Effect on Volatility of Earnings Announcements and Large Changes in the Underlying

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This project explores two questions with regard to volatility: what happens to volatility across earnings announcements and what happens to the volatility skew when the stock price changes abruptly. These questions are studied using data obtained from BYU’s Bloomberg terminal and IVY Option Metrics for three different stocks AMZN, YHOO, and AAPL over the time period of 1 Jan 2004 – 1 Jan 2007.

I. INTRODUCTION

In the world of finance volatility is often defined as the measure of the uncertainty of the return realized on an asset. If the volatility of a stock increases then the probability of an investment doing very well or very poorly increases.[1] These effects tend to balance out for holders of stocks, but are very important to those involved in trading Options, Futures, and Derivatives. These traders often use volatility spreads which keep delta neutral but benefit from increases or decreases in volatility. Because the difference in volatility results in changes in realized return on investments volatility is a very important and continually studied topic. The implied volatility can be derived from the Black-Scholes-Merton Equation using the option prices observed in the market. In this study I will first analyze the effects of earnings announcements on volatility. Next I will a short time period where a large movement in the underlying stock occurs and will study the resulting volatility skews for Delta and for Strike price.

II. VOLATILITY CHANGES ACROSS EARNINGS ANNOUNCEMENTS

As part of this study I have chosen to restrict my study to three stocks. These stocks are AMZN, YHOO, and AAPL. In order to examine the effect of earnings announcements on volatility I first used the Bloomberg Terminal to locate the earnings announcement dates. I chose to only examine these three stocks for the period 1 Jan 2004 – 1 Jan 2007. TABLE I shows the twelve announced earning dates as obtained from Bloomberg for the determined time period.

<table>
<thead>
<tr>
<th>AMZN</th>
<th>YHOO</th>
<th>AAPL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/27/04</td>
<td>1/14/04</td>
<td>1/14/04</td>
</tr>
<tr>
<td>4/22/04</td>
<td>4/07/04</td>
<td>4/14/04</td>
</tr>
<tr>
<td>7/22/04</td>
<td>7/07/04</td>
<td>7/14/04</td>
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<td>10/12/04</td>
<td>10/13/04</td>
</tr>
<tr>
<td>2/02/05</td>
<td>1/18/05</td>
<td>1/12/05</td>
</tr>
<tr>
<td>4/26/05</td>
<td>4/19/05</td>
<td>4/13/05</td>
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<tr>
<td>7/26/05</td>
<td>7/19/05</td>
<td>7/13/05</td>
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<tr>
<td>10/25/05</td>
<td>10/18/05</td>
<td>10/11/05</td>
</tr>
<tr>
<td>2/02/06</td>
<td>1/17/06</td>
<td>1/18/06</td>
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<tr>
<td>10/24/06</td>
<td>10/17/06</td>
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</tr>
</tbody>
</table>

Figures 1, 2 and 3 show the front month, next month and leap volatility graphs for Amazon, Yahoo, and Apple respectively. Clearly there is a large discontinuity that occurs at earnings announcement dates (represented by day 15 on the graphs). The volatility profile running up to earnings drop substantially in all the graphs of the front month as well as the graphs of the next available series for each earnings announcement date. However, the graphs of the leap implied volatility are more stable showing that as the time to expiry increases the effect of earnings announcements on volatility decrease.

III. FITTING A CURVE TO THE VOLATILITY PROFILE

In order to get a better idea of what happens to a stock right before and after an earnings announcement, I chose to focus on the volatility for the front month which shows the largest drops over announcement dates for the three stocks of interest.

Using MATLAB and the 3 years of data that I collected I was able to compute the mean volatility for the
FIG. 1: 1 month, 2 month, leap implied volatilities for AMZN

FIG. 2: 1 month, 2 month, leap implied volatilities for YHOO

FIG. 3: 1 month, 2 month, leap implied volatilities for AAPL

15 days running up to earnings announcement and the mean volatility for the the five days that follow. This was done for all three stocks resulting in one consolidated graph representing the period from Jan 1 2004 to Jan 1 2007. This approach makes it clearly shows that there is a significant regularity to the changes in volatility when the time approaches earnings announcements. By computing the mean volatility it becomes very apparent that on average a stock’s volatility will continue to increase up until the earnings are announced and then drop substantially afterwards. In Figure 4 the consolidated front month average is plotted along with a vertical line showing the announcement date.

Using the Basic Fitting Tool on MATLAB I was able to fit a 5th order polynomial to the average of the total data from 2001-2004 for AMZN, YHOO, and AAPL (shown in Figure 5). The best fit polynomial was computed to be:

\[ y = 0.00036x^5 - 0.016x^4 + 0.24x^3 - 1.4x^2 + 3.9x + 37 \]

IV. EFFECT OF ABRUPT PRICE CHANGES TO VOLATILITY SKEW

Some have suggested that there is a sticky strike or sticky delta behavior that occurs in options. If a strike is termed “sticky” then if the underlying changes the implied volatility of an option with a certain strike will not change. Hence the volatility is stuck to the strike. “Sticky Delta” or “Sticky Moneyness” refers to the instance when the underlying changes but the implied volatility of an option with a certain delta stays the same.

For example if the spot price moves from $40 to $50 a sticky strike would mean that the implied volatility of the $50 strike option would be the same as what it was before the change. In comparison, if in fact there is a “sticky delta” then the implied volatility of the $50 strike will be whatever the implied volatility of the $40
strike was before the move since the $40 strike was in-the-money (delta 50) before the move and the $50 strike is now in-the-money (delta 50). [2]

To test this theory I chose to restrict my study to the AMZN stock and to only consider two day periods where the stock dropped or rose more than 6.5%. If we assume that there are cases of “sticky delta” and “sticky strike” evidence should be most visible during times when there is a large swing in the underlying. Upon analysis of the data using Microsoft Excel I found that there was a large swing in the underlying between on May 25-26 and May 26-27 when the price rose a total of 7% between the 25 and 26th and rose 8% between the 26th and 27th. To graph the volatility surface I used the data from two days before the swing up until 4 days after.

The volatility surface of a stock is a three dimensional plot where the the Delta/Strike and the time to expiry are plotted along the x and y axis and the implied volatility of the option is plotted along the z-axis.

Figure 6 shows the volatility surface plotted with Delta, Time, and Implied Volatility using the data corresponding to the front month (30 days before expiry). The graph shows the volatility smile as well as contains a large dip in the middle of the graph. Figure 7 is the surface corresponding to the 60 days till expiry data and the graph also nicely portrays the volatility skew as well as shows a trough in the center corresponding to the large increase in the underlying.

Figures 8 and 9 depict the corresponding graphs of the volatility surface when graphed with respect to strike price rather than delta. The IVY Options Metric data base was used to obtain the implied strike values that were used to formulate these graphs. The graphs of the volatility surface plotted with respect to strike show a slight dip in the surface over days 3 and 4 when the large increase in the underlying occurred. But neither the graph is as recognizable as those plotted with respect to delta.

Based on these results we can see that it appears that the concept of “sticky delta” is at least marginally true but there is not enough data to tell for sure. It appears that the skew remains fixed for delta and therefore shifts with the stock movement.

V. CONCLUSION

This study has shown that when earnings announcements approach the volatility of an option will increase and then drop discontinuously across the announcement day. This study only considered three stocks so a more comprehensive study would provide more data and evidence for this effect but considering that this is a result of three years of data for each stock it can be assumed that this trend is not isolated to any one time or stock. This finding is correctly inline with the basic definition of volatility, the measure of risk or uncertainty of a financial instrument. When earnings are announced the measure of uncertainty as to the value of the stock decreases dramatically because with the advantage of the earnings information the worth of the company and therefore the
stock is much more evident. Since we are able to see and model this trend we are able to predict by how much an options volatility will fall across earnings and can invest accordingly.

The results concerning "sticky delta" and "sticky strike" are not as conclusive. Based on the data that was graphed it appears that there is a possibility of "sticky strike" and "sticky delta" but it would take much more analysis of many different stocks in order to start to come to any definitive conclusions. Future areas of research would include finding a more accurate fit to the volatility drop which is observed at earnings announcement and also a more detailed and expansive analysis of the volatility surface during large changes in the underlying.

Appendix

Acknowledgments

I would like to thank Dr. Anderson for his patience in answering many questions regarding the collection of data and formatting of this paper. I would also like to thank my colleagues for there help with the many nuances of LaTeX.

[1] Hulls, John C. "Options, Futures, and other Derivatives"