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DETERMINANTS OF BID–ASKED SPREADS IN THE OVER-THE-COUNTER MARKET*

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Security market regulators, among others, are concerned to know whether or not dealers are natural monopolists. Based on a randomly drawn sample of 314 over-the-counter stocks, the results of this study suggest that while there are economies of scale, they are not on the dealer level. In addition, both systematic and unsystematic risk were tested for association with the transaction costs in this market. The evidence suggests unsystematic risk is related to spread.

1. Introduction

The mark-up charged by dealers to consumers in the securities market, as in any other market, is a function of the operational efficiency of the dealers and the nature of the product. Because the security markets are regulated, the specific determinants of this mark-up need to be estimated to answer public policy questions as well as to satisfy intellectual and managerial interest in the dealers' production functions. The importance of these determinants is illustrated by the recent debate over whether or not specialists are natural monopolists, a question central to the furor over the relationship between the New York Stock Exchange (NYSE) and the third market. These questions make it essential that the nature of transactions costs in these markets be understood. The purpose of this paper is to analyze the determinants of spread in the over-the-counter market (OTC), to determine if the dealership function is a natural monopoly and to test other hypotheses.[1]

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[1]Several other studies analyze the determinants of the spread between bid and asked per share prices. Demsetz (1968) developed a theory of transactions costs in the securities markets (on which we rely, in large measure) and provides some empirical verification of the theory by analyzing the specialists' spread on NYSE stocks. Tinic and West (1972) used Demsetz's analysis to study the spreads on OTC stocks. These studies made important contributions to the theory and measurement of transactions costs but, as the authors pointed out, the data used are not sufficient to allow more than tentative support for Demsetz's theory. In addition, the treatment of risk in both studies is inadequate (Demsetz does not discuss risk; Tinic and West use a poor measure).

The analysis is based on standard demand theory. The product offered by security dealers [as Demsetz (1968) points out] is an immediate exchange of titles to securities instead of a delayed exchange. Dealers provide this immediate exchange by matching buy and sell orders and by holding an inventory of securities which is used to fill unmatched orders. The price charged for this product is the spread, the difference between the buying (bid) and selling (asked) price per share. The spread is a function of the market demand curve (the amount of immediacy demanded by investors), the competitiveness of the market, and the dealers' cost curves. In this study we take investors' demand for immediacy as given, and analyze per share spreads as a function of dealers' costs and market structure. This analysis allows testing of hypotheses about whether natural monopoly characterizes the share-trading market, whether the market is competitive and the prevalence and effects of insiders.

2. Determinants of the bid–asked price per share

An important factor affecting the dealers' costs is the amount of inventory required to provide the immediate transfer of shares they offer to investors. The amount of inventory a dealer must carry of a particular stock is a function of the volume of that stock's transactions. As volume increases so does the number of limit orders, which facilitate immediate exchange. These limit orders are a substitute for inventory; the greater the number of transactions, the lower the amount of inventory that must be held per transaction. Even without considering limit orders, standard inventory theory suggests that the inventory a dealer must hold to effect trading immediacy is less than a proportionate function of the number of transactions he expects to make. Thus the per unit cost of immediacy, i.e., the spread, should decline as the transactions rate for the security increases. The elasticity of the spread with respect to the number of transactions provides a measure of economies of scale from dealing in a particular stock, cet. par.

Inventory carrying costs per unit are a positive function of the riskiness of holding the inventory, if dealers are risk averse and are unable to eliminate the risk by portfolio diversification. (Since the concept of risk is not discussed extensively in previous studies,[2] an elaboration is provided in the following section.) Unlike most commodities, however, the cost of maintaining an inventory of securities does not include losses in value due to deterioration (although pilferage can be a problem). The cost of capital is also not a relevant

[2]Demsetz doesn't discuss risk. Tinic and West's (1972) basic discussion is the following: 'Our initial notion was to hypothesize a positive relationship between spreads and price volatility on the grounds that the greater the variability in price, the greater the risk associated with performance of the dealership function. On further reflection, however, we concluded that we should not try to predict the sign of this coefficient since it might be possible for the influence of price volatility to be negligible if a dealer could diversify his operations sufficiently.' Tinic's study (1970) of spreads on the NYSE reported in Tinic (1972) uses the standard deviation of the price of a security, presumably as a measure of risk (although no explicit rationale for inclusion of the statistic is given in the brief review of his analysis).

cost of carrying the inventory, since the returns from holding the securities normally reflect the opportunity cost of the capital invested. Thus, the inventory carrying costs are primarily due to the risks incurred in holding the inventory.

Dealers also incur costs in matching buy and sell orders. If economies of scale characterize these transactions, per share spreads should be a function of the volume of trades in a specific stock. Transactions costs also may be related to the dollar amount traded. While transactions are stated in terms of the number of shares traded, market participants trade basically in dollar denominated claims. Were all factors other than price per share equal, traders would use limit orders to equalize the spread per dollar regardless of the price per share traded.[3] Consequently, spreads would be proportional to the per share price. This strict proportionality might be eliminated by disportionate broker costs since, if it is costly per dollar traded to enter the market for low-priced securities, the arbitrage mechanism could not equalize the spread per dollar. Thus spread should be positively, though not necessarily proportionally, related to the price of a stock.

Trading with insiders increases the dealers' costs and hence affects the per share spreads as Bagehot (1971) has pointed out. Insiders (by definition) have information which dealers do not. If they cannot identify the traders who are insiders, dealers must increase spreads on those shares which they believe are traded by insiders.

Finally, the extent of competition, measured by the number of dealers who compete in making a market for a stock, should be reflected by the spread. A large number of dealers should keep the spread down to the competitive level. It is also possible that smaller spreads are associated with a larger number of dealers because the presence of other dealers allows any one dealer to offset a temporary inventory imbalance with interdealer trading. The two factors suggest that spread should be negatively related to the number of dealers making a market in the stock.

It should be noted that the number of dealers and the number of shareholders are likely to be correlated with each other since larger companies have more stockholders and more dealers who are interested in making a market in the stock. To the extent that these variables are correlated with company size, their coefficients may measure the relation between the size of the firm and the spread changed by dealers. This proxy relationship should be remembered when the coefficients are interpreted.[4]

In summary, standard economic theory applied to the market for immediate transfer of titles to shares, indicates that

$$SP = f(NT, PS, HR, IR, ND), \tag{1}$$

[3]There is some belief that lower priced shares, as such, have greater variation in price than do higher priced shares. However, Heins and Allison (1966) show that this belief is groundless. Also, as is discussed below, it is irrelevant as a determinant of spreads.

[4]There is also some reason to believe that residual variance, which is our measure of holding risk, is negatively related to company size.

where

SP = spread per share, the price of an immediate transfer of title;

NT = number of transactions in a stock;

PS = price per share;

HR = holding risk due to holding a stock in inventory whose price might change (up or down);

IR = insider losses due to trading with insiders in a stock which, if purchased, is likely to go down in price or, if sold, is likely to go up in price more than expected;

ND = number of competing dealers making a market in a stock.

The relationship between SP and NT provides an estimate of economies of scale that results from savings in inventory and transactions costs, cet. par. The number of transactions in a particular stock by a given dealer and the spread charged by him would be most appropriate for this estimate. Though market spreads are analyzed, appropriate inclusion of the number of dealers in the analysis allows making an estimate of the elasticity of spreads with respect to the total number of transactions, given the number of dealers. (Some additional evidence is brought in below to delineate market from individual dealer economies of scale.) The relationship of SP and HR, cet. par., also provides a measurement of the extent to which dealers can diversify risk and are risk averse. The relationship of SP and IR, cet. par., provides a measure of the extent and cost to dealers of trading with insiders. The relationship of SP and ND provides an indication of the effect of degrees of competition on the price of immediate stock title transfers. PS serves as a 'homogeneity' variable with respect to the transactions costs of transferring titles.

3. Specification of the variables and sources of data

Data for a five-year period, 31 January 1963 through 31 December 1967, were collected (laboriously) and checked (carefully) on a randomly selected sample of 314 over-the-counter firms which had at least 500 stockholders and one million dollars in assets and for which the information required to specify the variables was available.[5]

Spreads (SP) were computed as the difference between the bid and asked

[5]Initially, 326 securities were included in the sample, 12 of which had negative betas. Since we ran regressions in the logarithms, these 12 were dropped from the sample.

prices for each security. These prices, as of the last trading day in each month, were taken from the National Stock Summary.[6]

When several dealers quoted different prices for the security, the price quoted by the dealer who made a market for the most months in each six month interval was used, unless two-thirds or more of the other dealers quoted a different price, in which case their price was recorded.[7] The month-end spreads then were averaged for each security over the entire sixty month sample period to reduce potentially spurious correlations due to random fluctuations. The bid price was taken as the price per share of the security (PS), and averaged in the same way as the spreads.

The number of transactions (NT) are not available for OTC shares. Following Demsetz (1968) we approximated NT with the number of shareholders (NS). As he points out, the number of people holding the security is positively related to the number of potential buyers and sellers of the stock. The number of stockholders (NS) at the end of each year was taken from various Moody's Manuals. NS equals a simple average of the five yearly numbers.[8]

Specification of holding risk (HR) and insider risk (IR) requires some discussion, since risk either was not considered or ill-defined in previous studies. Demsetz (1968) does not mention risk. Tinic and West (1972) tested the relationship between risk and spread by using the high minus the low price divided by the average price for the period as a proxy for risk. This measure of risk can be criticized on two grounds. First, Pinches and Kinney (1971) have shown that it is not stable over time. Second, it is an ad hoc measure that has no theoretical basis. Consequently, one cannot accept or reject Tinic and West's (1972, p. 1716) conclusion that over-the-counter market makers are able to eliminate risk by diversification based on their empirical finding that spreads are not significantly related to their measure of risk. However, a well defined model exists that can provide theoretically defensible and meanfully specified measures of risk.

The 'market' model developed by Sharpe (1963) postulates that the relation-

[6]Demsetz's (1968) data are an average of spreads quoted on a randomly selected sample of 192 NYSE securities for two trading days, 5 January and 28 February, 1965. Tinic and West (1972) derive their findings from two sets of data: 68 stock issues traded on 18 January, 1962, and 300 issues traded during the first five trading days in November, 1971. The authors state: 'Due to the significant differences in the size of the samples for 1962 and 1971 and the variations in statistical methodology employed, it is not possible to make direct comparisons of the coefficients of the models estimated for those two periods' (p. 1720).

[7]Tinic and West (1972) describe their dependent variable as 'average representative bid-ask spread'.

[8]Tinic and West (1972) use total sales and purchases during the day(s) for which they recorded spreads. As they state in analyzing their findings for their January 18, 1962 sample: 'The relatively poor 'fit' no doubt reflects the use of only one day's trading data, i.e., the presence of considerable spurious variability in volume' (p. 1712). Their 1971 sample used average of five days' volume. The t-ratio for this variable is 3.9 compared to -1.3 for the 1968 sample. Demsetz (1968) uses the number of separately recorded transactions (T) per day (apparently on each of the two days for which he gathered data) and the number of shareholders (N) recorded in Moody's. He finds that N is a slightly better regressor than T, though N and T are highly correlated.

ship between the rate of return on a security and the market may be described by:

$$\tilde{R}_{jt} = a_j + b_j \tilde{R}_{mt} + \tilde{e}_{jt}, \tag{2}$$

where $\sim$ designates a random variable, and

$\tilde{R}_{jt}$ = $\ln[(\tilde{P}_{jt} + \tilde{D}_{jt})/P_{jt-1}]$,

$\tilde{P}_{jt}$ = price of the jth security at time t,

$\tilde{D}_{jt}$ = the dividend paid on the jth stock during t,

P_{jt-1} = the price of the jth stock at $t-1$ adjusted for capital changes during t,

$\tilde{R}_{mt}$ = $\ln[\tilde{M}_t/M_{t-1}]$,

$\tilde{M}_t$ = a general market index at t,

$\tilde{e}_{jt}$ = a random error term that is serially independent and contemporaneously independent of $\tilde{R}_{mt}$.

The relationship between the return on the stock and the market is measured by b_j which is often called the beta coefficient. If eq. (2) holds[9] then the variance of $\tilde{R}_j$ is equal to

$$\mathrm{Var}(\tilde{R}_j) = b_j^2 \sigma^2(R_m) + \sigma^2(e_j). \tag{3}$$

The term b_j measures the risk of the stock that is due to its correlation with the market; it usually is called the stock's systematic risk. The unsystematic risk, $\sigma^2(e_j)$, is the risk that is unique to the jth firm.

The capital asset pricing model, developed by Lintner (1965) and Sharpe (1964), implies that the expected return from holding an asset will fully compensate the owner for bearing the systematic risk associated with it. Thus the spread should not be affected by the systematic risk component of the holding risk (HR) since the dealer will already be compensated for it.[10]

Markowitz (1959) has shown that the unsystematic risk, $\sigma^2(e_j)$, can be eliminated as the number of securities held approaches infinity. However, dealers may not hold a perfectly diversified portfolio of securities because of diseconomies associated with increasing the number of markets they make. Since the number of securities required to reduce a portfolio's unsystematic risk is a positive function of the degree of the individual securities' unsystematic risks, spread and unsystematic risk may be positively associated.

As mentioned before, dealers face the risk of buying from or selling to insiders

[9]This model was tested by Fama, Fisher, Jensen and Roll (1969) and others who found it valid empirically.

[10]Jensen (1972) provides a thorough discussion of this model and its empirical validity.

who, on average, know something positive or negative about a firm's economic position before other market participants. We hypothesize that this insider risk (IR) is related to the security's unsystematic risk; since unsystematic risk (residual variance) results from the market's adjustment to firm specific information. The more frequent is the occurrence of firm specific events the larger the residual variance and hence the greater is the insiders' opportunity to trade against dealers, since dealers cannot readily determine if a stock price change is a consequence of inside activity or not.[11] A dealer's reaction to this situation will be to increase the spread on those stocks that present him with this risk and expend resources on discovering 'inside' information about the companies whose securities he trades.[12] Consequently, we expect a positive relationship between spreads and unsystematic risk. Because a significant positive relationship between SP and unsystematic risk (UR) is consistent with two hypotheses – insufficient diversification and inside trading – we conduct additional tests.

Thus two measures of risk are identified – systematic risk (SR) which measures the risk of holding a stock whose price changes relatively more or less with respect to market changes, and unsystematic risk (UR) which measures risk specific to a stock with general market risk accounted for. Systematic risk provides one measure of the cost of holding risk (HR). Unsystematic risk provides a measure of HR and insider risk (IR). The measures of risk (SR and UR) were calculated by estimating eq. (2) for each of the 314 securities in our sample using sixty monthly prices for each stock to calculate the stock's return and the Standard and Poor 500 Index as a measure of general market conditions (M). As discussed before, the b_j's are the proxies used for systematic risk (SR), and the residual variances from each regression, $\hat{\sigma}^2(e_j)$, are the estimates of unsystematic risk (UR).

The number of dealers making a market in each security (ND) during each half year in the sample period, as indicated by their having offered to buy and sell the security, was taken from the National Stock Summary and averaged.[13]

4. Empirical findings

Table 1 gives the mean, median, standard error, and interquartile range for

[11] The hypothesis that follows is due to Bagehot (1971) and Michael Jensen (in conversation).

[12] As with all allocations of resources, the dealer can maximize his gains (or minimize his losses) by using a mix of strategies according to the related marginal costs and revenues associated with each and with various combinations.

[13] In their study on OTC spreads, Tinic and West (1972) use a similar measure, although the number of dealers are only those giving quotes on the one day (1962 sample) or the five days (1971 sample) studied. Demsetz (1968) uses the number of markets in which a NYSE security was traded as his measure of competition. In his study of NYSE spreads, Tinic (1970, p. 16) criticizes Demsetz's measure because it 'need not indicate the degree of effective competitive pressure on the NYSE specialists', and calculates instead an 'index of trading concentration'. The index of trading concentration is a Herfindahl concentration index, the sum of the squared ratio of trading in each market, where the sum of the ratios = 1.

Table 1

Summary statistics describing how the dependent and independent variables are distributed over the securities in the sample, before transformation to logarithms (314 securities).

	Mean	Median	Standard error	Interquartile range
Dollar spread (SP), average	0.88	0.68	0.67	0.51
Bid price (PS), average	31.85	24.50	31.34	31.06
Number of shareholders (NS), average	3883.39	2304.08	4321.51	3279.96
Number dealers (ND), average	12.48	10.10	9.22	8.67
Systematic risk (SR)	0.82	0.63	0.68	0.68
Unsystematic risk (UR) × 10	0.10	0.03	0.17	0.09

Note: Variables which are averages were averaged over five years for each security.

each of the variables used in the analysis. The data in this table are the values of the variables for each security tabulated over all the securities in the sample.

Since there is no a priori functional relationship between the spread and the explanatory variables, various functional forms were estimated. The log-linear relationship satisfies best the assumptions required for least squares, primarily because this transformation eliminated the obvious skewness in the original variables. The results of the regression when b_j was used as the risk variable are shown in table 2. The coefficients associated with price per share (PS), number of dealers (ND), and number of stockholders (NS) are all of the hypothesized sign and are significant at the 1% level. The coefficient associated with systematic risk (SR) is insignificant, consistent with our a priori reasoning that the expected return on the stock should compensate the dealer for this risk.

Table 2

Results of regression using market risk (314 observations).

Independent variable	Coefficient	Standard deviation	t-ratio
Constant	0.63	0.01	46.84[a]
ln PS	0.471	0.018	26.16[a]
ln NS	−0.266	0.024	−11.00[a]
ln ND	−0.124	0.032	−3.87[a]
ln SR	−0.011	0.022	−0.500
$R^2 = 0.75$,	$F = 232.26$		

[a]Statistically significant at 0.1%.

Table 3 contains the regression results when unsystematic risk (UR) is used as the risk variable. All of the coefficients, including that of UR, have the expected sign and are statistically significant at the 0.1 % level. The discussion that follows refers to this table.[14]

Not surprisingly, the price per share (PS) is the most important explanatory variable (in terms of the *t*-ratio). Since all the variables are logarithms, the coefficients provide direct estimates of elasticities. The coefficient of PS, 0.594, indicates that higher priced shares have higher spreads per share but the relationship is less than proportional, since a doubling of share price is associated with only a 59 percent increase in spread, cet. par. This finding is consistent with both the Demsetz (1968) and Tinic and West (1972) studies which found a positive relationship between spread and share price. Demsetz's (1968, p. 53) results also

Table 3

Results of regression using unsystematic risk (314 observations).

Independent variable	Coefficient	Standard deviation	*t*-ratio
Constant	0.59	0.01	53.90*
ln PS	0.594	0.023	25.82*
ln NS	−0.165	0.026	−6.35*
ln ND	−0.268	0.032	−8.38*
ln UR	0.137	0.019	7.21*
$R^2 = 0.78$,	$F = 286.4$		

*Statistically significant at 0.1%.

indicate a lack of proportionality in this relationship, although he does not emphasize this finding. The fact that spread does not increase equally with share price is consistent with the hypothesis that brokerage costs may prevent arbitrage from ensuring an equal price of immediacy per dollar traded. This result suggests that simple linear models may be inappropriately specified when used to examine the determinants of spread.

The significant negative coefficient associated with the number of stockholders (NS), the proxy for scale (number of transactions, NT) suggests that as scale increases the per share price of immediacy declines. This result is consistent with Tinic and West (1972) and Demsetz (1968) in terms of sign. The estimated elasticity of −0.165 also indicates that the saving from increased scale (trading volume) is less than proportional to the increase in scale, which is again consistent with Demsetz's (1968, p. 49) results for the New York Stock Exchange. If the

[14]The regression results do not suffer from severe multicollinearity based on Haitovsky's (1969) test using a significance level of 0.001%.

cause of this decline was at the dealer level, then immediacy for any security would be provided by only one dealer who would be a natural monopolist. However, Tinic and West (1972) present evidence which shows that the number of dealers increases with volume, a finding which is not consistent with the hypothesis that the dealer cost curves decline as volume increases.[15]

This conflict can be reconciled by considering each dealer who makes a market in a particular stock as being a member of an industry comprised of all dealers who maintain an inventory of the stock. The spread is the industry supply price of immediacy and it can decline as volume increases because of industry economies which are external to the firm but internal to the industry. Thus, dealers may face positively sloped marginal cost curves which shift down as industry output increases.[16] This reasoning, which is consistent with the data, indicates that dealer firms need not be considered as natural monopolists for public policy purposes, since decreasing cost industries are consistent with pure competition.

Finally, the significant coefficient of unsystematic risk (UR) indicates either that the costs of diversifying make it uneconomical for dealers to eliminate this unsystematic risk and/or that unsystematic risk is a proxy for the average losses due to trading with insiders. Some evidence on the extent of dealer diversification is provided by a survey of dealers in the Special Study (1962, part III, p. 679) which indicates that 57% of the dealers made a market in ten or less stocks. Since Fisher and Lorie (1970) have shown that a portfolio of sixteen stocks is required to eliminate 90% of the unsystematic risk,[17] the survey results suggest that the majority of dealers are not adequately diversified. Since the dealers could, in principle, become more fully diversified by increasing their product line, this lack of diversification suggests that there are costs associated with diversifying.

The hypothesis that dealers increase the spread when faced with the risk of dealing with insiders also is supported by the significant coefficient of the unsystematic risk variable, on the assumption that unsystematic risk is related to insider trading. A crude test of this assumption was made by collecting the percentage of stock held by the top twenty stockholders who were officers and/or directors, i.e., insiders, of 59 banks in our sample.[18] We correlated these percentages, which are rough estimates of the potential for insider trading, with the unsystematic risk (UR) of the same 59 banks. The resulting Spearman rank order correlation coefficient was +0.28 which is significant at the 5% level. Although

[15]The correlation between the number of dealers and the number of stockholders in our sample is 0.47 when the untransformed data are used. The correlation between the natural logs of these variables is 0.41. As noted above, this correlation might also be due to size.

[16]This idea was first suggested to us by James Hamilton. Industry economies of scale could result from the ability of dealers to offset inventory imbalances by trading with other dealers, although additional research is needed to isolate these economies.

[17]See also Evans and Archer (1968) on this point.

[18]These data were collected from the U.S. House of Representatives, Subcommittee on Domestic Finance, Committee on Banking and Currency. Twenty Largest Stockholders of Record in Member Banks of the Federal Reserve System, 88th Congress, 2nd Session, October 15, 1964.

much more research needs to be done on the relationship between insiders and unsystematic risk, this evidence leads us to accept tentatively the hypothesis that exposure to insider trading is one of the determinants of spread in the over-the-counter market.

5. Summary and conclusion

Traditional economic analysis, first applied by Demsetz (1968) to the price for effecting immediate transfers of title to shares (bid–asked spreads), is used to analyze the determinants of spreads in the over-the-counter market. The sample collected allowed more theoretically and empirically valid tests of hypotheses than are presented in previously published studies. The present study found statistically significant (0.1% level) relationships of the sign postulated between spreads per share and price per share, number of stockholders (a proxy for the scale of transactions), number of dealers, and unsystematic risk. None of these relationships appear linear, which suggests that the linear models used in earlier studies were not appropriate, though the findings of these studies generally are consistent with ours.

The estimates provide evidence on the hypotheses presented in the first section of the paper. Economies of scale in trading are found – trading scale (measured by the number of shareholders) is negatively related to spreads (a doubling in the number of shareholders is associated with a 16.5% decrease in spread). While this might be taken to mean that dealers are natural monopolists, additional data suggests that the results may be more consistent with security dealing being a decreasing cost industry with economies external to the individual dealer. The coefficients estimated also indicate that competition (measured by the number of dealers) is associated with lower per share spreads (a doubling of the number of dealers is associated with a 26.8% decrease in spreads).

The risk (inventory holding and insider) measurements used are derived from the capital-asset pricing model. As was expected, systematic risk (beta) is not associated with spreads. Unsystematic risk (residual variance), which is associated with spreads, measures the dealers' cost of portfolio diversification and their cost of trading with insiders. Additional evidence suggests that both explanations are relevant.

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