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Profitability Analysis of the Straddle Strategy in Trading One-Month Options

Samson Cheffa
Westcliff University

Kaveh Shamsa
Westcliff University

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ABSTRACT

The most important consideration when trading securities is when to liquidate and, in the case of the straddle approach, how much capital is required to cover the initial premium cost. Clearly, the unrealized profit or loss of any straddle position depends on the intrinsic and extrinsic values of the options that comprise the arrangement. This research aims to identify the characteristics that impact the profitability of options when using the straddle strategy. One-month options on Apple shares were examined for this research, specifically those for which the strike price was equal to the market price at initiation. This study discusses when the upper limit on the rate of return of a straddle is reached, allowing the owner to liquidate. The main question is what the limit should be to ascertain best profitability for the trader in the long run. This study answers this question by estimating the long-term profitability for different values of the point at which liquidation is possible. A statistical comparison of the prices of the underlying asset both at initiation and expiry is also included in this research. Undeniably, the volatility of the underlying asset affects the profitability of the straddle strategy. Future studies should assess how the underlying asset's volatility influences the profitability of the straddle.

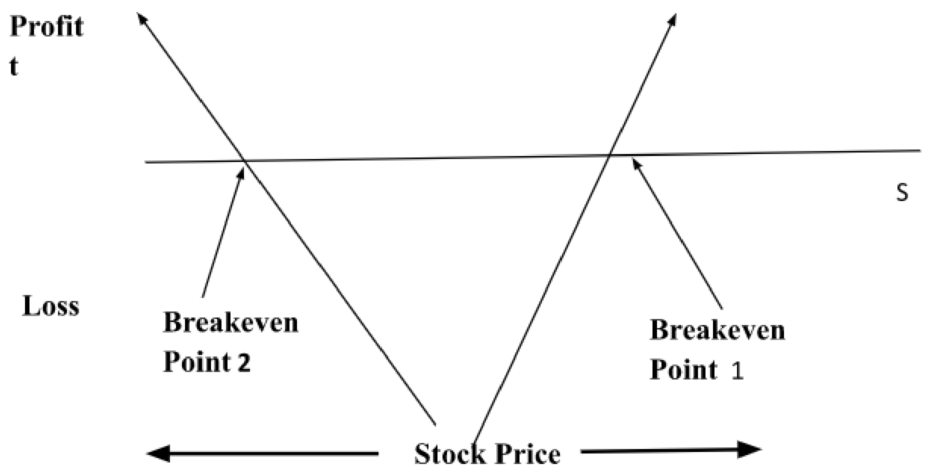
Keywords: Straddle, option trading strategies, put option, call option, security market

Profitability Analysis of the Straddle Strategy in Trading One-Month Options

Earning profit by trading options on securities is a common practice. One strategy in trading options is to form a long straddle, a combination of buying a call option and a put option on an underlying security, both of which have the same expiry date. (Cohen, 2013). In particular, investors who use the straddle strategy often set the strike price of both options to be equal to the market price of the underlying security at initiation. These practices are the focus of this study. Figure 1 shows the return of a long straddle as a function of the underlying asset's market price at liquidation. The lines in this graph have slopes of -1 and 1, respectively, and the minimum return is the loss of the premium.

Figure 1

Return of the Long Straddle



There have been several statistical studies analyzing the profitability of the straddle strategy for various underlying assets. Chong (2004) considered the profitability of long straddles on the GBP/DEM and JPY/DEM currency exchanges, noting high returns if these positions are based on volatility forecasts using moving averages. Guo (2000) addressed the profitability of long straddles on several currency exchanges and concluded that these straddles yield significant positive profits in absence of transaction costs, regardless of the volatility of the underlying assets. Furthermore, low correlation between a straddle and many other major assets was observed, making this practice a good strategy for achieving 'market neutrality' in one's portfolio. Abdullozoda (2018) analyzed the profitability of long straddles based on two-and-a-half month options on Apple shares issued between December 2010 and February 2018. It was found that if liquidation is achieved while also attaining a suitable limit on the profit, then, on average, these straddles are worthwhile investments. The research presented in this article follows Abdullozoda's (2018) approach but is based on non-time-overlapping, one-month options on Apple shares issued between 2018 and 2021.

The daily options price data used in this study was obtained from Cboe (n.d.). As mentioned above, the data was used to construct straddles that had strike prices equal to the price of their underlying assets at formation. It was assumed that all positions were formed at the time the calls and puts were issued. Moreover, it was assumed that a position could be liquidated any day before the expiry. Ideally, liquidation would be *at* expiry—if not before. Liquidation could occur either by exercising the options or selling them at the market price. It turned out, for all straddles, it is preferable to sell the options at the market price. Naturally, at expiry, there is no difference between the two.

The objective of this research is to analyze how variations in price of underlying assets affects straddles, from formation to expiry. This comparison is done in terms of the ratio

$$\frac{\textit{price of the underlying asset at expiration}}{\textit{price of the underlying asset at formation}}$$

The motive for this objective is to find whether, on average, the underlying price at expiration tends toward the positive or negative direction. This objective is formulated in terms of the following two research questions.

Research Question 1: Is the distribution of the natural logarithm of the ratio mentioned above normal? That is,

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right) \sim N(0, \sigma)$$

Research Question 2 is implicitly stated in the latter equation and is formulated as follows.

Research Question 2: Is the expected value of the variable in Research Question 1 equal to 0? That is,

$$E\left(ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)\right) = 0$$

The reason for using the logarithm is to allow infinite range on both sides of neutrality, namely

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right) = 0 \leftrightarrow \frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation} = 1$$

Research Question 1 seeks to find whether the distribution

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$$

has the same symmetry as the normal distribution. Research Question 2 seeks to find whether the center of the aforementioned distribution is at neutrality.

In liquidating the straddles, the following strategy was used. If the rate of return of the straddle equaled or exceeded a preset limit, then the straddle was liquidated; otherwise, liquidation was done at expiry. To analyze the profitability of the straddles, different values for the preset limit were chosen, and the mean of the rate of return for each value of the limit was estimated. Attempting to determine the overall profitability of the straddle strategy suggests a third research question.

Research Question 3: What value of the preset limit mentioned above maximizes the mean of the rate of return of the straddles, and what is this maximum mean?

The hypotheses associated with research questions 1 and 2 are formulated as follows.

H_{1n}: The distribution of $ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$ is normal.

H_{1a}: The distribution of $ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$ is not normal.

H_{2n}: $E\left(ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)\right) = 0$

H_{2a}: $E\left(ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)\right) \neq 0$

The Author's Method

In testing the hypotheses associated with Research Questions 1 and 2, the probability of type 1 error, α, was taken to be 0.05, as it is the common choice in social and business research. A chi-squared goodness of fit test was used to test the hypothesis associated with Research Question 1. To test the hypothesis associated with Research Question 2, a t-test was performed on the mean of the variable. This is justified since the underlying variable has a normal distribution.

46 one-month straddles were formed based on the historical data obtained for the years 2018 through 2021. Daily rate of return was calculated for each straddle, after which the liquidation strategy mentioned above was applied. Finally, the rate of return of each straddle was calculated based on the value of the preset limit. Note that some rates of return were positive, and some were negative. Naturally, the rate of return of each straddle depended on the choice of the preset limit. Consequently, the mean of the rate of return for each preset limit was estimated by summing all rates of return and then dividing this value by the number of straddles.

Results

As mentioned above, based on the obtained historical data, 46 straddles were created on the option's issuance date. If an exact match was not possible, the strike price of each straddle was assumed to be closest to the price of the underlying asset at formation. All pertinent statistical data can be found in Table 1 below.

Table 1

Descriptive Statistics of

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$$

Mean	0.024603737
Standard Error	0.014756256
Median	0.055712499
Mode	#N/A
Standard Deviation	0.1000818
Sample Variance	0.010016367
Kurtosis	-0.131149637
Skewness	-0.79354646
Range	0.392786329
Minimum	-0.218776969
Maximum	0.174009359
Sum	1.131771908
Count	46

A histogram of

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$$

can be found in Figure 2 below. Normalized values of

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$$

are given in Table 2. The histogram of these normalized values is presented in Figure 3. As observed, both histograms indicate that the two sides of the neutrality,

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right) = 0,$$

have approximately equal accumulation of frequency.

Figure 2

Histogram of

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$$

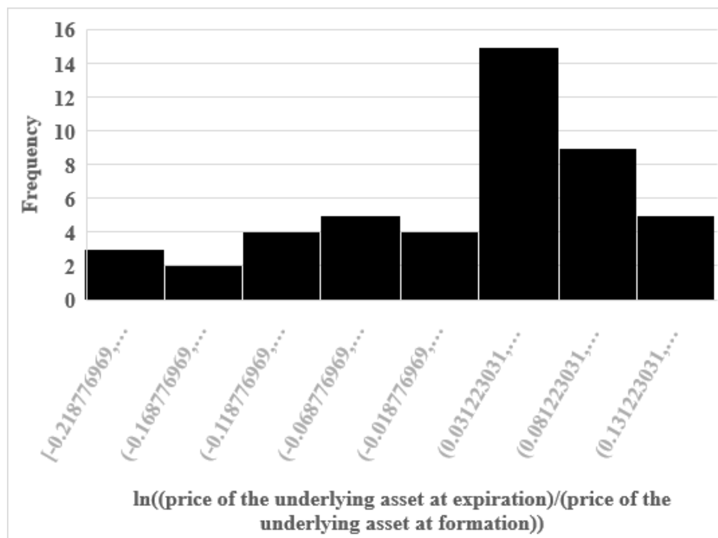


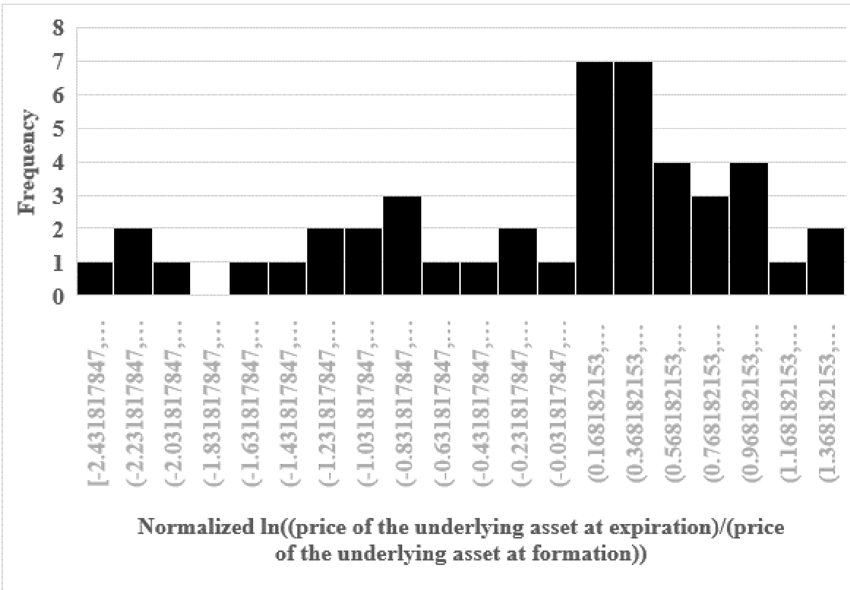
Table 2

$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$ *and the Respective Normalized Values*

Straddle	Value	Normalized value	Straddle	Value	Normalized value
1	-0.091937921	-1.164464054	24	0.118490873	0.938103992
2	0.04691692	0.222949455	25	0.061416273	0.367824482
3	-0.04917127	-0.737147087	26	-0.127545601	-1.520249823
4	0.086225557	0.61571455	27	-0.218776969	-2.431817847
5	0.032579282	0.079690263	28	0.173952015	1.492262117
6	-0.024960658	-0.495238851	29	0.125243596	1.005576031
7	0.104718152	0.80048935	30	0.129727347	1.050376893
8	0.06532708	0.406900585	31	0.174009359	1.492835092
9	-0.011305154	-0.358795415	32	0.138059504	1.133630365
10	-0.096342504	-1.208473885	33	-0.164522034	-1.889711935
11	-0.182084548	-2.065193531	34	0.017471787	-0.071261208
12	-0.044343623	-0.688910072	35	0.043428703	0.188095794
13	0.143204977	1.185043035	36	0.06222908	0.375945911
14	0.043603797	0.189845311	37	0.053846981	0.292193428
15	0.115090423	0.904127292	38	-0.109698917	-1.341928853
16	0.090992048	0.663340495	39	-0.039089019	-0.636406984
17	-0.188458126	-2.12887722	40	0.072100455	0.474578975
18	0.136530252	1.118350343	41	-0.058849639	-0.833851676
19	0.0088929	-0.156979964	42	0.063652705	0.390170518
20	0.094855929	0.70194773	43	0.057578016	0.329473283
21	0.088468222	0.638122868	44	-0.069431925	-0.939588041
22	0.071958079	0.47315638	45	0.065049969	0.404131746
23	0.051343877	0.267182842	46	0.071325656	0.46683732

Figure 3

Histogram of Normalized Values



Research Question 1

To test Research Question 1, the domain of the variable

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$$

was divided into intervals, and in each interval the frequencies of the observed normalized values were compared with the expected frequencies of the standard normal variable. These comparisons are shown in Table 3.

Hypothesis 1 was tested using the following calculation:

$$test\ statistic = \frac{(3-1.04650607)^2}{1.04650607} + \frac{(5-6.251635611)^2}{6.251635611} + \frac{(9-15.70185832)^2}{15.70185832} + \frac{(22-15.70185832)^2}{15.70185832} + \frac{(7-6.251635611)^2}{6.251635611} + \frac{(0-1.04650607)^2}{1.04650607} = 10.41995003$$

The value of the test statistic was found to be less than the critical five-degrees-of-freedom chi-squared value, 11.07049769. Therefore, the researcher cannot reject Null Hypothesis 1. It is reasonable to assume that the distribution of

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$$

is normal. Table 3 juxtaposes the expected with the observed frequencies.

Table 3

Observed Frequencies with Expected Frequencies

	Expected frequencies	Observed frequencies	expected-observed2expected
Less than – 2	1.04650607	3	3.646551747
Between -2 and -1	6.251635611	5	0.250589094
Between -1 and 0	15.70185832	9	2.860483391
Between 0 and 1	15.70185832	22	2.526235292
Between 1 and 2	6.251635611	7	0.089584437
Greater than 2	1.04650607	0	1.04650607

Research Question 2

The t-statistic to test Hypothesis 2 was evaluated as follows:

$$\frac{0.024604}{0.014756} = 1.667343$$

The rejection region for this test based on a t-distribution with 45 degrees of freedom is (−∞, −2.014103) ∪ (2.014103, ∞). The test statistic is not in the rejection region; therefore, the researcher cannot reject Null Hypothesis 2. It is reasonable, then, to assume that

$$E\left(ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)\right) = 0.$$

Research Question 3

As mentioned, this study used a sample size of 46 straddles. A straddle was liquidated if the rate of return on that day met or exceeded the preset limit; otherwise, it was liquidated on expiry. Naturally, the number of straddles liquidated prior to expiry decreases when the preset limit is increased. Consequently, for a particular limit, the estimate of the mean of the rate of return of the straddles was computed by dividing the sum of all rates of return by the total number of straddles. Table 4 shows the decrease in liquidations prior to expiry as well as variations in the average rate of return as the preset limit is increased. Figure 4 shows how, as the number of liquidations is decreased, the preset limit is increased. Figure 5 shows the dependence of the average rate of return of the straddles on the preset limit for liquidation.

Table 4

Dependence on the Number of Straddles Liquidated Prior to Expiry and the Average Rate of Return on the Preset Limit

Limit on the rate of return	Number of straddles terminated before expiration	Average rate of return
0	45	0.130881759
0.1	43	0.230821421
0.2	40	0.308351459
0.3	35	0.37484037
0.4	33	0.451825592
0.5	30	0.440749051
0.6	24	0.413644344
0.7	21	0.442412771
0.8	18	0.458534611
0.9	15	0.48339685
1	15	0.500472381
1.1	14	0.500881641
1.2	12	0.462658218
1.3	9	0.441732132
1.4	9	0.475617371
1.5	7	0.485576178
1.6	6	0.485576178
1.7	6	0.485576178
1.8	6	0.485576178
1.9	5	0.448941017
2	5	0.448941017
2.1	2	0.400526714
2.2	1	0.356630043
2.3	1	0.362993293
2.4	1	0.362993293
2.5	1	0.362993293
2.6	1	0.372266132
2.7	1	0.372266132
2.8	1	0.372266132
2.9	1	0.372266132
3.1	1	0.374560686
3.2	0	0.375554205
3.3	0	0.375554205
3.4	0	0.375554205
3.6	0	0.375554205
3.7	0	0.375554205
3.8	0	0.375554205
3.9	0	0.375554205

Figure 4

Decrease in the Number of Liquidations as the Preset Limit is Increased

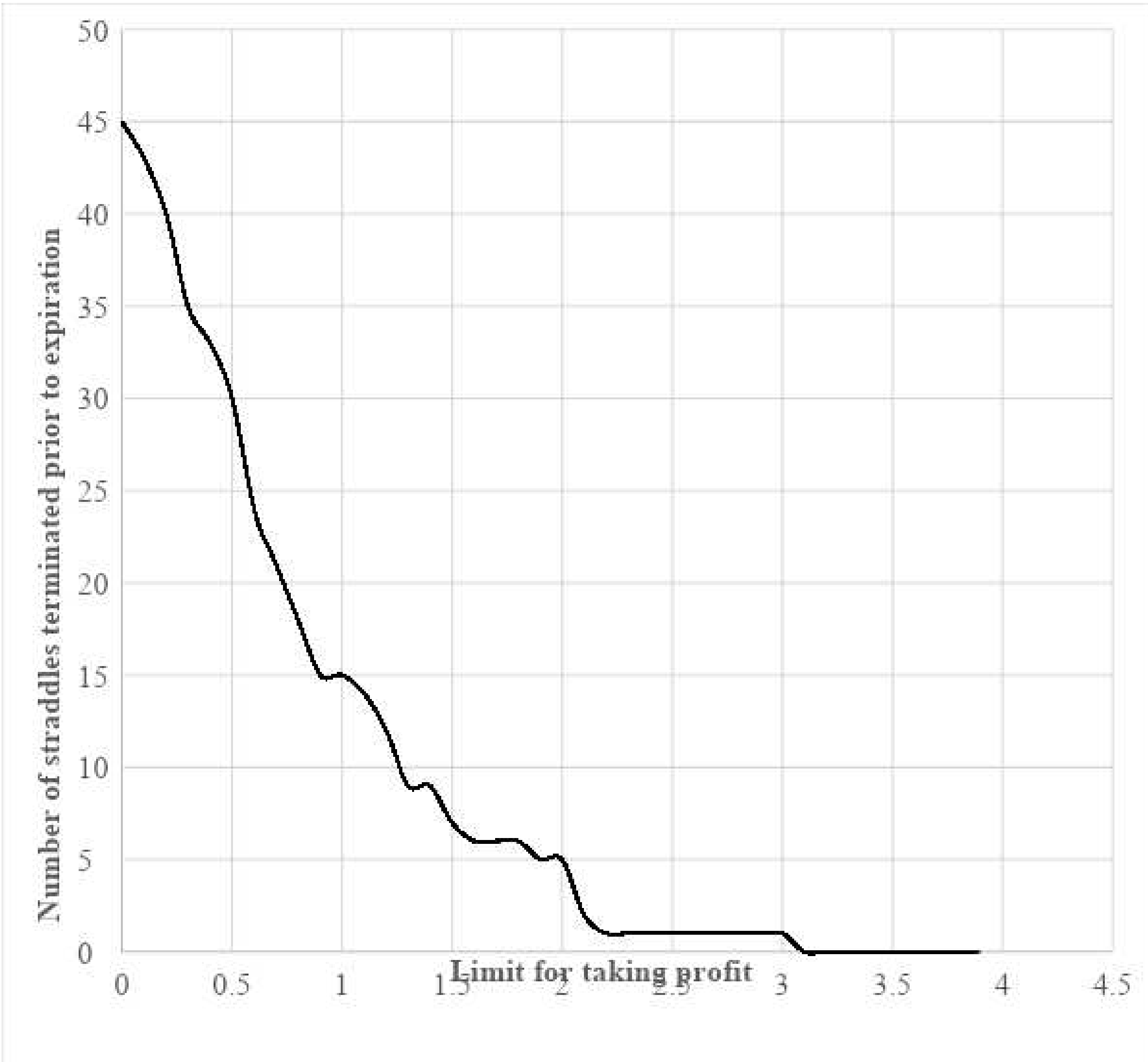
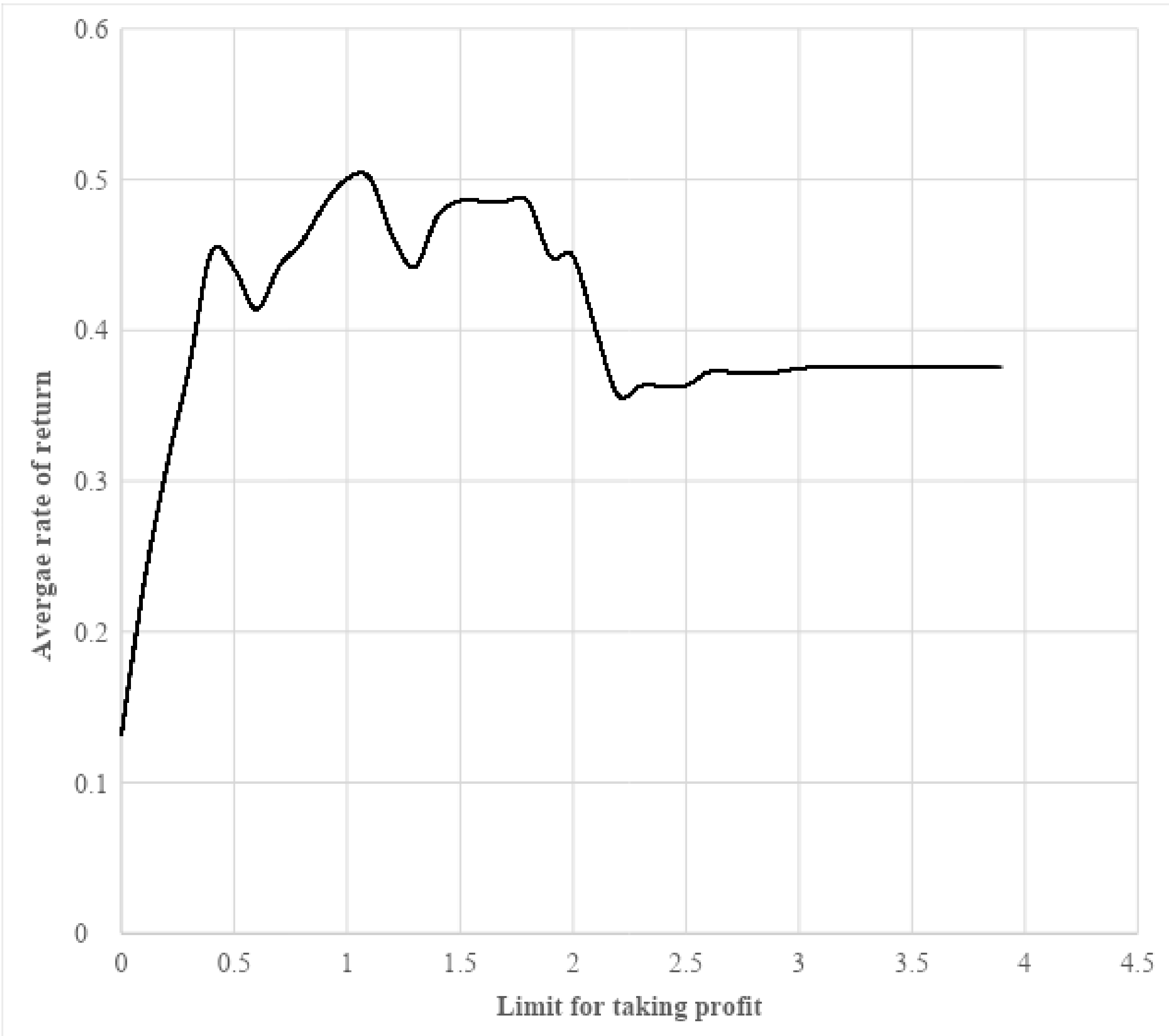


Figure 5

Dependence of the Average Rate of Return on the Preset Limit



Discussion/Implications

The analysis in this research indicates that it is reasonable to assume the distribution of

$$ln\left(\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}\right)$$

is normal for one-month straddles of Apple options and that the mean of this distribution is 0. This assertion is equivalent to stating that on average the ratio

$$\frac{price\ of\ the\ underlying\ asset\ at\ expiration}{price\ of\ the\ underlying\ asset\ at\ formation}$$

is equally inclined to be less than 1 or greater than 1. The latter statement is synonymous with saying that the average of the above fraction is at neutrality.

Furthermore, the results in this research indicate that trading one-month Apple options based on long straddles can be profitable, particularly if the limit for liquidation is set at 1.9. The latter limit yields a mean rate of return of 0.448941017.

Abdullozoda (2018) performed a study similar to the research presented in this article. The long straddle formation and liquidation are identical in the two studies. One difference is that Abdullozoda's (2018) research was based on two-and-a-half-month options on Apple shares. However, the findings of both studies are very similar. Namely, Abdullozoda (2018) could not reject the null hypothesis that the difference between the distributions of final underlying price and initial underlying price is normal and that the mean of these deviations is 0. Furthermore, he concluded that liquidating the straddle once a limit on the rate of return is achieved or exceeded yields a positive overall mean for the rate of return. Despite the similarities mentioned above, there is a stark difference between the results in the research presented in this article and the outcomes of Abdullozoda's (2018) study. It seems that trading one-month options using the straddle strategy yields a significantly higher mean of the rate of return when the limit is set at the optimal value. Using the straddle strategy for one-month options, which denotes a comparatively shorter investment period, provides a mean rate of return above 44%. The mean rate of return for two-and-a-half-month options was slightly above 25%. It is left to future researchers to investigate why, when using the straddle strategy, one-month options perform better than two-and-a-half-month options.

Conclusion

This research concludes that the long straddle strategy in trading one-month Apple options can be profitable. Furthermore, through the duration of these straddles, the average of the ratio between the underlying price at expiration to the underlying price at formation is at neutrality. Effectively, this means that one cannot bet on the rise or decline of the underlying price through one-month periods. This neutrality lends credence to the contention that Apple shares, at least on the surface, "randomly walk." Such corroboration of the behavior of other securities, and even market indices, is demonstrated in other studies (Solnik, 1973). Any successful prediction of price movement in any direction should be based on in-depth forecasting.

The findings of this study are worth further investigation. Suggested areas include (1) the influence of an underlying asset's volatility on the profitability of a long straddle, (2) the statistical properties of liquidation time and rate of return per unit time, and (3) extrapolating the principles and methods contained herein to straddles exceeding two and a half months.

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