Why Do Option Prices Predict Stock Returns? The Role of Price Pressure in the Stock Market

INTERNET APPENDIX

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IA.1 Stock mispricing and implied-volatility changes, spreads, and skews

In this Appendix, we describe how stock mispricing relates to option-based predictors of stock returns, such as changes in the implied volatilities of calls and puts, the spread in implied volatilities between calls and puts, and implied volatility skews. These measures have been used in prior studies to predict future stock returns, and interpreted as a proxy for informed trading taking place in the options market before it takes place in the stock market. We argue instead that the stock return predictability associated with these measures is mechanically related to the degree of mispricing of the underlying stock that is not reflected in option quotes, and is not necessarily due to an asymmetry in information between the two markets.

IA.1.1 Changes in implied volatilities

Suppose one month ago a stock traded at its fundamental value and the option-implied volatility had been at its true unchanging value of 30%. The monthly change in call option-implied volatility will then be positive (negative) if the stock has become underpriced (overpriced) relative to its value by the end of the month. The opposite will be true for the change in put option-implied volatility. The relation between the current level of mispricing of the stock and the change in option-implied volatility over the past month is as depicted in Figure IA.1. Figure IA.1 is a straightforward transformation of Figure 2 and depicts the monotone relation between the level of stock mispricing and the monthly change in option-implied volatility.

[Figure IA.1 about here]

IA.1.2 The implied-volatility spread

The spread between the implied volatility of an at-the-money call and an at-the-money put provides another measure of stock mispricing. The volatility spread is monotonically increasing in the level of underpricing of the stock. Figure IA.2 shows that, for the parameters used to create the figure, a one percent mispricing of the stock leads to a near ten percent implied-volatility spread.

[Figure IA.2 about here]

The qualitative properties of the relations depicted in Figures 2 and IA.1 do *not* depend on whether option prices are determined by the Black-Scholes model.

IA.1.3 The implied-volatility skew

The volatility skew, also termed the volatility smirk, can be defined as the difference between the implied volatility of an out-of-the-money put and the implied volatility of an at-the-money call. Like the other volatility measures, the skew is a monotonic transformation of the level of stock mispricing. For the parameter values used to create it, Figure IA.3 shows how the difference between the implied volatility of an out-of-the-money put and an at-the-money call varies with the level of stock mispricing.[1]

[Figure IA.3 about here]

The qualitative properties of the relations depicted in Figures 2, IA.1 and IA.2 do *not* depend on whether option prices are determined by the Black-Scholes model. When option prices are determined by Black-Scholes and the stock is correctly priced, then the implied volatility skew is zero. But when option prices are not given by Black-Scholes, the implied

[1]The correlation between *DOTS* and the 1-month implied volatility skew measure used in Xing, Zhang, and Zhao (2010), defined as the difference between the implied volatility of a put option with delta equal to -0.2 and a call option with delta equal to 0.5 as given by the OptionMetrics Volatility Surface, equals -0.45.

volatility skew will be non-zero even for a correctly-priced stock. In that event the qualitative relation between the skew and mispricing as depicted in Figure IA.3 will be overlaid on the skew applicable when the stock is correctly priced.

References

Xing, Y., X. Zhang, and R. Zhao. 2010. What does the individual option volatility smirk tell us about future equity returns? *Journal of Financial and Quantitative Analysis* 45:641–662.

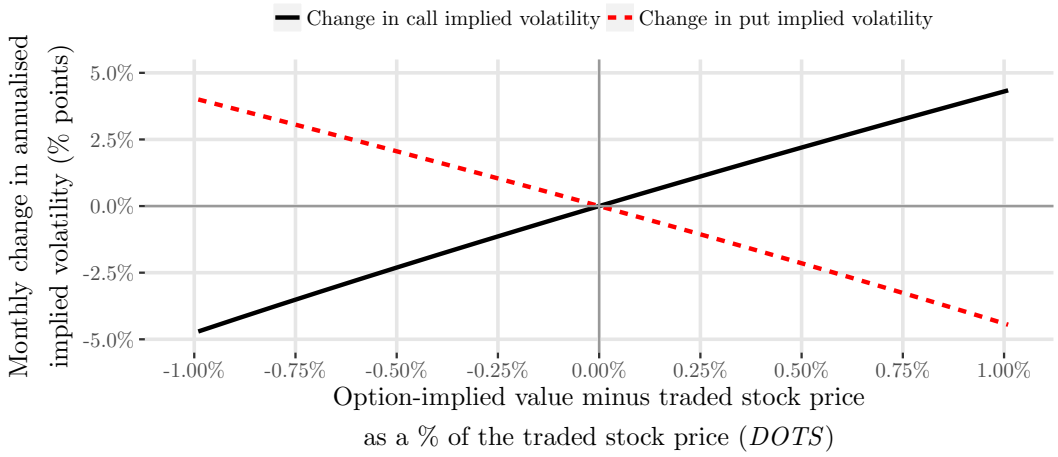

Figure IA.1: **Changes in at-the-money call and put implied volatilities**

This figure plots monthly changes in the Black-Scholes implied volatilities of a call and a put option as a function of *DOTS*. The options have a strike price equal to the stock's fundamental value and a maturity of 1 month. The risk-free interest rate and the stock return volatility per annum are 0% and 30%, respectively. The dollar option prices are computed by Black-Scholes using the stock's option-implied value as an input. The implied volatilities are computed from Black-Scholes using the traded stock price as the input. At the end of the prior month the stock is assumed to have traded at its option-implied value. The traded stock price at the end of the current month can deviate from the option-implied value.

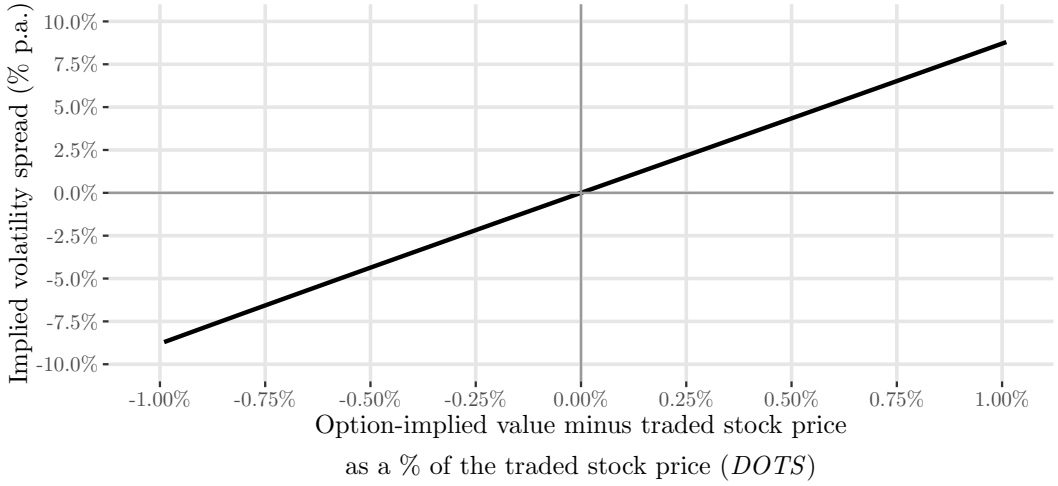

Figure IA.2: **Spread between at-the-money call and put implied volatilities**

This figure plots the difference in the Black-Scholes implied volatilities of a call and a put option as a function of *DOTS*. The options have a strike price equal to the stock's fundamental value and a maturity of 1 month. The risk-free interest rate and the stock return volatility per annum are 0% and 30%, respectively. The dollar option prices are computed by Black-Scholes using the stock's option-implied value as an input. The implied volatilities are computed from Black-Scholes using the traded stock price as the input.

Figure IA.3: **Difference between implied volatility of out-of-the-money put and at-the-money call**

This figure plots a proxy for the implied volatility skew as a function of *DOTS*. The proxy is calculated as the difference between the Black-Scholes implied volatility of an out-of-the-money put option and the Black-Scholes implied volatility of an at-the-money call option. The out-of-the-money put option's strike price equals 0.95 times the stock's fundamental value, and the at-the-money option's strike price equals the stock's option-implied value. All options have a maturity of 1 month. The risk-free interest rate and the stock return volatility per annum are 0% and 30%, respectively. The dollar option prices are computed by Black-Scholes using the stock's option-implied value as an input. The implied volatilities are computed from Black-Scholes using the traded stock price as the input.