AN INTRODUCTION TO DERIVATIVE MARKETS

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ABSTRACT. Investors use different tools to earn profits in financial markets. Through the use of derivatives, investors have been able to find more ways to reduce risk. By familiarizing oneself with different investment strategies with derivatives, an investor has a better chance at positive returns.

I. INTRODUCTION

Investments revolve around the buying and selling of assets. In recent years, investing has become much more complex through the use of derivatives instruments. When investors don't want to risk taking an outright position in an asset, but want increased exposure to the asset in case of a large movement in price, they can use options to reduce risk.

II. DERIVATIVES

A derivative is a financial instrument whose value is derived from an underlying asset or group of assets. They are a contract between two or more parties. The value of this contract depends on changes in the value of the asset that the derivative's value is derived from. Derivatives can also be thought of as bets on a change in price, or as insurance. Examples of underlying assets are stocks, bonds, and commodities.

There are four main reasons for the use of derivatives. The first is risk management. When used effectively, derivatives can be used as insurance to hedge risk. In addition, derivatives are often used because of speculation of the price of an asset. While being used as an investment vehicle, derivatives can lower transaction costs by avoiding brokerage fees that would typically be incurred from the trading of stocks and bonds. Users of derivatives also benefit from regulatory arbitrage by avoiding unfavorable regulation. For example, derivatives can be used for an economic sale of stocks, where the seller receives cash but loses the risk of holding the stock, without exchanging physical possession of the stock. This allows the seller to avoid taxes on the sale or retain voting rights. In essence, derivatives provide a more complex alternative to the buying and selling of assets, which allows for a broader range of investment possibilities.

III. DERIVATIVE TERMINOLOGY

The spot price is the current market price of an asset. The strike price of an option is the predetermined amount a buyer pays for an asset. The exercise of an option is the act of purchasing an asset at the strike price. The date at which the option must be exercised by is known as the expiration. Within the derivative market industry, there are three different exercise styles. European-style allows an option to be exercised only on the expiration date, American-style allows an option to be exercised at any time before the expiration, and Bermudan-style allows an option to be exercised at certain given times before expiration. In this study, the focus is on European exercise style. The cash value of an asset at the point of expiration is known as the payoff. By subtracting the future value of the initial cost of the option from the payoff, the profit of the investment is obtained.

IV. OPTIONS

Options are examples of derivatives sold from one party to another. These contracts offer the buyer the right, but not the obligation, to buy or sell an underlying asset at an agreed upon price at a later specified date.

Call options give the buyer the right to purchase an asset at a certain price. These options are used when the purchaser expects the price of the underlying to go up. By purchasing a call option, a buyer has the potential to purchase an asset for less than what the market says it is worth. The following is an example of how a call option works. Suppose the stock of XYZ Company is currently selling for $40. A call option with a strike price of $40 that expires in a month's time is currently being sold for a premium of $2. An investor believes that the price of this stock will increase after the company releases its earnings report. This investor spends $200 to purchase a call option covering 100 shares at a $40 strike price. Now, suppose the investor was correct and in a month's time the stock price of XYZ has risen to $50. The investor exercises their call option and purchases these 100 shares at $40 per share. They can then immediately sell the shares in the market for $50 per share. This creates a $10 payoff per share. Because they have 100 shares to sell at $10 per share, the proceeds from the sale total $1,000. Subtracting the $200 that the investor paid as a premium for the call option, they now have a profit of $800. If the spot price at expiration was less than the strike price, the option owner would not exercise the option because they could purchase the asset for less money in the market. In this scenario, the option purchaser would lose only the money invested in the premium.

The formula used when calculating the payoff of a purchased call is:

$$\text{Max}\ (0, S_t - K).$$

In layman's terms, this means that if the spot price at expiration is greater than the strike price, the call will be exercised. If the spot price is smaller than the strike price, the call will not be exercised and the payoff will be 0. The profit of a purchased call is calculated by subtracting the premium from the payoff, Premiums must be priced such that the purchase price and the cash value at the end of expiration break even. If the call is priced too high, the option seller can always make money. For example, selling a call results in a cash inflow of $+C$. Buying Δ shares of stock results in a cash outflow of $-\Delta S_0$. If the call option is exercised, the payoff is $-(S_U - K)$. Liquidating the position gives a cash inflow of $+\Delta S_U$. Hence, the cash value at expiration is:

$$C + \Delta(S_U - S_0) - (S_U - K).$$

If the call is not exercised, the payoff is 0. Liquidating the position results in a cash inflow of $+\Delta S_D$. Hence, the cash value at expiration is:

$$C - \Delta(S_0 - S_D).$$

As shown, if the premium is priced too high, the option seller will profit in either scenario, which violates regulations. Similarly, if a premium is priced too low, the option purchaser can always make a profit. For example, buying a call results in a cash outflow of $-C$. Short selling Δ shares results in a cash inflow of $+\Delta S_0$. If the call option is exercised, the payoff is $+(S_U - K)$. Buying the shares back at a later time results in a cash outflow of $-\Delta S_U$. Hence, the cash value of this position at expiration is:

$$(S_U - K) - (C + \Delta(S_U - S_0)).$$

If the call is not exercised, the payoff is 0. Buying the shares later results in a cash outflow of $-\Delta S_D$. Hence, the cash value at expiration is:

$$\Delta(S_0\text{-}S_D) - C.$$

As shown, if the premium is priced too low, the option purchaser will profit in either scenario, which violates regulation. Using this information and the binomial pricing model, we obtain that the premium of a call option can be determined by the following equation:

$$C=\frac{S_U-K}{S_U-S_D}\left(S_0-\frac{S_D}{1+rt}\right).$$

For the proceeding example, assume the following: the interest rate = 0, the spot price at time 0 =10, time =1, the upper spot price =10.8, and the lower spot price =9.2. Upon substituting the previously mentioned numbers into the premium equation, one can solve for C. In an example where K=10, it can be found that C=.40. Essentially, the call premium for a call with the aforementioned assumptions and a strike price of $10 is priced at 40¢. When observing the profit obtained from different spot prices, graph in Figure 1 is obtained.

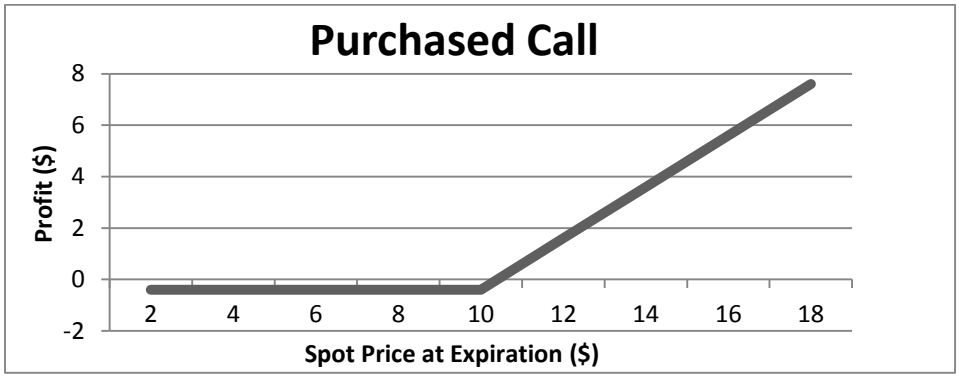

Figure 1

As shown, the call option purchaser gains more profit as the spot price rises. Until the spot price reaches $10, the profit is -40¢, the cost of the premium. The investor who purchases this call option hopes that the spot price rises.

Put options give the purchaser the right to sell an asset at a certain price. These options are used when the purchaser expects the price to go down. By purchasing a put option, a buyer has the potential to sell an asset for more than what the market says it is worth. An example of a put option is as follows. Suppose the stock of XYZ Company is currently selling for $40. A put option with a strike price of $40 that expires in a month's time is currently being sold for a premium of $2. An investor believes that the price of this stock will dramatically decline after the company releases its earnings report. The investor spends $200 to purchase a put option covering 100 shares at a $40 strike price. Now, suppose the investor was correct and in a month's time the stock price of XYZ has fallen to $30. The investor decides to exercise their put option. The investor doesn't own any shares in XYZ, but can easily go to the market and purchase 100 shares of XYZ for $30 per share. By exercising their put option, they can then sell these shares at a price of $40 per share. This creates a $10 payoff per share. Because there are 100 shares to sell at $10 per share, the proceeds from the sale total $1,000. After subtracting the $200 that the investor paid as a premium for the put option, they now have a profit of $800. If the spot price at expiration were more than the strike price, the option owner would not exercise the option because they would sell the asset at a higher cost in the market. In this scenario, the option purchaser would lose only the money invested in the premium.

The formula used when calculating the payoff of a purchased put is:

$$\text{Max } (0, K - S_t).$$

In layman's terms, this means that if the strike price is greater than the spot price at expiration, the put will be exercised. If the strike price is smaller than the spot price, the put will not be exercised and the payoff will be 0. For the proceeding example, the following assumptions are made: the interest rate =0, the spot price at time 0 =10, time =1, the upper spot price =12, and the lower spot price =9. Using the binomial pricing model, we obtain that the premium of a put option can be determined by the equation

$$P = \frac{K - S_D}{S_U - S_D}\left(S_0 - \frac{S_U}{1+rt}\right).$$

Upon substituting the previously mentioned numbers into the equation, one can solve for P. In an example where K=10, it can be found that P=.6667. Essentially, the put premium for a put with the aforementioned assumptions and a strike price of $10 is priced at 67¢. When observing the profit obtained from different spot prices, the graph in Figure 2 is obtained.

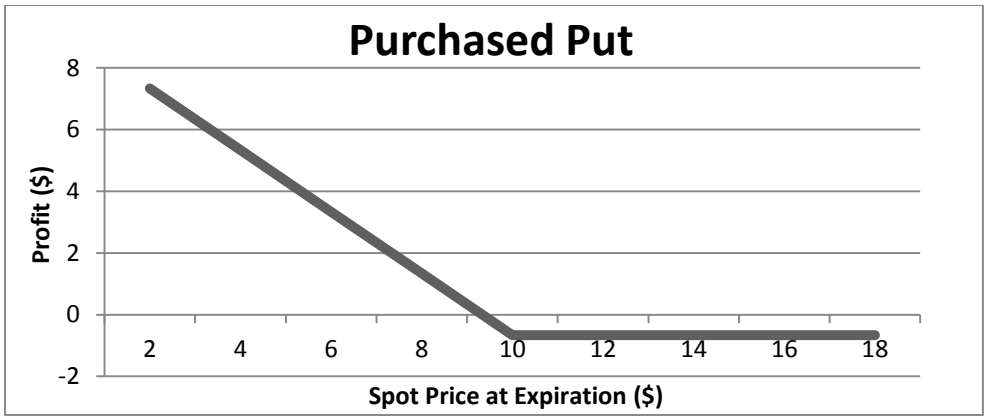

Figure 2

As shown, the put option purchaser gains more profit as the spot price decreases. While the spot price is above $10, the profit is -40¢, the cost of the premium. The investor who purchases this put option hopes that the spot price decreases greatly.

Options can also be examined from the viewpoint of the option seller. The seller of a call option is said to have a short position in a written call. This person's position is counter to the option purchaser. With a written call, the seller is obligated to sell the underlying assets if the purchaser exercises the option. The seller of a call option will expect the price to go down. The profit of a written call option is negative the profit of a purchased call. The formula used when calculating the profit of a written call is:

$$-\text{Max } (0, S_t - K) + C(1 + rt).$$

In the previous call example, using the same assumptions, the written call profit graph can also be obtained:

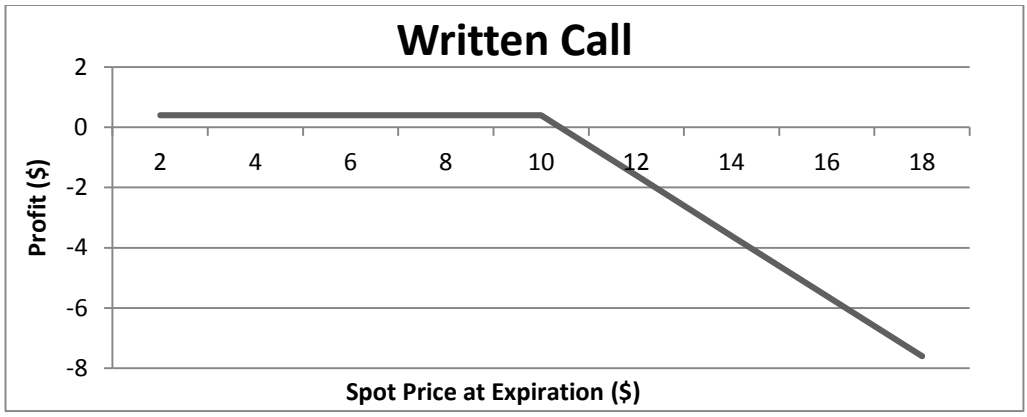

Figure 3

As shown, the call option writer gains profit when the spot price decreases. While the spot price is below $10, the profit is 40¢, the cost of the premium. The call option writer can endure unbounded losses as the spot price increases. The investor who sells this option hopes that spot price decreases.

As with call options, put options can also be examined from the point of the option seller. The seller of a put option is counter to the option purchaser. With a written put, the seller is obligated to buy the underlying assets if the purchaser exercises the option. The seller of a put option will expect the price to increase. The profit of a written put is negative the profit of a purchased put. The formula used when calculating the profit of a written put is:

$$- \text{Max}(0, K - St) + P(1 + rt).$$

In the previous put example, using the same assumptions, the written put graph can also be obtained:

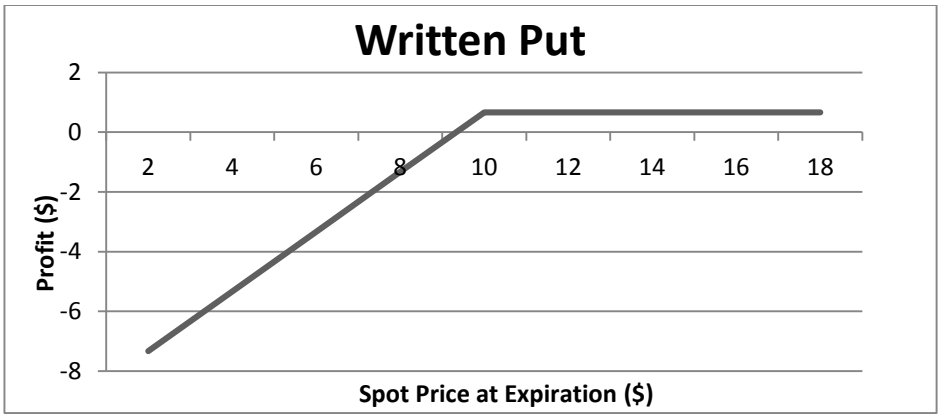

Figure 4

As shown, the put option writer gains profit when the spot price increases. While the spot price is above $10, the profit is 40¢, the cost of the premium. The put option writer can endure unbounded losses as the spot price decreases. The investor who sells this option hopes that spot price increases.

V. COMBINATIONS

Investors have created a variety of more complex investing strategies by combining options to create different payoffs. The strategy of buying a call and a put with the same strike price and time to expiration is known as a straddle. If the spot price increases, there will be a profit on the purchased call, while there will be a profit on the purchased put in the case of a spot price decrease. Hence, the advantage to a straddle is that the buyer will profit if the spot price changes, regardless of the direction. Combining the purchased call and purchased put from the previous examples results in the profit graph in Figure 5.

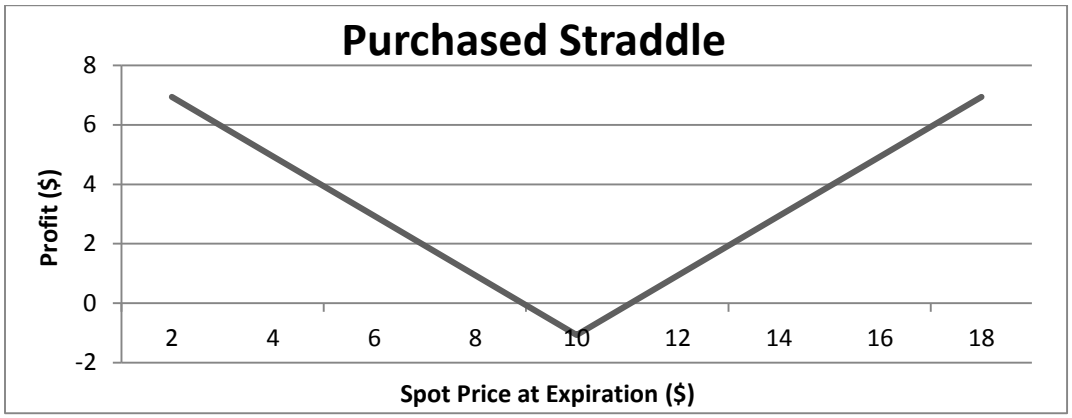

Figure 5

As shown, the straddle purchaser profits with large changes in spot price, regardless of the direction of change. In the case that the spot price does not change, the maximum loss incurred is the total amount of the premiums, or 80¢. The investor who purchases this combination is in hopes of a volatile market.

In contrast to a purchased straddle, the seller of a written straddle will sell a call and a put with the same strike price and time to expiration. The investor who takes this position earns the most profit when the spot price doesn't change. In this instance, the seller will collect two premiums. Alternatively, the seller can potentially incur large losses as the spot price changes in either direction. Combining the written call and written put from the previous examples results in the profit graph in Figure 6.

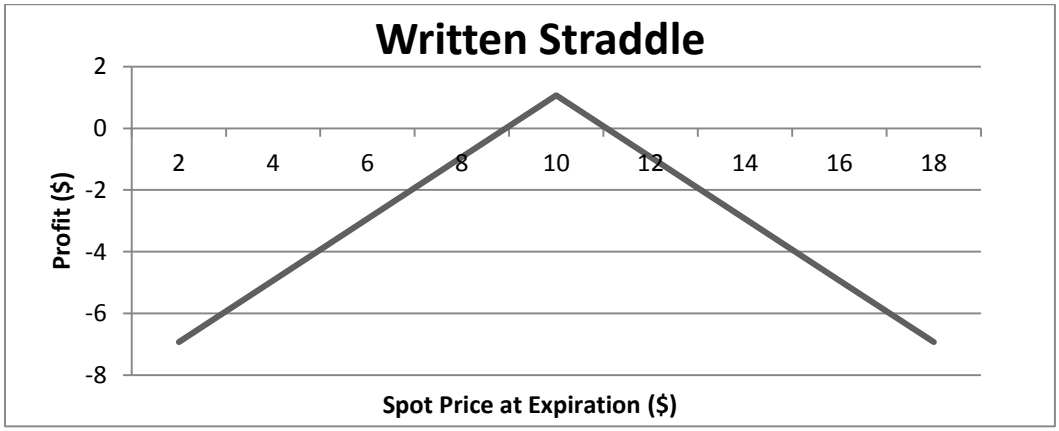

Figure 6

As shown, the straddle seller profits with little or no changes of the spot price. In this instance, the seller will profit the premium of both options, or 80¢. In the case that the spot price does change, the seller can incur unlimited loss, regardless of the direction of price change. The investor who purchases this combination is in hopes of a nonvolatile market.

VI. MARKET VOLATILITY

Options can be used to create positions depending on speculation of volatility in the market. Volatility can be described as variation of prices. Investors can undertake three different market volatility views: high volatility, low volatility, or no volatility view. In a high volatility market, large fluctuations in price should be expected. In a low volatility market, prices should expect to remain the same. Different volatility views call for different investment strategies.

VII. VOLATILITY WILL INCREASE

In a market where volatility is expected to increase, prices are expected to change largely. There are different investment strategy recommendations depending on how the prices will move. If an investor expects prices will fall, they should buy puts. As seen in Figure 2, a high profit is earned with large decreases in price. If the investor is anticipating a price increase, they should buy calls. As seen in Figure 1, a high profit is earned with large increases in price. If they have no price view, they should buy a straddle. As seen in Figure 5, no matter which direction the volatile prices change, a large profit can be earned.

VIII. NO VOLATILITY VIEW

If an investor has no volatility view but believes that the price will fall, they should sell their underlying assets before the price drop to receive maximum profit. If they believe the price will increase, they should buy underlying assets in hopes to gain profit from a later sale. This is in accordance with the stock market strategy of "buy low, sell high." If an investor has no volatility view, and no price view, they should take no action.

IX. VOLATILITY WILL FALL

In a market where volatility is expected to decrease, prices should expect to remain fairly stable with small deviations. If an investor believes that both the volatility of the market and prices will fall, they should sell calls. As shown in Figure 3, if the spot price remains the same or falls only slightly, the call seller receives the premium of the option, and may never even have to purchase the underlying. If an investor has no price view but expects volatility to fall, they should sell a straddle. As shown in Figure 6, a straddle writer receives the premium from both options if prices don't change. Lastly, an investor who believes that prices will increase should sell puts. As shown in Figure 4, even in the spot price increases by a trivial amount, the put writer receives profit from the premium, again without the necessity of purchasing the underlying.

X. CONCLUSION

Investors can use options and combinations of options as different investments strategies within markets to maximize profits.

REFERENCES

McDonald, Robert L. *Derivatives Markets.* 2nd ed. Boston: Pearson Education, 2006. Print.