# Examination of Tobin's q for Takeover Firms

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## Abstract

This study investigates whether the Tobin's q's for firms involved in takeovers are significantly different from those of similar firms not involved in takeovers. The hypotheses are that the q of an acquiring firm is higher than that of control firms and that the q of a target firm is lower than that of control firms. After correcting for bias, a paired comparison t-test is employed to test the hypotheses. Acquirers' q-values are higher than those of control firms. Targets' q-values are not significantly different from those of controls—which is contrary to previous evidence that suggests targets have lower q's.

## Introduction

Most takeover studies focus solely on stock market returns to the shareholders of participating firms. Numerous studies attempt to measure wealth effects of takeover by estimating abnormal returns using event studies for successful and unsuccessful bidding and target firms around the announcement date of tender offers (e.g., Bradley, 1980; Bradley and Wakeman, 1983; Dodd and Ruback, 1977; and Kummer and Hoffmeister, 1978) and mergers (e.g., Asquith, 1983; Dodd, 1980; Eckbo, 1983; Halpern, 1973; Langetieg, 1978; Malatesta, 1983; and Stillman, 1983).

Few studies examine financial characteristics other than returns of participating firms. Monroe and Simkowitz (1971) in a study of targets conclude that targets generally are smaller and have lower PE ratios, lower dividend payout ratios, and lower equity growth. They suggest that such characteristics may play a role in motivating mergers. Stevens (1973) concentrates on the financial characteristics of acquired firms. His results are inconsistent with those of Monroe and Simkowitz—he finds liquidity to be important, but not dividend payout ratio and PE ratio. Harris *et al.* (1982) examines financial statement variables and product market characteristics to determine whether characteristics of acquired firms differ from those of nonacquired firms. Product market characteristics are


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not important, but size (small) and PE ratio (low) do affect whether a firm is acquired. In general, these studies do not present a consistent picture of acquired and acquiring firms and do not provide clear evidence favoring certain merger motives.

Hoffmeister and Dyl (1981) examine only targets to determine what factors may predict a successful takeover. They find target management reaction to be a decisive factor. Financial characteristics (assessable *ex ante*) that differ between successfully and unsuccessfully acquired targets include (in order of importance): size, earnings growth, current ratio, payout ratio, and price-earnings ratio. One reasonably may expect a firm's q-ratio to be related to the last four factors. The importance of size in this and other studies mandates that size be controlled while studying differences in q's.

Inconsistencies between these studies' results are understandable. The purposes of the studies differ. Further, their time periods are different; characteristics of acquired firms may change over time. Many of the studies deal with only acquired firms or only acquiring firms. Takeovers involve two or more firms; studies that consider only one party may give erroneous impressions. Finally, most of the studies, implicitly or explicitly, attempt to test a particular theory of merger motives. This may affect variable selection and interpretation of the results. A more general, multicausal model with control samples is needed to alleviate these problems.

This study investigates whether takeover decisions are consistent with Tobin's theory of investment. The study has two objectives. The first, and more important, is to examine whether takeover firms have atypical Tobin's q's. Next, if the targets' and acquirers' Tobin q's are different, this research attempts to see if they are different enough to help predict takeovers. Successfully acquired targets are more likely to be atypical. Therefore, this study is limited to firms actually involved in successfully completed takeovers.

The first part of the study serves to replicate both Chappell and Cheng (1984) and Hasbrouck (1985). The results support those of Chappell and Cheng, but contradict those of Hasbrouck. The prediction results are dismal.[1] There are not enough differences in q's to be of predictive value.

## Tobin's q

Tobin (1967, 1969) posits that the rate of investment is related to q, the ratio of the firm's market value relative to its replacement cost. In equilibrium,

[1]The inability to predict takeover firms is not surprising. Such a finding is consistent with earlier studies (e.g., Harris *et al.*, 1982) and the efficient market hypothesis. That is, given the extraordinary returns to owning shares in target firms, being able to pre-identify such firms would provide investors a way of earning above average returns.

every firm should have a q-value of one. If a firm's q is above one, this should stimulate investment; a q below one should discourage investment. (For further elaboration, see Tobin and Brainard, 1977, p. 242.)

An important characteristic of the q theory of investment is that q can be derived by assuming that firms face adjustment costs and make investment and output decisions to maximize market value. In other words, a modified neoclassical theory of investment with adjustment costs and the q theory of investment are equivalent. (See Lucas and Prescott, 1971; Yoshikawa, 1980; and Hayashi, 1982.)

Tobin's q has been used as an explanatory variable to evaluate the monopoly status of firms. Lindenberg and Ross (1981) use it to assess firms' monopoly rents. Smirlock *et al.* (1984) also uses q to examine the empirical relationship between firm rents and market structure. Chappell and Cheng (1984) consider whether q signals favorable opportunities for a firm to make acquisitions. All of these studies find q useful in measuring a firm's monopoly power and in evaluating the profitable investment opportunities available.

Hasbrouck (1985) studies differences in financial characteristics of target and nontarget control firms using multivariate logit analysis. His control firms are matched by either size or industry; his explanatory variables include q, size of firm, total financial leverage, long-term financial leverage, current liquidity, and net current liquidity. Hasbrouck's results indicate that target firms are characterized by low q-ratios and, to a lesser extent, high liquidity.

## Methodology

### *Hypotheses*

The implicit hypothesis of this study is that markets are allocationally efficient. If a firm's opportunity to invest is summarized by Tobin's q, q can be used to evaluate whether markets are allocationally efficient. To allocate the resources of a society better, high q firms should invest and low q firms should be acquired by those who can do more with resources.[2] The implications of this theory provide the following research hypotheses:

$H_O1$: There will be a significant difference in the q's of acquiring and control firms, where control firms are not involved in the market for corporate control. All high q firms may not seek external investment. Recognizing that external investment is a quicker way to grow than is internal investment, however, the higher a firm's q, the greater its incentive to grow externally.

[2]The idea that low q firms should become targets comes from Scherer (1980), as explained by Chappell and Cheng (1984).

$H_O2$: Because low q firms are selling for below replacement cost, they are more apt to become targets. Target firms will have lower q's than will control firms.

*Sample: Experimental Firms*

There are two groups of firms in the experimental sample: acquirers and targets. Targets come from the Compustat research tapes; 1,022 firms were deleted from the tapes because of mergers and acquisitions—760 after 1977. The SEC began requiring replacement cost (RC) data in 1976. To calculate Tobin's q, market value of common stock is needed, so only NYSE-listed firms (222) are included as targets; 171 of 222 firms had the desired (mining and manufacturing) SIC codes.

Acquirers corresponding to these target firms are identified from the *Wall Street Journal Index*, as is the announcement date of merger plans. The announcement date determines which year's data to use in order to calculate Tobin's q (the fiscal year of the announcement date). Seventy-one acquired firms are found that satisfy data restrictions:

- Acquiring firm listed on the Compustat industrial tape; and
- Ten years of data available for the acquirer.

A list of the firms and the matched controls is available from the authors.

*Sample: Control Firms*

Each experimental firm, acquirer and target, is matched by industry and size with one control (nontakeover) firm. Industry is defined by SIC code. If no size-matched (total assets within plus or minus 50 percent of the experimental firm) control firm can be found in the four digit SIC, a three digit (two digit) designation is employed. Within the SIC group the closest size match possible is chosen.

*Summary of Sample Firms*

Seventy-one firms originally were included in each of the four sample groups. Applying a minimum size restriction ($100 million of total assets in merging year) eliminates 11 firms, leaving 60 firms. Eight of these 60 acquiring firms merged more than once. Only one merger for each acquirer is included in the sample, leaving 52 firms. One firm was deleted because of missing information on preferred dividends, and four firms were discarded because of missing data needed to calculate RC estimates. Two merger announcements were pre-1976.

The final sample consists of 45 firms in each of four sample groups, and only 45 are included in the paired-comparison t-test. Other elements of the analysis, however, include more—as many as possible in each case. All of the available bond ratings, for example, are included in the bond rating prediction models.

Of the 180 sample firms, 162 are manufacturers (SIC code 2000-3999). Eight firms are from mining. Matched acquiring firms are included regardless of their industry codes.

### *Measurement of Tobin's q*

Tobin's marginal q theoretically is related to the firm's rate of investment, but direct measurement of Tobin's marginal q is not possible.[3] Tobin's average q is used as a proxy for the marginal q. The use of average q to explain investment has been supported by Tobin and Brainard (1977, p. 243), and average q has been used frequently in empirical work.[4]

For each sample firm, Tobin's q for the takeover year is calculated using the most recently preceding year for which financial information is available. The Tobin's q for the control firm is calculated for the same calendar year as that of the sample firm.

## Market Values (MV)

The MV of a firm is the sum of the MVs of the common stock, preferred stock, and debt. Compustat's recorded year-end common stock MV is used as MV for equity. Unlike common equity, preferred stock is not actively traded. Preferred dividends are capitalized to approximate the preferred's MV, following Lindenberg and Ross (1981). Standard & Poor's provided a preferred stock yield index upon request by the authors.

MV of debt is difficult to obtain from book value data. MV depends on the maturity distribution of the firm's bonds, coupon rates, and the current yield to maturity. Lindenberg and Ross provide an approximation.

[3]Gordon and Bradford (1979) suggest an indirect method for calculating a marginal q. They argue that the capital gain equivalent to a dollar of dividend equals Tobin's marginal q if firms optimize dividend policy.

[4]See Chappell and Cheng (1984), Ciccolo and Fromm (1979), and Malkiel *et al.* (1979).

## Replacement Cost (RC)

RC is defined as "the dollar outlay needed to purchase the current productive capacity of the firm at minimum cost and with the most modern technology available" (Lindenberg and Ross, 1981, p. 12). Therefore, it is necessary to include not only inflation but also technological advances and real depreciation to determine RC. For practical purposes, technological factors are not considered in this study.

Firm assets fall into three broad categories: plant and equipment, inventories, and other assets. Other assets include liquid assets (such as cash and securities) and land. These assets are assumed to have a RC equal to book value. Total RC at time t, $RC_t$, is defined as:

$$(1)\ RC_t = TA_t + RNP_t - HNP_t + RINV_t - HINV_t$$

where:

$TA_t$ = Total assets as reported in year t;
$RNP_t$ = Net plant at RC in year t;
$HNP_t$ = Net plant at its historical value in year t;
$RINV_t$ = Inventories at replacement cost in year t; and
$HINV_t$ = Inventories at historical cost in year t.

Although RC data are available from SEC 10-K filings, they are estimated instead because the SEC gives broad latitude in estimating replacement values, and RC data for many firms are missing in 10-K filings (Lindenberg and Ross, 1981). Parker's (1977) method is used to estimate replacement value for net plant, Lindenberg and Ross's methods for valuing FIFO and average inventories, and Parker's algorithm to estimate the RC for LIFO inventories.[5]

### *Test of Hypotheses and Effects of Violation of t-test Assumptions*

To test the hypothesis that the Tobin's q of experimental firms is significantly higher (or lower in the case of acquired firms) than those of control firms, the paired-comparison t-test for the matched samples (adjusted for bias) is used. The t-test assumes two independent random samples. The case-control design makes it impossible to have two independent random samples. The t-test also

[5]Lindenberg and Ross are unclear on how to estimate RC for LIFO inventories; therefore, this research chooses Parker's algorithm.

assumes that both samples (experimental and control) are from populations in which Tobin's q is normally distributed and in which the population variances are equal. Moderate departures from these two assumptions are known to have little effect on the validity of the test (Edwards 1967, p. 214).

Where there are two independent random samples, the means of the two samples will be the same except for the treatment effect, $\theta$. The null is that $\theta$ equals zero. To ensure that this assumption holds, two independent random samples are needed.

If the two samples are not independent, the difference between the means will be the treatment effect plus a bias effect. The problem is to keep the bias small enough so that the value of $\theta$ is not misinterpreted (Cochran, 1983, pp. 25-29).

Bias is the difference between population means for Tobin's q for the two groups of firms. Tobin's q may be influenced by a number of factors. There is likely to be at least one confounding variable differing systematically between populations that lessens the validity of statistical tests. Controlling all possible confounding variables is impossible, but as in equilibrium asset pricing models, a few variables seem to capture a major portion of the bias. Three variables are considered to be the major confounding variables affecting values for Tobin's q: industry, size, and responsiveness to market trend.

### *Techniques to Reduce Bias*

There are two principal techniques to reduce bias: matching and adjustment in analysis (Cochran, 1983). The difference between the techniques is the stage where confounding is handled. In matching, confounding variables are treated at the planning stage. Adjustment handles confounding during analysis. The current study controls industry and size by matching.

Market trend must be adjusted for during analysis. The important issue is how two groups of firms (experimental and control) differ collectively, not individually, in their responsiveness to the general market trend. This study adjusts for market trend by estimating market sensitivity coefficients for the q's—betas. These betas then are used to adjust the sample and control firms' betas in each year for the extent to which market q's were above or below average in that year.

### *Takeover Prediction*

There are several statistical methodologies for explaining and predicting firm behavior. The linear probability model and discriminant analysis are rejected because the assumptions underlying these techniques make them inappropriate for this problem.

Probit is a widely used nonlinear probability model based on the cumulative distributions of normal random variables. When there are few repeated observations on the data (as in this study, where there is only one observation for each firm), maximum likelihood estimation of probit models may be performed (Fomby *et al.*, 1984; Judge *et al.*, 1985). The estimation of coefficients is obtained numerically, i.e., by iterative procedures using SHAZAM from the University of British Columbia. Probit equations are estimated for each year in the sample period 1977-1983.[6]

Manski and Lerman (1977) claim that estimating parameters of a probabilistic choice model is a problem when choices rather than decision makers are sampled. Exogenous random sampling selects decision makers first, then observes their choice behaviors; choice-based sampling reverses the order. Manski and Lerman show that the maximum likelihood estimators appropriate to choice-based sampling methods (random choice-based sampling and random-exogenous sampling) have the same likelihood functions.

For random choice-based sampling, the sample share for a particular choice should be equal to the population share for the same choice. In other words, the ratio of experimental firms to control sample firms should be in line with the ratio of such firms in the economy as a whole. Although it is hard to estimate population share correctly, clearly there are fewer firms involved in takeover activities than those not involved in such activities.

This study selects the same number of firms for both groups through matching. This deviation of sample share from population share may produce misleading coefficient estimates for the probit functions.[7] To alleviate this problem, coefficients are estimated year by year. If mergers occur evenly during the sample period, then the number of mergers in a year will be about one-seventh of all firms. To estimate probit (and logit) coefficients for a year, the analysis includes only experimental firms that merged in the year along with all control firms. Thus, the sample shares are one-eighth and seven-eighths, respectively, for experimental and control firms.

[6]The analysis is repeated with logit, yielding essentially the same results.

[7]It is important to remember when modeling the probability that a firm will be involved in a takeover that only a relatively small fraction of all firms will be involved in takeover activities. Attempts to estimate probability of takeover involvement should use a sample where the ratio of takeover to nontakeover firms is roughly equivalent to the ratio of such firms in the economy. Deviation from this sample design may produce misleading results, For elaboration see Harris *et al.* (1982, p. 168)

## Measurements

*Market Values*

### Equity

To calculate Tobin's q, market values of preferred and common stock are calculated by the methods described in the previous section.

### Debt

MV of long-term debt, $BL_t$, ideally can be estimated for each individual issue using yields associated with the firm's bond rating. Lack of data made this impossible.

To estimate a maturity distribution of long-term debt, Lindenberg and Ross's (1981) assumptions and procedures are used to estimate the maturity structure of the firms' outstanding bonds. The Lindenberg and Ross methodology produces reasonable results assuming a ten year maximum bond maturity. The annual fractions sum to approximately one; i.e., they total 100 percent. To insure they total 100 percent, they are rescaled by the sum of the fractions. For example, if the fraction for first year bonds were 0.09 and the sum of the fractions were 0.90, 10 percent of the bonds' market value (0.09/0.90 = 0.10) would be allocated to first year bonds. Each year's corrected fraction is multiplied by the MV of outstanding bonds to find the market value for the different maturities.

Table 1 presents this debt maturity structure across the sample groups. The values in the most recent four years (j = 0 to 3) are consistently larger than those of remote years (j = 4 to 8) in all groups. Most notably, the acquirers had the highest values in the most recent four years. The targets had the smallest values in the most recent four years.

To estimate MV of long-term debt, yields to maturity for the period of 1968 to 1982 are needed. *Moody's Bond Records* provide bond ratings and yields for Aaa, Aa, A, and Baa bonds.

Many sample firms have no bond ratings. For these firms, ratings are predicted using multiple discriminant analysis (MDA) and the discriminating variables suggested in Perry *et al.* (1985).[8] Where ratings prediction is

[8]The 33 variables suggested in Perry *et al.* (1985) are used in forward-stepping, stepwise MDA models using SAS (1985) PROC STEPDISC. Both four group (Aaa, Aa, A, Baa) and six group (Aaa, Aa, A, Baa, Ba, B) models are fitted. Discriminating power of the models is measured using Wilk's Lambda and Pillai's Trace. The six group models generally (although not universally) have greater discriminating power. Sample proportions are used as prior probabilities. All MDA models are significant at 0.01. Discriminant functions can be based on either individual within-group covariance matrices or a pooled covariance matrix. If a likelihood test of homogeneity were significant at 0.10, within-group covariance matrices is used. Otherwise a pooled covariance matrix is used to determine the classification criterion.

impossible because of missing information on the discriminating variables, past ratings are used—an average of the past five bond ratings.

Yields to maturity for bonds are available for only four (Aaa to Baa) ratings in *Moody's Bond Records*. The sample firms' bond ratings range from Aaa to C, but yields are not available for ratings from Ba to C. Rating differences from Ba to C are ignored in the calculation of MVs.

Yields to maturity corresponding to the ratings for the sample period of 1968-1982 are obtained from Moody's corporate bond yield averages. December yields are used for each year. MVs of bonds are calculated as the present value of future coupons and principal payments evaluated at time t.

### *Replacement Cost for Net Plant*

Parker's algorithm (1977) is used to estimate RC for net plant and equipment. This method adjusts for changes in plant value due to changes in general price levels.[9, 10] First, average age of a firm's plant is obtained by dividing accumulated depreciation by depreciation for the year.

With h denoting the average age of a firm's assets, the RC of net plant at time t, $RNP_t$, is calculated as follows:

$$(2)\ RNP_t = HNP_t \cdot \frac{\text{GNP Deflator at Time t}}{\text{GNP Deflator at Time t - h}}$$

RC for net plant is estimated by restating the historical net plant (HNP) using the GNP Deflator Index of the acquisition date. GNP Deflator Indexes are available from National Income Accounts. Quarterly indices are used to approximate the GNP Deflator Index at time t - h. The calculated ages of sample firms' assets are summarized in Table 2. Average ages for targets and their controls are a little lower than those of acquirers and their controls.

### *Replacement Cost for Inventories*

The Lindenberg and Ross calculation is simple for FIFO inventories; assuming cost of sales exceeds inventory value, RC is historical book value. For

[9]This algorithm also is used in Hasbrouck's (1985) study.

[10]Depreciation methods could not be checked, as they are not specified in the Compustat data. If there has been considerable technological progress, Parker's algorithm will underestimate RC for the net plant. Parker's algorithm implicitly assumes that firms use straight-line depreciation, and that there has been no significant change in technology. The estimated average age and derived RC for net plant may be overestimated if firms use accelerated depreciation.

average cost method valuation, historical cost is restated to RC by assuming inventories are half from the current period and half from one period prior. RC is historical cost restated using a general price level adjustment (Lindenberg and Ross, p. 15).

Parker's method is used to estimate RC for LIFO inventories. In this algorithm, average age for inventories is estimated using inventory book value and cost of sales for the period—similar to the calculation for net plant. A general price level adjustment is used to estimate current RC.

## Results

### *Observed Tobin's q Values*

Tobin's q is calculated for each sample firm. Table 3 shows yearly average and merger announcement year average q's for the different groups. Panel A lists the average of Tobin's q when each q-value is given equal weight in the average. The average Tobin's q at the year of merger announcement for both target and control is almost the same, but there is a 0.215 difference between acquirers and their controls.

Another set of Tobin's q averages are calculated using firms' market values as weights. The market values used as weights are the same ones used to calculate q-values. These results are summarized in Panel B of Table 3.

When market weights are used, the acquirer and acquirer control q's are smaller than those calculated using equal weights. This implies that there may be relatively large size firms that have smaller q's. The exception is target control q's, which are larger when weighted equally than the market-value weighted averages, without exception. The target q's display no evident pattern, which would suggest evenly distributed firm sizes.

To adjust q for the differences in the responsiveness of the q's to market trend in aggregated q's, annual means for each group and the market are calculated. An adjustment regression for each of the four sample groups is run using the individual and average q-values calculated above:

$$(3)\ q^{i}_{tj} = a^{i} + b^{i} (\bar{q}^{m}_{t} - \bar{q}^{i}_{t}) + e^{i}_{tj},\ j = 1, \ldots, n$$

where:

$q^{i}_{tj}$ = q-value of firm j in sample group i at merger announcement year t; and

m = Mean over both the experimental and control groups.

The regressions are run using both market-weighted and equally weighted averages (eight adjustment regressions). The estimated coefficients are presented in Table 4. Another set of regressions, which includes all of the available q-values, is run to check whether responsiveness at the time of merger announcement differs from general responsiveness.

The intercepts for the four different groups, which may be viewed as long-run values for q's, are all significant at the 0.01 level, whichever adjustment regression is used. Among the four groups, acquirers have the highest constant (except for equally weighted all year data). The constants for both targets and acquirers for the merger announcement year are higher than those for all year. Mergers generally occur when both acquirers and targets have higher q-values than usual.

The slope coefficients are negative in all of the adjustment equations. There do not seem to be marked differences among the four groups in their responsiveness to market changes. Most of the slope coefficients are not significant at the 0.05 level. The null hypothesis of b=0 cannot be rejected in the majority of the regressions.[11]

In only three cases are the slope coefficients statistically significant—individual merger year regressions for targets (both market-value weighted and equally weighted) and the all year regressions for acquirers versus controls (equally weighted). Later results omit reference to adjusted q's except for the case of acquirers versus controls using equally weighted all year data.

### *Hypotheses Tests*

A paired-comparison t-test is used to test the hypotheses that merging firms' q-values are significantly different from those of their control group. The paired-comparison t-test is used because q-values in experimental groups will be correlated with the values of control firms, i.e., correlated or nonindependent variables (Edwards, 1967, p. 216). The estimated variance of the differences between the two paired mean values, $S_D^2$, is calculated as follows:

$$(4)\ S_D^2 = S_{\bar{q}1}^2 + S_{\bar{q}2}^2 - 2r_{q1q2} S_{\bar{q}1}^2 S_{\bar{q}2}^2$$

where:

[11] Results of four adjustment regressions run using the log-transformed values of Tobin's q also are not significant. These differences in the responsiveness to the market trend are adjusted to see how the adjusted q values behave in the normality test.

$r_{q1q2}$ = Correlation coefficient between $q_1$ and $q_2$.

If $r_{q1q2}$ is positive, the standard error of the difference between two means is reduced—increasing the t-value. The most important assumption of the t-test is normality; normality of q-values was examined first.

## Normality Test

To check whether the observed differences in q-values between experimental and control firms come from a normal distribution, the current research employs a Shapiro-Wilk's statistic.[12] With a Shapiro-Wilk (1965) statistic, if the empirical distribution in question is close to normal, the normal probability plot tends to fall near the straight line, and the squared correlation of points will be close to one if the tested distribution is normal. The Shapiro-Wilk statistic, W, is similar to the squared correlation. In a paired-comparison t-test, the difference between two variables is treated as a variable. A normality test is performed on the matched differences. Table 5 presents the values of the Shapiro-Wilk statistic.

The variable Dq denotes the difference in q between experimental and control firms. Dlnq is the difference of log-transformed q between two groups. Dqade is the difference of adjusted q using equal weights. Dqadeln is the difference of log-transformed adjusted q with equal weights. As in Table 4, merger year indicates that q-values of only merger announcement years are used in the adjustment regressions.

The Dq's for the acquirer-control groups have significant Shapiro-Wilk statistics at the 0.01 level, implying that the distribution of Dq is significantly different from normal. Dqade is also significantly different from a normal distribution at the 0.01 level. The differences of log-transformed q-values, Dlnq and Dqadeln, however, have nonsignificant Shapiro-Wilk statistics at 0.05 (except Dlnq of target controls). Even Dlnq of the target control group is not significant at the 0.01 level. Consequently, the emphasis in the paired-comparison test is the log-transformed q-values, Dlnq.

## Paired Comparison t-test

The q-values of target firms (on average) should be smaller than those of control firms. The t-values are presented in Table 6. All t-values are not significant at the 0.05 level. There are no significant differences in Tobin's q between target firms and the related control firms. To the contrary, the average value of

[12] Pearson's chi-square test could be used—but because the chi-square test utilizes only the number of observations in intervals rather than the observations themselves, there would be a loss of information with continuous variables.

Tobin's q for targets seems to be higher than that of control firms, although the difference is not statistically significant.

Table 7 lists t-values for paired-comparison tests for acquirers versus controls. Although the t-values for the market-adjusted measures are not significant at the 0.05 level, Dq and Dlnq (the difference between q and log-transformed q-values for acquirers and their control firms) have significant t-values.

The variable Dlnq, which satisfied the normality condition and which was not adjusted using nonsignificant slopes, has a significant t-value. The significant positive t-value for Dlnq indicates that acquirers' q-values, on average, are significantly higher than those of control firms. This result is consistent with the research hypothesis; acquiring firms should have higher q-values than those of control firms if markets are allocationally efficient.

### *Takeover Prediction*

Probit analyses are conducted to see whether the behavior of merging firms is predictable using the value of Tobin's q and other adjusted q's. As the log-transformed values of q for acquirers were found to have a significantly higher mean than that of the controls, lnq is used first as an independent variable. The dependent variable is one if a firm is an acquirer and zero if a firm is not an acquirer. For each of seven sample years from 1976 to 1982, separate probit coefficients are estimated by the maximum likelihood method. One more probit estimation was done using only merger announcement year data.

The results of probit estimation are summarized in Table 8. Maximum likelihood estimators of constant and slope are shown in the first and second columns. The third column shows the asymptotic t-values for slopes. The likelihood ratio statistic and Cragg-Uhler $R^2$ (Maddala, 1983, p. 40), a measure of goodness of fit, are presented in the fourth and fifth columns. Column six gives the number of correct predictions of the total observations. The last column provides the number of right predictions for acquirers of total acquirers included in the analysis.

The positive slopes mean higher lnq's are associated with acquirers, but the significance of slope coefficients indicated by the asymptotic t-values is low except when only merger announcement year data are included. The significant t-value when only merger announcement year data are included in the probit analysis indicates that there is a difference in q-values of acquirers and nonacquirers around the merger announcement period.

The intercepts are negative and have high t-values, implying that lnq does not predict acquirers well. Negative intercepts result because most of the q-values are less than one.

The likelihood ratio statistic, -2 $\ln(L_\omega/L_\Omega)$, which is known to converge to a chi-square distribution with one degree of freedom (Theil, 1971, p. 397), where $L_\omega$ is the maximum of likelihood function with respect to only the constant, and $L_\Omega$ is the maximum of likelihood function with respect to all parameters, is low. Cragg-Uhler $R^2$, which can have a maximum value of one, is also low. Overall, the independent variable lnq does not predict acquirers. Although the proportion of correct predictions to total observations appears impressive, the correct predictions are all nonacquirers.

Understanding the prediction results is made easier by concentrating on the last two columns of the table. In 1976 90 of the 180 observations were control firms (45 target controls and 45 acquirer controls). In 1976 another 78 observations were for takeover firms not involved in takeovers that year. Six of the acquirers (and six of the targets) were involved in takeovers. The probit analysis correctly identifies none of the acquirers.

In 1977 the sample shrinks by six because the 1976 targets drop from the sample. Again, none of the acquirers (13 in 1977) are identified correctly. Each year the number of observations shrinks by the number of targets lost (the same as the number of acquirers) in the previous year. In each single year none of the acquirers is identified correctly by probit analysis.

When only merger year q-values are used, there are 180 observations—45 in each of the four groups. When only merger year q-values are used, three of 45 acquirers are identified correctly.

Several other adjusted q variables are used as independent variables. The results for acquirers are similar. Results of the probit analysis for targets are also miserable. It is impossible to predict whether a firm will become a successfully acquired target—much less whether they will "come into play."

## Comparison to Related Studies

### *Chappell and Cheng*

Results of the paired-comparison t-test, that is, significantly higher q-values of acquirers compared to those of control firms, indicate that high q-value firms engage more actively in mergers than do lower q-value firms. This result is consistent with the results of Chappell and Cheng (1984), who studied the relationship between the percentage of assets acquired by mergers and several financial variables, including q, using Tobit analysis.

Although the current results are similar, the methodology is different. Chappell and Cheng estimate Tobit equations for each period from 1971 to 1978. The dependent variable used is the ratio of assets acquired by merger to the book value of the firm's total assets in the year preceding merger. Leverage, prof-

itability, liquidity, growth, firm size, and q are used as independent variables. q and profitability are found to be important explanatory variables.

The current methodology is a case-control methodology where control firms are matched by size and industry classification. Only q-value is used because, theoretically, q summarizes all investment opportunities of a firm.

### *Hasbrouck*

Hasbrouck (1985) sought to discern differences in financial characteristics between targets and nontargets. He also attempted to determine the causal mechanism for the differences, whether firm-specific or industry-related. Target firms were found to have low q-ratios and high current financial liquidity. Hasbrouck also found that the attributes giving rise to differences in q are firm specific, while those giving rise to the liquidity differences are industry related. The methodology Hasbrouck uses is a multinomial logit analysis with case-control sample selection methods where control firms are matched by either size or industry classification.

The observed acquired firms and their controls in this study did not have significantly different q-values, which is at variance with Hasbrouck's results. Although the difference is not statistically significant, the control group has a nominally smaller q-value than that of the acquired group. Not only is this result inconsistent with that of Hasbrouck, who found that target firms are generally characterized by low q-ratios, but it also does not support the research hypothesis that targets' q-values should be lower than those of control firms.

The differences from Hasbrouck could be attributed to several sources, although most methodologies to calculate Tobin's q are similar. Hasbrouck selected two control groups—one size-matched, the other industry-matched. This study matches both size and industry at the same time to select one control group of firms. As the objective of matching is to find a firm with similar characteristics, controlling for as many confounding variables as possible is preferable.

Hasbrouck used SEC-reported RC as the estimate of the replacement value for those firms that reported replacement value. For those firms that did not report replacement value, he made estimates using a methodology similar to that used in this study. As noted earlier, the SEC allows considerable latitude in calculating replacement value; this may cause bias if both SEC-reported and estimated values are used in a t-test. The current study uses estimates exclusively, which means data are internally consistent.

This study uses a paired-comparison t-test, while Hasbrouck uses a t-test for difference between means. When the assumption of two random independent samples is not satisfied, a paired-comparison test for matched samples is recom-

mended (Edwards, 1967; Lerner, 1944). Further, the t-test normality assumption was untested in Hasbrouck's study.

The essential difference between Hasbrouck's and the current study is the handling of size and industry effects. The current study eliminates size and industry effects by selecting control firms matched by both industry and size. In other words, only firm-specific effects of q-values matter in this study.

## Summary

Tobin's q calculated by the methods described is generally low compared to a hypothetical equilibrium q-value of one, using either of two different weighting schemes. The values range from the mid-0.70s to the high 0.90s. This finding is consistent with those of other studies for these time periods (e.g., Lindenberg and Ross, 1981, Figure 2, p. 23).

The responsiveness of sample and control firm q's to the market trend of q is not markedly different. Several different adjustment regressions produce essentially the same results.

A paired-comparison t-test provides enough evidence to infer that the average value of log-transformed q-values for the acquiring firms is significantly higher than that of the control group of firms. The variable lnq satisfies the most important assumption of the t-test—normality. The significant observed difference in lnq indicates that Tobin's q may measure a firm's investment opportunities. This finding is not only consistent with the research hypothesis, but also provides some evidence of an allocationally efficient market for takeovers. Such a result is consistent with Chappell and Cheng's (1984) results.

Targets and their controls, unlike acquirers, do not have significantly different q-values. Although the difference is not statistically significant, the control group has a nominally smaller q-value than that of the acquired group. This result is inconsistent with Hasbrouck (1985), who found that target firms generally had lower q-ratios, and it does not support the research hypothesis.

A merger officially requires consent of both an acquirer and a target firm. Acquirers usually initiate the action, however, and a target firm's decision to merge with an acquirer could be against the target's will. Morck, Shleifer, and Vishny (1988) report that hostile takeover targets have low q's, while friendly targets are smaller and younger and have q-values comparable to the universe of Fortune 500 firms.[13] Whether one finds targets to be high q or low q could be a

[13]The Morck, Shleifer, and Vishny (1988) study was published after the study reported in this paper was completed. Future studies must be careful to distinguish between friendly and hostile targets.

function of how many hostile versus friendly targets are in the sample.[14] This could be a factor in both Hasbrouck's study and the current findings.

Although the variable lnq is found to have statistically different means between acquirer and control, lnq alone is not enough to be used for prediction purposes.

[14]Future studies of takeover returns also must consider the q-values of the participants. A recent study by Lang, Stulz, and Walking (1989) reports that the highest returns involve well-managed (high q) firms taking over poorly managed (low q) targets.

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**Table 1**
**Average Value of the Fractions of the Estimated Long-Term Debt Newly Issued at t - j to the Sum of Estimated Long-Term Debt**

| j | Targets | Acquirers | Target Controls | Acquirer Controls | Total |
|---|---|---|---|---|---|
| 8 | 0.1141 | 0.0794 | 0.0600 | 0.0679 | 0.0819 |
| 7 | 0.0983 | 0.0839 | 0.0683 | 0.0802 | 0.0827 |
| 6 | 0.0677 | 0.0857 | 0.1123 | 0.1055 | 0.0928 |
| 5 | 0.1086 | 0.0969 | 0.0760 | 0.0931 | 0.0937 |
| 4 | 0.0994 | 0.0936 | 0.0958 | 0.0870 | 0.0940 |
| 3 | 0.1333 | 0.1204 | 0.1231 | 0.1103 | 0.1218 |
| 2 | 0.1457 | 0.1259 | 0.1197 | 0.1753 | 0.1417 |
| 1 | 0.1164 | 0.1754 | 0.1520 | 0.1065 | 0.1376 |
| 0 | 0.1163 | 0.1386 | 0.1422 | 0.1520 | 0.1373 |

**Table 2**
**Average Age of Plant**

| Group | Average Age of Plant |
|---|---|
| Targets | 7.509 |
| Acquirers | 6.837 |
| Target Controls | 7.517 |
| Acquirer Controls | 7.196 |
| Total | 7.181 |

**Table 3**
**Mean Values of Tobin's q**

| Year | No. | Targets | Acquirers | Target Controls | Acquirer Controls | Total |
|---|---|---|---|---|---|---|
| | | | Panel A<br>Equally Weighted | | | |
| 1976 | 6 | 0.7997 | 0.9982 | 0.8186 | 0.9194 | 0.8840 |
| 1977 | 13 | 0.7715 | 0.9202 | 0.7632 | 0.7997 | 0.8151 |
| 1978 | 10 | 0.7659 | 0.8826 | 0.7289 | 0.7405 | 0.7814 |
| 1979 | 2 | 0.8074 | 0.9225 | 0.7714 | 0.7306 | 0.8081 |
| 1980 | 8 | 0.7702 | 1.0189 | 0.7899 | 0.7366 | 0.8411 |
| 1981 | 4 | 0.8108 | 0.8496 | 0.7216 | 0.6926 | 0.7570 |
| 1982 | 2 | 0.4610 | 0.8490 | 0.8238 | 0.7600 | 0.8054 |
| Merger | 45 | 0.8081 | 0.9884 | 0.8011 | 0.7730 | 0.8427 |
| | | | Panel B<br>Market Value Weighted | | | |
| 1976 | 6 | 0.8256 | 0.8939 | 1.0039 | 0.8567 | 0.8855 |
| 1977 | 13 | 0.7447 | 0.8206 | 0.8163 | 0.7451 | 0.7882 |
| 1978 | 10 | 0.7154 | 0.8250 | 0.7764 | 0.6890 | 0.7672 |
| 1979 | 2 | 0.7875 | 0.8885 | 0.8596 | 0.6669 | 0.8081 |
| 1980 | 8 | 0.8254 | 1.1443 | 0.9323 | 0.6902 | 0.9729 |
| 1981 | 4 | 1.0131 | 0.8214 | 0.7612 | 0.6663 | 0.7714 |
| 1982 | 2 | 0.4935 | 0.7529 | 0.9091 | 0.7369 | 0.7603 |
| Merger | 45 | 0.8270 | 0.9098 | 0.8661 | 0.7193 | 0.8370 |

**Table 4**
**Regression Coefficients of Adjustment Equations**

| Wt | Data Used | Constant | (t-value) | Slope | (t-value) |
|---|---|---|---|---|---|
| | | Adjustment: Merger Year | | | |
| MV | Targets | 0.855 | (15.44)** | -0.951 | (-2.02)* |
| | Acquirers | 0.933 | ( 7.86)** | -0.899 | (-0.62) |
| | Target Controls | 0.769 | (12.62)** | -1.197 | (-1.16) |
| | Acquirer Controls | 0.796 | (10.58)** | -0.233 | (-0.40) |
| EQ | Targets | 0.879 | (14.46)** | -1.409 | (-2.07)* |
| | Acquirers | 0.918 | ( 3.14)** | -0.613 | (-0.25) |
| | Target Controls | 0.884 | ( 5.05)** | -1.685 | (-0.50) |
| | Acquirer Controls | 0.802 | (11.89)** | -0.745 | (-0.63) |
| | | Adjustment: All Year | | | |
| MV | Targets | 0.794 | (26.49)** | -0.275 | (-0.79) |
| | Acquirers | 0.887 | (21.53)** | -0.602 | (-1.15) |
| | Target Controls | 0.756 | (33.17)** | -0.416 | (-1.34) |
| | Acquirer Controls | 0.807 | (21.99)** | -0.385 | (-1.38) |
| EQ | Targets | 0.805 | (23.21)** | -0.506 | (-1.02) |
| | Acquirers | 0.768 | ( 8.65)** | -1.423 | (-1.82) |
| | Target Controls | 0.792 | (22.08)** | -0.460 | (-0.61) |
| | Acquirer Controls | 0.832 | (24.43)** | -1.423 | (-2.56)* |

* Significant at 0.05
** Significant at 0.01
MV—Denotes adjustment regression with market-value weighted q's
EQ—Denotes adjustment regression with equally weighted q's
Merger Year—Denotes adjustment regression with only merger announcement year q-values
All Year—Denotes adjustment regression with all available q-values

**Table 5**
**Results of Normality Tests**

| | Adjustment Regression | | | |
|---|---|---|---|---|
| | Merger Year | | All Year | |
| Variable | Target/Control | Acquirer/Control | Target/Control | Acquirer/Control |
| $D_q$ | 0.927* | 0.897** | 0.927* | 0.897** |
| Dlnq | 0.944* | 0.963 | 0.944* | 0.963 |
| Dqade | - | - | - | 0.901** |
| Dqadeln | - | - | - | 0.979 |

* Significant at 0.05
** Significant at 0.01
All others not significant at 0.05

**Table 6**
**Results of Paired Comparison t-Test for Targets and Controls**
**(No Adjusted Comparisons)**

| | t-values | |
|---|---|---|
| Variable | Merger Year | All Year |
| $D_q$ | 0.10 | 0.10 |
| Dlnq | 0.09 | 0.09 |

None significant at 0.05

**Table 7**
**Results of Paired Comparison t-Test for Acquirers and Controls**

| Variable | t-values: Merger Year | All Year |
|---|---|---|
| Dq | 2.58* | 2.58* |
| Dlnq | 2.81** | 2.81** |
| Dqade | - | -0.04 |
| Dqadeln | - | -1.16 |

* Significant at 0.05
** Significant at 0.01
All others not significant at 0.05

**Table 8**
**Summary Statistics for Probit Analysis (lnq)**

| Year | Constant | Slope | t-value | Likelihood Ratio | C-U R-square | N[a] | n[b] |
|---|---|---|---|---|---|---|---|
| 1976 | -1.796 | 0.228 | 0.46 | 0.211 | 0.005 | 174 (180) | 0 ( 6) |
| 1977 | -1.371 | 0.289 | 0.72 | 0.513 | 0.007 | 161 (174) | 0 (13) |
| 1978 | -1.399 | 0.509 | 1.21 | 1.476 | 0.025 | 150 (161) | 0 (10) |
| 1979 | -2.100 | 0.954 | 1.40 | 1.957 | 0.098 | 149 (151) | 0 ( 2) |
| 1980 | -1.503 | 0.536 | 1.55 | 2.368 | 0.046 | 141 (149) | 0 ( 8) |
| 1981 | -1.768 | 0.469 | 1.10 | 1.197 | 0.037 | 137 (141) | 0 ( 4) |
| 1982 | -2.057 | 0.857 | 1.48 | 2.223 | 0.115 | 128 (137) | 0 ( 2) |
| Merger | -0.525 | 0.659 | 2.60** | 6.960 | 0.056 | 138 (180) | 3 (45) |

**Significant at 0.01 percent level
[a]N is the number of correct predictions out of total observations (in parentheses)
[b]n is the number of acquirers correctly predicted (of those in that year)