

A MODEL OF THE PUT AND CALL OPTION MARKET

by

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## ABSTRACT

Interest in put and call option transactions has increased markedly in recent years. However, serious study of the option market has been hampered by a lack of reliable data. The author has been an active option writer for over five years, and through his broker has obtained records of over 10,000 actual transactions. These records have been systematically transcribed and verified into what is thought to be a highly reliable data base.

Call options of six months plus ten days' duration, numbering 1665, were selected for study. The Sharpe capital asset pricing model was a good framework for evaluating the way in which risks and expected returns can be exchanged between option traders. Three portfolio strategies were compared, both excluding and including transaction costs (brokerage commissions, estimated markup of put and call dealers, and transfer taxes). These were: (1) hold the underlying stock, (2) hold the stock and sell a call, (3) buy a call.

Linear regression analysis was used to investigate the relationship of the returns from each strategy to the returns from the Standard and Poor index. Strategy (2) was markedly less sensitive than (1) to changes in the Standard and Poor index, while strategy (3) was markedly more sensitive than (1). Transaction costs for option traders were found to be very high relative to strategy (1), with the impact falling most heavily on option buyers. It appears that an otherwise fair game has been converted into a substantial gamble for the option buyer. The conclusion is that option trading is a highly effective but quite inefficient means of transferring leverage on the market return.

Other conclusions reached were that the variance of past price changes was the most important factor in option pricing (duplicating the findings of St. Peter), and that inside information appeared not to be a significant factor.

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## CHAPTER I

### INTRODUCTION

It is estimated that no more than one percent of investors purchase puts and calls, and that an even smaller number sell them. Certainly less than two percent of exchange transactions are the result of the exercise of these options. However, it has been reported that option trading has increased as a percentage of total transactions in recent years, which means that in absolute numbers, options have increased enormously. Evidence of this interest is the opening of option departments in certain large brokerage firms, and, most recently, the announcement of the Chicago Board of Trade that it intends to establish an option trading market.<sup>1</sup>

This writer has been an active option seller for the past five years, having sold about 400 options during

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<sup>1</sup>Public Policy Aspects of a Futures-Type Market in Options on Securities, A report prepared for the Chicago Board of Trade by Robert R. Nathan Associates, Inc., November, 1969.

that time. I agree with the various writers who report the option market to be very interesting, but little understood. It is also true that a major problem for serious students has been a lack of reliable data about actual transactions. The data developed for this study will substantially fill that void, and I hope will add to an understanding of the objectives and behavior of the participants in this market.

Option trading is currently done by means of imperfect negotiation between option buyers and option sellers, working through brokers and put and call dealers. It is a competitive market, responsive to supply and demand, but characterized by imperfect communications. The option seller undertakes an obligation at the time he writes a contract. Therefore, in order to protect the option buyer, each contract must be endorsed by a Stock Exchange member firm which guarantees performance. A number of brokerage houses willing to do such endorsing have established departments to service their option writing clients. The option writer maintains a margin account there, in which he usually conducts other business as well.

The put and call dealers are not members of the Exchange. They either maintain an inventory of options available for sale, or they seek writers for options that are currently in demand. The option is delivered through any broker representing the buyer. A contract is usually agreed to in telephone negotiations between a broker representing one or the other principal and the dealer acting as a middleman. The dealer makes a markup between the price he pays and the price he gets. The brokers generate income through the commissions that result if the options are ever exercised.

The data for this thesis came from the daily diaries of my broker covering the period from mid 1966 through 1969. During this period the details are listed for over 10,000 transactions representing the option seller, and over 1,000 representing the option buyer. A major part of the work of the thesis has been the transcribing, correcting and verifying of this data base. (See Chapter III on data preparation.)

Rather than describe the terminology, and all the complex details of option trading, I refer the reader who is unfamiliar to a basic work, such as R. J. Kruiuzenga,



"Introduction to the Option Contract."<sup>2</sup> The option field is not without authors--in fact they cover a rather wide variety of approaches. I will describe the ones I have read that were useful in developing my thinking.

Kruizenga continues with "Profit Returns From Purchasing Puts and Calls,"<sup>3</sup> in which he analyzed the profits possible to buyers of calls from 1946 to 1956. The study suffers, typically, from a data reliability point of view, as it is based on nominal prices (not actual transactions), reported to the Securities and Exchange Commission by put and call dealers. Further, it leaves unanswered the rationality of the option seller. He asks, essentially, if this was profitable for call buyers over a ten year period, why did sellers continue to provide options?

In "Some Evidence of the Profitability of Trading in Put and Call Options," A. James Boness<sup>4</sup> analyzes some actual transactions. However, the sample is so small, that it is questionable what the significance of the results

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<sup>2</sup>In The Random Character of Stock Market Prices, ed. by P. H. Cootner, pp. 377-391.

<sup>3</sup>Ibid., pp. 392-411.

<sup>4</sup>Ibid., pp. 475-496.

might be. He found large losses for option buyers, and significant profits for sellers--if they employed a complex strategy. As he says:

. . . very large numbers of options of all types must be collected over each of many years before one is free to generalize with much confidence on the profitability of option trading.

There are several authors dealing with strategies. These range from a thoughtful pragmatic approach, primarily for option sellers,<sup>5</sup> to the complex simulations and sixteen strategies of Malkiel and Quandt.<sup>6</sup> And finally, there are works that deal with pricing models based on probability distributions, which try to compute the "fair" premium for an option. Among the best of these is C. M. Sprenkle, "Warrant Prices as Indicators of Expectations and Preferences."<sup>7</sup> His mathematical derivations and conclusions are equally applicable to options, because a warrant is nothing but an option of longer duration. Furthermore, warrants are actively

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<sup>5</sup>Z. A. Dadekian, The Strategy of Puts and Calls.

<sup>6</sup>B. G. Malkiel and R. E. Quandt, Strategies and Rational Decisions in the Securities Options Market.

<sup>7</sup>N. 2, pp. 412-474.

traded on the American Stock Exchange, where their price behavior, relative to the underlying stock, can easily be studied. (But, be forewarned that Sprenkle is not light reading, as the mathematics becomes quite difficult.)

Using the Sprenkle formulas, St. Peter<sup>8</sup> compared actual premiums paid for some 1,200 options with their calculated theoretical values. He found that in the aggregate the actual premiums were about the same as those calculated by the model. However, there was a systematic discrepancy regarding the weight to be given to the risk of the underlying stock. (In this sense, risk is synonymous with volatility, and is measured by the statistical variance of stock price percentage changes.) Apparently to option traders, this "risk" was the principal determinant of the observed difference between otherwise identical options. However, St. Peter's calculation indicated that the weight given to variance was less than half of what it should have been. This led to the conclusion that options on high volatility stocks are underpriced, and options on

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<sup>8</sup>J. T. St. Peter, "An Estimation Procedure for the Pricing of Put and Call Stock Options" (unpublished Master's thesis, Massachusetts Institute of Technology, 1969).

low volatility stocks are overpriced. He then showed that selectively purchasing "underpriced" options and selling "overpriced" options would have resulted in greater profits than a random selection.

Such a finding would have very significant implications, if confirmed. Therefore, the original intent of my study was to investigate this question with the new data base, which is ten times St. Peter's sample. Furthermore, Prof. Myron Scholes, who was an advisor to St. Peter, and is now my advisor, had developed another variation of the Sprenkle formula which has somewhat greater intellectual appeal. However, reporting on such an investigation (which is currently under way) must wait for publication in the future, because of a rather mundane discovery.

It became apparent that the transaction costs (dealer markup, brokerage commissions, and taxes) are very significant, and can not be tacked on to the option model as an afterthought. Their impact is not linear, is not evenly distributed between buyer and seller, and is affected by the proportion of options that are actually exercised. Consequently, transaction costs must be made internal to the model before it can be of much practical

significance. Therefore, the direction of this study has been turned to an analysis of results in a frictionless market compared to a market with transaction costs.

The next chapter describes the scope of the study as it was actually conducted.

## CHAPTER II

### SCOPE OF THE STUDY

#### Data Base and Subset Selection

Reference was made in Chapter I to the new, large set of data on actual option transactions which became available to me. Further description of the data base, its preparation for use, and an indication of its accuracy can be found in Chapter III.

Because of the size of the total data base, it was possible to select a narrow subset that was large enough to provide statistically significant results. Six month plus ten day call options were chosen because they constitute one of the largest categories, and because they are the simplest to handle conceptually and analytically. They have become the most popular option because of tax considerations, the duration being specifically set to facilitate achievement of long term capital gains, but

short term capital losses.<sup>9</sup> To further simplify the analysis, only options written at the existing market price were used. All transactions represented actual premiums received by the option seller, transactions at the option buyer's purchase price being eliminated. This was done because the broker who supplied the data primarily represented option sellers. Consequently, there were much fewer data on purchase prices, and it was more difficult to check their consistency and accuracy.

#### The Sharpe Capital Asset Pricing Model

The reference frame for study of the option contracts was the Sharpe<sup>10</sup> capital asset pricing model. I will restate the equation used, but not go into the details of its derivation. The equation will be useful in

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<sup>9</sup>An option is a capital asset which can be bought or sold, as well as exercised. If the holder has a loss, he can sell it, just short of six months, to his broker for a nominal sum. If he has a profit, he can sell it just after six months for its value less transaction costs.

<sup>10</sup>W. F. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," Journal of Finance, XIX (September, 1964), 425-42.

evaluating the relationship between risk and expected return for various option trading strategies.

$$RET = RF + BETA (RMK - RF) + ERR$$

Where:

RET is the return to be expected from any security during a given time period.

RF is the risk free interest rate during the same period. I used a six month borrowing rate of 0.035 and lend-rate of 0.030. These compare to commercial paper rates which varied from 0.0275 to 0.0325 during the years in question.

RMK is the return on the market, which was taken to be the change in the Standard and Poor 500 stock index, plus dividends of 0.015 per six months.

BETA is a measure of the covariance of the price of any security with the market average. From the equation, it implies proportionality to the amount by which the expected market return exceeds the risk free rate. However, for BETA close to 1.0, RF drops out. Therefore, with some loss of accuracy, BETA can be thought of as a proportional index of a stock's expected return relative to the market return. That is, for a given percentage market return, a stock with BETA = 1.0 would be expected to return the same percentage. A stock with BETA = 1.5 would be expected to yield approximately  $1\frac{1}{2}$  times the market percentage return. A negative BETA implies percentage changes in the opposite direction from the market. BETA = 0 implies no correlation between the stock price change and the market price change.

ERR is an error term, recognizing that stock prices do not change exactly as predicted by BETA. ERR is a random variable with a mean of zero, and a variance which is different from stock to stock.



The Sharpe model is predicated on investors being risk averse, and hence requiring a proportionally higher expected return from increasingly risky assets. The investor need not be exposed to the entire risk of a security. Since the error term in the equation has a mean of zero, it is possible by appropriate portfolio diversification to eliminate this risk. Historical analysis shows that, on the average, the error term explains about two-thirds of the variance of stock prices. However, the risk represented by BETA, often called systematic risk, is much more of a problem. There are a few stocks with negative BETA (such as gold mining stocks), but for practical purposes it is impossible to reduce the BETA of a portfolio to zero. What Sharpe is really saying, then, is that investors demand a proportionately higher return for taking on non-diversifiable risk.

#### Probability Distribution and Expected Value of Options

The essence of option trading is the redistribution of risk and expected return between the option buyer and option seller. Obviously, they can re-apportion the risk

and return of the underlying stock, but they also have a portfolio opportunity, which I will take up shortly.

Every individual stock has a probability distribution of future prices. (Strictly speaking, "returns" includes both dividends and price changes, and the profitability calculations of this study include both.) Option pricing models, such as the St. Peter model, have assumed a distribution that is mathematically workable. That is, they assume a random walk, with sequential price changes uncorrelated to each other and fitting (usually) a log-normal distribution. Further, they assume a stationary underlying process, whereby estimates of the parameters (especially the variance of price changes) can be made from historical data. (Not to be confused with market "chartists" and technicians, this historical approach gives a prediction of the magnitude of price changes, but not their direction.)

The average investor need not be overly concerned with the exact probability distribution of each stock. Under market equilibrium conditions, the present price is close to the mean of all future price expectations, discounted to present value. The option traders, however, are splitting the distribution and selling half of it.

For the stock holder, who owns both halves of the distribution, the exact value of each half is not too important. For the option trader, the exact value of each half is of vital concern. The option buyer and seller are playing a "zero sum game" relative to the price changes of the underlying stock. For example, in the call contract, the buyer has purchased all rights to positive returns, for a sum known as the premium. In exchange for this premium, the seller (assuming that he owns the stock) agrees to accept all negative returns.<sup>11</sup> When the time for settlement comes, whether it be at expiration date or sooner, the dollar returns of buyer and seller must add up exactly to the dollar return on the underlying stock. If the premium is not equal to the expected value of the upper half of the probability distribution, the game will obviously be biased against one or the other trader, in terms of dollar returns.

However, such a bias may in fact be fair, considering the traders' individual attitudes toward risk. It is

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<sup>11</sup>In case the option writer does not own the stock, it is even more clearly a zero sum game, for the buyer's gain is directly the seller's loss.

obvious that net risk has been transferred from the option seller to the option buyer, relative to holding the underlying stock itself. For the option seller, any negative returns accruing to the stock will be reduced by the amount of the premium received. For the option buyer, if any negative return accrues to the stock, his total investment (the premium) is lost. Under Sharpe's assumption of the risk averse investor, this implies that the option seller has an expectation of lower returns than from holding the stock. If the option buyer is also risk averse, he must expect higher returns. However, it is quite possible that the option buyer is not risk averse. He may be willing to take a lower expected return, because the option gives him a very skewed distribution, with the probability of a few huge returns. (Analogous to the gambler who is quite willing to bet repeatedly against the house odds.)

Finally, compensation for higher risk must be viewed from portfolio consideration. As Sharpe discussed,<sup>12</sup> the total risk of an asset is not to be reflected in expected return, but only that part of the risk

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<sup>12</sup>Op. cit., p. 440.

which can not be diversified away. The option buyer, unless he is a one shot gambler, must be concerned about the correlation of returns from a portfolio of options with the market return.

For these reasons, it is not clear, a priori, exactly where equilibrium will be reached, but it will surely have some close relationship to the "expected value" of the option. The expected value is the summation of the dollar values of all stock prices above the striking price, weighted by the probability of their occurrence. The most important determinant of the weighting is the anticipated magnitude of price changes. This anticipation may be measured precisely by the statistician as variance, or subjectively by the trader as volatility. One more criterion for the trader, of course, may be the possession of real or imagined "special information." One analysis will be run to examine this latter question.

### Pricing of Options

The premium actually paid is what traders saw to reflect the fair relationship to expected value of the

option. It will be informative to investigate what factors most influence option traders in determining the premium. In order to do so, I used an historical data base assembled by Professor Myron Scholes, which was stored on a computer disk. It contained the daily returns of the Standard and Poor Index and of some 3,000 stocks, for the period July 1, 1962 to July 1, 1969 (daily returns being defined as today's closing price divided by yesterday's closing price, minus 1.000000). Assuming these data to be available to the option trader up to the date the option was written, two statistics were calculated for every option contract.

These were the beta, as in the Sharpe model, and the standard deviation of returns. The standard deviation is a six month prediction, calculated as follows: calculate the variance of daily returns, multiply by the number of market days in the ensuing option duration, take the square root. For most of the options in the sample, the historical data were available from July 1, 1962, and no options were included if there were less than one year's data.

It should be mentioned that the statistics were calculated using all available data, and there is no representation that this gave the optimum time period. No way was known to pick a more relevant span, because of two conflicting circumstances. Choosing a shorter period increases the sampling error, assuming a stationary underlying statistical process. But, choosing a longer period raises increasing doubts about the stationarity of the process itself, due to mergers, rapid growth, and other major changes in the nature of a corporation.

For every option contract, the relationships were calculated between the actual premiums and these statistics. As in most other option studies, dollar premiums were converted to percentage of striking price, for meaningful comparison. Linear, least-squares regressions were run to determine the relationships between percentage premium and subsequent six month returns on the stock. The hypothesis here was that if people had worthwhile special information, they would bid up the price of call options in order to take advantage. The results of these analyses are discussed in Chapter V.

Profitability: Three Strategies  
for Comparison

We turn now to the profitability of option trading, given that the traders did in some manner agree to the premium. I will compare the results of three possible strategies for investors who expect positive stock returns:

1. Buy the stock and hold it six months plus ten days. (Purchase on margin, with 80% investment, borrow the balance at the risk-free borrowing rate.)
2. Buy the stock and sell a call on it. (Purchase on margin, the investment being equal to 80% minus the premium received, and borrow the remaining 20% at the risk-free rate.)
3. Buy a call on the stock (Investment is the premium paid.)

Assume that the investors dealt in a single round lot of each of the 1,665 transactions offered. Investment for each strategy was calculated as described above. Returns were obtained from the Scholes Returns disk, previously described, deducting only the margin interest costs. Histograms were plotted showing the distribution of



returns on investments for the three strategies. From them, it is quite apparent how the total risk was apportioned between option buyer and option seller. From the sums of the three strategies, the overall returns on investment were calculated. Finally, scatter plots were made relating the returns on investments for each transaction to the return of the market average for the same period. Linear, least-squares regressions were run in order to determine the sensitivity of each strategy to the market risk. These three regression lines, plotted on the same chart, allow some interesting conclusions to be reached concerning the way in which option traders apportion the systematic portfolio risk between themselves.

However, the conclusions are more interesting for what might have been, rather than valuable for what really happened. They present a view of the frictionless world, and we must be very cautious before making any judgments about rationality of behavior. Therefore, the regressions were run again, this time taking account of all transaction costs (described in some detail in Chapter IV). These comparisons, as well as the sums of returns on investments, lead to some rather different conclusions than in the

frictionless case.

Subsequent chapters now describe in more detail the preparation of the option transaction data base, the estimation of transaction costs, and the results of the analyses which have just been described.

## CHAPTER III

### PREPARATION OF THE DATA BASE

The universal complaint of students of the option market has been the shortage of data about actual transactions. Analyses of the costs and profitability of various strategies have of necessity suffered because of small sample size, data of unknown reliability, or the use of nominal prices (put and call dealers' quotations, which may or may not reflect actual transactions). For example, in the Nathan Associates report to the Chicago Board of Trade,<sup>13</sup> a contemplated mathematical model was abandoned "due to the dearth of data on the existing option market . . ." Recognizing, then, the unique opportunity presented by the data available for this study, and recognizing my own unique position for determining its accuracy, a great deal of effort went into data preparation. In fact, much more time went into data preparation than into

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<sup>13</sup>Op. cit., p. x.

subsequent analysis. Consequently, the data base is available for future analytical work that is beyond the scope of the present simple study. Therefore, I will describe in more than usual detail what was done to prepare it.

The raw data is by no means perfect, as will be seen from the ensuing discussion, but I believe that in its final form, it will prove to be highly reliable and useful. The basic data obtained were the diaries of a major New York option broker (who chooses at this time not to be identified) for the years 1966 through 1969. They contain the details of every option contract handled by the firm, arranged in chronological order by expiration date. The entries are in long hand, sometimes hastily written, apparently copied at the end of each working day from the original transaction slips prepared as the contracts were made. The record includes:

expiration date

contract writing date

number of round lots of stock involved

type of option (put, call, straddle, strip, or strap)

representing (whether the option buyer, or

option seller)

ticker symbol

striking price

premium paid or received

name of put and call dealer representing the  
opposite side

name of the trader making the contract

date of option exercise (if at all)

One key piece of information not recorded was the market price at the time the contract was written. This omission necessitated extensive stock price look-up later, as will be discussed. All data (except the trader's name) were key punched onto 80 column cards, either directly from the diary, or from intermediate tabulating sheets. This produced 11,800 cards, broken down by expiration date:

1966 . . . .	480	(all complete entries. Most entries prior to August did not contain the premium paid)
1967 . . . .	4,000	(approx.) (all entries in the diary)
1968 . . . .	6,000	(approx.) (all entries in the diary)
1969 . . . .	1,435	(50% sample of options expired prior to July 1)

Five separate systematic runs will be described by which it is thought that most erroneous entries have been removed. (From a glance at the diaries, it is obvious that transcription errors were inevitable.)

The first screening was a computer run to check completeness and validity of the characters punched in each column of the card. Approximately 50 incomplete cards were discarded, and 100 key punching errors were corrected.

On the next run, the ticker symbols were searched against the list of 3,044 stocks contained in the Scholes daily "Returns" disk. This removed 807 entries with symbols that could not be found. About two-thirds of the rejects have enough entries to conclude that they are valid, but for some reason are not on the Returns disk (over the counter stocks, newly listed, changed ticker symbol, etc.). Since the balance of rejects may be transcribing errors, it is informative to estimate the proportion of errors that would be caught by this test. There are 3,000 symbols on file, out of over 18,000 possible three letter combinations. Therefore, five-sixths of randomly generated errors should be caught.

The remaining entries (10,900) were sorted by ticker symbol and put into chronological order by the writing date of the contracts. All suspicious looking sequences of striking prices were then compared to monthly-basis stock price charts (and some daily basis charts that were available). At this step, 225 entries for warrants were removed, since no warrant data is available on the Returns disk. An additional 220 entries were deleted because an error obviously existed. The nature of the errors could have been ticker symbol, date, or price entry gross enough to show up against monthly charts.

The next step was to calculate an approximate expected premium for each option. This was done using charts of historical average premiums for three month and six month calls, puts, and straddles.<sup>14</sup> Adjustments for other durations were made using a factor equal to the square root of the relative durations. At the same time, the writing and expiration dates were searched against the calendar of the Returns disk. Options are always written and always expire on a day when the stock market is open.

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<sup>14</sup>Z. A. Dadekian, The Strategy of Puts and Calls, pp. 98-103.

Consequently, failure to match the Return's calendar identifies a date error. There were 724 market days out of 1,096 total days in the study period, or 66%. Thus, one-third of all random date errors should be caught by this simple test. A total of 128 date errors were found and corrected out of 10,460 entries.

The ratio of actual premium to calculated premium was printed out for every entry. This proved to be a remarkably useful index for locating suspicious entries. It wasn't really that the ratio usually came out close to 1.0, but that it tended to have a characteristic value for each stock. Although the characteristic value often drifted up or down with time, significant deviations were obvious. At this time, the stocks listed on the American Exchange (2,390) were separated for later work, and not included in the analyses of this study. Working with the ISL Daily Stock Data for the New York Exchange, and referring again to the broker's diaries, approximately 1,800 of the remaining 8,068 entries were double checked. This was really a detective job where my own experience as an option trader was very useful. Many of the errors were glaring-- such as miscopied data, misplaced decimal point, and total premium for more than one option entered as if it were for



only one. Others were more subtle, yielding only to careful analysis of the patterns of entries in the diaries--such as similar options on the same or consecutive days, or even to identifying penmanship patterns on some of the numbers. However, I felt that a high degree of detail was necessary, for we were working with the data points that lie far from the mean, and have a disproportionate effect on variances and correlations. It was important that we get rid of erroneous data, but it was equally important that we not discard outliers that really belong there. In total, 400 errors were found and corrected, and 370 transactions were removed because of some identifiable defect. (Of these, in 290 cases the stock did not trade at the striking price on the option writing date.) An additional 74 entries were deleted because in my judgment they were incorrect, although I could not find out what exactly was wrong.

The final step in preparing the data was to examine the distribution of contracts by duration. The distribution showed a distinct pattern, as expected, with most options written for certain durations. However, a spread of durations is observed, for the following reasons:

(1) options that would expire on a date when the market is closed, expire instead on the next following market date. This can add one, two, and occasionally three extra days.

(2) Transactions executed late in the day sometimes get posted the following day, and could appear to be one day short.

(3) Months have differing numbers of days. Consequently, options measured in months have differing numbers of days. The identifiable nominal duration and their actual spans are listed below, together with the number of contracts of each duration. Since contracts are often written for more than one hundred shares, the last column lists the total round lots involved.

<u>Nominal Duration</u>	<u>Actual Duration</u> (Days)	<u>Number of Contracts</u>	<u>Number of Round Lots</u>
1 month . . . . .	29- 33	54	83
35 days . . . . .	34- 38	200	363
2 months . . . . .	60- 63	41	66
65 days . . . . .	64- 68	677	1,025
3 months . . . . .	90- 93	120	146
95 days . . . . .	94- 98	1,420	2,048
4 months . . . . .	120-123	14	21
6 months . . . . .	180-189	141	205
6 months plus 10 days . .	190-196	4,340	6,460
9 months . . . . .	273-280	23	51
12 months . . . . .	364-369	324	500
12 months plus 10 days . .	375-378	49	91
All others (102 different durations) . .		<u>221</u>	<u>337</u>
Total . . . . .		7,624	11,396

The peaked nature of this distribution affords one last method of reducing errors. If date errors are randomly distributed, then the background error level is very low. If we were to assume that half the options of odd duration are really date errors (quite unlikely), then the  $\frac{221}{2}$  options covering 102 odd durations is equivalent to 1.1 per duration. Thus, when we analyze 6 month 10 day options covering durations of 190 to 196 days, the error rate caused by dates is likely to be less than  $7 \times 1.1$  or less than 8 date errors in 4,340 transactions.

Having selected these 4,340 contracts as the basis for the analytical work of this study, I tested for accuracy against a known sample. During the data period, I had personally been the writer of 68 option contracts of 6 months 10 days. When checked against the final data base, the results were:

- 62 recorded and copied perfectly
- 2 "late" transactions, recorded the following day
- 1 date error screened out by the 190-196 day cut-off (recorded correctly, but 10 day error in copying)
- 1 ticker symbol changed; not on Return disk
- 1 ticker symbol recorded as another stock; screened out on price consistency test
- 1 not recorded in diary

## CHAPTER IV

### TRANSACTION COSTS

Transaction costs for the option trader have an impact greater than for most stock traders. The results of this study indicate that transaction costs are large enough to substantially distort the results anticipated from a frictionless model--in fact large enough to thwart, in the aggregate, the objectives of the rational option buyer. Since the extent of this impact has not been fully analyzed in previous studies, I will proceed in some detail. The possible amount of transaction costs for any single trade are either known, or can be estimated. But not all options are exercised, so not all possible transaction costs are actually expended. Therefore, the most interesting aspect is the way in which these costs sum up for a typical portfolio. First, I will describe the calculation of costs used in this study.

The two major costs are brokerage commissions and put and call dealer markup. The former may be calculated exactly, but the latter must be estimated. The commission rate tables for the New York and American Exchanges are widely available, but the equations are restated here for completeness. (The figures quoted are those in use during the time of this study, and do not include the recent surcharge on trades of less than 1,000 shares. The surcharge adds \$15 or 50% of the commission, whichever is less.)

<u>P=stock price per share</u>	<u>Commission per 100 shares</u>
\$4 to 24	$\$7 + P$
\$24 to 50	$\$19 + P/2$
Over \$50	$\$39 + P/10$
Maximum charge	\$75

In the typical call transaction, if the price rises the option writer experiences two commissions, as does the option buyer, assuming that he disposes of the shares he receives. If the price declines, the option buyer has no commissions. The writer has two commissions if he disposes of the stock used to cover the option, one

if he keeps the covering stock, and none if the option was not covered.

The mark up for the put and call dealer varies, depending on the supply and demand at the moment, and on the degree of competition between dealers. It tends to become standardized at some lower than average figure for popular stocks, and rises proportionately as there is less active interest, less communication of bids between buyer and seller, and less competition. Brokers state that the dealers' markup is as much or more than the brokerage commission. One would estimate from the disparity between the bid and asked prices in the dealer advertisements that it is in fact greater than the commission. Malkiel and Quandt<sup>15</sup> use \$62.50 as the average markup on a \$50 stock (compared to \$44 brokerage commission). In this study, I use 1.5 times the brokerage commission, and of course the purchaser pays it whether or not he ever exercises the option.

Certain other relatively minor costs exist, one being New York transfer tax, which is charged to the call

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<sup>15</sup>Op. cit., p. 17.

buyer whether or not a stock transaction ever results. There is no tax on a put. (Federal transfer tax is no longer applicable, and the SEC fee of 1/500 of 1% is too small to include.)

<u>Stock Price</u>	<u>New York Tax Per 100 Shares</u>
\$5 to \$9.99	\$2.50
\$10 to \$19.99	\$3.75
\$20 or more	\$5.00

There are substantial costs involved in the conversion of a put to a call, but these are reflected in the difference in premium received by the option seller. Remember that it is always possible for the option dealer to "sell" a put to a conversion house, and buy back a call, for a differential only slightly greater than the risk-free borrowing rate on the value of the underlying stock. This is so, because the converter, holding a put and one hundred shares against the call he delivered, is in a risk-free position.<sup>16</sup> The estimates of conversion costs

<sup>16</sup> An extensive discussion of conversion theory, both put to call and call to put, could be found in the Journal of Finance, December, 1969. "The Relationship between Put and Call Option Prices," Hans. R. Stoll.

used in this study are as follows: The interest part of the charge is calculated at 7% per year, which was approximately the rate charged on brokerage margin accounts. An additional 2% per year rate is charged as the converter's administrative fee. Finally, one transfer tax is charged, as shown in the previous table, and two floor brokerage commissions are charged according to the following table. (Conversion houses are Stock Exchange member firms, and pay these rates on their own transactions.)

<u>Stock Price</u>	<u>Floor Brokerage Per 100 Shares (Charged twice for conversion)</u>
\$5- \$9.99	\$4.20
\$10- \$19.99	\$6.20
\$20- \$39.99	\$7.30
\$40- \$99.99	\$7.70
\$100- \$149.99	\$8.70

The charges for conversion have been determined in the following manner for the strategies where the option writer sold straddles, but the option buyer purchased calls. In the frictionless case, the call buyer has been charged the straddle premium plus the interest (3.5% for



six months). For the full cost case, taxes, floor brokerage, and converter fee are all charged, as well as put and call dealer markup on the two calls.

Since we cannot know completely the actual decisions made by option traders, the following arbitrary rules were applied for uniform evaluation of the strategies which include transactions costs. The option buyer is assumed always to dispose of stock at the price existing on the option expiration date. He holds no long or short stock positions. The option writer, whether he is pursuing a covered or naked strategy for calls or straddles, experiences double commissions if the option is exercised, and none if it is not exercised. An example will illustrate the use of these tables and rules. The option seller receives \$500.00 for a six month straddle at a striking price of \$20. In the frictionless model, the option buyer pays  $\$500.00 + (.035)(2000.) = \$570.00$  for two calls. In the real world, however:

1	Straddle . . . . .	\$500.00	
	3½% Interest on \$2,000 . . . . .	70.00	
	1% Conversion fee on \$2,000 . . . . .	20.00	
2	Floor brokerage charges . . . . .	14.60	
	Transfer tax on two calls . . . . .	10.00	
	Put and call dealer		} .
	markup (approx.) . . . . .	<u>81.00</u>	
	(\$7.00 + \$20.00) x 2 x 1½	\$695.60	
			for two calls

Assuming that the price rises to 24, and the calls are exercised, the option seller incurs a buying and a selling commission totaling \$54.00. The option buyer incurs two commissions and an additional transfer tax on each call exercised, or  $(\$20 + 7 + 24 + 7 + 5) \times 2 = \$126.00$ . In the frictionless world, the writer's profit was \$500.00, and the buyer's profit was \$230.00. But in the real world, the transaction costs reduced the writer's profit to \$446.00 and turned the buyer's profit to a loss  $(\$800.00 - \$695.60 - \$126.00 = -\$21.60)$ .

The above example is more complicated than necessary for an understanding of the study reported in this

paper. Since time did not allow completion of the straddle analysis, the reader can ignore such costs as conversion fee and floor brokerage. However, all the detail will be necessary for further work using this data base. Consequently, I decided to leave the discussion as it stands, rather than simplify it to calls alone.

## CHAPTER V

### ANALYSIS OF RESULTS

#### Procedures and Computer Programming

All computation was done on a time sharing system, consisting of an IBM model 360-67 located at the Interactive Data Corp., Waltham, Massachusetts. Fortran programs were written to:

1. Make various calculations and printouts during the preparation and screening of the data base.
2. Access the Scholes Returns disk and calculate each beta, predicted standard deviation of returns, and actual return on both the stock and the market average.
3. Calculate each investment, profit, and return on investment for the three strategies.

Transaction costs were neglected on one run

and deducted on the other, as described in detail in Chapter IV.

Prepackaged programs were available from Professor Scholes for running linear regressions, plotting scatter diagrams, and printing histograms. Figures 1 through 18 are photostatic reproductions of the histograms and scatter diagrams, the formats of which are now described.

Referring to the histogram, such as Figure 1, the variable range for which the distribution is desired is divided into twenty equal classes. The twenty-two figures across the top of the histogram represent, from left to right, the number of items falling below range, within each class, and above range. The eleven figures across the bottom represent the starting values of the first, third, fifth, etc., classes, and the ending value of the twentieth class. The height of each bar of asterisks is proportional to the number of items in that class.

Referring to the scatter diagram, such as Figure 6, the variable ranges are selected by the computer program to exactly fill the space available. The upper and lower limits, and the smallest scale divisions are listed in the heading. Each point is marked by an asterisk. If more

than one point falls in the same place, a number is printed, representing the number of additional points. An X represents six or more points. The mean of each variable is printed in the heading, and their intersection is marked with an M on the diagram. The least-squares regression line is calculated in the form  $Y = A + BX$ , and the coefficients are printed in the top row. STD. ERROR is the standard deviation of the coefficient B. RESVAR is the residual variance of Y, which has not been explained by the regression. CORR is the correlation coefficient between X and Y.

### Option Pricing Results

The histograms in Figures 1-4 show the distributions of striking price, historical standard deviation of returns, historical beta, and percentage premium for each optioned stock. The regressions in Figures 5-7 show the relationship of the premium to standard deviation, to beta, and to subsequent realized returns on the stock. Comments on each figure follow:

### Figure 1, Distribution of Striking Prices

Call options were written on stocks selling from \$6 to \$370 per share. However, the median was \$27, only about half the price of an average share on the New York Stock Exchange--clearly not a random sample of stocks. The reason for the low median is probably a bias toward higher risk stocks, which tend to be lower priced. (A scatter diagram did show negative correlation between price and standard deviation. However, the scatter was quite wide, indicating that price alone is a poor proxy for risk.) A bias to higher risk stocks can be expected, considering that transaction costs are substantial (a finding to be discussed later). On risky stocks, the percentage premium should be relatively higher, and consequently the transaction costs relatively lower.

### Figure 2, Distribution of Standard Deviation of Six Month Returns on Stock

Historical data shows that call options were written on stocks with a median six month standard deviation of 0.23, which is considerably above the Stock Exchange average of about 0.17. The range is very wide, from 0.10 for American Telephone to 0.65 for Benguet, but

the bias is obviously toward stocks of higher than average risk.

Figure 3, Distribution of Beta of Optioned Stock

Once again, the range is very wide, from -0.8 for a few mining stocks to +3.0 for Fairchild Camera. The median of 1.4 is substantially above the average beta, which is 1.0 by definition.

Figure 4, Distribution of Percentage Premiums for Six Month Call Options

The percentage premiums range from about 8% to 22%, with a median of 12.3%.

Figure 5, Regression of Percentage Premium on Standard Deviation

This figure shows a significant relationship between the premium paid and the standard deviation of the stock returns (correlation coefficient = 0.59)

$$\text{Percentage Prem.} = .0836 + (.1869)(\text{Std. Dev.})$$

For comparison, the results of St. Peter's<sup>17</sup> regressions are also shown. (Since his regressions were run against variance, taking the square root causes curved plots on

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<sup>17</sup>Op. cit., p. 68.



my coordinates.) His theoretical option value, calculated from a hypothesized probability distribution, is also plotted. Clearly, the results with the new data come much closer to St. Peter's actual results than to his calculated value. Apparently, whatever subjective reasoning option traders use to determine premiums, standard deviation is a reasonably good proxy for it. Whether or not they give it enough weight is still an open question, and not within the scope of the present study. The magnitude of the intercept, A, is another striking difference between the calculated and actual premiums. I believe that failure to account for transaction costs in the model is a primary factor in this difference.

#### Figure 6, Regression of Percentage Premium on Beta

This figure suggests a slight positive relationship to beta, but the correlation coefficient is very low (0.098). From this regression, it is doubtful that option traders give any significant weight to beta in setting premiums. This is a rather unexpected result, because from the previous discussion, beta represents a substantial part of the risk--especially the part that can not be

diversified away. Therefore, this relationship should be further studied. (One valid change in the regression, that would improve the correlation, would be elimination of the negative betas. Clearly, one wouldn't pay a negative premium for a negative beta!)

Figure 7, Regression of Percentage Premium on Realized Returns

The realized returns refer to changes in the stock price, not to returns for any investment strategy. These two variables appear to be uncorrelated (correlation coefficient = 0.057). The hypothesis here was that call traders with special knowledge about a stock would bid up the price of calls. If they were right, the returns on the stock would be more positive than expected. The observed result suggests that special knowledge either is not significantly useful, or that it is present in too small an amount to be detected. It does not preclude the possibility that option traders in general have knowledge superior to random stock buyers, that causes optioned stocks to have a higher return than random stocks!

DISTRIBUTION OF PRICES

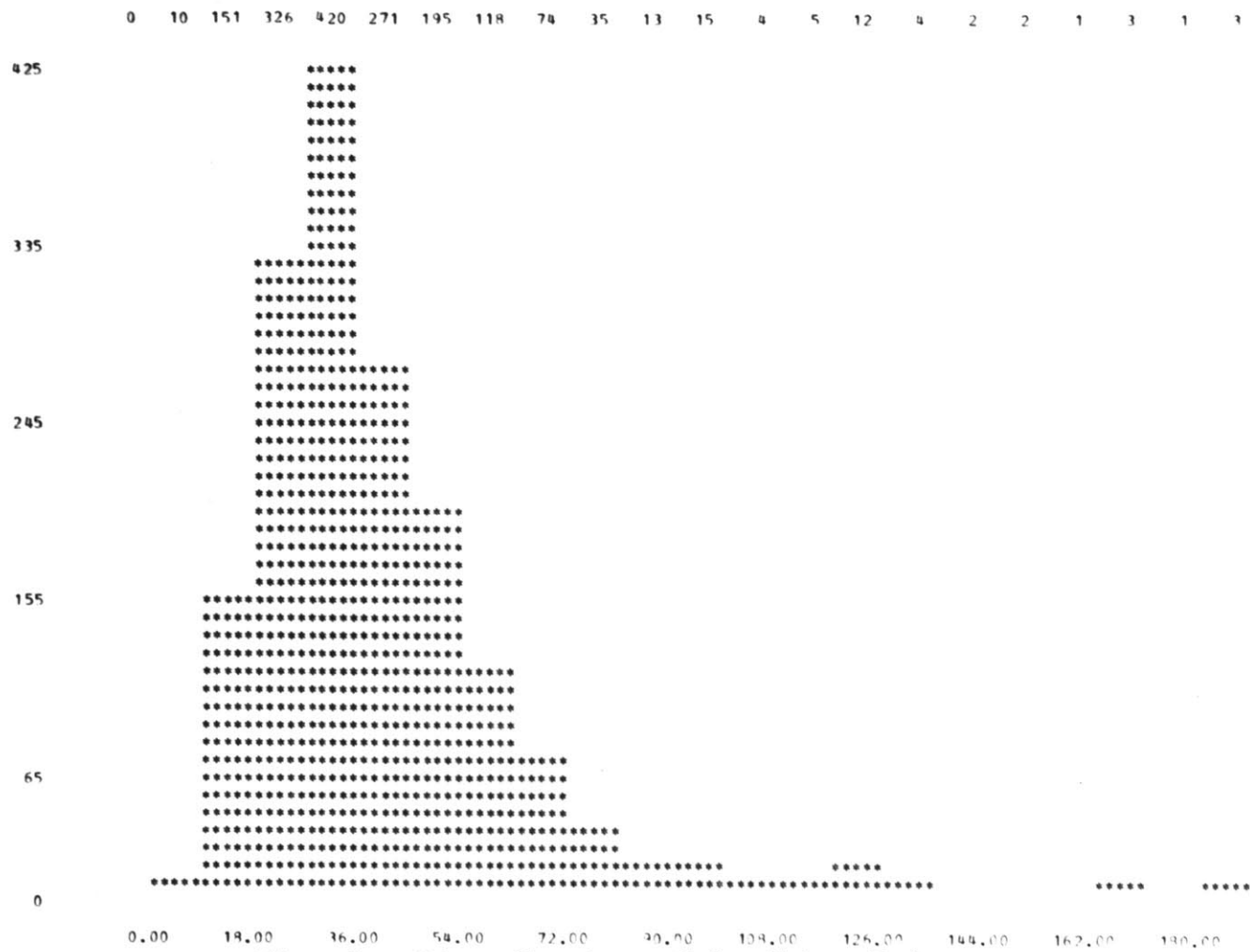


Fig. 1.--Distribution of Striking Prices

DISTRIBUTION OF STANDARD DEVIATIONS  
 TOTAL CALLS 1665

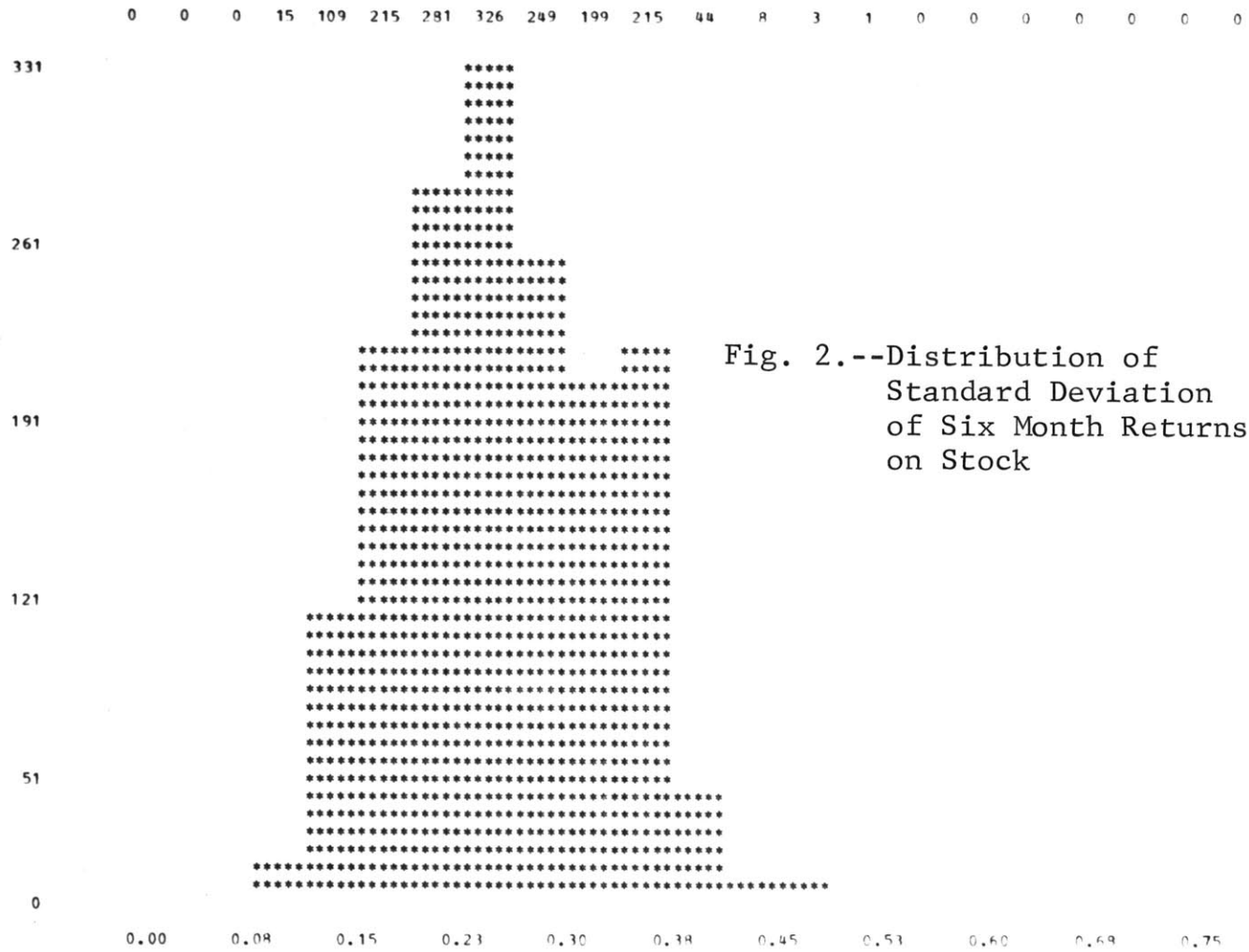


Fig. 2.--Distribution of Standard Deviation of Six Month Returns on Stock

Fig. 3.--Distribution of Beta of Optioned Stocks

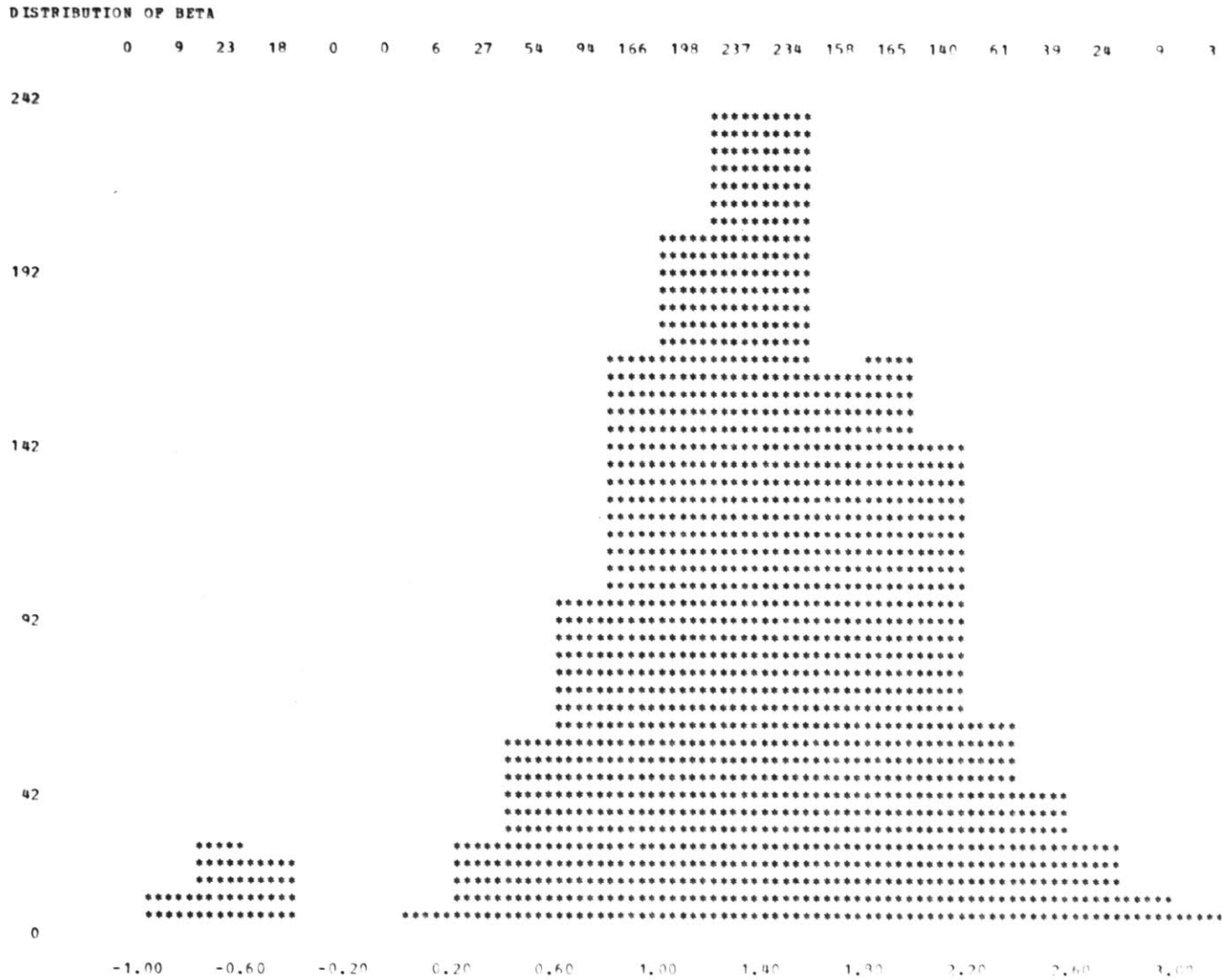
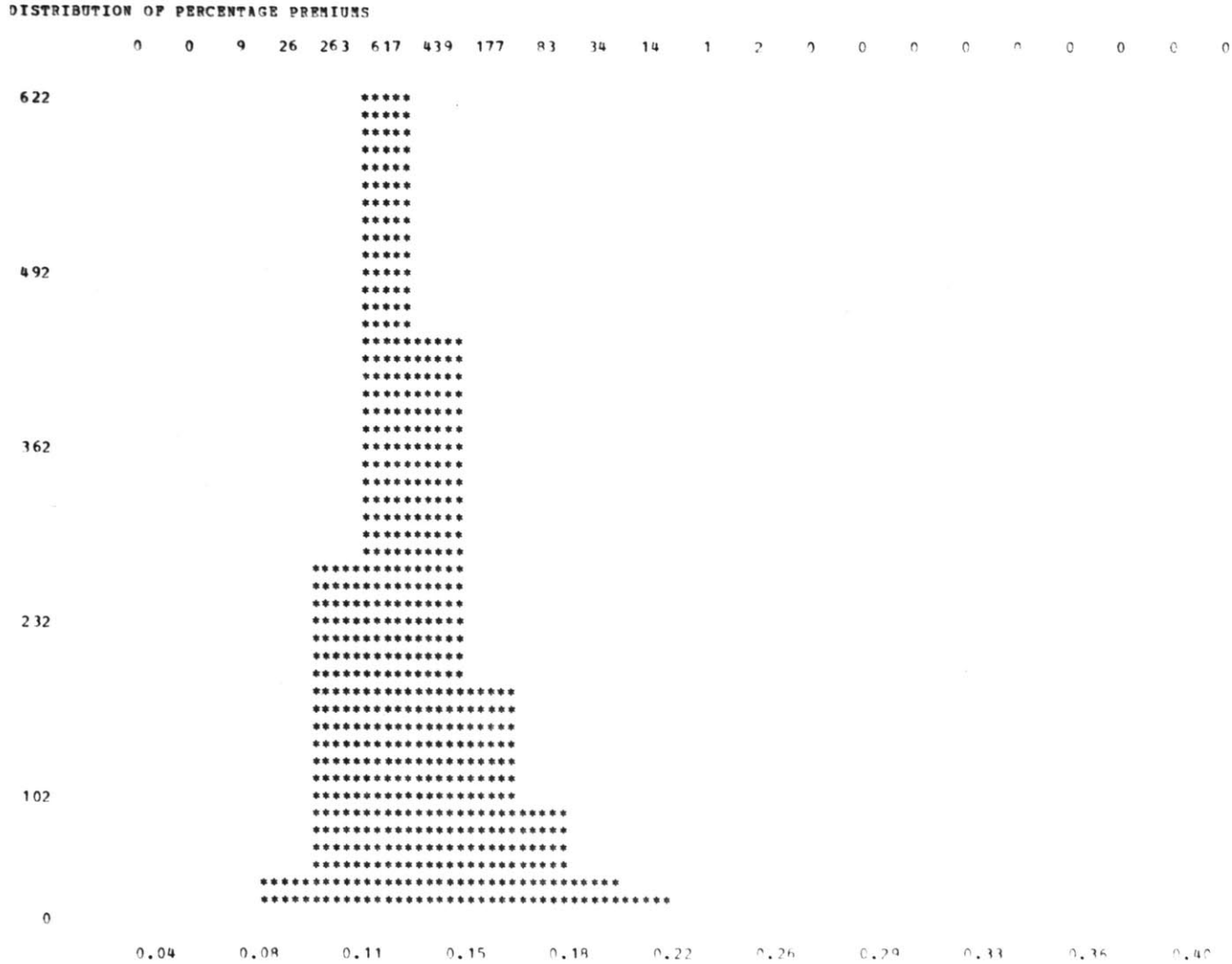
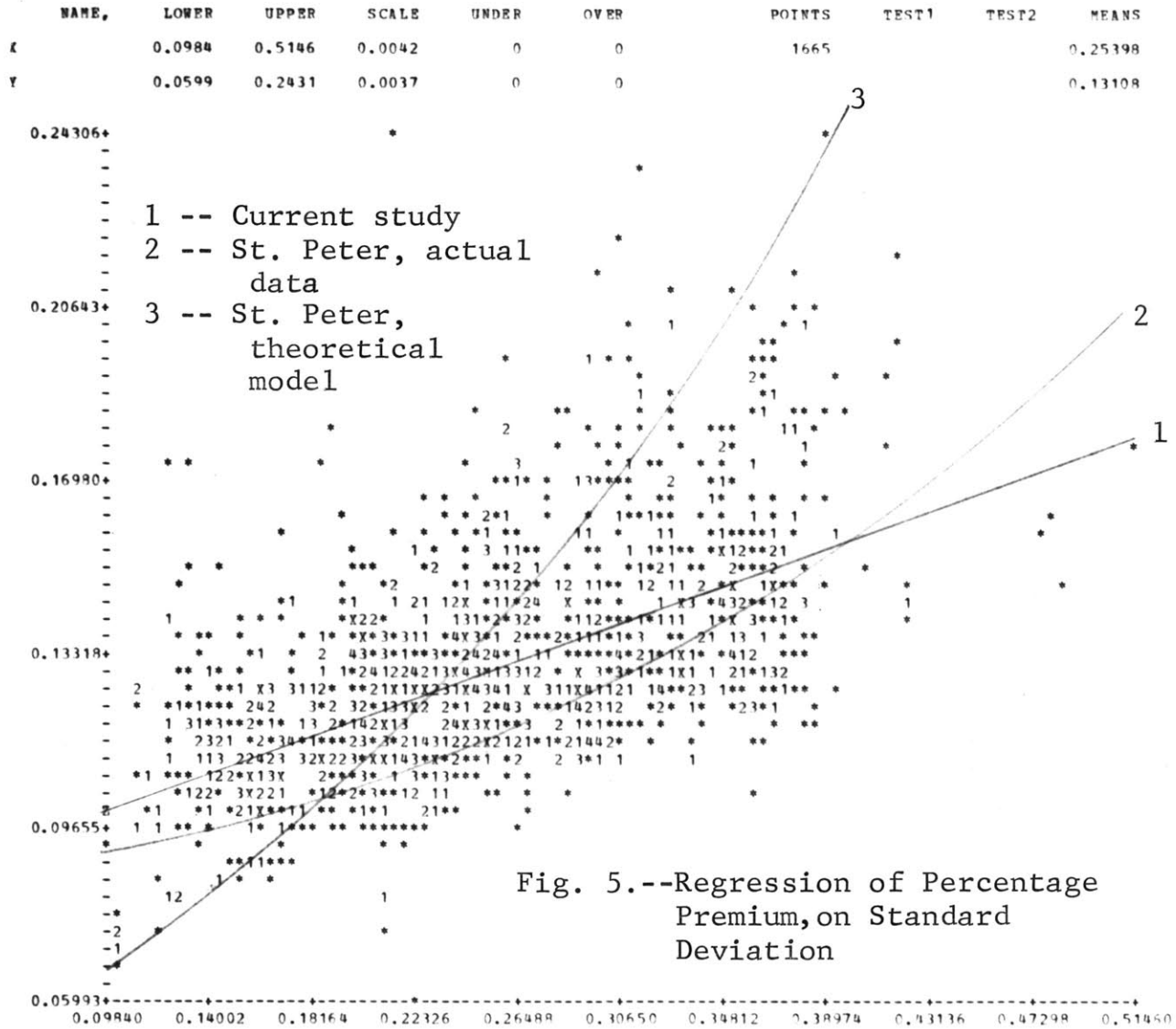


Fig. 4.--Distribution of Percentage Premiums for Six Month Call Options

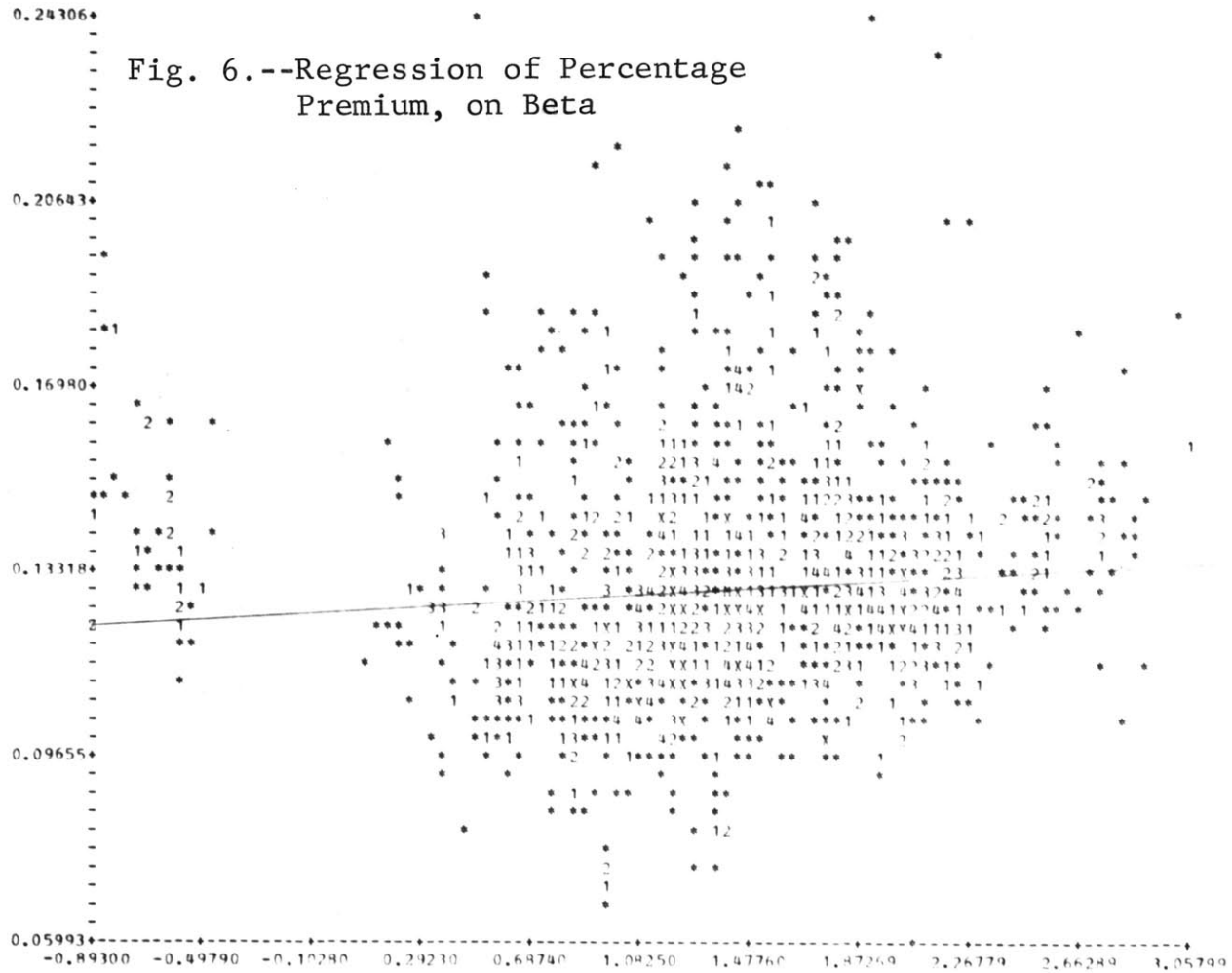


yA= 0.08361 B= 0.18691STD. ERROR= 0.00625 RESVAR= 0.00034 CORR=0.59149



YA= 0.12625 B= 0.00349STD. ERROR= 0.00097 RESVAR= 0.00052 CORR=0.09802

NAME,	LOWER	UPPER	SCALE	UNDER	OVER	POINTS	TEST1	TEST2	MEANS
X	-0.8930	3.0580	0.0395	0	0	1665			1.38575
Y	0.0599	0.2431	0.0037	0	0				0.13108





A= 0.13043 B= 0.00055 STD. ERROR= 0.00002 RESVAR= 0.00053 CORR=0.95736

NAME	LOWER	UPPER	SCALE	UNDER	OVER	POINTS	TEST1	TEST2	MEANS
X	-49.7050	215.1570	2.6486	0	0	1665			14.07244
Y	0.0599	0.2431	0.0037	0	0				0.13108



Fig. 7.--Regression of Percentage Premium, on Realized Returns

Profitability Results

The histograms of Figures 8-11 show the distribution of returns of the market average, and the return on investment for each of the three strategies, neglecting transaction costs. The pictures tell the story, and in general show just what we expected about the division of risk on any transaction. (Recall that the market return is the fractional change in the Standard and Poor index over the six month ten day period, adding 0.015 as the implied dividend. The three strategies are (1) buy stock on 80% margin, (2) buy stock on 80% margin, sell a call, (3) buy a call.)

However, a completely unexpected result is the high rate of return on this group of stocks relative to the market average. Recalling the market model equation (Chapter II),  $RET = RF + BETA (RMK - RF) + ERR$ . Taking  $RF = 0.03$ , median  $RMK = 0.07$ , median  $BETA = 1.4$ , corrected to 1.75 for 80% margin, and assuming that overall  $ERR = 0$  for 1,665 transactions,

$$\text{Expected Return} = 0.030 + 1.75(0.070 - 0.030) = 0.10$$

Actual median return for strategy (1) was 0.14, and actual

mean return was 0.175, either way substantially greater than predicted. It is highly improbable that this result occurred by chance in so large a sample. This result suggests either that option traders overall had superior special information, or that the underlying statistical process changed during this period of market history. In view of the non-correlation between option premiums and stock returns (Figure 7), and some personal feel for the diversity of sophistication of option traders, I greatly doubt the special information hypothesis. The most likely explanation is that during this time (mostly 1967 and 1968), investor expectations changed significantly upward under the influence of growing inflationary psychology. This put more favor on growth, technology, and acquisition oriented companies at the expense of traditional or former growth industries. My hypothesis would be that this caused a widening of the risk spectrum, and specifically that stocks which formerly had a high beta were upwardly valued during this period, relative to all stocks in the market average. Note, for example, that during the three year span of these data, the Standard and Poor index rose 14% from 85.8 to 97.5. Meanwhile, the Dow Jones Industrial

Average barely managed a gain from 878 to 880. Since the Dow Jones stocks are included in the Standard and Poor index, it follows that other subsets of stocks must have done considerably better than the Standard and Poor index. These alternate hypotheses could readily be checked using the data on the Scholes Returns disk. I think this situation does not detract substantially from the findings about risk and return apportionment among option traders.

Transaction costs were found to have a marked effect. Because this effect was most pronounced for the call buyer, Figure 12 was included, which is a histogram of the returns from the call buying strategy, deducting transaction costs. Figures 13-18 are scatter diagrams of the returns from the strategies, neglecting and deducting transaction costs, plotted against market return for the same period. The best fit regression lines are drawn through the data points. Calculations of the sum of investment, profit, and return on investment were made for each strategy, assuming one round lot of each transaction. A summary of the regression results and the strategy sums appears in Table 1.

TABLE 1

## RETURNS FROM VARIOUS STRATEGIES

Strategy	Portfolio Summations			Regressions of Investment Returns vs. Market Return, $RET = A + B(RMK)$			
	Total Investment	Total Profit	Six Month Returns	A	B	Standard Error of B	Correlation Coefficient
1 buy stock	\$5,249,000	\$775,000	14.8%	.068	1.758	.126	.325
1A buy stock	5,249,000	664,000	12.7%	.031	1.752	.125	.325
2 buy stock sell call	4,415,000	447,000	10.1%	.087	.685	.047	.335
2A buy stock sell call	4,415,000	373,000	8.5%	.061	.618	.044	.328
3 buy call	834,000	328,000	39.4%	-.013	7.300	.639	.270
3A buy call	943,000	134,000	14.2%	-.228	6.074	.543	.265

I make the following notes and comments regarding the results shown in Table 1:

1. The exact results of strategies with transaction costs depends on the details assumed. The strategies are representative of those followed by many option traders. In strategy 1A, the stock is bought at the striking price and sold at the market price on the day of expiration. In strategy 2A, stock is bought and sold at the striking price, if the call is exercised. If the call is not exercised, the stock is held for possible sale of another option against it. Thus, on average, two commissions are charged if call is exercised, no commissions if not exercised. In strategy 3A, stock is disposed of at the market price if call is exercised. Otherwise, no commission costs. However, put and call dealer markup is paid at the time a call is purchased. Therefore, dealer markup is both an increase of investment, and a transaction cost.

2. Notice that the regressions were run directly on market return, rather than using Sharpe's adjustment for the risk-free rate. Thus B is similar to, but not identical to beta. Regressions were also run in the form:

$$RET_i = A + B(RF + BETA_i(RMK_i - RF))$$

$i = 1$  to 1665, the number of transactions.

Correlation coefficients were up to 10% better. Nevertheless, it was decided to report regressions on market return alone, for the improved correlation did not seem worth the conceptual complication.

3. The low correlation coefficients do not cast doubt on the existence of the relationship. They do mean that there is a great deal of residual variance of individual points around the regression line. Thus, a relatively larger number of data are necessary to establish the slope of the regression line. The significance of the standard error of B is: the probability is about 65% that the true value of B lies within one standard error, 95% within two standard errors, 99% within three, etc.

4. The regression calculates the best straight line through the data. Obviously, for strategies 2 and 3 the relationships are not linear over the entire range, although it may be a reasonable approximation in mid-range. A more accurate approach would be to plot the means of various sub-ranges of the market return. Nevertheless, I believe the results as presented are useful in showing the direction and approximate extent of the risk shifting that has taken place.
5. In the regressions, A is the expected yield of the portfolio if the market average return were zero. Option traders' expectations must surely have been greater than zero, because call buyers had a negative return, in a frictionless market, even though their set of stocks substantially outperformed the market. In the real world, their losses would be 22.8%, considering transaction costs.
6. The coefficient B for strategy 1 is reasonable, considering that stocks are purchased on 80%



margin, and that their median beta was 1.40. This may be evidence that the higher returns for this set of stocks was achieved by upward displacement rather than by a major change in beta.

7. Clearly, an overwhelming observation from these results is the degree to which systematic risk has been transferred from option seller to option buyer. What the call buyer has as his portfolio is an asset highly levered on the returns of the market average.
8. The summations of overall returns look quite reasonable in the frictionless case. However, deducting transaction costs, the position of the call buyer looks unattractive to all but the hardy gambler. On balance, he barely beat the returns of the stock buyer, despite the fact that the median market return was 7%, and that his stocks outperformed that average by about 7% more than could have been expected. Simultaneously, he took on risk that was about four times the risk of the margin stock buyer.

9. How far from a zero sum game have the transaction costs made option trading? The total profit available from the underlying stock in strategy 1 was \$775,000. For that person, the transaction costs were \$111,000, or 14.3% of the gross profit. (As a percent of investment, just 2.1%.) In strategies 2 and 3, the option traders contracted to divide the same underlying return. In the frictionless case, the call seller earned \$447,000, or 57.7% of the gross profit, and the call buyer earned \$328,000, or 42.3% of it. The following list shows where the gross profit went in the case with transaction costs:

	<u>\$</u>	<u>%</u>	
Call seller, net profit . . . . .	373,000	48.1	
Call buyer, net profit . . . . .	134,000	17.3	
Mark up to put and call dealer . . . . .	109,000	14.1	}
Brokerage and transfer tax, call buyer . . . . .	85,000	11.0	
Brokerage, call seller . . . . .	<u>74,000</u>	<u>9.5</u>	
	775,000	100.0	

The combined transaction costs, then, were 34.6% of the gross profit. Of course, this is for a single portfolio under one set of conditions. If the profit were higher, the percentage of transaction costs would be lower. But, how often can one expect the average return on an underlying stock portfolio to be almost 14% every six months? Clearly, this is not a typical case, and one could in fact expect transaction costs to take an even higher percentage.

For a final comparison of strategies, see Figures 19 and 20. In Figure 19, the regression lines are plotted for the three strategies without transaction costs. In Figure 20, they are repeated, deducting costs. In the frictionless case, the three lines intersect in a point at a market return of 0.015 and a return on all strategies of 0.095. This is the point of indifference for an expected value maximizer. If option trading were frictionless, then for expected returns below this point, strategy 2 dominates, and for higher expected returns, strategy 3 dominates (0.095 is the expected return on a portfolio of stocks held at 80% margin for six months).

For the case with transaction costs, there is no point, but rather a triangular intersection. At the portfolio return of 0.095, we find a point of indifference between strategies 2 and 3, but at that point, both are dominated by strategy 1. In fact, an expected value maximizer would not engage in option trading at all if the expected portfolio return were between 0.08 and 0.14. The most significant factor about the transaction costs is that they have pushed the indifference point for call buyers up to a level that is probably unattainable over any sustained period. If call buyers realize this, then they must be classified as gamblers rather than expected value maximizers.

DISTRIBUTION OF RETURNS OF MARKET AVERAGE

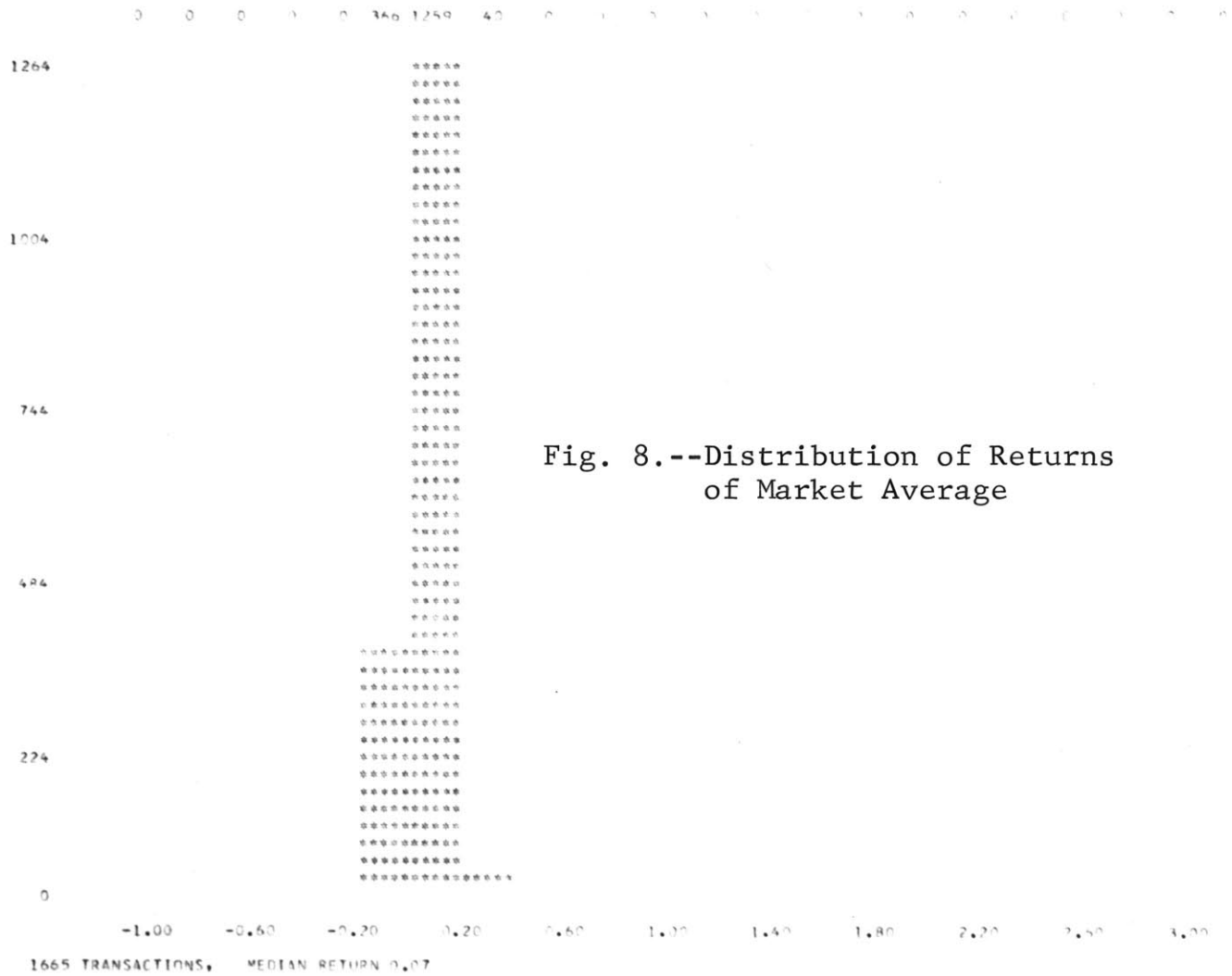


Fig. 8.--Distribution of Returns of Market Average

DISTRIBUTION OF RETURNS OF BUYING STOCK

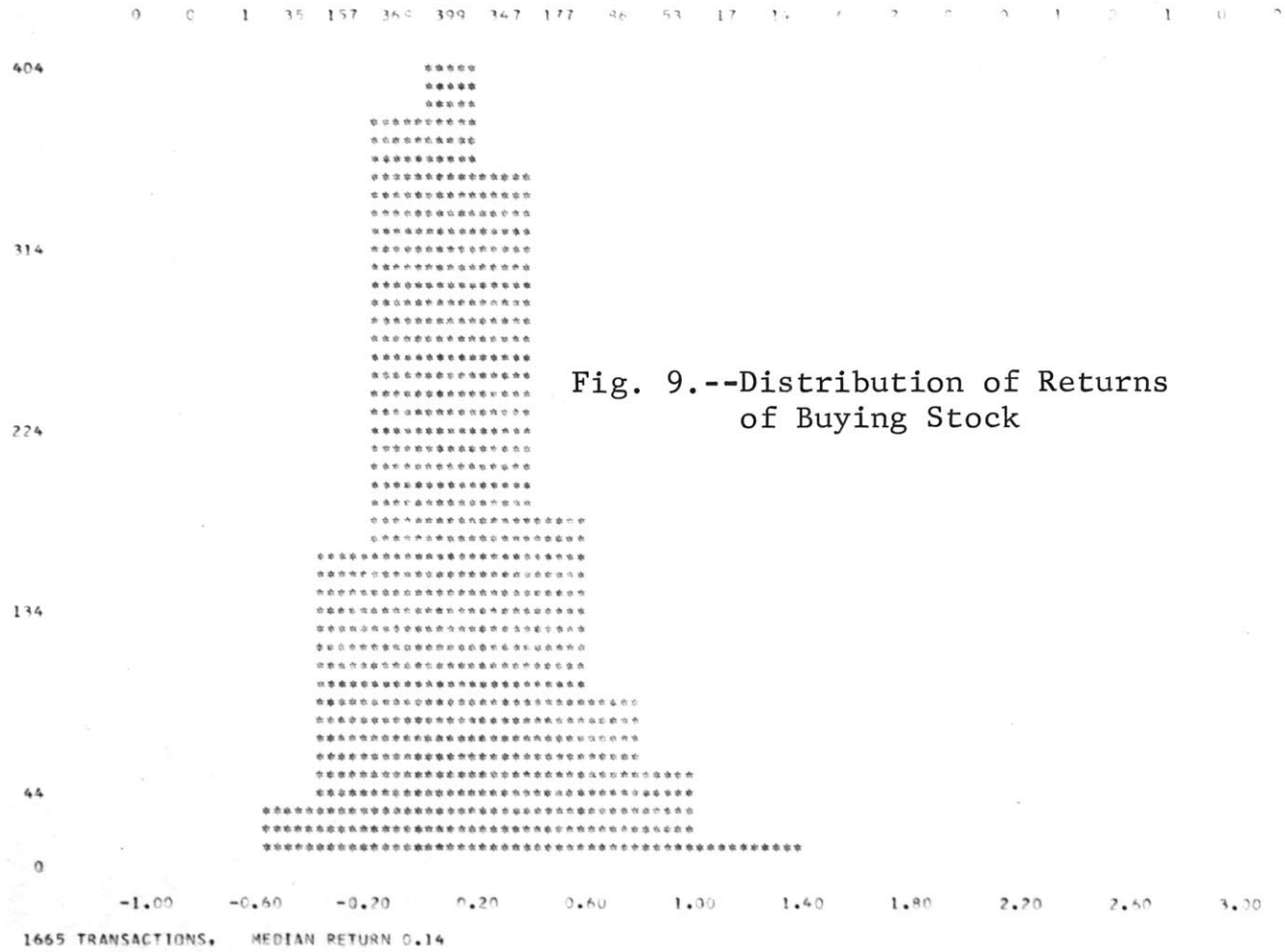


Fig. 9.--Distribution of Returns of Buying Stock









A= 0.36832 B= 1.753695TD. ERROR= 0.12561 RESVAR= 0.11309 CORR=0.32464

NAME	LOWER	UPPER	SCALE	UNDER	OVER	POINTS	TEST1	TEST2	MEANS
X	-0.0914	0.2732	0.2036	0	0	1665			0.06067
Y	-0.6213	2.6895	0.2662	0	0				0.17503

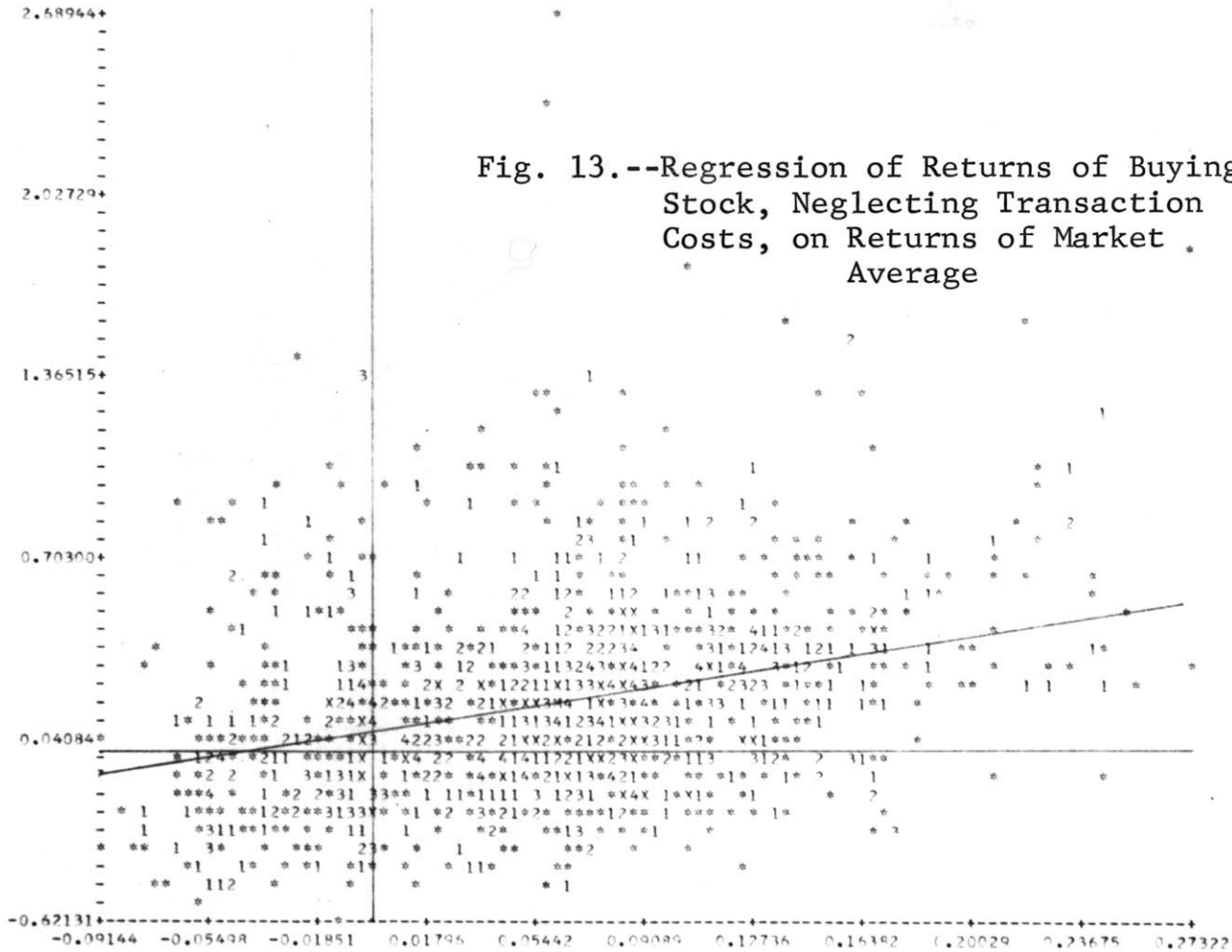
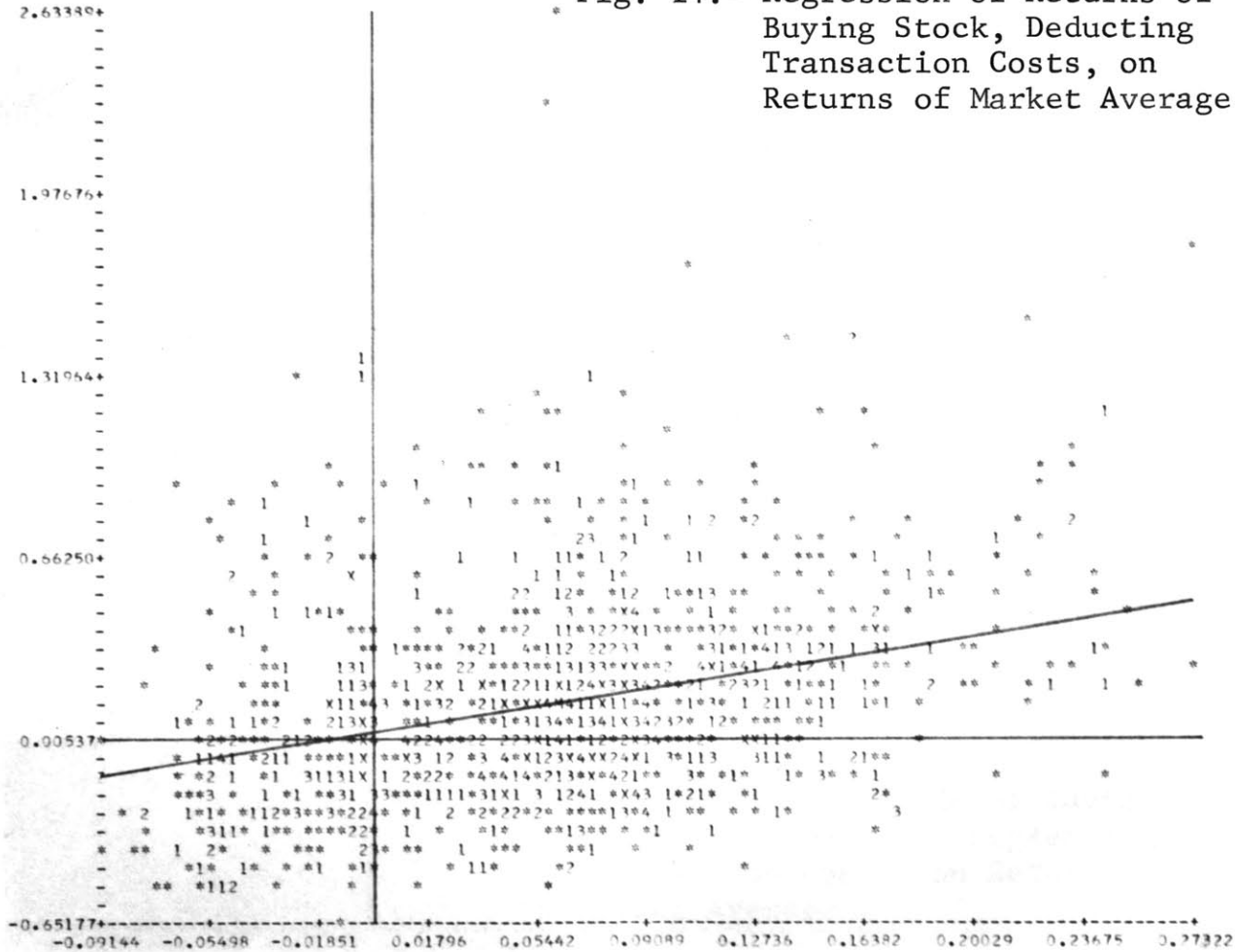


Fig. 13.--Regression of Returns of Buying Stock, Neglecting Transaction Costs, on Returns of Market Average

A= 0.03382 R= 1.75226575. FPROB= 0.12493 RESVAR= 0.11187 CORR=0.32516

NAME	LOWER	UPPER	SCALE	UNDER	OVER	POINTS	TEST1	TEST2	MEANS
X	-0.0914	0.2732	0.0036	0	0	1655			0.06067
Y	-0.6518	2.6339	0.0657	0	0				0.13714

Fig. 14.--Regression of Returns of Buying Stock, Deducting Transaction Costs, on Returns of Market Average



A= 0.09744 B= 0.69478 STD. ERROR= 0.14779 RESVAR= 1.01422 CORR=0.33461

NAME	LOWER	UPPER	SCALE	UNDER	OVER	POINTS	TEST1	TEST2	MEANS
X	-0.0914	0.2732	0.0036	0	0	1665			0.06067
Y	-0.5556	0.4364	0.0198	0	0				0.12899

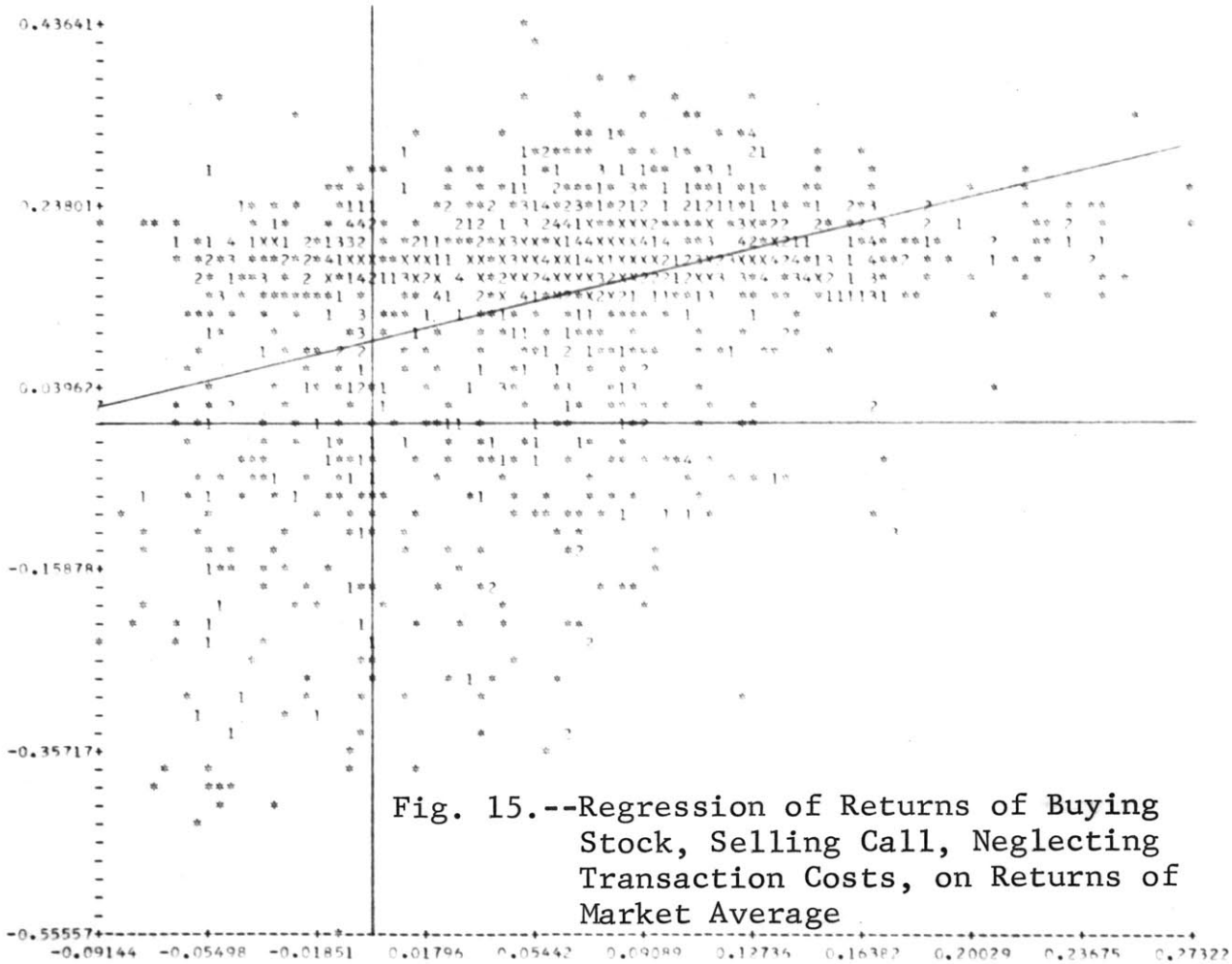
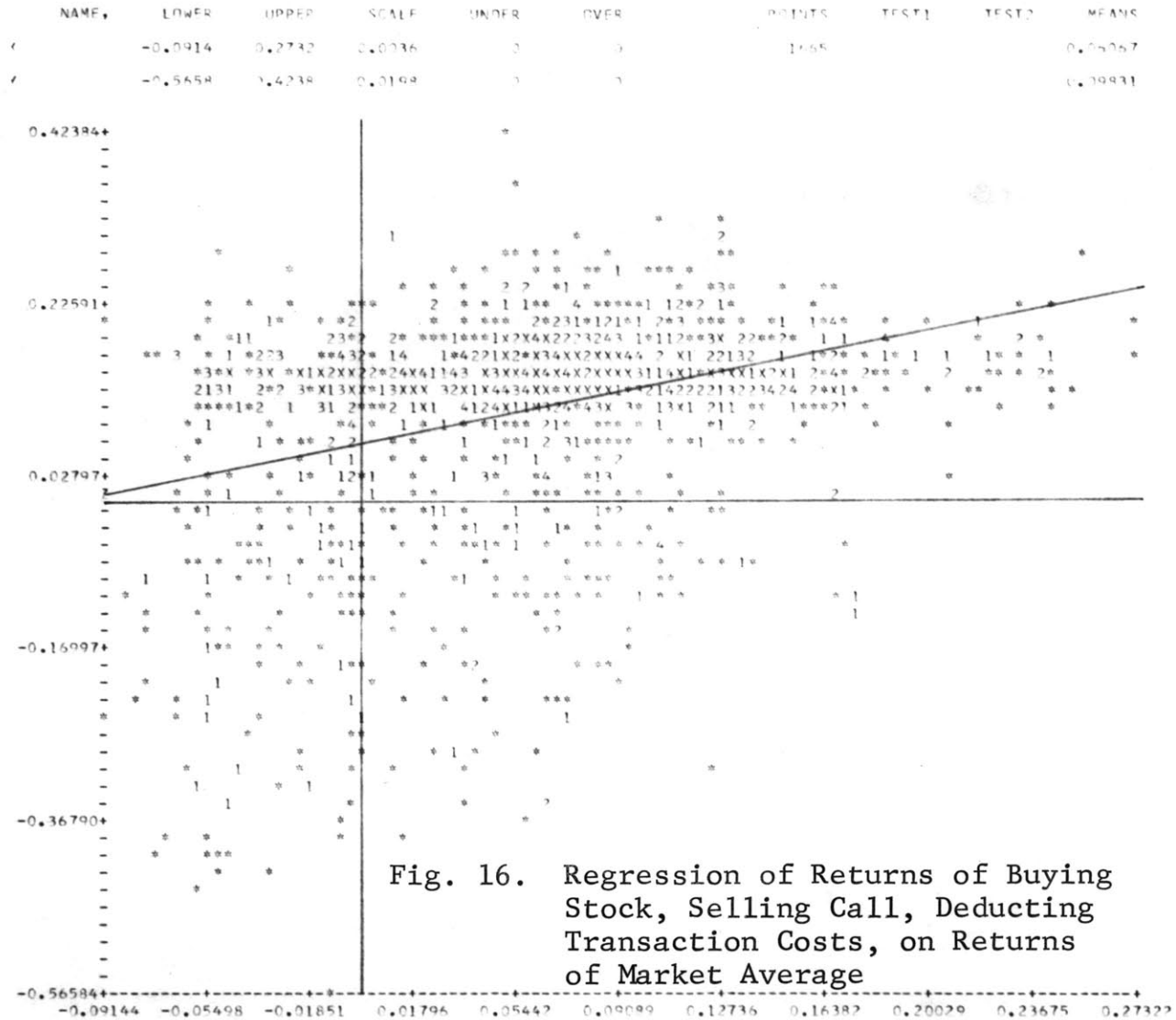


Fig. 15.--Regression of Returns of Buying Stock, Selling Call, Neglecting Transaction Costs, on Returns of Market Average

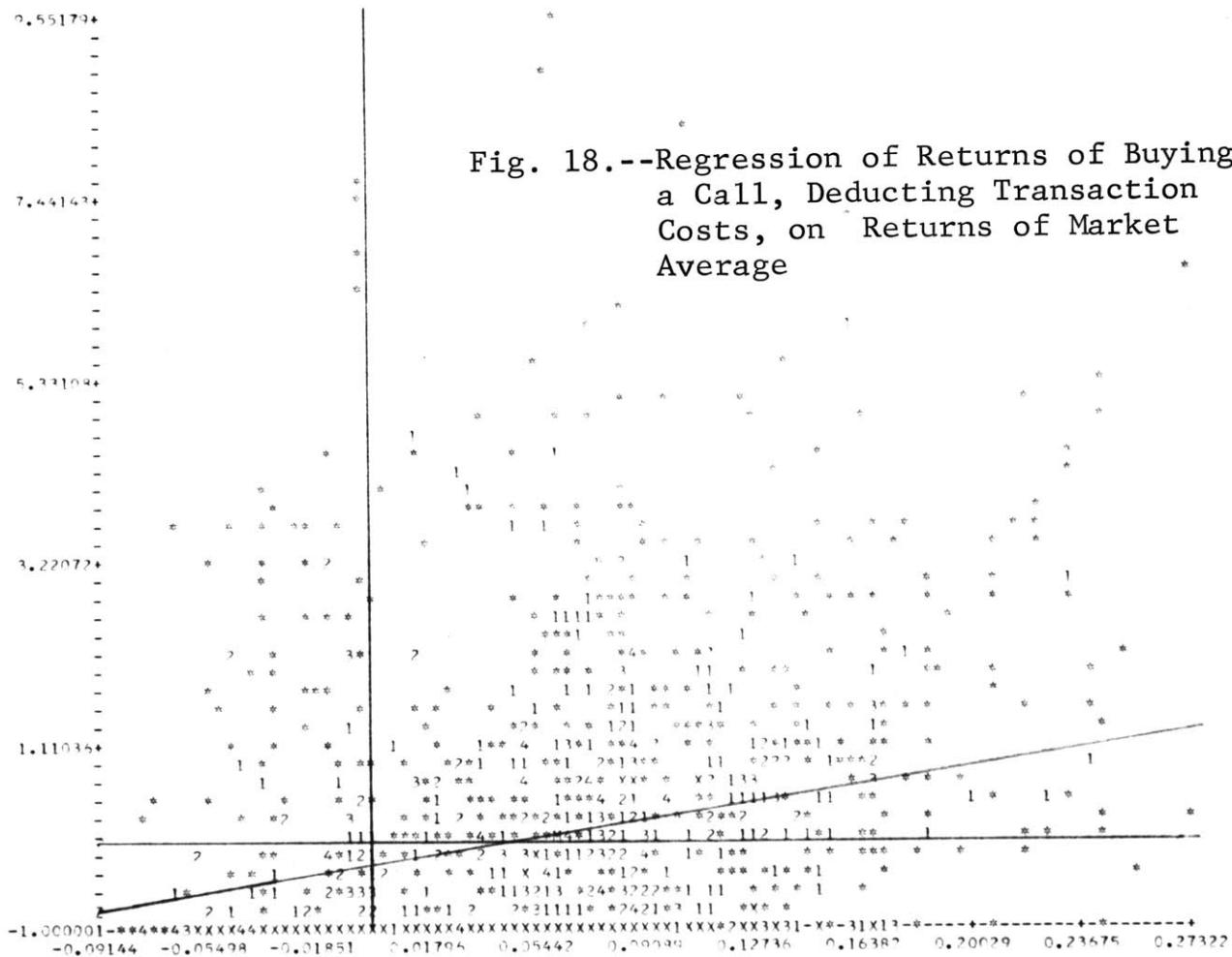
A = 0.26094 R = 0.61753 STD. ERROR = 0.14367 RESVAR = 0.21367 CORR = 0.32751

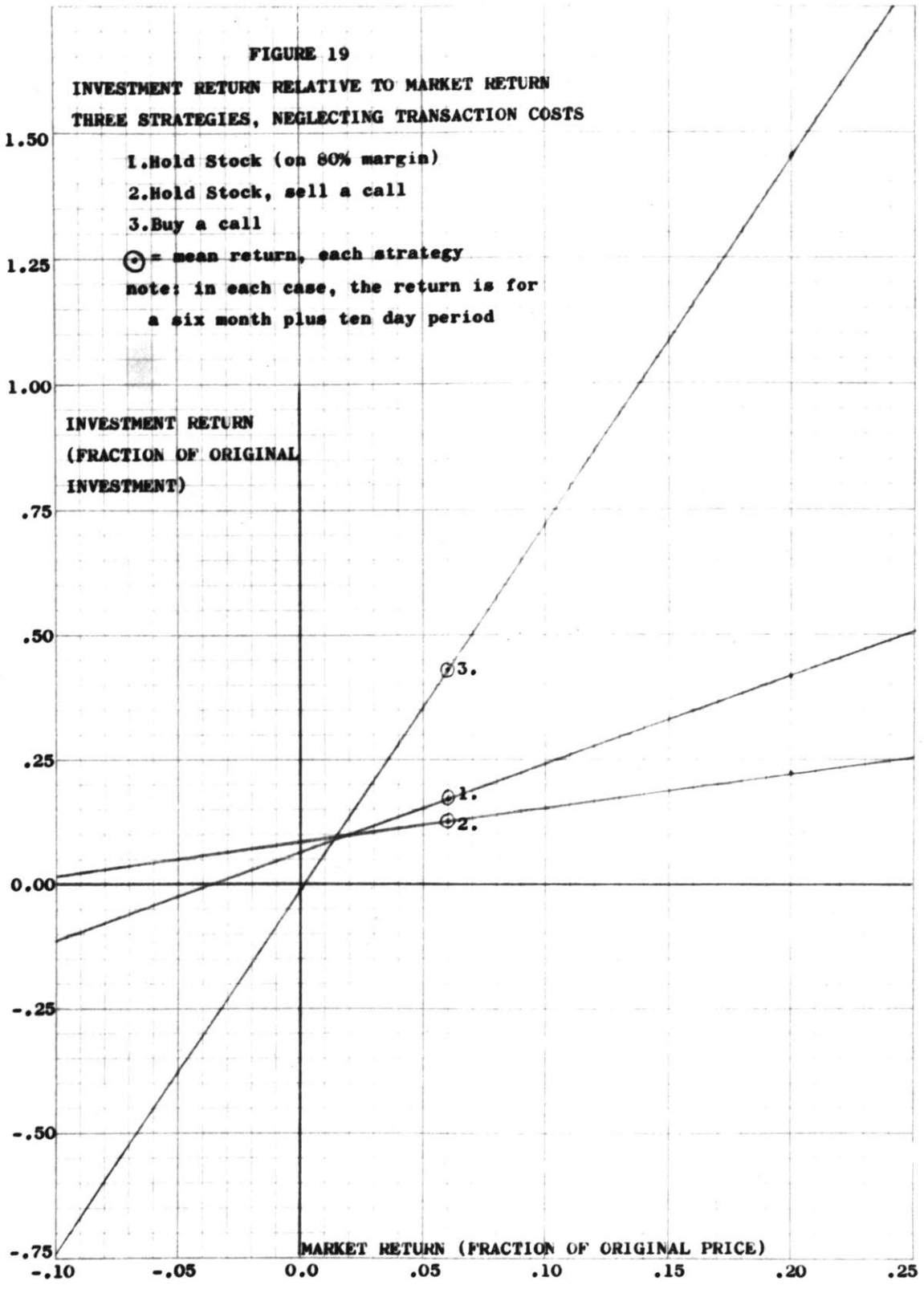




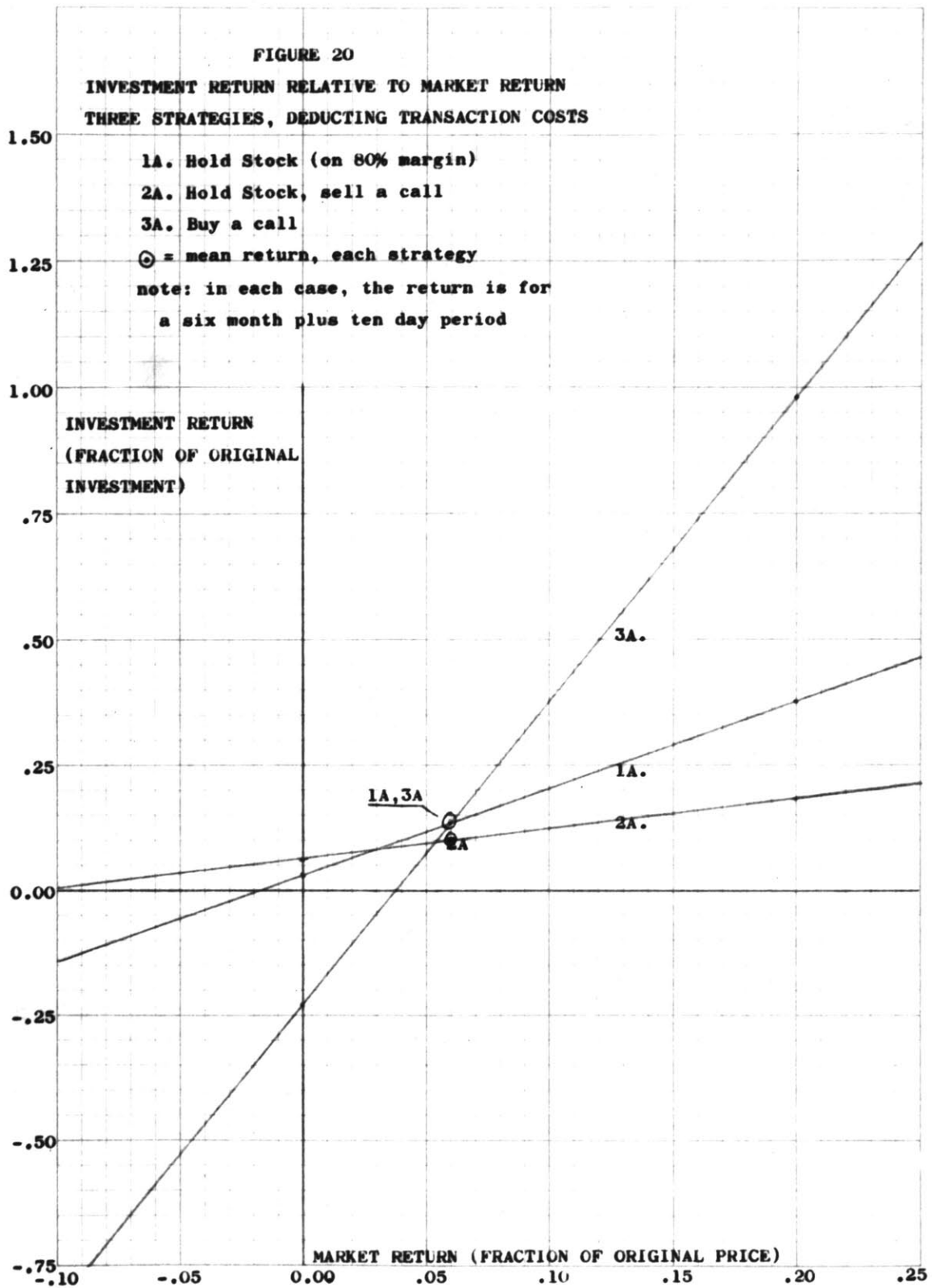
MEAN = 0.22495 RE = 7.074 COSTS, ERROR = 0.54267 RESVAP = 0.11074 CORREL = 0.26461

NAME	LOWER	UPPER	SCALE	UNDO	OVER	POINTS	TEST1	TEST2	MEANS
X	-0.0914	0.2732	0.2036	0	0	1565			0.06067
Y	-1.0000	0.5519	0.2110	0	0				0.13069









## CHAPTER VI

## SUMMARY AND CONCLUSIONS

The Sharpe capital asset pricing model provides a good frame of reference for evaluating option trading. Based on records of 1,665 call options of six months plus ten days' duration, three portfolio strategies were compared: (1) hold the underlying stock (80% margin), (2) hold the stock and sell a call, (3) buy a call. These strategies were compared without transaction costs and again with transaction costs.

This provided a very useful method of comparison, because strategies (2) and (3) together are actually a "zero sum game" relative to strategy (1). That is, the sum of investments of (2) and (3) and the sum of profits of (2) and (3) must be exactly the investment and profits of (1). Likewise the total risk of (1) is divided between (2) and (3).

An obvious conclusion is that a great deal of risk is transferred from strategist (2) to strategist (3). The histograms of distribution of returns show that strategy (2) is much narrower than strategy (1), and that strategy (3) is an order of magnitude wider than either (1) or (2). In the frictionless world of no transaction costs, the returns on investments for the three portfolios were, respectively, 14.8%, 10.1%, and 39.4%, per six months, a seemingly rational distribution. However, transaction costs for strategy (1) consumed 14.3% of the profits, whereas for (2) and (3) combined the transaction costs consumed 34.6% of the same gross profits. The actual returns on investments for the three portfolios were, respectively, 12.7%, 8.5%, and 14.2%, per six months. It is clear that the call buyer has been most hard hit by the transaction costs, and that his strategy was, in the aggregate, really thwarted.

These actual results were achieved during a period when the mean return on the Standard and Poor index was 6% per six months. Curiously, the mean return on the stocks in the option sample was 12.7%, substantially greater than predicted by the market model. I believe that this

discrepancy is due to a general upward evaluation of higher risk stocks during the period under study (August 1966-June 1969), and not to any special knowledge of option traders in general.

The random risk of any asset can be diversified away by portfolio selection, and this is true even of the enormous variance of the call buying strategy. Therefore, regressions were run of return on investment against return on the market average, in order to measure the non-diversifiable risk. Although the relationships are clearly not linear at the extremes, still, least-squares linear regressions yielded significant coefficients. The coefficients are analagous to beta in the Sharpe model, as they are the factor by which percentage changes in the market average are multiplied to predict percentage changes in portfolio return. The coefficients for the three frictionless strategies were, respectively, 1.75, 0.68, and 7.30; and for the cases subtracting transaction costs 1.75, 0.62, and 6.07.

To state a single conclusion from the foregoing summary, it appears that option trading is a highly effective but quite inefficient means of transferring

leverage on the returns from the market average. Especially for the call buyer, the magnitude of the transaction costs changes an otherwise fair game to a gamble in which there is a substantial expectation of loss.

The total variance of returns, taken historically to the date a contract was written, seems to be a most important determinant of the option premium. The regression of percentage premium against total variance approximately duplicates the relationship found by St. Peter. Given the high leverage on market return that option trading provides, it was expected that the covariance of a stock's return with the market return (beta) would be a determinant of the premium. It was found that optioned stocks in general have a higher than average beta (median 1.4), but surprisingly, that the regression of premium against beta was of doubtful significance. In order to investigate the effect of special knowledge (such as insider information) on the pricing of options, the percentage premium was regressed against subsequent returns on the stock. The relationship was insignificant, indicating either that the amount of inside information is small, or that it is not very valuable.

The total data base prepared for this study is almost 10,000 transactions. Since only a small fraction was analyzed, it is recommended that this study be continued along the present lines. An analysis should be made of profitability, especially considering transaction costs, for other types of options--puts and straddles, and for other durations--one, two, three, and twelve months. There is also the opportunity to extend the study to the end of 1969, and possibly into the severe downward market of 1970. Similarly, option pricing models, such as that proposed by St. Peter, or further revisions by Professor Scholes, should be pursued considering the findings of the present study. It is anticipated that out of such a combined approach a comprehensive model of the actual option market can be developed.