

Investment Portfolio Strategies Based On Options Market Activity

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ABSTRACT

We propose a multiple regression model that incorporates options market activity to forecast future stock prices. To capture the information content from the options market, we use a predictor based on the activity of call and put options as measured by relative open interest across available strike prices. We use a sample of stocks with actively traded options on the Chicago Board Options Exchange to test the model. Investment strategies that use these forecasts are shown to be superior to more simple strategies which ignore options market activity.

Keywords: Options, Open Interest, Trading Strategies.

INTRODUCTION

Equity options markets are regarded by many academicians and practitioners as attractive markets for informed traders. Trading activity in these markets may reflect information that has not yet been incorporated into the underlying stock price and might possibly improve the prediction of future price movements of the underlying security. The purpose of our research is to investigate the benefits of using options market activity for designing investment strategies.

We utilize relative open interest over all available put and call strike prices to generate a price predictor which we then use, along with the contemporaneous stock price, to forecast the underlying stock price for the option expiration day. We obtain coefficients for our forecast model using thirty stocks over a three month period and use the resulting coefficients in the following three month period to forecast the stock price at option maturity. The objective is to test if investors can generate superior trading gains by selecting appropriate trading strategies to take advantage of open interest data in the options market.

We compare the returns of two types of investors: Informed investors who have access to the forecasts based on information from the options market, and uninformed investors who do not. In our first test, the uninformed investors always take long positions in the stock, while informed traders use the price forecast to decide between a long and a short position. Our second test allows for the use of options as well as the underlying stock in the investment portfolio. The uninformed investors use a covered call strategy using the nearest out-of-the-money strike price while informed investors use the price forecast to select the strike price for the covered call. In addition, if the forecast is lower than the contemporaneous stock price, informed investors also add a purchased put to the covered call.

All the strategies, irrespective of their reliance on open interest information, outperform the S&P 500 Index. The strategies used by the informed investors, based on options market activity, result in mean returns that are higher than the returns for the strategies used by the uninformed investors that ignore options market activity. The best performing strategies for the informed investors not only use the options market information but also use options as part of the strategy.

LITERATURE REVIEW

The information content of derivatives has been a subject of researchers since the onset of trading on the Chicago Board Options Exchange and the subsequent publication of first successful option pricing model by Black and Scholes [3]. Chiras and Manaster [5] find that different strike prices and maturities of options on the same stock result in different implied standard deviations for the stock. Manaster and Rendleman [7] use daily closing option prices as predictors of the equilibrium stock prices. The comparison reveals that the implied prices contain information regarding equilibrium stock prices that are not fully reflected in observed stock prices.

Anthony [1] investigates the relation between common stocks and call options trading volumes. Using daily closing data, he finds that option volume leads trading in common stock. Blume, Easley, and O'Hara [4] emphasize the vital role of transaction volume as a statistic for technical analysis. Easley, O'Hara, and Srinivas [6] find that some option volume has predictive power of the underlying stock return.

Volume and open interest are different measures of trading activity. For every purchase and accompanying sale of a single call or put contract, volume for the day increases. But whether there is an equivalent increase in open interest depends on the previous trading history of both seller and buyer. If both the buyer and seller are initiating new positions, open interest will increase. If both buyer and seller are closing out previous positions, open interest will decrease. It is also possible that open interest will remain unchanged if one side is opening a new position while the other side closes out a previously held position. In general, open interest builds up from the point that new option contracts become available and decreases as the option maturity draws near; it is cheaper to offset contracts with opposite positions rather than go through with an exercise at expiration.

Table 1: Sample Stocks

Firm Name	Ticker Symbol
Barrick Gold Corp.	ABX
Altera Corp.	ALTR
Applied Materials	AMAT
Amgen, Inc.	AMGN
American Airlines, Inc.	AMR
Ascend Communications	ASND
Citigroup Inc.	C
Chase Manhattan Corp.	CMB
3Com Corporation	COMS
Compaq Computer Corp.	CPQ
Cisco Systems, Inc.	CSCO
Century Telecommunications Inc	CTL
Delta Airlines, Inc.	DAL
E.I. DuPont De Nemours	DD
Dell Computer Corporation	DELL
Walt Disney Company	DIS
General Electric Company	GE
Coca-Cola Company	KO
McDonald's Corporation	MCD
Philip Morris Companies	MO
Motorola, Inc.	MOT
Micron Technology, Inc.	MU
Oracle Corporation	ORCL
Proctor and Gamble Co.	PG
Sears, Inc.	S
Schlumberger Limited	SLB
Sun Micro Systems Inc.	SUNW
United Technologies	UTX
MCI WorldCom, Inc.	WCOM
Wall-Mart Stores, Inc.	WMT

DATA AND FORECASTING MODEL

The data are obtained from the Dreyfus Brokerage Services’ Options Data Base which is derived from the Market Data Report of the Chicago Board of Options Exchange (CBOE). Table 1 shows the firm names and ticker symbols of our sample of thirty actively traded firms which trade options on the CBOE over six consecutive months from February through July of 1999. We use options data for the first three months to conduct regression analysis to verify if a price predictor based on open interest data can explain the movements of the underlying stock price in the presence of contemporaneous security prices. Options data for the next three months is then used to forecast the ex-ante stock price.

Suppose that on day t , for a given stock with price P_t , there is available for trading K possible strike prices for calls and L possible strike prices for puts, all with common expiration day T . For the calls, we denote O_{it}^C as the open interest for strike price X_i^C . For the puts, we denote O_{it}^P as the open interest for strike price X_i^P . We define our price predictor P_t^Z from the options market as:

$$P_t^Z = \frac{\sum_{i=1}^K O_{it}^C X_i^C + \sum_{i=1}^L O_{it}^P X_i^P}{\sum_{i=1}^K O_{it}^C + \sum_{i=1}^L O_{it}^P} \tag{1}$$

The price predictor is a weighted average of all available strike prices for both puts and calls, and the weights are the proportion of open interest associated with that particular strike price, relative to the total open interest for all options with common expiration day T . This price predictor is directly utilized for investment strategies in Bhuyan and Chaudhury [2], with favorable results.

Consider an investor having positive information regarding the stock price. He may be inclined to use the options market for reduced trading costs or increased leverage. If he is truly informed, he is likely to buy deep out-of-the-money options. The greater his optimism, the more willing he is to purchase a higher strike price call. Another strategy would be to sell in-the-money puts. Again, increased optimism or knowledge about high stock price at expiration should favor the use of a higher strike price for selling puts. This is the intuition behind using the weighted average of the strike prices with relative open interest being the weights.

We design a multiple regression model for forecasting the stock price at expiration, using both the predictor P_t^Z , and the contemporaneous stock price P_t :

$$P_{jTm} = a_{0m} + a_{1m}P_{jtm}^Z + a_{2m}P_{jtm} + \varepsilon_{jtm} \tag{2}$$

Subscript “ j ” denotes the cross section of firms, $j = 1, 2, 3, \dots, 30$; the subscript “ m ” denotes the time series dimension, “ m ” = February, March, or April. The disturbance term ε_{jtm} has the following error structure:

$$\varepsilon_{jtm} = \mu_{jt} + \eta_{jtm} \tag{3}$$

This formulation is the simplest way of capturing the notion that two observations from the same individual firm will have a firm specific effect as well as other stochastic effects that are not captured by the specification of the model. Both errors on the right hand side of have zero means. We estimate the regression equation using the General Method of Moments for day $T-21$ where T is the option maturity date. Table 2 shows the coefficients obtained for each month. The Newey-West [7] chi-square test does not reject the hypothesis that a_0 , a_1 and a_2 are the same for each month. Identical coefficients for all three months are shown in the last column.

Table 2: Coefficient Estimates For Forecasting The Stock Price

Explanatory Variables		Coefficients February	March	April	Identical Coefficients Each Month
Intercept:	Coefficient	-3.769	-0.684	-4.133	-3.672
	Std. Error	2.819	5.246	2.144	1.801
P_{im}^Z	Coefficient	0.230	-0.208	0.545	0.383*
	Std. Error	0.140	0.311	0.104	0.076
P_m	Coefficient	0.819	1.209	0.535	0.672*
	Std. Error	0.124	0.271	0.087	0.066

*Statistically significant at the 0.01 level.

TRADING STRATEGY

We consider two types of investors: Informed investors who generate the option-based price predictors and uninformed investors who do not. Our first strategy has informed investors going long or short based on the forecast, while uninformed investors only go long. A second strategy allows for the use of options by both investor types. Merton, Scholes, and Gladstein [5] show that investors can improve a stock only strategy through the use of covered call writing. The use of covered calls will reduce risk exposure. Another advantage for using options is the possibility of a restriction on short sales due to limited availability of shares.

For our second strategy, uninformed investors write covered calls, using the closest out-of-the-money strike price to the contemporaneous stock price. Informed investors consider the forecast price based on open interest. When the forecast is above the contemporaneous price, they also write covered calls, but pick the out-of-the-money strike price closest to the forecast price. When the forecast price is below the contemporaneous price, they again write a covered call with a strike price closest to the forecast price and also add a purchased put with a strike price closest to the contemporaneous price. For this last case, no consideration is made to the moneyness of either options.

For the informed investor, the use of the forecast price to select the strike price for the covered call will increase the return if the forecast turns out to be accurate. The addition of a purchased put for a forecasted market downturn turns the covered call into a bear spread, which has a higher payoff should the forecast turn out to be accurate. Informed traders use the forecasted price P_{ii}^f from equation 2, using the estimated coefficients given by Table 2, when the coefficients are restricted to be identical across months. The strategies for both informed and uninformed traders are:

- Stock Only Strategy:
 - Uninformed: Purchase the security i at price P_{ii} .
 - Informed:
 - If $P_{ii}^f > P_{ii}$, purchase security i at price P_{ii} .
 - If $P_{ii}^f < P_{ii}$, sell security i short at price P_{ii} .

- Stock with Options Strategy:
 - Uninformed: Purchase the security i at price P_{ii} and sell an out-of-the-money call option with strike price nearest to price P_{ii} .
 - Informed:
 - If $P_{ii}^f > P_{ii}$, purchase security i at price P_{ii} and sell an out-of-the-money option with strike price nearest to P_{ii}^f .
 - If $P_{ii}^f < P_{ii}$, purchase security i at price P_{ii} , sell a call option with strike price nearest to P_{ii}^f , and purchase a put option with strike price nearest to price P_{ii} .

We allow the open interest to accumulate during the option month. Since open interest is a cumulative measure, it will reflect investors' revised expectations, which will make the inference of future stock price more

informative. Investors are assumed to make their portfolio decisions three weeks prior to the expiration day of each month (day T – 21) with the intention to close out their positions on the expiration day of the option.

We do not consider the transaction costs on stocks, because the transaction fees on trading stocks is very low. Also, since we compare the performance of our trading strategy using the same stock for both investor types, transaction costs would be similar. Informed investors may trade greater amount of options, therefore we do consider the transaction cost of options. We allocate roughly \$10,000.00 to trade on each of the 30 securities to each type of investor. The number of shares of each stock would be determined by dividing the total dollar amount to be invested by the closing stock price on the day a position would be taken on that stock. If the number comes out as a fraction, we round it to the nearest whole number. In the case of a short sale, the dollar amount allocated is used as collateral for the short sale. Since the time period is only three weeks, no interest income is allowed to be earned on the collateral amount. In the case of portfolios with derivatives, since options cannot be written on fraction of shares, we round total number of shares to the nearest hundred so that a full option contract can be written on the stock holdings.

Table 3: Percent Rates Of Return For Informed And Uninformed Investors For The Stock Only Strategy For May 1999

Stock Symbol	P_{Ti}	P_{ii}^Z	P_{ii}	P_{ii}^f	Strategy for Informed Investors	Return to Informed Investors	Return to Uninformed Investor
ABX	17.88	18.90	20.25	17.17	Short	11.70	-11.70
ALTR	72.00	70.05	72.75	72.05	Short	1.03	-1.03
AMAT	59.56	61.78	53.63	56.03	Long	11.06	11.06
AMGN	61.25	67.97	61.44	63.65	Long	-0.31	-0.31
AMR	66.38	61.69	69.81	66.87	Short	4.91	-4.91
ASND	93.75	85.65	96.25	93.81	Short	2.60	-2.60
C	67.82	68.60	72.50	71.32	Short	6.46	-6.46
CMB	78.94	76.78	82.50	81.17	Short	4.32	-4.32
COMS	29.44	25.07	26.12	23.48	Short	-12.71	12.71
CPQ	25.06	25.56	22.31	21.11	Short	-12.33	12.33
CSCO	113.25	109.10	114.00	114.72	Long	-0.66	-0.66
CTL	41.69	44.20	40.25	40.30	Long	3.58	3.58
DAL	60.50	60.25	63.44	62.04	Short	4.63	-4.63
DD	68.25	62.35	70.69	67.71	Short	3.45	-3.45
DELL	37.31	37.25	41.19	38.27	Short	9.42	-9.42
DIS	29.50	30.15	31.75	29.21	Short	7.09	-7.09
GE	104.13	97.25	105.38	104.39	Short	1.19	-1.19
KO	68.00	64.50	68.06	66.77	Short	0.09	-0.09
MCD	39.88	44.10	42.38	41.70	Short	5.90	-5.90
MO	39.88	41.35	35.06	35.73	Long	13.75	13.75
MOT	86.06	79.94	80.00	80.71	Long	7.58	7.58
MU	37.31	43.15	37.25	37.89	Long	0.16	0.16
ORCL	25.75	26.78	27.06	24.77	Short	4.84	-4.84
PG	97.25	96.30	93.81	96.25	Long	3.67	3.67
S	48.25	49.26	46.00	46.11	Long	4.89	4.89
SLB	61.06	54.90	63.89	60.29	Short	4.43	-4.43
SUNW	60.19	60.99	59.82	59.89	Long	0.62	0.62
UTX	128.25	130.51	144.88	143.67	Short	11.48	-11.48
WCOM	84.88	87.34	82.19	85.01	Long	3.27	3.27
WMT	43.25	47.65	46.00	45.49	Short	5.98	-5.98
Mean Return						3.74	-0.56
Standard Deviation						5.70	6.79

RESULTS AND ANALYSIS

The comparative performance analysis is conducted for these portfolios for three consecutive option months, May through July 1999. Results for the April 30th trading day are shown in Table 3 for both types of investor using the stocks only strategy. The first column indicates the stock ticker in the sample, while the second column displays the stock closing price on the option maturity date, which is May 21, 1999. The third column shows the option-based price predictor for April 30th. The fourth column indicates the stock price on April 30th. The fifth column indicates the stock price forecast for the expiration day as given by equation 2, when coefficients are restricted to be identical across months. The sixth column shows the informed investor's strategy. His choice is to go long or short depending on the forecast price in column 5 and its relation to the contemporaneous stock price in column 4. The last two columns display the percentage rates of return over the 21 day period for the two types of traders, where the percentage rates of return are simply the net profit on each transaction divided by the purchase price of the stock.

The results from Table 3 indicate that the mean percentage return to informed investors is 3.74%, while the mean percentage return to uninformed investors is -0.56%. For informed investors, the standard deviation of the cross-sectional returns of the stock positions for the month is 5.70%. For uninformed investors it is 6.79%.

Table 4 provides the mean percentage return for all three months. The first column shows the option expiration month. Open interest is observed 21 days prior to option expiration. The monthly average percentage returns and standard deviations (in parenthesis) for the informed and uninformed investors are shown in columns two and three for the informed investor and columns four and five for the uninformed. Finally, the last column shows the performance of the S&P 500 index during the same period. Informed investors' overall mean percentage return is 6.88%. Uninformed investors' overall mean percentage return is 6.07%. Both informed and uninformed investors outperform the return on the S&P 500 market index, which is 1.39% for the same period.

Table 4: Mean Percent Rates Of Return For Informed And Uninformed Investors For Stock Only Strategy

Option Expiration Month	Informed Investor		Uninformed Investor		S&P 500 Index
May	3.74	(5.70)	-0.56	(6.79)	-2.25
June	5.55	(22.95)	10.70	(19.95)	2.34
July	11.36	(17.78)	8.08	(19.09)	4.09
Mean For All Three Expiration Months	6.88		6.07		1.39

(Values in parenthesis are standard deviation)

The comparative performance analyses for the strategies which use options are shown for the April 30th trading day in Table 5. For each stock, column 6 indicates the strategy for the informed investor. Both informed and uninformed investors invest in a covered call, but the uninformed investor always uses the out-of-the-money strike price nearest to the contemporaneous stock price. If the expiration day stock price forecast is above the stock price, the informed investors use the out-of-the-money strike price nearest to the forecast price in the covered call strategy. If the forecast is below the stock price, the informed investor will select the strike price nearest to the forecast price and further, add a purchased put with a strike price nearest to the contemporaneous stock price. In this last case, the moneyness of both the call and the put does not come into consideration.

Consider the first stock in Table 5: Barrick Gold (ABX). The forecast price of \$17.17 is less than the contemporaneous stock price of \$20.25. The informed investor will write a covered call, using the \$17.50 strike price and also buy a put with strike price \$20. The uninformed investor will write a covered call with strike price \$22.50, although this is not shown in the table. Because the stock price at expiration is \$17.88, the informed investor's portfolio outperforms the uninformed in this particular instance.

The last two columns in Table 5 display the percentage rates of return over the 21 day period for the two types of investor. The results from Table 5 indicate that the mean percentage return to informed investors is 4.52%,

while the mean percentage return to uninformed investors is 0.81%. For informed investors, the standard deviation of the cross-sectional returns of the stock positions for the month is 4.37%. For uninformed investors it is 7.32%.

Table 6 provides the summary results for all three months. Informed investors' mean overall percentage return is 8.38%, which outperforms uninformed investors' mean percentage return of 5.88%. For every month, the mean return for informed investors is greater and the standard deviation is less than the same measures for uninformed investors.

In the Table 7, we present the summary statistics of all signals generated from our option-based forecasted stock prices for three consecutive months and their level of accuracy. In the month of May 1999, out of 12 up signals, 10 are accurate, and out of 18 down signals, 16 are accurate. In total, 26 out of 30 signals are accurate. In the month of June, out of 20 up signals, 16 are accurate and out of 10 down signals, 3 of them are accurate. In total, there are 19 signals out of 30 that are accurate in this month. The down signals are mostly inaccurate in this month. Finally, in the month of July 1999, out of 15 up signals 12 of them are accurate and 8 of the down signals are accurate. In this month, in total, 20 out of 30 signals are accurate. Overall, 65 out of 90 signals turn out to be accurate in all three months.

Table 5: Percent Rates Of Return For Informed And Uninformed Investors For The Stock With Options Strategy For May 1999

Stock Symbol	P_{Ti}	P_{ii}^Z	P_{ii}	P_{ii}^f	Strategy for Informed Investors	Return to Informed Investors	Return to Uninformed Investors
ABX	17.88	18.90	20.25	17.17	$X^C = 17.5 X^P = 20$	6.16	-12.53
ALTR	72.00	70.05	72.25	72.05	$X^C = 72.5 X^P = 72.5$	0.46	1.46
AMAT	59.56	58.24	53.63	56.03	$X^C = 60$	7.66	10.28
AMGN	61.25	67.97	61.44	63.65	$X^C = 65$	0.49	2.42
AMR	66.38	61.69	69.81	66.87	$X^C = 70 X^P = 70$	4.35	-4.01
ASND	93.75	85.65	96.25	93.81	$X^C = 95 X^P = 95$	5.25	-1.45
C	67.82	68.60	72.50	71.32	$X^C = 70 X^P = 75$	4.00	-5.97
CMB	78.94	76.78	82.50	81.17	$X^C = 85 X^P = 85$	2.98	-2.01
COMS	29.44	25.07	26.12	23.48	$X^C = 25 X^P = 27.5$	-4.30	16.01
CPQ	25.06	25.56	22.31	21.11	$X^C = 25 X^P = 25$	-4.78	17.04
CSCO	113.25	109.10	114.06	114.73	$X^C = 115$	-0.35	-0.35
CTL	41.69	44.20	40.25	40.30	$X^C = 42.5$	3.52	3.52
DAL	60.50	60.25	63.44	62.04	$X^C = 65 X^P = 65$	5.87	-3.57
DD	68.25	62.35	70.69	67.71	$X^C = 65 X^P = 70$	3.28	-1.98
DELL	37.31	41.56	41.19	38.27	$X^C = 35 X^P = 45$	10.94	-6.79
DIS	29.50	32.86	31.75	29.21	$X^C = 27.5 X^P = 30$	1.67	-7.47
GE	104.13	97.25	105.38	104.39	$X^C = 105 X^P = 105$	3.27	1.27
KO	68.00	64.50	68.06	66.77	$X^C = 65 X^P = 65$	1.78	0.07
MCD	39.88	44.10	42.38	41.70	$X^C = 42.5 X^P = 42.5$	5.67	-5.96
MO	39.88	41.35	35.06	35.76	$X^C = 37.5$	10.39	10.39
MOT	86.06	79.94	80.00	80.71	$X^C = 85$	12.73	12.73
MU	37.31	43.15	37.25	37.89	$X^C = 40$	0.83	0.83
ORCL	25.75	26.78	27.06	24.77	$X^C = 25 X^P = 27.5$	4.03	-5.33
PG	97.25	96.30	93.81	96.71	$X^C = 100$	8.57	3.65
S	48.25	49.26	46.00	46.11	$X^C = 50$	13.23	13.23
SLB	61.06	54.90	63.89	58.89	$X^C = 60 X^P = 65$	3.46	-4.12
SUNW	60.19	60.99	59.82	59.89	$X^C = 60$	2.30	0.59
UTX	128.25	130.51	144.88	143.67	$X^C = 145 X^P = 145$	11.27	-5.35
WCOM	84.88	87.34	82.19	85.01	$X^C = 85$	3.02	3.60
WMT	43.25	47.65	46.00	45.49	$X^C = 45 X^P = 45$	7.84	-6.01
Mean Return						4.52	0.81
Standard Deviation						4.37	7.32

Table 6: Mean Percent Rates Of Return For Informed And Uninformed Investors For The Stock With Options Strategy

Option Expiration Month	Informed Investor	Uninformed Investor	S&P 500 Index
May	4.52 (4.37)	0.81 (7.32)	-2.25
June	9.04 (9.81)	8.97 (14.79)	2.34
July	11.58 (11.82)	7.85 (13.63)	4.09
Mean For All Three Expiration Months	8.38	5.88	1.39

(Values in parenthesis are standard deviation.)

Table 7: Summary Statistics Of All Signals

	May	June	July
Number of Up Signals per Month	12 (40%)	20 (67%)	15 (50%)
Number of Accurate Up Signals per Month	10 (83%)	16 (80%)	12 (80%)
Number of Down Signals per Month	18 (60%)	10 (33%)	15 (50%)
Number of Accurate Down Signals per Month	16 (89%)	3 (30%)	8 (53%)
Total Signals per Month	30	30	30
Number of Accurate Signals (Up or Down) per Month	26 (87%)	19 (63%)	20 (67%)
Number of Accurate Signals for All Three Months:	65 (72%)		

(Values in parentheses represent percentages)

CONCLUDING REMARKS

In this paper we test the performance of strategies using stock price forecasts based on option open interest data. We propose a measure, which we call the predictor, which preserves the information captured by the distribution of open interest across available strike prices. The predictor is a significant variable in the forecast model. We use a three month sample to estimate coefficients for the model, and a subsequent three month sample to test the benefit of using the forecasts to design investment strategies. A stock only strategy and a stock with options strategy are used by both informed and uninformed investors.

For the stock only strategy, the informed investors outperformed the uninformed overall, but not for one of the option expiration months. For the stock with options strategy, the informed investors outperformed both overall and in every individual option expiration month. The cross-sectional standard deviation for stock positions was less in every month for the informed investors compared to the uninformed. The informed investors using an option-based strategy also outperform the informed investors' stock only strategy, both overall and month by month. The standard deviation of the cross-sectional returns for the option-based strategy was also smaller than the stock only strategy for every month. This was clearly the best strategy.

It seems that not all publicly available information is fully reflected in the security price. Our findings also suggest that covered call writers can benefit when they can select appropriate strikes prices of the derivative securities based on open interest information.

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