Global Options Markets

Accuracy and Speed Matters

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Introduction

There are several factors that determine the price of an options contract. Option prices can change due to directional price movement in the underlying asset, changes in the implied volatility, dividend rate, interest rates and even time decay. In order to understand their risks as well as have the highest probability of profit, traders must understand and quantify the price, implied volatility and an option's sensitivity to these various factors.

Accuracy and latency are two elements that are crucial to options trading. Equipping themselves with a more accurate and faster pricing tool, traders are capable of grasping market's information edge, develop powerful HFT strategies, and avoid great losses.

Pricing Accuracy and Latency

Option pricing is a key issue in option trading because it is decided by the supply and demand in the market, and it will influence the profit of the option seller and buyer. The first option pricing model can be traced back to 1900 when Bachelier derived a closed formula for pricing the standard European options. Later in 1973, Fischer Black, Myron Scholes and Robert C. Merton published the Black–Scholes–Merton underlying model leading to the seminal Black–Scholes European option pricing formula, which led to a boom in options trading and legitimized scientifically the activities of the Chicago Board Options Exchange (CBOE) and other options markets around the world.

The American option pricing problem however remains a challenging puzzle for more than 40 years. In 1979, John C. Cox, Stephen Ross and Mark E. Rubenstein proposed a binomial tree option pricing method, later improved in a form of a more accurate trinomial tree. The binomial/trinomial tree option pricing methods are very accurate when the numbers of time nodes are large, but it is very time consuming. It also does not allow computing accurate and stable Greeks. A danger of reaching an overflow on finite computers and improper handling of the optimal exercise boundary due to discreetness and a conic shape can be mentioned as other issues limiting accuracy, especially at higher maturities and/or higher volatilities. However, for shorter (except for ultra-short), mid-range and longer (except for ultra-long) maturities a tree of 10,000 time nodes combines simplicity of implementation and accuracy sufficient for providing dollars and cents and being a benchmark for other methods. However, speed remains a major issue for trees with large nodes.

Another discrete method commonly used for pricing is partial differential equations (PDE). Advantages of this method are the independent time and state stepping, eliminating a danger of overflow, and one order higher accuracy, comparing to a tree, due to use of the explicit-implicit Crank-Nicolson scheme. However, due to discreteness there is a general increase in accuracy, and in particular the precision for handling the free optimal exercise boundary can be reached by taking a high number of state steps. This leads to a longer computation time, longer than the tree. Moreover, the problem with Greek computations remains the same.

The oldest and most popular quadratic analytical approximation attempting to address these issues was developed by MacMillan (1986) and Barone-Adesi and Whaley (1987). However, its specific internal assumptions for the optimal exercise premium, are based on mimicking the perpetual American option behavior, this lead to a noticeable mispricing, especially for mid-range maturities. Ju-Zhong's pricing is more accurate in regions where Whaley is less accurate. Furthermore, the quadratic denominator in the early exercise premium presents a risk of zero division, negative sign and non-monotonicity causing an unwanted distortion in the optimal exercise premium for very short maturities and imprecision at longer maturities, and/or more remote strikes. In fact, both MBAW and Ju-Zhong approximations at very long maturities can exceed the perpetual option price. Another known approximation by Bjerksund-Stenseland is rarely accurate due to its too simplistic assumption about the optimal exercise boundary as a 2-step function.

Providing a technique capable of solving American options accurately in real-time still remains a challenge due to the absence of a powerful analytical approach. Additionally, needs for further analytics such as the time-dependence (term structure) in parameters and discrete dividends are making the described set of systemic problems even more complicated. The new Oquant (OQNT) approach is a breakthrough proprietary algorithm that's 1000 times faster than the binomial/trinomial tree method and at the same time provides major Greeks at no extra time, and yields highest accuracy outperforming all existed methods. Oquant is based on a new, accurate and still fast analytic approximation, computing the price with precision matching dollars, cents and in many cases basis point - fractions of cents. Besides the analytic approximation this approach ***doesn't rely or use in background the following***;

- any type of simulation or heuristics with random numbers
- any type of computations based on trees
- any PDE solving procedure that's based on finite differences
- any computation of a direct or inverse integral transform
- any type of combinatorial search and/or dynamic programming
- any reference to older analytic approximations
- any type of usage or generation of precomputed and/or stored data

Dollars and Cents | Billions and Millions

Let's see an example why pricing accuracy is so important in trading. Suppose that John, a hedge fund analyst, invests in 10,000 option contracts across 100 asset classes in 1 month. If John prices the options with an inaccurate model that generates 0.001 error every time it computes, how much will he loss compared to an accurate method? As we know, one option contact is written on 100 shares of the underlying. So the losses will be $0.001*100*10,000=$1,000. If the error goes up to 1 cent, then the losses will go up to $10,000. What about 1 dollar error each time? The losses will be one million! Thus, even though a small pricing error will cause great losses and greatly influence the profits. OQNT provides highest accuracy compared to other pricing algorithms and helps investors save money and generate better profits.

There is another problem existing in American option pricing – latency. In high frequency trading underlying asset prices can change in nanoseconds. With powerful computer systems and complicated trading algorithms, HFT may buy or sell great amount of options in milliseconds. In order to gain an advantage of every millisecond, some companies even place their servers very close to the Exchange. However, the current accurate option pricing methods do not satisfy the time requirement in the HFT due to a time lag between the change of the underlying assets price and the reprice of the American options. This is because volatility needs to be computed first and then be inputted in to pricing model.

Typically, there is a tradeoff between accuracy and latency. Trinomial trees with large number nodes price most accurately but it can take a long time to get results. Some current pricing methods, based on the MBAW or Ju-Zhong approximation, can generate results within microseconds, but they will come up with inaccurate results - cents or even dollars off.

Scenarios

OQNT provides a better choice – repricing options in microsecond and generates super accurate results. Consider the same example of John under three scenarios:

1. To maximize profits and minimize losses John would like to get the most accurate results. Therefore, he decides to use the trinomial trees with 10,000 nodes to compute option prices. In order to reprice options quickly, he has to rely on a very expensive distributed computing grid with 1000 GPUs. The NVIDIA GPU costs $300, $750 and $1100 for GTX 970, GTX 980 Ti, GTX Titan X respectively. Thus, John needs to pay $300,000, $450,000 or $1,100,000 just for buying the computing devices supporting his pricing method. John can also buy computing service from AWS. The service fee for GPU Instances is $0.65/$2.6 per hour. Suppose John use the service 8 hours per business day, then the service fees for one year will be 8*250*0.65=$650/8*250*2.6=$2600. If John uses the service 7/24, then his fees will be 24*365*0.65=$5694/24*365*2.6=$22776.
2. John considers using trinomial trees with 150 nodes to price options fast without paying a lot for computing. However, with the so low number of nodes, a tree will generate a noticeable pricing error. Suppose that there is an average error of $0.1 for each pricing result. From the above example we already know that the losses caused by a 10 cent error can be $100,000 in a month and John will loss 1.2 million in a year.
3. John plans to use OQNT to support his trading. He doesn't need to pay up to one million for computing devices and service, since OQNT offers best computing infrastructure for reprice options in microsecond, and real-time streaming computations - this can save him million dollars a year. He doesn't need to lose millions of dollars for pricing errors either, since OQNT breakthrough generates super accurate pricing results. Besides saving money, John will be capable to explore more investment opportunities using varity of options analytics. He can construct portfolios across thousands of asset classes and discover new global investment opportunities since he can get accurate prices for any number of underlyings in seconds. Finally, John will much more accurately evaluate the risk of his portfolios and make much better grounded strategic actionable decisions based on more accurate analytic greeks obtainable from OQNT at the time of pricing unlike another previous method.

Options are the most leveraged instruments on the planet. Thus, inaccurate option prices and latency delays are one of the biggest market inefficiencies among many others, like liquidity, supply-demand, dividends, real-time Greeks, options indexes issues and etc. Oquant is the first of its kind cloud based options intelligence platform, next generation Bloomberg for options analytics. Following are some of the upcoming analytics that will include; aritificial intelligence, predictive analytics and market surveillance extracted from options data (hidden information).

Greeks Computations	**Discrete Dividends**	**Bulk Computations**
Predictive Analytics	**Volatility Analytics**	**Portfolio Curation**
Exploratory Analytics	**Market Intelligence**	**Visualizations (Options)**