Solutions – Second City Options

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**Goals**

1. Illustrate the importance of volatility in option pricing and the difficulty in estimating it
2. Explore relative strengths and weaknesses of the Black-Scholes-Merton and Binomial models
3. Provide the opportunity for students to analyze various strategies, choose the best alternative, and then defend their choice via written and oral arguments

**Assumptions**

These solutions make two key assumptions at the outset to narrow the range of possible answers:

1. To obtain a single option price for constructing profit diagrams and calculating implied volatilities, we use the arithmetic mean of the corresponding bid and ask prices.
2. All strategies are volatility strategies, i.e., strategies that exploit expected changes in volatility.

These assumptions represent an attempt to keep the number of “solutions” manageable. The first assumption is critical. It affects all the calculations that follow. If students use different option prices from the start, then their answers continually differ throughout their entire case analyses. This makes checking answers much more difficult, if not outright impossible. It can be time-consuming and frustrating trying to determine whether slight variations in answers result from different initial data or from subtle methodological errors. The second assumption is also important. Students occasionally pick strategies that do not depend on volatility. For instance, they sometimes recommend bullish or bearish strategies, even arbitrage strategies, based on their reading of the case. Most students, however, choose a strategy based entirely on volatility, which is what the case writers intend. Therefore, we restrict our attention to volatility strategies.

**Data**

We have two general comments regarding the data. First, we strongly urge professors to discuss features of the real-world data in SCO-Data.xls with their students. It is worthwhile noting pros and cons of using averages of bid and ask prices versus alternatives such as transaction prices, bid prices, or ask prices. Different choices can impact the analysis significantly. For instance, in Part I a student might analyze a reverse butterfly strategy “conservatively” by buying options at ask prices and selling options at bid prices. This yields profit estimates that are negative for all index values and for both indexes, which generally leads the student to reject this popular volatility strategy immediately. Hence, although it would be simpler to give one price for each option, we give multiple prices so that students can gain insight from considering the alternative data. Second, in the data analysis that follows, we use software for the 8th edition or higher of *An Introduction to Derivatives and Risk Management, 8th ed.*, by Don M. Chance and Robert Brooks. References to spreadsheets with “8e” in the file are the 8th edition versions, but more recent versions can be used.

**Part I**

Given SCO’s forecast of high and possibly increasing market volatility, students generally select two of the following three strategies: straddle, strangle, and reverse butterfly. For a straddle one buys a call and a put having the same strike price X. For a strangle one buys a put having strike price X1 and a call having strike price X2 where X1<X2. For a reverse butterfly one sells a call having strike price X1, buys two calls having strike price X2, and sells a call having strike price X3 where X1<X2<X3 and X2=(X1+X3)/2. Although one could also construct a reverse butterfly with puts, we consider only calls in the analysis given here.

Students should provide complete details for their strategies. They must clearly state which options are bought or sold, whether calls or puts are used, which strike prices are used, etc. Students should also mention key attributes of their recommended strategies. Some examples include:

* Unlimited upside as the index increases toward infinity for the straddle and strangle strategies,
* Limited upside for the reverse butterfly strategy,
* Limited downside to all three strategies, although there is significantly more downside risk for the straddle and strangle strategies than for the reverse butterfly.

Students occasionally want to use a strategy that takes advantage of increasing market volatility, but that is also either bullish or bearish. As a result, they might recommend a strap or a strip. With a strap one buys two calls and one put having the same strike price X. With a strip one buys two puts and one call having the same strike price X. These strategies are quite similar to, yet different from, the corresponding straddle. Although one can make a valid case for choosing a strap or a strip, we do not provide details for them. We cannot give details for all conceivable strategies. We restrict our attention to three volatility strategies which are neither bullish nor bearish – the straddle, strangle, and reverse butterfly.

Sometimes students recommend arbitrage strategies based on violations of parity relations when using various combinations of prices from Table 1. Although it is important that students know parity relations such as put-call parity, arbitrage strategies are not realistic alternatives in this situation. Timing is absolutely critical in arbitrage-based trading, and students must be aware that they cannot realistically expect to execute trades at prices given in Table 1. The data in Table 1 are available after trading has ended on July 2, 2007. There is no guarantee that those prices would be available the next day. Unlike a buy-and-hold strategy based on a volatility forecast, an arbitrage strategy would depend critically on exploiting a fleeting mispricing opportunity. Hence, an arbitrage strategy based on a violation of a parity relation is not a viable recommendation in this context.

The strategies chosen by a student can shed light upon a student’s tolerance for risk. They also can provide insight regarding a student’s expectation that the stock market will move significantly. For example, students often recommend the straddle and strangle as their two strategies. These students typically do not wish to relinquish the “upside potential” of these strategies for the limited profits available from a reverse butterfly. This is certainly justifiable – it depends on the student’s risk tolerance and the student’s probability estimate that a big move in the stock market will occur.

Our choice is to recommend the straddle and the reverse butterfly. It provides the most contrast between alternatives. In a sense, a strangle can be considered less risky than a straddle and more risky than a reverse butterfly. Because each of these three strategies is reasonable, we provide profit diagrams for all of them in this section. (These diagrams, by the way, incorporate a multiplier of 100 to adjust for contract size.) In later sections of this analysis, however, we shall restrict our attention solely to the straddle and reverse butterfly.

**Exhibit 1: Profit Diagram for SPX Straddle**

**(Buy Aug 1520 Call @ $33.90, Buy Aug 1520 Put @ $28.00)**

(Maximum profit is infinite, maximum loss is $6190, and breakeven points are 1458.10 and 1581.90.)

**Exhibit 2: Profit Diagram for OEX Straddle**

**(Buy Aug 700 Call @ $14.65, Buy Aug 700 Put @ $13.00)**

(Maximum profit is infinite, maximum loss is $2765, and breakeven points are 672.35 and 727.65.)

**Exhibit 3: Profit Diagram for SPX Reverse Butterfly**

**(Sell Aug 1515 Call @ $37.10, Buy 2 Aug 1520 Calls @ $33.90, Sell Aug 1525 Call @ $30.90)**

(Maximum profit is $20, maximum loss is $480, and breakeven points are 1515.20 and 1524.80.)

**Exhibit 4: Profit Diagram for OEX Reverse Butterfly**

**(Sell Aug 695 Call @ $18.00, Buy 2 Aug 700 Calls @ $14.65, Sell Aug 705 Call @ $11.80)**

(Maximum profit is $50, maximum loss is $450, and breakeven points are 695.50 and 704.50.)

1. We thank John Peterson for providing preliminary analysis of Parts I–III. These solutions were last revised on September 22, 2009. [↑](#footnote-ref-2)