= Volatility of asset

*N(x)* = The cumulative normal distribution function

If and are Asian *call* and Asian *put* respectively, with exercise date T, fixed strike price K, and n averaging dates, then the put-call parity for the Asian option at present date is

= .

And thus – .

For example*, if S = 100, T = 26, 1* week, *r = 0.08, b = 0.03* and *n = 27*, we obtain Curran’s approximation by adjusting the volatilities as seen in table below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | S |  |  |  |  |  |
|  | 95 | 0.2758 | 1.4262 | 2.8099 | 4.2581 | 5.7298 |
| 0 weeks | 100 | 1.9466 | 3.4899 | 5.0395 | 6.5878 | 8.1320 |
|  | 105 | 5.7110 | 6.7024 | 8.0489 | 9.5063 | 11.005 |
|  | 95 | 0.8956 | 2.9260 | 5.0916 | 7.2866 | 9.4866 |
| 10 weeks | 100 | 3.0019 | 5.2739 | 7.5597 | 9.8425 | 12.1171 |
|  | 105 | 6.6074 | 8.4137 | 10.5604 | 12.7983 | 15.0669 |
|  | 95 | 1.5308 | 4.1925 | 6.9307 | 9.6780 | 12.4172 |
| 20 weeks | 100 | 3.8838 | 6.6982 | 9.5350 | 12.3667 | 15.1844 |
|  | 105 | 7.4609 | 9.8449 | 12.5693 | 15.3776 | 18.2081 |
|  |  |  |  |  |  |  |

Conclusion

Because of the complex nature of Asian options, several models have been developed to calculate its value of which the Curran approximation is one of those. However, Curran’s approximation has an undesirable side effect of diverging for large value of strike because the approximation is strike price dependent which makes the Curran model not a good approximation for valuing Asian options when the strike price turns to infinity, especially with high volatilities and long maturities.

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