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Author(s): Stephen Figlewski and Gwendolyn P. Webb
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Options, Short Sales, and Market Completeness

STEPHEN FIGLEWSKI and GWENDOLYN P. WEBB*

ABSTRACT

This paper presents empirical evidence that trading in options contributes to both transactional and informational efficiency of the stock market by reducing the effect of constraints on short sales. The significantly higher average level of short interest exhibited by optionable stocks supports the argument that options facilitate short selling. We also find significant effects on option prices, related to the short interest in the underlying stock. We then present evidence that options also increase information efficiency. Earlier work, that is replicated and extended here, has suggested that short sale constraints cause stock prices to underweight negative information. Options appear to reduce that effect.

IN THIS PAPER WE present empirical evidence that trading in options contributes to both the transactional and informational efficiency of the stock market by reducing the effect of constraints on short sales. Modern option valuation models are derived under assumptions that make options redundant securities,[1] but theoretical work on the role of contingent claims has often focused on their ability to "complete" the market.[2] Practical discussions of the role of actual options markets also emphasize the new trading strategies that are made possible,[3] and studies of how opening options trading affects the underlying stocks find statistically significant effects on returns and volatility.[4] If options were merely redundant assets, one would not expect any measurable impact when they were introduced.

Options trading may also play an informational role in the market by helping the market incorporate certain types of information into prices.

* Figlewski is from the Stern School of Business, New York University, and Webb is from Baruch College, City University of New York. We would like to thank the Interactive Data Corporation for providing data used in this study, and Baruch College for research support. We are grateful for helpful comments on earlier versions of the paper from Robert Whaley, participants in seminars at Baruch College and Boston College, and two anonymous referees. Thanks also to Jeffrey Heisler for excellent research assistance.

[1] See Black and Scholes (1973) or Cox, Ross, and Rubinstein (1979).

[2] See Ross (1976) or Arditti and John (1980), for example.

[3] For example, Cox and Rubinstein (1985, chapter 2), list nine different ways in which options create new trading opportunities for investors, including "Options offer the opportunity to avoid certain impediments to the short sale of stock" (p. 58).

[4] Nabar and Park (1988) conduct a careful and extensive investigation of option introduction and find, among other things, that there is a significant reduction in price volatility for the underlying stock. This phenomenon is also documented by Skinner (1989), who explores a number of possible explanations for it. Conrad (1989) also finds evidence of price effects associated with option introduction.

Jennings and Starks (1986) and Skinner (1990) both find evidence that prices of optionable stocks respond more quickly to earnings announcements, while Grossman (1988) advances a new argument that traded options reveal information about investors' future trading intentions, and therefore about future price volatility, in a way that a dynamic option replication scheme does not.

Another strand of the financial markets literature has focused on the effect that restrictions on short sales have on market efficiency. Comparatively few investors are actually able to sell short and obtain the full use of the proceeds.[5] Investors who believe a given stock is underpriced will buy it, but those with unfavorable beliefs will be constrained: They will not buy the stock, but few will actually sell it short. Miller (1977), Jarrow (1980), and Diamond and Verrecchia (1987) all examine the interaction between short sale constraints and security pricing. The models differ in the sophistication (or "rationality") that they assume investors will bring to bear in trying to adjust for the market's asymmetric treatment of favorable and unfavorable information, but all show that the informational efficiency of the pricing mechanism is reduced because stock prices deviate from the values they would have in a frictionless market.

Figlewski (1981) provides empirical evidence that short sale constraints affect realized stock returns. He takes the recorded level of actual short interest as a proxy for the amount of short selling there would have been if it had not been constrained, and therefore, the amount of adverse information that was excluded from the market price. For a sample of 414 stocks included in the Standard and Poor's 500 index, those with relatively high short interest were found to have significantly lower risk-adjusted returns in the following period than did stocks with relatively low short interest.

Introducing options trading can potentially reduce or even eliminate the informational effect of short sales constraints, by providing alternative trading strategies for investors with unfavorable information to sell short *indirectly*.[6] For example, when a put is purchased from an options market maker

[5] Small investors have the proceeds of their short sales held in escrow by their brokerage firms, generally earning no interest, and they must also deposit collateral, currently equal to 50 percent of the value of the shorted securities. Most institutional investors do not sell short at all. Although not explicitly prohibited from doing so, many say they consider it too risky or simply inconsistent with their investment philosophy. Investors who want to sell stock short are also somewhat constrained by the regulation against selling short on a downtick, and by the need to find shares that can be borrowed, although these last impediments are probably not too important except for small and illiquid stocks.

[6] For example, if an investor thinks a given stock's expected return is zero, he will not sell short if he cannot earn interest on the proceeds, but if options exist the information can be exploited by writing a call option and profiting from the time decay. Trading in put options provides even better opportunities for an investor who thinks the stock price is going down sharply, since the maximum profit from writing a call is limited to the initial premium. Margin treatment for buying a put option is also substantially more favorable than for writing an uncovered call. To buy a put, the price must be paid in full. An uncovered call writer, on the other hand, must *maintain* margin equal to the current option price plus 15 percent of the price of the underlying stock. This can be reduced if the option is out of the money, to a minimum margin of the option value plus 5 percent of the stock price.

he will normally hedge by shorting the stock, and perhaps buying a call also to turn the position into a reverse conversion arbitrage. The put buyer's desire to sell the stock is transformed through the options market into an actual short sale by a market professional who faces the lowest cost and fewest constraints. Thus the increase in transactional efficiency makes possible an increase in informational efficiency as well.

This paper examines the connection between short sales and options trading empirically. If options trading does play a role in reducing the impact of short sales constraints, we expect to see it manifested in various ways. First, we should see a positive relationship between the existence of options and the average level of short interest, due to the hedging activities of options market makers and professional traders. Empirical support for this connection between option trading and short sales is presented in Section I.

Next, if investors with unfavorable information buy puts and write calls when they would really like to short the underlying stock, we should see upward pressure on put prices and downward pressure on calls, which will be reflected in higher implied volatilities for puts than calls at times when actual short interest is high (assuming market frictions are large enough that not all such discrepancies are arbitraged away). In Section II, we find strong evidence of this pattern.

Finally, if trading in options permits unfavorable information to enter stock prices indirectly, the connection Figlewski found between high short interest and subsequent negative excess returns should be reduced or eliminated for stocks with traded options. The results presented in Section III are consistent with that effect, although they are not strong enough to rule out an alternative hypothesis, that short selling is correlated with future underperformance because it is done primarily by sophisticated traders who have better than average information. Section IV concludes.

I. Short Interest and Option Trading

In this section, we test whether short interest is higher for stocks that have exchange-traded options than for stocks with no options. A stock's short interest refers to the total number of shares that have been sold short and not yet covered (repurchased) as of a point in time.[7] Introducing exchange-traded options on a stock permits investors who could not, or would not, sell stock short to take equivalent options positions. This, in turn, should lead to short sales by options market makers and cause an increase in short interest that is associated with options trading.

However, there could also be a substitution effect operating in the opposite direction. Investors who formerly would have sold the stock short may now trade options instead. To the extent that investors *switch* from short sales to option trading, stock short interest could decline when options are intro-

[7] Although ideally we would also like to examine data on short sales *transactions*, these are unavailable for individual stocks.

duced. We expect this substitution to be a weaker effect than the first one, for two reasons. First, only a small number of investors are already active short sellers, while a much larger number are able, and may be willing, to trade options, especially as part of a strategy like buying a "protective put" that could be described as a hedge. Second, even if former short sellers do switch their trading to options, the options market makers may simply respond by shorting the underlying stock themselves to hedge their positions, thus leaving total short interest unchanged.

Short interest data for a sample of 342 stocks were used. This sample consists of the firms in the Standard & Poor's Index of 500 Common Stocks (S & P 500) as of April 1985, that had a continuous series of returns data on the CRSP Monthly Stock Returns tape since 1969. This particular selection criterion was imposed so that the sample could also be used in the stock return analysis of Section III.

Short interest for individual stocks is published monthly by the stock exchanges, based on information provided by their member firms. The figures are as of the fifteenth of the month, or the nearest preceding trading day if the fifteenth is not a trading day. The data used in this study were provided by the Interactive Data Corporation. To make the figures comparable across firms, the short interest was divided by the number of shares outstanding as of the end of the month, from the CRSP Monthly Stock Return tape, adjusted for stock splits and stock dividends made between the middle and end of the month. We refer to these figures as relative short interest.

Call options were first traded on the CBOE in April 1973. Twenty-five puts were introduced in June 1977 on five different exchanges. Many more calls and puts were introduced beginning again in May 1980, when the SEC ended its moratorium on new options. Between 1973 and 1983, exchange-traded options were introduced on over one-half of the stocks in the sample.

Table I shows the average relative short interest annually from 1973 to 1983 for stocks with and without options. One striking fact is how little short selling there actually is. The average short interest for the entire sample is only about 0.2 percent of outstanding shares. It is also apparent that relative short interest is significantly higher for stocks that have traded options than for those without options. This is true in each year of the sample and the significance of the difference for every year but 1976 is confirmed by the t-statistics.

One possible problem with this analysis is selection bias in the data. If short interest happens to be correlated with the characteristics of a stock that make it a good candidate for options trading, there would be an association between short interest and option trading, but not one that is due to the causal connection we have suggested.

To verify the results in Table I, we took all of the stocks that had options trading at some time during the period and compared the level of short interest before and after options introduction. For each stock, we performed a t-test on the difference between the mean short interest during the 12 months immediately prior to and immediately following the date options trading

Table I

Tests on Average Percent Short Interest with and without Options

The table compares the annual average (across firms and months) of short interest as a percent of the firm's total outstanding shares, for stocks with and without traded options. The sample consists of 342 stocks contained in the Standard and Poor's 500 Index. Stocks that had options introduced in the middle of a year were excluded from the sample for that year.
The t-statistic tests the null hypothesis H_0: $\mu_1 - \mu_2 = 0$ against the one-sided alternative H_a: $\mu_1 - \mu_2 > 0$, where μ_1 and μ_2 are the mean short interest levels for stocks with and without options, respectively. The test statistic is given by

$$\frac{x_1 - x_2}{\sigma(1/n_1 + 1/n_2)^{0.5}} \sim t_{n1+n2-2}$$

where σ is the sample standard deviation, and x_1 and x_2 are the sample means. For large samples, the critical value for t at the 0.01 confidence level is 2.326.

	Annual Average Short Interest			Number of Observations			
	Options	No Options	Difference	Options	No Options	Sample Standard Deviation	t-Statistic
1974	0.254	0.111	0.143	28	309	0.374	1.94
1975	0.279	0.111	0.168	33	237	0.310	2.92
1976	0.195	0.145	0.050	105	198	0.467	0.89
1977	0.200	0.123	0.076	144	190	0.247	2.79
1978	0.226	0.102	0.123	152	188	0.266	4.25
1979	0.243	0.097	0.147	154	188	0.257	5.24
1980	0.307	0.093	0.214	154	166	0.299	6.40
1981	0.333	0.117	0.217	176	164	0.364	5.49
1982	0.508	0.182	0.327	178	146	0.622	4.70
1983	0.506	0.238	0.268	196	140	0.610	3.97

began. Of the 169 stocks, 111 had higher relative short interest after option introduction. Among those stocks that showed a statistically significant change, 71 had higher and only 24 had lower short interest.

Simply considering the binomial probability of observing 111 positives out of 169 trials easily allows us to reject the hypothesis that the probability of an increase was just one half. If $p = 0.5$, the expected number of positives in the sample is 84.5 with a standard deviation of $[(169)(0.5)(1 - 0.5)]^{0.5} = 6.5$. Thus 111 positives falls more than 4 standard deviations above the mean. Applying the same test to only the statistically significant changes yields an even stronger rejection of the hypothesis of no change in the average level of short interest after option introduction.[8]

[8] The average level of short interest was generally rising during this period. Fitting linear time trends showed average growth of 0.025 and 0.031 percent per year for stocks without and with options, respectively. To check whether this influenced the results, we also performed the test after deflating the postlisting year's short interest figure by the annual rate of growth in total short interest. The number of positives fell to 105, which was still more than 3 standard deviations above the mean, under the null hypothesis that $p = 0.5$.

The results are consistent with the findings of Brent, Morse, and Stice (1990) in their study of the determinants of short interest during the years 1981 to 1984. In a cross-sectional regression analysis of short interest, a significantly positive coefficient was estimated for a dummy variable representing the existence of options. They also observed a significant positive relationship between month to month changes in option open interest and short interest in the underlying stocks.

II. The Relationship between Short Interest and Option Prices

The results in Table I show that the level of a stock's short interest is correlated with options trading. In this section we examine whether this has a measurable effect on options prices. For many investors, buying puts or writing calls is preferable to selling short. Transactions costs are lower, there are fewer impediments like the uptick rule, and buying puts also has the virtue of limited liability. The hypothesis we test is that when high short interest indicates a large investor demand for short positions, put prices will also be high relative to call prices, as manifested in their implied volatilities. If puts are bid up and call prices depressed by pressure from pessimistic investors, we should see a positive correlation between short interest and the difference between put- and call-implied volatilities.

There is a problem with linking the short interest data, which are published once a month, with option price data, for which daily closing prices and even transactions data are available. Since we do not have option prices as of the same points in time that short sales were being made, we use option prices on the last day relevant to the date of the short interest figure. Short interest on the fifteenth of the month relates to stock trades that have settled by that date, so we take the options prices from five trading days earlier.

To calculate the implied volatilities, we use closing stock and option prices. Closing stock prices are set at the close of the NYSE, at 4:00 P.M., New York time, but the option exchanges close at 4:10 P.M.[9] If the effects of asynchronous prices—as well as related factors such as the bid-asked spread—are random, then the test results are unbiased, although the estimates may have relatively larger variances. We use the average of the bid and asked discounts on the Treasury bill expiring closest to the options' expiration date to calculate the interest rates. We assume that all dividends paid prior to option expiration were known.

In May 1980, when the regulatory moratorium on put trading was lifted, 45 new put contracts were introduced simultaneously and many more were

[9] The ten-minute difference in closing times only started in 1979. Prior to that, the NYSE and the option exchanges all closed at 4:00 P.M., New York time.

added in the succeeding months. A data sample that is concentrated in a short time period might be unduly affected by short-run phenomena, so we felt it was preferable in this test to examine options prices spanning a relatively long period of time. Accordingly, we limited the analysis in this section to options on the sixteen stocks in our sample for which put trading began in June 1977.

The data are therefore drawn from the period June 1977 through January 1982, the last full month prior to the start of trading on futures contracts on the Value Line Stock Price Index. We end the sample at this point because of the anticipated impact of index futures arbitrage. Once futures on indexes were traded, changes in a stock's short interest could reflect changes in investors' expectations either about the particular stock or about the market as a whole.

We selected at-the-money, intermediate-term pairs of puts and calls with the same strike price and expiration to limit the analysis to the most heavily traded option classes, that are less prone to distortions associated with market thinness. Specifically, the sample includes all pairs with options that were between 15 percent in-the-money and 15 percent out-of-the-money, and from 10 to 150 days to expiration, making a total of 2,125 put-call pairs.[10]

Implied volatilities are computed using a binomial model that takes account of the dividend payouts on the underlying stocks and the value of possible early exercise for both the puts and the calls. Equation (1) shows the results of regressing relative short interest on the difference between put and call implied volatilities. To adjust for possible heteroscedasticity, we use White's (1980) method to compute the standard errors.

$$(\mathrm{ISD}_p - \mathrm{ISD}_c)_{s,t,o} = \underset{(-7.50)}{-0.0156} + \underset{(8.37)}{0.0237}\,\mathrm{SI}_{s,t} + \epsilon_{s,t,o} \tag{1}$$

$$\text{Adj } R^2 = 0.034 \qquad \text{Variable means: Dependent} = -0.004$$

$$\text{Independent} = 0.491$$

where subscript s denotes the stock, t the month, and o the option for the particular observation. $(\mathrm{ISD}_p - \mathrm{ISD}_c)_{s,t,o}$ is the difference between put and call implied volatilities, $\mathrm{SI}_{s,t}$ is the relative short interest, and $\epsilon_{s,t,o}$ is the residual. t-statistics are shown in parentheses.

The coefficient on short interest is highly significant, with a t-statistic of 8.37. These results strongly support the hypothesis that high short interest is correlated with the option price pattern that we have argued should occur

[10] We also required that both the put and the call price exceeded 1/16 ($0.0625).

when investors try to exploit unfavorable information by taking positions in the options market.[11,12]

III. Short Interest and Excess Returns

The strong connection between short interest and both the existence of option trading and option pricing supports the hypothesis that options make markets more complete by improving transactional efficiency. This should lead to an improvement in informational efficiency as well, and not just because stock prices become more responsive to investors' expectations. By facilitating short positions, option trading has an asymmetric impact on investors with favorable and unfavorable information. In this section we examine evidence that unfavorable information is underweighted in prices when the market constrains short sales, but that option trading helps to reduce the inefficiency.

There are at least three common explanations of the relationship between short interest and stock returns, each with different implications. First, because shares sold short will eventually have to be repurchased, many investors interpret high short interest as an indication that the stock should outperform the market when the short positions are covered. While plausible, this argument would have more weight if short sales accounted for a significant proportion of trading in the stock. However, the average short interest in our sample amounts to only about 0.2 percent of outstanding shares. Also, while individual investors must eventually cover their short positions, short covering creates upward price pressure only when the *market* as a whole does it, i.e., when the stock's total short interest is reduced. By this logic, a high but steady level of short interest in a stock should not produce any particular price effects.

According to what might be termed the "sophisticated trader" view, on the other hand, short selling is done primarily by market professionals. A high

[11] The data sample for this regression has a time-series cross-section structure with, in most cases, more than one option pair per month for each stock. This could give rise to a complex pattern of cross correlations among the residuals. To evaluate how large an effect this was likely to have on the results, we experimented with the specification by first averaging observations to obtain one data point per stock per month (which reduced the sample size from 2,125 to 875) and then correcting for the effect of an unspecified pattern of heteroscedasticity and time dependence using the approach of Newey and West (1987). In brief, the estimated t-statistics were smaller, partly due to the smaller sample, but they remained highly significant.

[12] In a closely related experiment to this one involving implied volatilities, we examined the bounds on put prices imposed by put-call parity. The advantage of such an approach is that it does not require us to assume a specific option-pricing model in order to calculate implied volatilities. The parity relation, as it applies to American options, restricts the put price to lie within a range that is a function of the current prices for the stock and the matching call, and the expected future dividend payouts. Positive correlation between the level of short interest and demand for puts should lead to puts being priced toward the upper end of the parity bounds when short interest is high. The test supported the hypothesis at a similar level of statistical significance to what we observed with implied volatilities.

level of short interest therefore indicates that the best informed traders expect the stock to underperform the market in the future.

The third view stems from considering the interaction between constraints on short sales and heterogeneous beliefs. When investors are constrained from short selling freely, they will limit the size of their positions or choose not to engage in short sales at all, even when they have strongly negative expectations about a stock. Since the market price is determined by demand and supply from investors who are actually trading, impediments to short sales will cause negative expectations within the market population to be relatively underweighted. Other things equal, the more negative information that is excluded from the market, the higher the price will be relative to the mean assessment of the stock's true value across all investors. Assuming there is no difference in the informational value of favorable and unfavorable opinion, the stocks whose prices are driven up most by this phenomenon will tend to underperform the market. The fact that short sales are not strictly prohibited allows us to use measured short interest as an indicator of the amount of (nonpublic) negative information that is *not* being communicated to the market.[13]

Figlewski (1981) tested this hypothesis using a sample of 414 of the S & P 500 stocks in the 1970s. The stocks were grouped into market value-weighted portfolios according to their average short interest during six-month periods and average portfolio excess returns were computed for the following twelve months. The results showed a strong inverse relation between the level of short interest and subsequent excess returns.

This evidence is inconsistent with the view that stocks with a high level of short interest will outperform the market due to subsequent purchases made to cover short positions, but it is consistent with both of the other views. The major difference between them is that the "sophisticated investor" story depends on short sellers having better information than purchasers of stocks, while the "excluded negative information" explanation applies equally well when all investors have the same forecasting ability, because the market "imperfection" of constraints on short selling induces a bias in the way the market aggregates heterogeneous expectations.

The two hypotheses are not mutually exclusive, but it may be possible to distinguish their relative importance by looking at the effect of trading in stock options. Options ought to enable some of the previously excluded negative information to enter the financial markets through a different

[13] Note that if short interest data contains valuable information either about the market's underweighting of unfavorable information or about the opinions of the most sophisticated traders, rational investors should make use of it in forming their returns estimates, which would cause the information to be at least partially impounded in prices. For example, in Diamond and Verrecchia's (1987) model with fully rational expectations, there is no price effect from short sales restrictions. The tests described below, however, show that proper analysis of reported short interest can produce excess returns, which implies that actual investors do not make full use of this publicly available information. Confusion over whether short interest should be considered bullish or bearish may be one explanation.

channel. Thus, under the excluded information hypothesis, the relationship between short interest and excess returns should be weakened, and perhaps eliminated, for stocks with options. By contrast, options may have little effect on sophisticated traders' ability to trade on their information, since they face the lowest transactions costs and fewest constraints in selling short in any case.

To examine these issues, we begin by applying Figlewski's methodology to our sample. We partition the stocks into ten portfolios according to their average short interest in one period, and then examine their excess returns over the next period. We then disaggregate the data and run a much more sensitive pooled cross-section time series regression that allows us to examine the joint impact of short sales and option trading directly.

Monthly stock returns data were taken from the CRSP Monthly Stock Returns tape, and the market return was that of the CRSP value-weighted market index, including dividends. The one-month commercial paper rate data were taken from *The Analytical Record of Yields and Yield Spreads*, Salomon Brothers Inc.

Monthly excess, or risk-adjusted, returns are defined as

$$\mathrm{ExRet}_{s,t} = \mathrm{R}_{s,t} - \left[\mathrm{R}_{f,t} + \beta_{s,t}(\mathrm{R}_{m,t} - \mathrm{R}_{f,t})\right] \tag{2}$$

where

$\mathrm{ExRet}_{s,t}$ = Excess return on stock s in month t,
$\mathrm{R}_{s,t}$ = Return, including dividends, on stock s in month t,
$\mathrm{R}_{f,t}$ = Interest rate on one-month commercial paper,
$\mathrm{R}_{m,t}$ = Return on the CRSP value-weighted market index, including dividends,
$\beta_{s,t}$ = Beta of stock s, defined below.

Following the method in Figlewski (1981), we ranked the firms by average relative short interest for six-month periods, beginning with January to June 1973. Ten portfolios ranked by relative short interest were then formed from the 342 stocks and the average return for each was computed for the subsequent twelve months (i.e., July 1973 to June 1974 for the first observation). This procedure was repeated for each year after that, yielding ten time series of portfolio returns for July 1973 through June 1983.

The values of $\mathrm{ExRet}_{s,t}$ for the first twelve months, July 1973 to June 1974, are based on betas estimated from the returns in the preceding 36 months, July 1970 through June 1973. $\mathrm{ExRet}_{s,t}$'s for the next twelve month period then use betas calculated over July 1971 to June 1974, and so on.

The portfolio short interest and returns data for the July 1973 to June 1979 time period considered in Figlewski (1981) are summarized in the top panel of Table II, and the overall results for our sample are almost identical to his. They show the same striking pattern of negative excess returns for high short interest portfolios and positive excess returns for those with lower short interest. The rank correlations of portfolio relative short interest with total

Table II

Portfolio Short Interest and Returns by Rank

The table analyzes the relationship between short interest and subsequent returns over two periods of time. The first corresponds to the time period analyzed in Figlewski (1981) and the second updates the analysis to the end of our data sample. The 342 stocks in the sample are partitioned according to their average short interest during a six-month classification period (January through June of each year) into 10 market value-weighted portfolios. Portfolio returns are then calculated for the following 12 months (July through June). Returns are measured in percent per month and include dividends. Portfolio short interest is the weighted average of the individual stock short interest figures. The portfolio beta is the weighted average of the stock betas, which are estimated relative to the CRSP value-weighted index from returns over 36 months ending at the end of the classification period. Excess return, defined in equation (2), is the total return in excess of the riskless rate (assumed to be the rate on one-month commercial paper), minus the beta multiplied by the market's excess return over the riskless rate.

Portfolio	Short Interest	Total Return (% per Month)	Beta	Excess Return (% per Month)
Six-Year Period: July 1973 to June 1979				
1	0.0004	1.60	1.04	0.95
2	0.0045	1.11	0.95	0.51
3	0.0107	1.02	1.02	0.50
4	0.0200	0.71	0.85	0.13
5	0.0355	0.69	1.00	0.07
6	0.0568	0.11	0.98	−0.53
7	0.0875	0.54	1.03	−0.10
8	0.1358	0.26	1.02	−0.39
9	0.2279	0.11	1.04	−0.48
10	0.6568	0.20	1.20	−0.43
Four-Year Period: July 1979 to June 1983				
1	0.0017	1.91	0.91	0.56
2	0.0121	1.53	0.82	−0.21
3	0.0298	1.58	0.60	0.27
4	0.0475	1.60	0.92	0.04
5	0.0747	1.93	0.88	0.36
6	0.1062	1.28	0.98	−0.41
7	0.1507	1.37	0.95	−0.16
8	0.2078	1.75	0.91	0.32
9	0.3510	0.91	1.01	−0.49
10	1.0658	1.57	1.30	0.05

and excess returns are −0.87 and −0.87 compared to −0.88 and −0.81, respectively, found in the earlier study.

The lower panel of Table II extends the analysis to the following four years, July 1979 to June 1983. The rank correlation of portfolio total return and relative short interest falls to −0.41. While it is still negative, it no longer exceeds the five percent critical value of −0.63.

Like the original study, this table does not take option status into account. One difference between the two sample periods is in the number of optionable stocks. Prior to 1979, an average of 45 percent of the stocks in the sample had traded calls and less than 5 percent had puts. These figures grew to 58 and 57 percent, respectively, by the end of the second time period. We also see a distinct increase in the average short interest for each of the 10 portfolios.

To examine the effects of short sales and options trading simultaneously, we computed the returns and short interest variables for each individual stock as we described for the portfolios above. We then ran a pooled cross-section time series regression of excess returns on a set of variables relating to short interest and option status, in addition to other factors that have in the past been found to be correlated with returns.

If a stock's measured short interest is a reliable proxy for the amount of adverse information that the market is *not* incorporating into the price because short sales are constrained, the regression coefficient on short interest should be negative. Given the results shown in Table II, we might expect the relationship to be fairly strong. But if options trading allows pessimistic investors to take effective short positions without selling short directly, this effect should be reduced for optionable stocks. To test this, the regression is fitted with separate short interest variables for stocks with options and stocks without options.

We consider only stocks whose option status is the same in both years $t-1$ and t. $SI_{s,t-1}$ contains the average short interest value for stock s in the year prior to the year for which the return is measured. $SI.Option_{s,t-1}$ is equal to $SI_{s,t-1}$ multiplied by a dummy variable that is 1 if options were traded on stock s in both years $t-1$ and t, and 0 if the stock did not have traded options in either year.[14] With this definition, the short interest effect for optionable stocks is measured by the sum of the two coefficients, while for stocks without options it is the coefficient on $SI_{s,t-1}$ alone. Thus, the coefficient on $SI.Option_{s,t-1}$ shows the net effect of options trading on the relationship between short interest and returns.

Optionable stocks as a class are different from stocks without options. For example, Skinner (1989) documents that they tend to have significantly higher betas, and it is evident that other characteristics that may be correlated with returns, such as firm size, daily trading volume, volatility, and so on are carefully weighed by an exchange in trying to decide which options to list. We try to separate the effect of short sales on returns from the other differences between optionable and nonoptionable stocks in two ways.

First, we include separate explanatory variables to account for two such factors, firm size and beta. Relative firm size, $Value_{s,t-1}$, is defined as the natural log of the average market value of firm s shares during year $t-1$ divided by the average total market capitalization for $t-1$ from the CRSP monthly tapes. Based on the studies of Banz (1981) and Reinganum (1981), we expect the coefficient on $Value_{s,t-1}$ to be negative, reflecting the small firm effect.

[14] Note that "year" in the discussion of the variables refers to a 12-month period from July to June.

The second factor is beta. Through equation (2), which defines the stock's excess return relative to the theoretical security market line, beta already enters the regression, but in such a way that its coefficient is effectively constrained to be 1.0. Tests of the CAPM, however, typically find that high beta stocks tend to have negative alphas relative to the theoretical SML and low beta stocks have positive alphas. Since optionable stocks have higher than average betas, we add the stock's beta as an additional right-hand side variable, to allow for the possibility that a stock's mean return will deviate from the security market line in a regular fashion, as a function of its beta. If high beta stocks underperform on average, the coefficient on beta will be negative.

We cannot hope to include explicit variables to adjust for all of the differences between optionable and nonoptionable stocks that might be correlated with returns. However, the mean effect of all other explanatory variables that are excluded from the regression is impounded in the regression constant term. Allowing the intercept terms for the two groups to differ can adjust for differences in the *mean* effects of any excluded factors.[15] Therefore, in addition to the short interest variables, the regression contains an intercept dummy variable for stocks with options, $\text{D.Option}_{s,t-1}$. The regression intercept α_0 applies to stocks without options and the intercept for stocks with options is then α_0 plus the coefficient on D.Option, α_1.

The final specification for the regression equation is now

$$\begin{aligned}\text{ExRet}_{s,t} = {} & \alpha_0 + \alpha_1 \text{ D.Option}_{s,t-1} + \beta_0 \text{ SI}_{s,t-1} + \beta_1 \text{ SI.Option}_{s,t-1} \\ & + \delta_0 \text{ Value}_{s,t-1} + \delta_1 \text{ Beta}_{s,t} + \epsilon_{s,t} \end{aligned} \tag{3}$$

We first estimated equation (3) over the full sample period, July 1974 through June 1982. This period starts with the first possible full year of our sample, taking into account the need for lagged values of short interest, and ends after the introduction of trading on futures contracts on stock price indexes in the spring of 1982.[16] There were a small number of observations with extremely high levels of short interest. These are likely to reflect the effects of risk arbitrage and other special circumstances which are not directly related to the effects we are considering. To limit the influence of such outliers, we excluded observations in which stock short interest exceeded 1.2 percent of shares outstanding (approximately ten times the mean short interest for data points included in the sample). Also excluded were any

[15] As an illustration, if nonoptionable stocks were on the whole less liquid than optionable stocks and this factor caused investors to require higher expected returns to hold them, the average effect would be captured in a higher intercept for nonoptionable than optionable stocks. The difference in mean returns due to the liquidity factor would not be incorrectly attributed to a different response of the two groups to short interest.

[16] The last year in the sample contains a few months after stock index futures had begun to trade. For example, the most active futures contract, based on the Standard and Poor's 500 Index, was introduced in late April, 1982. It is unlikely that our regression results are materially affected by short sales related to arbitrage involving the index futures contracts during their first few months of trading.

Table III

Regression of Stock Excess Returns on Short Interest, Accounting for Stock Option Status, and Other Factors

The table presents regression results for equation (3),

$$\text{ExRet}_{s,t} = \alpha_0 + \alpha_1 \text{ D.Option}_{s,t-1} + \beta_0 \text{ SI}_{s,t-1} + \beta_1 \text{ SI.Option}_{s,t-1} + \delta_0 \text{ Value}_{s,t-1} + \delta_1 \text{ Beta}_{s,t} + \epsilon_{s,t}$$

where,

$\text{ExRet}_{s,t}$ = Average excess returns for stock s in year t,
$\text{D.Option}_{s,t-1}$ = 1.0 if options traded in year $t-1$, 0 otherwise,
$\text{SI}_{s,t-1}$ = Short interest in year $t-1$,
$\text{SI.Option}_{s,t-1}$ = Short interest on optionable stocks: $(\text{D.Option}_{s,t-1}) \times (\text{SI}_{s,t-1})$
$\text{Value}_{s,t-1}$ = Log of average market value for stock s divided by average total market value for all stocks in year $t-1$,
$\text{Beta}_{s,t}$ = Beta for stock s over 36 months prior to year t.

See the text for further discussion of the variables. The sample covers 342 stocks over eight years (July to June), from July 1974 through June 1982. Observations were eliminated if there was a change in option status in year t or $t-1$, or if short interest was an outlier. t-Statistics, computed from standard errors corrected by White's (1980) method, are shown in parentheses.

Variable	Full Sample (1974–1982)	First Part (1974–1979)	Second Part (1979–1982)
Constant	−0.00325	−0.00318	−0.00270
	(−2.031)	(−1.692)	(−0.925)
$\text{D.Option}_{s,t-1}$	−0.00161	−0.00111	−0.00238
	(−1.344)	(−0.783)	(−1.081)
$\text{SI}_{s,t-1}$	−0.00998	−0.01008	−0.00934
	(−2.478)	(−2.094)	(−1.324)
$\text{SI.Option}_{s,t-1}$	0.00349	0.00356	0.00522
	(0.649)	(0.575)	(0.550)
$\text{Value}_{s,t-1}$	−0.00351	−0.00414	−0.00241
	(−7.683)	(−8.191)	(−2.542)
$\text{Beta}_{s,t}$	−0.00096	−0.00155	−0.00080
	(−0.823)	(−1.171)	(−0.348)
NOBS	2,385	1,552	832
R-squared (adj.)	0.060	0.082	0.026

observations for which there was a change in option status during years t or $t-1$. This produced a sample of 2,385 observations, of which 1,529 were for stocks without options and 856 were for stocks with options.[17]

The OLS estimation results for equation (3) with heteroscedasticity corrected errors are summarized in Table III. For the full sample, shown in the first column, the estimate of β_0 is −0.00998, significantly less than zero at

[17] Of these, 602 were for stocks with just calls, and 254 were for stocks with both puts and calls.

the 1 percent confidence level. This confirms our previous results on the relationship between short interest and subsequent excess returns.

The estimated value of β_1, showing the difference between the short interest effect for optionable and nonoptionable stocks, was 0.00349, making the total short interest coefficient for them equal to -0.00649. While this is considerably smaller than the estimate for nonoptionable stocks, the t-statistic on β_1 is only 0.649, so the difference is not significant at the 5 percent confidence level. (The p-value is about 26 percent). This result is therefore consistent with the hypothesis that option trading reduces the informational impact of short sale constraints, but also with what we have called the sophisticated trader hypothesis.

Among the additional explanatory variables, the coefficient on the log of relative market value is negative and highly significant, with a t-statistic of -7.68, consistent with the small firm effect. Both the coefficient on beta and the intercept dummy for optionable stocks are also negative, but neither is significantly different from zero at the 5 percent level.

Table II suggests that the relationship between short interest and subsequent returns seems to weaken somewhat in the later part of the sample, for both stocks with and without options. To examine the influence of the time period we ran the regression over subsamples of the data, breaking the sample in 1979 so that the first subsample corresponds to the period examined in Figlewski (1981). The results are shown in the second and third columns of Table III.

The subperiod regressions are very similar to what was found for the whole sample, especially as regards the coefficients on the short interest variables. With a smaller number of data points in each regression, the t-statistics go down a little, but the coefficient point estimates in the two subsamples are very close. Rather than indicating a weaker relationship in the later period, the coefficient on SI.Option actually goes up, but the difference is far from statistically significant. The results reported in Table III appear to be quite robust, and representative of what was found under a wide range of specifications.[18]

As we anticipated, there are many things that cause excess returns, including all firm-specific events, so the explanatory power of a regression such as equation (3) is bound to be quite low. And, indeed, adjusted R^2 is

[18] As in the earlier tests, we experimented with a number of alternative specifications for equation (3). Although each variation produced somewhat different results, the general pattern shown in Table III was found in almost all cases. The coefficient on short interest was negative and either significant or very close to it, with a t-statistic greater than 1.5 in absolute value. The difference in the coefficient for optionable stocks was always positive but not significant at the 5 percent level.

We checked for a difference between stocks with calls only and those with both calls and puts, finding only small differences, of dubious significance. We also tried different measures for the size effect and the "beta" effect, with little change in the results for the short interest variables. Finally, we examined different cutoff values for eliminating short interest outliers, and found only small changes in the results over a fairly wide range of values.

only 0.060. However, the estimated coefficients have the expected signs, and significance levels are sufficient for us to feel that the results shown in Table III generally support the hypotheses discussed above. There is a statistically significant negative relationship between short interest and subsequent excess returns for stocks that do not have traded options. The existence of options appears to reduce the effect, but since the difference is not statistically significant at the 5 percent level, we cannot reject the sophisticated trader hypothesis as an additional explanation. Overall these results are consistent with the view that options help to make the market more informationally efficient with respect to negative information.

IV. Conclusion

Academics and practitioners typically assert that options create new trading opportunities and play a real role in making markets more complete. A complete market is one in which, for each possible state of the world, an investor can create a strategy that has a positive payoff in that state and zero in every other state. Our markets, even with a full set of contingent claims, are bound to remain far from complete. However, the presence of options does make it easier for most investors to create positive payoffs for states in which an optionable stock has a low or negative return.

In this paper we provide empirical evidence that this increase in market completeness has measurable effects. Table I shows that optionable stocks exhibit a significantly higher level of short interest than stocks without options, and additional results confirm that an individual stock's short interest increases after option listing. We interpret this as evidence that options trading creates a channel which effectively allows investors who are constrained from taking direct short positions to short a stock through the options market.

Regression equation (1) demonstrates that when short interest is high for an optionable stock, the implied volatility computed from a put option tends to be high relative to implied volatility computed from the call option with the same strike price and maturity. This supports the argument that constrained investors will buy puts and write calls as a substitute for selling a stock short directly. Both of these results point to an increase in "transactional" efficiency in the market associated with options.

The results in Section III suggest that options may also increase information efficiency in the market. Tables II and III show that high relative short interest on a stock is associated with future underperformance in terms of its returns, because constraints on short sales cause negative information to be underweighted in the market price. Our finding that the effect appears to be weaker for optionable stocks (although not significantly so at the 5 percent confidence level) is consistent with the argument that the existence of options reduces the information inefficiency caused by short selling constraints.

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