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It's All About Probability

Computing Expected Returns On Options Strategies

With the many strategies you can trade, computing expected returns can be tedious. Using one strategy as an example, we look at how calculating maximum profit and loss plus factoring in the probability of profit can identify profitable statistical arbitrage opportunities.

by *Douglas Lyon, PhD*

The basic probability assumption (BPA) assumes that all probabilities for all outcomes of any given experiment must sum to 1 and that the probabilities are known with 100% certainty. The statistical arbitrageur knows that the BPA is without foundation and that there is a nonzero probability of losing money for any given trade.

Even though BPA is without foundation, the theory has yet to be adjusted sufficiently to relax the assumption. In this article, I'll describe several real-world options strategies and a means for computing an expected return under the basic probability assumption.

Basic computation of expected return

Suppose you are given an ideal coin such that the probability of a head is equal to the probability of a tail and that all probabilities sum to 1. Assume also that there are only two outcomes. We can represent the two outcomes with the following mathematical expression:

$$f(k;p) = \begin{cases} p & \text{if } k = 1, \\ 1 - p & \text{if } k = 0. \end{cases}$$

where k=1 corresponds to the outcome of flipping a coin resulting in a head, and k=0 for a tail. For an ideal coin, p = 0.5. Suppose that every time you get k=1, you get paid $2 and if you get k=0, the payout is $1. The expected value of the coin flip must therefore be:

$$E(f(k;p)) = 2p - (1-p) = 2/2 - 1/2 = 0.5$$

In other words, you must multiply the probability of a win times the amount you win and subtract from that the probability that you lose times the amount of the loss. This simple idea is expressed by:

$$E(f(k;p)) = M_p\, p - M_L(1-p) = 2/2 - 1/2 = 0.5$$

where:

M_p = max profit
M_L = max loss

The BPA and jade lizard

In the *jade lizard* options strategy, you write or sell a call and put while buying a call at a higher strike price. I'll use Clarus Corporation (CLAR) as an example. The stock is trading at $8.25. Using TastyWorks (a platform that can report the probability of a profit), I set up a trade as shown in Figure 1.

TASTYWORKS

FIGURE 1: BASIC PROBABILITY ASSUMPTION. In this trade using the jade lizard options strategy, the expected return is 407.50.

You see that the probability of profit (POP) is 99.5% and that I was paid a credit of $4.10 with 16d (16 days) until expiration. This credit represents the maximum profit per contract (100 shares * $4.10/share = $410). Because one leg of the jade lizard is a naked put at $5, you can lose $5 of intrinsic value in the put if the stock goes to zero in 16 days. However, because I have already been paid $4.10 per share, my max loss is $5-$4.10=$0.90. For 100 shares, the max profit is therefore $410 and max loss is $90. Here's how I compute my expected return:

$$E(f(k;p)) = M_p\, p - M_L(1-p) = 410\,(0.995) - 90\,(0.05) = 407.5$$

Naturally, this scheme can scale. You don't have to trade just one jade lizard. You could trade 10 or 100 jade lizards with expected returns of $4,075 or $40,750. However, with little volume, this may not be a practical trade. We may not even be able to trade a single jade lizard.

Selecting jade lizard stocks

How do you select jade lizard stocks? As mentioned earlier, you are exposed to a stock that can go to zero. So if you select a low-priced stock with a low-priced put, along with a call spread, you obtain a synthetic reverse iron condor in profit profile (that is, you are selling the body and purchasing the wings). The sale of the body is a sale of a straddle (the call and put). Being naked on the put side is okay, since the stock cannot go below zero, thus limiting your loss.

However, from a margin perspective, the sale of the call without the corresponding purchase of a high-strike call would expose you to unlimited loss. Unlimited loss will also cause the expected return computation to tend toward minus infinity.

How could this happen? Suppose you had a naked short call and during the next 16 days, CLAR received a takeover bid for $100 a share. At that point a naked call is assigned and you are living in *Mudville*. As unlikely as that may be, you must therefore have the higher-priced call, even if the likelihood of a takeover is trivial. Operating without such insurance is the moral equivalent of picking up quarters in front of a steam roller.

The BPA and the reverse iron condor

Let's look at a higher-priced stock such as Nabors Industries, Ltd. (NBR). I structure the reverse iron condor so you buy the guts and sell the wings (for cost offset). Figure 2 shows that the wings are positioned close to a single standard deviation away from a Gaussian-distributed probability density function, computed

FIGURE 2: REVERSE IRON CONDOR. The wings are positioned close to a single standard deviation away from a Gaussian-distributed probability density function.

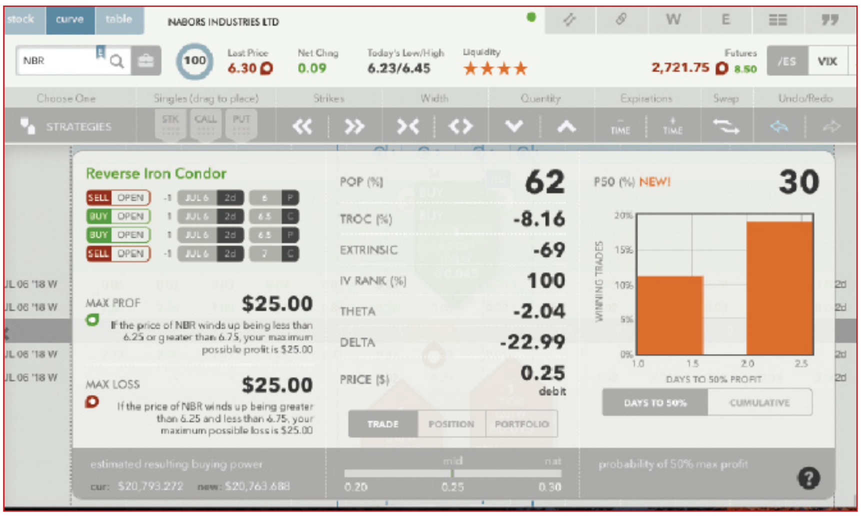


FIGURE 3: MAX PROFIT & LOSS. The max profit & loss are the same, $25. The probability is skewed toward a probability of profit (62%). Expected return is $6.

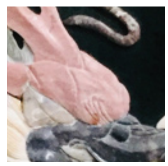
FIGURE 4: IRON CONDOR ON A STOCK WITH HIGH IMPLIED VOLATILITY RANK (IV RANK). The iron condor provides a credit of $3.31 with a 61% probability of profit. A maximum loss is $1.69 (which occurs if the stock is less than $296.69. This gives us an expected return of $136 per iron condor.

using observed price action.

While the max profit and loss are the same, $25 as shown in Figure 3, the probability is skewed toward a probability of profit (62%) so that:

$$
\begin{aligned}
E(f(k;p)) &= M_p\,p - M_L(1-p) \\
&= 25\,(0.6) - 25\,(0.4) \\
&= 6
\end{aligned}
$$

The $6 expected return is low. However, with the number of days to go equal to two days, the ROI on a yearly basis is high (you can conduct such trades more often). Even better, your belief in the BPA may be strengthened with only two days to go. Even if you do not have good belief in the BPA, the max loss is $25, no matter how dire the exogenous elements appear. After all, it is hard to accurately predict war (or tweets).



THE BPA AND THE IRON CONDOR

In the case of the iron condor, you sell the guts and purchase the wings. The wings are your insurance against a black swan event. In the case of higher-priced stocks, putting on strategies with naked legs will eventually trip up even the most disciplined trader. This can result in a life-changing event from which you may never recover (consider that famed trader Jesse Livermore was worth $100 million in 1929, but after he lost all his money he shot himself in the head). The statistical arbitrageur must always be mindful that there is a nonzero probability of losing money on any given trade. Large gambles on any single trade negate the advantage obtained from repeated Bernoulli trials. (A Bernoulli trial, also known as a binomial trial, is a random experiment with only two possible outcomes—either success or failure—and the probability of success is the same every time the experiment is conducted.)

For the iron condor, I selected Tesla (TSLA), a stock with a high implied volatility rank (high IV). See Figure 4.

The iron condor provides a credit of $3.31 with a 61% probability of profit. The max loss is $1.69, which occurs if the stock is less than $296.69. This gives an expected return of $136 per iron condor.

FIGURE 5: SELL A CALL BUTTERFLY. In this options strategy, you sell the wings with an in-the-money (ITM) call and an out-of-the-money (OTM) call. You then purchase two of the at-the-money (ATM) calls.

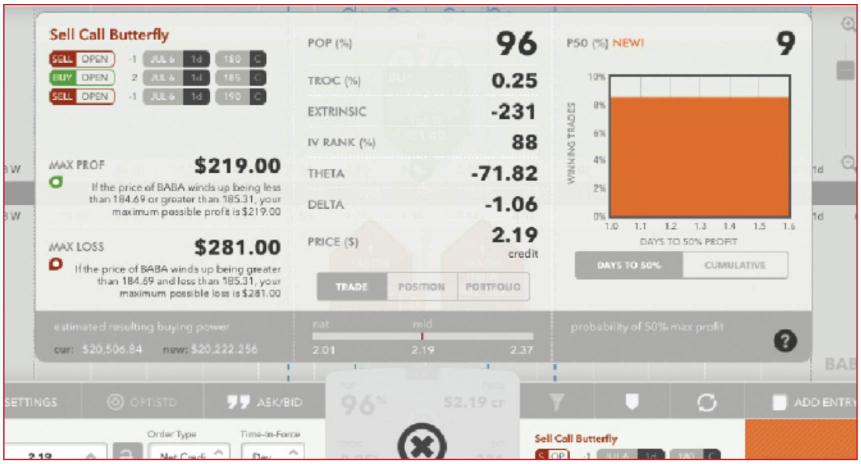


FIGURE 6: DEFINED RISK AND HIGH-PROBABILITY BUTTERFLY. Max loss occurs when the price winds up greater than 184.71 or less than 185.30. Probability of profit is 96% and this more than makes up for the max loss being larger than the max profit.

Option traders are encouraged to take defined-risk trades that have a high probability of success.

$$E(f(k;p)) = M_p p - M_L(1-p) = 331\ (0.61) - 169\ (0.39)$$
$$= 136$$

The sell call butterfly

In the sell call butterfly, you sell the wings with an in-the-money (ITM) call and an out-of-the-money (OTM) call. You then purchase two of the at-the-money (ATM) calls. See the trade on Alibaba (BABA) in Figure 5.

With one day to go, you have a 2.21 credit, the max profit. The max loss occurs when the price winds up greater than \$184.71 or less than \$185.30, as shown in Figure 6.

The probability of profit is 96% and this more than makes up for the max loss being larger than the max profit. It's possible that the impact of trade wars or geopolitical tensions could be baked into the stock's price.

$$E(f(k;p)) = M_p p - M_L(1-p)$$
$$= 219\ (0.96) - 281\ (0.04)$$
$$= 199$$

If expected return is high, it is possible that the impact of external events may not be accounted for in the stock's price action.

Expectations

Options traders are encouraged to take defined-risk trades that have a high probability of success. This is *almost* correct. They should take defined-risk trades with a high expected return. Statistically, you must also consider placing many bets before the law of large numbers kicks in.

If you are running a casino, you are better off having a bus load of people with quarters playing slots than you are with a single high-roller who puts down \$1 million on red. You can have a reasonable expectation of a long-term profit by conducting many trials with known probabilities. This statement brings up the question of the accuracy of probabilities. The question of how much error these probabilities have as a function of time remains open.

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‡Tastyworks

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