

White Papers



The Binary Options Trade System: Theoretical Insights

Abstract

Binary options are a novel type of investment and it follows that a successful trade system will have characteristics different from those of more traditional investment assets. Studying the mathematics behind trading binary options can help move the trader along the learning curve by revealing useful insights into the design and evaluation of a binary options trade system.

Binary options on financial assets are options that return one of two different payouts at expiration depending upon a condition being met in the price of the underlying asset. A common type of binary option is the above/below option, the purchase of which locks in the current market price of the asset as the strike price of the option. If, at option expiration, the asset's price is above the strike price in the case of a call, or below the strike price in the case of a put, then the option finishes in-the-money and the maximum payout is received by the option buyer. If not, then the smaller payout is received.



Above/Below Binary Option on the FTSE 100. The current index price is 6051.718. An investor contemplating that, at option expiration in just under 38 minutes, the FTSE will be above (below) this price will buy a call (put) option. If the investor's expectations turn out to be correct, then the option will finish in-the-money and return the invested amount plus 85% of this amount. If not, then the option will return nothing; the invested amount will be lost.

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Online retail trading of binary options on electronic trading platforms has been growing rapidly over the last few years, especially among those with little prior investment experience. Chief among the reasons for this growth are the intuitive simplicity of a binary option, the fixed risk of every trade, and the ease of entry from both an administrative and investment consideration. Online trading platforms have also become more user-friendly with improved graphics, content availability across various languages, and an expanded array of tradable assets including select stocks from the Asian, European and American trading markets.

A Simpler Trade System

As is true when trading any asset, binary option trading should follow the rules of a well-designed trade system. In general, a trade system provides the objective criteria of when to initiate a trade, either long or short, and when to close a trade, either at a profit or a loss. The unique feature of retail binary options makes the trade system simpler: in most cases, binary options can only be purchased and not sold. Also, a binary option position is automatically closed upon option expiration and usually cannot be closed prior. Finally, the risk is limited to the initial investment. Consequently, a binary options trade system need only provide the rules for which particular option(s) to trade, when to buy a call or put, and how much to invest or risk on the position.

Studying the dynamics of binary option trading from a theoretical or mathematical viewpoint can help answer some of these questions as well as provide other insights into trade system design and evaluation. For the most part, we'll consider just the above/below option, though many of the results can be extended to other types of binary options.

Theoretical Valuation Model

Since a binary option has only two possible outcomes, the payout of each being known and fixed in advance, and since retail trading of binary options requires no fee or commission, the performance of trading binary options can be effectively modeled mathematically.

Let's say that you just opened a binary options trading account and deposited cash as a starting balance. We'll call the dollar value of your account VAL. You decide to risk the same amount on every binary option trade and we'll call that amount INV. In practice, this may be anywhere from \$30 to \$1,000 per trade. If the binary option finishes in-the-money, meaning that you win, then your payout is P_W and if the option finishes out-of-the-money, then the payout is P_L . So, for example, if a binary option has a payout matrix of 75/10, then $P_W = 1.75$ and $P_L = 0.10$. We'll assume that these payouts are fixed across all option trades that are made.

The value of your account, VAL_t after t option trades is given by:

$$VAL_t = VAL_{t-1} + [p_t P_W + (1 - p_t) P_L - 1] INV$$

Where $VAL_{t=0}$ = starting balance

The stochastic variable, p , can have only one of two values: "1" meaning that the binary option finishes in-the-money (you win), and "0" meaning that the binary option finishes out-of-the-money (you lose).

The equation above is dynamic since the value of your account at any given time is dependent upon the success or failure of prior trades. Not surprisingly, there are a great number of ways that the value of your account can evolve even when the number of winning trades and losing trades are equal but just occur in differing order.

The success ratio of a trade system, SR_t , after t binary option trades is simply:

$$SR_t = (\sum p_t)/t$$

So, for example, if 25 out of 40 trades are winners, meaning that the binary option finishes in-the-money, then the success ratio of the trade system is 62.5%.

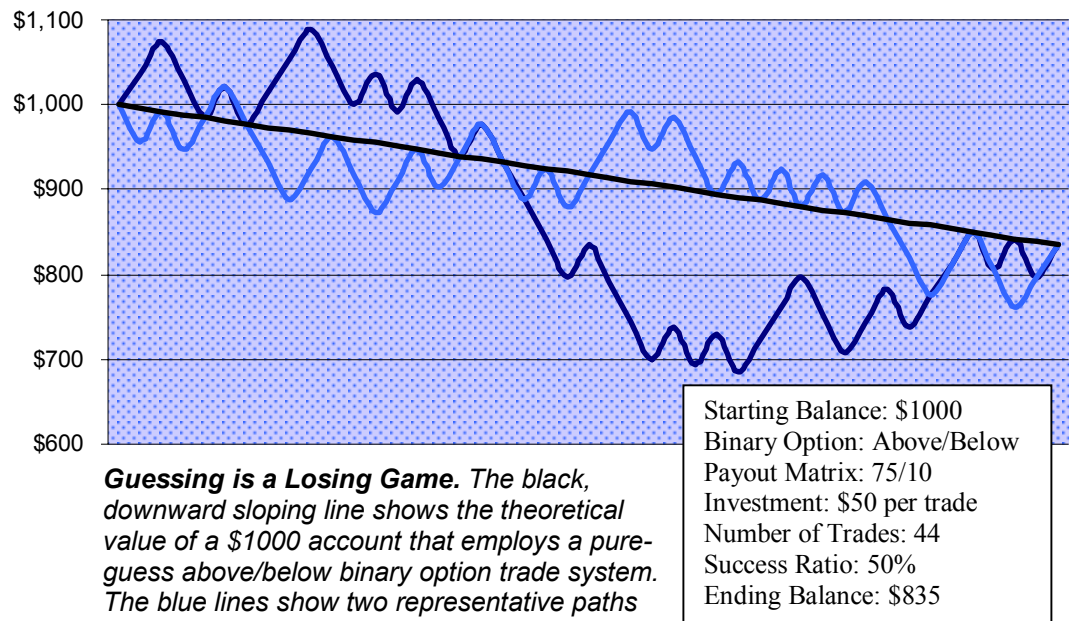
Armed with our mathematical model, let's explore the dynamics of binary option trading and let's begin with the pure guess scenario.

The Pure Guess Scenario

A pure guess means that the trade system provides no value in improving the success ratio beyond the expected value of p , $E(p)$. The expected value of p is determined by the type of binary option and the stochastic nature of the asset price underlying the binary option.

An above/below binary call (put) option will finish in-the-money if the asset price at expiration is above (below) the current, locked-in price. Since it is generally the case that the percentage change of an asset's price is distributed symmetrically around zero, then $E(p) = 0.5$ or 50%, meaning that it is equally likely that an above/below binary option will win or lose. By way of comparison, a barrier binary option – where the price of the underlying asset must rise or fall to some designated level for the option to finish in-the-money – has an expected value of p that is much less than 50%.

An above/below binary option trade system that amounts to guessing would be expected to have a success ratio of 50% so that if 44 trades are made, for example, then 22 of those will be winners. When trading a typical binary option, such as one having a payout matrix of 75/10, this system will not be profitable in the long run, as shown in **Guessing is a Losing Game**. For a given payout matrix, the rate of deterioration of the account value becomes more abrupt the greater is the investment amount and this provides rationale for limiting the investment to a small percentage of the starting balance.



Guessing is a Losing Game. The black, downward sloping line shows the theoretical value of a \$1000 account that employs a pure-guess above/below binary option trade system. The blue lines show two representative paths that an account balance may follow, each reflecting the same number of winning and losing trades but in different order.

For these 44 trades, half of which are winning trades, there are over 1.7 trillion possible paths that the account balance can follow, all depending upon the order in which winning and losing trades are realized. While all will fluctuate around the theoretical account value, there are some cases when the account balance can rise above the starting balance. This is more likely to occur when more of the initial trades are winners. The dark blue line, for example, represents an account that was up nearly 10% after 9 trades, even though the success ratio of the trade system is not high enough to sustain this performance. If the trader erroneously believed that the trade system was better than it actually was, then he or she might have been tempted to increase the investment level, only to be disappointed by subsequent trades. This suggests that, when trading binary options, a sufficiently high number of trades need to be made in order to provide an accurate measure of the success ratio of a trade system. Four or five trades, whether winners or losers, are not enough to make this determination.

In practice, no trader would implement a trade system that is expected to provide no greater chance of success than a pure guess and this is true regardless of the market. Consequently, we'll turn our attention to a more important consideration, the break-even scenario.

The Break-Even Scenario

A binary options trade system will break even if the accumulated payouts received after t trades are equal to the total investment made. Formally, this means:

$$\sum p_t P_W \text{ INV} + \sum (1 - p_t) P_L \text{ INV} = \text{INV}t$$

Solving for the break-even success ratio, SR_{BE} :

$$SR_{BE} = (\sum p_t)/t = (1 - P_L)/(P_W - P_L)$$

The success ratio required to break even depends upon the payout matrix of the binary option. The table below calculates success ratios for various payouts that are typically available with online above/below binary options. For example, a binary option having payout 75/10 has a success ratio of 0.5454 meaning that 54.5% of the option trades would have to be winners in order to break even.

Binary Option Payout:		Break-Even Success Ratios
If win:	If lose:	
85%	0%	54.1%
71%	15%	54.5%
75%	10%	54.5%
69%	15%	55.2%
81%	0%	55.2%
70%	10%	56.3%
73%	5%	56.5%
69%	10%	56.6%
65%	15%	56.7%
72%	5%	56.9%
68%	10%	57.0%
71%	5%	57.2%

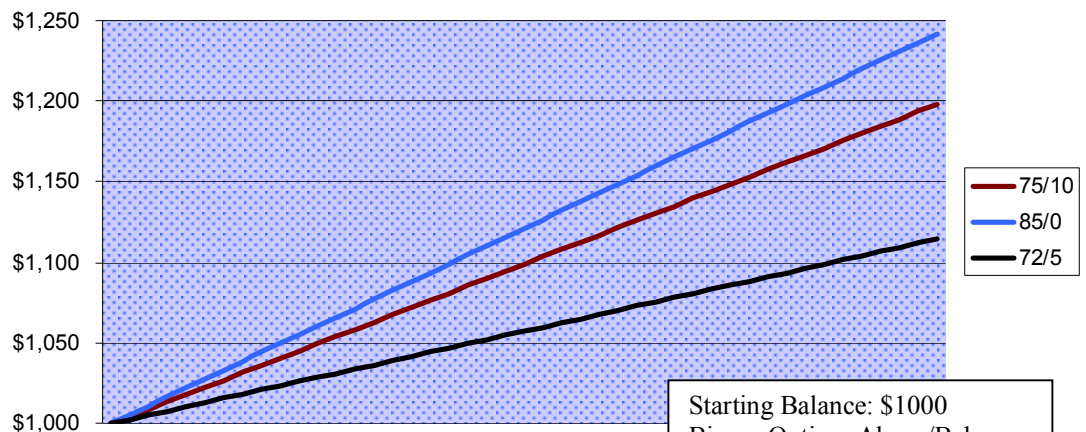
Even though payouts may differ markedly among options, the corresponding break-even success ratios tend to lie close together. This is, in part, a consequence of healthy competition among the binary option platform providers. When success ratios differ, it is usually a reflection of the liquidity of the asset underlying the binary option. The most attractive payouts are typically associated with binary options on forex since the forex market is the most liquid, but the payouts of any particular market may change during the day as liquidity improves or diminishes.

As is evident in the table, the success ratios required to break even are only marginally higher than the pure guess scenario of 50%. When trading a binary option having a payout matrix of 75/10, for example, only 12 out of 22 trades need be winners in order to break even – and this is just one more winner than what would be expected by guessing. This reinforces the earlier suggestion that a proper evaluation of a binary options trade system requires many transactions: if only one out of every 22 trades means the difference between a system that breaks even and one that provides essentially no value, then a great deal of trades are needed in order to resolve this performance metric.

Picking the Best Option

When designing a binary options trade system, a trader should focus on those options that have the lowest break-even success ratios. Trading such options also ensures that, for a trade system success ratio beyond the break-even value, profit will accumulate more quickly.

Option Payout and Profit Growth shows the theoretical growth of a \$1000 starting balance based on the employment of a trade system that has a 60% success ratio but that trades three different binary options, each one having a different payout matrix. Account value grows the fastest with the binary option that has the lowest break-even success ratio.



Option Payout and Profit Growth. A trade system that has a 60% success ratio will accumulate profit the fastest if trading the binary option whose payout matrix provides the lowest break-even success ratio (light blue line). In contrast, this same system will generate profit less quickly when trading binary options having progressively higher break-even success ratios, represented by the red and black lines, respectively.

Starting Balance: \$1000
 Binary Option: Above/Below
 Investment: \$50 per trade
 Number of Trades: 44
 Success Ratio: 60.0%

Implications for Trade System

The following summary points can be made for above/below binary options trade system design and evaluation

Option Selection. The payout matrix of a binary option determines what level of success a trade system needs in order to break even. These can differ among options and even for the same option at different times of the day. Choosing an option that has the most favorable payout matrix will both lower the break-even success ratio and lead to faster profit accumulation.

Winning Trades. For a given binary option payout matrix and invested amount, an above/below binary option trade system must generate more winning trades than losing trades to be viable. This is different than trade systems for other assets such as stocks or commodities that can tolerate a relatively higher number of losing trades (and many do), so long as the cumulative gain on the winning trades more than offsets the loss. In most cases, a binary option trade system need only generate a marginally higher success ratio than what would be expected by guessing in order to break even. Success ratios higher than that directly translate into improved profit performance of the system.

High Volume. Evaluating the performance metric of a binary options trade system requires the completion of a great number of trades. The more trades, the more precisely a success ratio can be calculated, especially to determine whether it lies above or below the break-even value. This need not be a costly exercise. As shown in **Guessing is a Losing Game**, a trade system that in practice provides no better success than a pure guess would be expected to cost just \$165 after 44 trades (starting balance of \$1,000 less the ending balance of \$835 with no commissions). This is a small price to pay. Moreover, with the feedback resulting from having executed and followed 44 actual trades, the trader is very likely in a good position to modify the trade system to improve performance.

Low Investment. Because the proper evaluation of a binary options trade system requires a high number of trades, the amount invested on each option relative to the starting balance must be low enough so as to mitigate the probability of ruin. Even with a trade system success ratio above the break-even value, it is still theoretically possible to suffer a string of losing trades. The system needs to be able to tolerate this without shutting down because of insufficient funds. Calculating the exact amount to invest is dependent upon the success ratio, and this is only known after the system is run. As a starting point, the amount to invest can be set between 5% and 10%, with the lower value being more advisable.

Reversibility. Unlike trade systems for most other assets, an above/below binary option trade system is reversible and this can be a useful feature. Consider a trade system that has a very low success ratio and consequently, loses money. Every time that a call (put) option was purchased and finished out-of-the-money, had a put (call) option been purchased instead, it would have finished in-the-money. The success ratio of the system can therefore be improved by simply reversing the trade signals: buy a call (put) when the system signals to buy a put (call). The reason that a trade system with a low success ratio can have value is that, from a theoretical viewpoint, it is just as difficult to realize a high number of losing trades as it is to realize a high number of winning trades when investing in above/below binary options. Reversibility is impractical for discretionary trade systems and provides good rationale for developing an objective system free of personal influence and emotion.

Disclosures

INVESTING IN BINARY OPTIONS INVOLVES RISK OF LOSS AND IS NOT APPROPRIATE FOR EVERYONE. ONLY RISK CAPITAL SHOULD BE USED. BINARY OPTIONS TRADING MAY BE PROHIBITED BY LAW IN SOME AREAS. CUSTOMERS SHOULD CHECK WITH THEIR LOCAL REGULATORY AUTHORITIES.

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