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**CHANGES IN EQUITY OWNERSHIP
AND CHANGES IN THE MARKET
VALUE OF THE FIRM**

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ABSTRACT

Changes in Equity Ownership and Changes in the Market Value of the Firm*

We study the stock price response to announcements of share purchases by corporate insiders over the period 1994 through 1999. The cross-sectional variability in the response is consistent with a curvilinear relation between firm value and insider ownership, where the value of the firm first increases, then decreases as insider ownership increases. These results are consistent with a causal interpretation of the relationship between insider ownership and firm value. The results of further tests are inconsistent with an interpretation that the firms in our sample are moving toward a new equilibrium ownership level or that insiders are purchasing shares to signal that the firm is undervalued.

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Changes in Equity Ownership and Changes in the Market Value of the Firm

1. Introduction

Morck, Shleifer, and Vishny (MSV) (1988), McConnell and Servaes (1990, 1995), Hermalin and Weisbach (1991), Holderness, Kroszner and Sheehan (1999) and others document a statistically significant cross-sectional correlation between share ownership by corporate insiders (usually defined as managers and members of the board) and corporate performance, where performance is measured either as Tobin's Q or return on assets. This observed empirical relationship has often been interpreted to mean that ownership "matters" and that a change in share ownership by insiders can be used to change corporate value. Such interpretations have been criticized for ignoring the potential endogeneity that may arise when external pressures push firms toward optimal ownership structures that jointly optimize over ownership and value.

Such criticisms have their origins in Demsetz (1983) who argues that the observed *level* of share ownership by insiders and firm performance is the outcome of market forces such that each firm's ownership structure will be optimal for that firm. If so, changes in ownership cannot be used to enhance corporate value. He further argues that any observed cross-sectional empirical relationship between the level of insider share ownership and firm performance must be spurious. Studies by Demsetz and Lehn (1985), Agrawal and Knoeber (1996), Loderer and Martin (1997), Cho (1998), Demsetz and Villalonga (2001), Himmelberg, Hubbard, and Palia (1999), and Coles, Lemmon, and Meschke (2003) support Demsetz' criticism empirically.

In this study, we examine directly the relationship between changes in share ownership by insiders and changes in the value of the firm. In particular, we examine changes in firm value around announcements that insiders have purchased shares. We use the curvilinear relationship

reported by McConnell and Servaes (1990) as the starting point for our analysis. McConnell and Servaes estimate a quadratic relationship as:

$$\text{Tobin's Q} = a + b_1(\text{Insider ownership}) + b_2(\text{Insider ownership})^2$$

$$+ c_1(\text{Other ownership}) + c_2 (\text{Control variables}). \qquad (1)$$

where Tobin's Q is the market value of the firm divided by the replacement value of assets, insider ownership is the fraction of shares controlled by officers and directors, and other ownership is ownership by large blockholders and institutional investors. They report that b_1 is positive and significant and that b_2 is negative and significant in cross-sectional regressions.

If we accept the relationship in (1) as being literally true, a change in ownership by insiders gives:

$$\text{Tobin's Q} + \Delta Q = b_1(\text{Insider ownership} + \Delta \text{Insider ownership})$$

$$+ b_2(\text{Insider ownership} + \Delta \text{Insider ownership})^2 + c_1(\text{Other ownership})$$

$$+ c_2(\text{Control variables}). \qquad (2)$$

Subtracting (1) from (2) gives:

$$\Delta Q = b_1(\Delta \text{Insider ownership}) + b_2(\Delta \text{Insider ownership})^2$$

$$+ 2b_2(\Delta \text{Insider ownership x Insider ownership}) \qquad (3)$$

where insider ownership is measured before the change. The predicted sign of b_1 is positive; the predicted sign of b_2 is negative; and the predicted sign of the coefficient of the third term is negative and twice the magnitude of the coefficient of the second term. Henceforth, we refer to the coefficient of the third term as b_3. The first two terms of equation (3) say that an increase in share ownership by insiders gives rise to an increase in firm value up to a point after which value declines with further increases in insider share ownership. The third term says that the increase in firm value associated with an increase in insider ownership depends upon the initial level of

insider ownership. Note that the increase in value due to an increase in share ownership by insiders becomes progressively smaller the higher the initial level of insider ownership. That is, the market value effect associated with a given share purchase by insiders is smaller the higher the initial level of insider ownership, and can be negative for sufficiently high initial levels of insider ownership.

We test the predictions of (3) using stock price changes around announcements of share purchases by managers and members of the board as a proxy for changes in firm value (i.e., as a proxy for changes in Q). We perform these tests with insider share purchases taken from *Thomson Financial* for the period 1994 through 1999. When announcement period excess stock returns are regressed against the change in the fraction of shares owned by insiders, the change in the fraction of shares owned by insiders squared, and the cross product of the change in and the initial level of insider ownership, the results are largely, but not completely, consistent with the literal interpretation of (3). We find that b_1 is positive and significantly different from zero and that b_2 and b_3 are negative and significantly different from zero. In most cases, we cannot reject the hypothesis that the coefficient of the interaction term (i.e., b_3) is twice the magnitude of b_2 at the 10% level of significance. However, in most regressions, the point estimate of b_3 is actually smaller than b_2. For example, in our base case regression, $b_2 = -1.58$ and the coefficient of the interaction term is -1.10.

An aggressive interpretation of our results is that ownership matters exactly as specified by equations (1) and (3) and that an increase in share ownership can either increase or decrease value depending upon the firm's initial ownership structure. A less aggressive interpretation is that equations (1) and (3) provide a rough approximation of the relationship between insider ownership and firm value, but, nevertheless, an increase in insider ownership can lead to an

increase in firm value up to a point after which further increases in insider ownership reduce value. A weak interpretation is that the relationship between changes in ownership and changes in value is the endogenous outcome of market forces that compel each firm towards an optimal ownership structure and the changes that we observe are simply a consequence of that process. We are inclined toward the less aggressive interpretation, but we later comment on other interpretations and present tests that attempt to distinguish among them.

The remainder of this paper is organized as follows. The next section gives an overview of related literature and motivates our empirical analysis. Section 3 describes our data. Section 4 presents our basic empirical results. Section 5 presents various tests of robustness of our basic results. Section 6 considers the question of whether the insider share purchases in our sample should be viewed as moving firms toward their optimal equilibrium levels of insider share ownership. Section 7 addresses the question of whether the results should be interpreted to mean that market participants merely view share purchases by insiders as a signal that the firm is undervalued. Section 8 summarizes our findings and sets forth our conclusions.

2. Background

Theoreticians have made a compelling case for the proposition that ownership of shares by corporate decision makers (i.e., managers and members of the board of directors) can have an important influence on the way in which the firm is managed and, therefore, on the firm's observed market value (Baumol (1959), Jensen and Meckling (1976), Demsetz (1983), Stulz (1988)). While supporting this theory, Demsetz (1983) has argued that no relationship between ownership structure and value will be observed empirically or, if one is, it is spurious. That is, if each firm has optimized its ownership structure, in a cross-section of firms, any correlation

between market value and ownership structure must be accidental. And, thus, the empirical relationship should not be interpreted as an indication of a causal relationship between ownership structure and firm value. For example, in a cross-section of firms, if firms with high ownership by insiders happen to have high market values and vice versa, that should not be interpreted to mean that low value firms can increase their market values by requiring that insiders own more shares. Indeed, if each firm is at its optimum, any change in ownership should result in a decline in corporate value.

Empirically, Demsetz and Lehn (1985) use a sample of 511 U.S. companies for which they have ownership data for 1980 to examine the relationship between corporate profitability and the fraction of outstanding shares held by the top five (or top 20) shareholders. They find no correlation between profitability and ownership concentration. They conclude that their results are consistent with the argument that ownership structure is endogenous. Loderer and Martin (1997) consider the role of inside ownership on the value created in corporate acquisitions. Though they find a statistically significant correlation between value and ownership, the explanatory power of their regression is small and the statistical significance disappears altogether in a simultaneous equations specification. Similar to Loderer and Martin (1997), Agrawal and Knoeber (1996), Cho (1997), and Demsetz and Villalonga (2001) each use a system of equations to examine the determinants of insider ownership and firm value simultaneously for various samples of U.S. firms. The latter two studies conclude that corporate value and/or profitability affects the level of inside ownership, but not vice versa. The first study reports no connection between ownership and value.

Himmelberg, Hubbard, and Palia (HHP) (1999) use firm fixed effects in a regression model in which firm value is regressed against insider ownership. They, too, report no

significant relation between insider ownership and firm value. (However, Zhou (2001) takes HHP to task. He points out that insider share ownership adjusts slowly through time such that even if there is a relationship between firm value and insider share ownership, a fixed effects model will obscure the relationship in a cross-sectional regression.) Coles, Lemmon, and Meschke (2003) construct a structural model to study the determinants of ownership. They argue that a spurious curvilinear relationship between firm value and insider ownership may emerge in cross-sectional regressions even though each firm is at its optimal ownership level and they present data to support their argument. These studies all support Demsetz' contention.

On the other side of the coin, MSV (1988) use a sample of 371 *Fortune* 500 firms to estimate a piecewise linear regression with Tobin's Q as the dependent variable and the fraction of shares owned by members of the company's board of directors as the independent variable of interest. They find a significant correlation in which value initially increases with ownership of shares by the board up to 5% and then declines up to ownership of 25% after which the relationship again becomes positive. They hypothesize that this nonlinear relationship is due to the interaction of two offsetting factors - - an incentive effect and an entrenchment effect. They allow for the possibility that the observed relationship is causal with "too much" ownership causing a decline in value.

In similar spirit, McConnell and Servaes (1990, 1995) estimate the relationship between Tobin's Q and the fraction of shares held by managers and directors (i.e., corporate insiders), large-block shareholders, and institutional investors for large samples of NYSE and AMEX firms for the years 1976, 1986, and 1988. Among other things, they report a significant curvilinear relationship in which the value of the firm first increases and then decreases as insider ownership increases. They cautiously interpret their results as being "…consistent with

the hypothesis that corporate value is a function of the structure of equity ownership" (McConnell and Servaes (1990), p. 595). Hermalin and Weisbach (1991), Holderness, Kroszner and Sheehan (1999), and Habib and Ljungqvist (2003) also report evidence of a significant relationship between insider ownership and the value of the firm for publicly traded U.S. companies. Anderson and Reeb (2003) take a slightly different tack. They consider 141 "family firms" among the *Fortune* 500. Similar to McConnell and Servaes, they report a significant curvilinear relationship between firm value and family ownership.

On the international front, La Porta, Lopez-de-Silanes, Shleifer and Vishny (LLSV) (2002), Claessens, Djankov, Fan and Lang (CDFL) (2002), and Lins (2003) examine the correlation between value and ownership structure across a variety of countries. They focus on the distinction between ownership of voting/control rights and ownership of cash flow rights. LLSV and CDFL report that firm value increases as management ownership of cash flow rights increases; Lins reports that value declines as management ownership of control rights increases.

Our study is largely motivated by the results in McConnell and Servaes (1990, 1995) in that we ask whether *changes* in the fraction of shares owned by insiders exhibit a relationship with *changes* in the value of the firm that is consistent with the curvilinear relationship documented by them for the relationship between the level of insider ownership and the level of firm value. McConnell and Servaes, in turn, motivate their study on the basis of Stulz (1988), although their analysis could also have been motivated by the arguments put forth by MSV (1988).

In particular, Stulz (1988) constructs a model in which the takeover premium that a bidder must pay to gain control increases as the fraction of shares owned by management increases, but the probability that the takeover will succeed declines. Initially, an increase in

ownership by insiders has the effect of increasing the value of the firm (i.e., increasing the expected value of the takeover premium) but because increasing ownership reduces the likelihood of a successful takeover offer, value eventually reaches a peak, then declines. That is, the firm's value reflects the intersection of two opposing forces. Similarly, MSV (1988) present an argument in which value is a function of two opposing forces - - the incentive effects of ownership and the entrenchment effects. They do not specify a curvilinear relationship, but their argument allows for that possibility. As we described at the outset, we use stock returns from an event study around share purchases by insiders to investigate the relationship between changes in share ownership and changes in corporate value as specified in equation (3).

3.   Data

Data on insider purchases are taken from *Thomson Financial* over the period 1994 through 1999. Individuals defined by the Securities and Exchange Commission (SEC) as insiders are required to report any personal trades in the shares of their firms to the SEC by the 10th of the month following the trade date. This includes open market purchases and sales, shares acquired and sold through the exercise of options, and a variety of other types of transactions.

For the analyses in this paper, we focus on a subset of the reported trades. First, we include only purchases of at least 10,000 shares. Second, we consider only open market purchases. Acquisitions through the exercise of options are more likely to be anticipated by the market because information on option holdings is publicly available. Moreover, Ofek and Yermack (2000) document that when executives exercise options to acquire stock, nearly all of the shares are sold shortly thereafter. Thus, the increase in insider ownership that comes about

through option exercise is unlikely to be permanent. For this reason, we also exclude sales, many of which are likely to be related to option exercise and, therefore, are likely to have been anticipated by the market. Third, we exclude trades by individuals who are considered by the SEC to be insiders, but who are not officers or members of the board. For example, owners of more than 10% of the shares of the company are deemed insiders by the SEC even if they are not part of the management team or the board. Fourth, it is sometimes the case that one insider reports a purchase and another reports a sale on the same day. These days are removed from our analysis; only days when no insider sales are reported are considered in this study. If more than one insider from the same company reports a purchase on the same day, we sum those trades and use the total as the insider purchases on that day.

Data on the level of share ownership by officers and members of the board of directors are taken from *Compact Disclosure*. *Compact Disclosure* gathers such data from annual corporate proxy statements. In addition, within each year, we update the level of insider ownership after each insider trade. However, at the beginning of each year, we reset the level of insider ownership using *Compact Disclosure*.

To determine the reliability of this database, we selected 200 firms at random across all years and sought to hand collect ownership data from corporate proxies for these 200 companies. We were able to collect data for 172 of them.[1] We then compared the insider ownership from the proxies with the insider ownership reported by *Compact Disclosure*. In most instances, insider ownership is precisely the same from the two sources. Further, the correlation coefficient between insider ownership from the two sources is 0.92, and the means and medians of the ownership levels are nearly identical. In the tests that follow, for the 172 firms for which we

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[1] We do not have access to proxies for 28 of the companies.

collected data from proxies, we use the proxy data. For all others, we use the *Compact Disclosure* data.

The announcement period excess return (APER) for each purchase is computed by subtracting the return of the value-weighted CRSP Index from the return of the company's stock for the day on which the insider reported the trade to the SEC and the five following days. These six daily excess returns are summed to give the APER for the relevant insider share purchase. We use this six-day interval because the trade information usually does not enter the public domain for several days after it is filed with the SEC (Lakonishok and Lee (2001)). To avoid problems with outliers, we remove any APER that is not within three standard deviations of the mean APER. We also delete firms whose share price was below $2 at the time of the announcement and cases where the price at which the insider bought differed by more than 20% from the closing price on the day of the trade. Finally, we find that in about 11% of the cases, insiders report trades after the required reporting deadline. Such trades are retained in the sample if they are reported within 90 days of the reporting deadline. Otherwise, they are removed from the sample.

Table 1 provides summary statistics of the data. Our sample includes 4,141 different purchases by insiders representing 1,700 different companies, or about 2.5 trades per company. The mean and median purchase are 61,158 and 20,000 shares, respectively, which represent 0.42% and 0.15% of the company's outstanding stock (recall that we dropped all trades of less than 10,000 shares). Thus, the typical purchase in our sample is not small. In dollar value terms, the mean and median purchases are $898,783 and $213,750, respectively. Before the purchase, mean and median insider ownership were not trivial at 19.88% and 13.83% of total outstanding shares. The purchases are spread reasonably evenly through time although 1998 has a modest

bulge relative to other years. The final row of the top panel of Table 1 gives the mean and median six-day APERs of 0.94% and 0.35%, respectively. Both are highly statistically significant with p-values < 0.001.

4. A direct test of the relationship between insider purchases and changes in firm value

We estimate the following regression model:

$$APER = b_1(\Delta \text{Insider ownership}) + b_2(\Delta \text{Insider ownership})^2$$

$$+ b_3(\Delta \text{Insider ownership x Insider ownership}) + e \qquad (4)$$

where APER is a proxy for the change in Q. We test the hypothesis that b_1 is positive; b_2 is negative; and b_3, the coefficient of the interaction of the change in insider ownership with the initial level of insider ownership, is negative and twice the size of b_2. The dependent variable is the six-day APER around announcements of insider purchases. The independent variables are the number of shares purchased divided by the number of shares outstanding (i.e., the increase in the fraction of shares held by insiders), the increase in the fraction of shares owned by insiders squared, and the cross product of the initial level of insider ownership and the increase in the fraction of insider share ownership. (Hereafter, we refer to the fraction of shares owned by management and the board as insider ownership.) As we noted, insider trades must be reported by the 10th day of the month following the trade. Not surprisingly, many trades for many different companies are reported on the 10th of each month. Additionally, trades by more than one company are sometimes reported on the same day even when it is not the 10th. Because the excess returns are likely to be correlated for trades that are reported on the same day, we include an indicator variable for each reporting day. That is, we estimate a model with reporting-day fixed effects. There are 934 reporting days in the sample.

The results of the regression are presented in column 1 of Table 2. As shown in the table, b_1 is positive and significantly different from zero (p-value = 0.04); b_2 is negative and significantly different from zero (p-value = 0.07); and b_3 is negative and significantly different from zero (p-value = 0.07). Additionally, an F-test indicates that b_3 is not significantly different from $2b_2$ at any traditionally acceptable level of statistical significance for rejection of a null hypothesis (p-value = 0.26). These results are consistent with a literal interpretation of equations (1) and (3). In particular, an increase in share ownership by insiders may give rise to either an increase or decrease in the value of the firm depending upon the initial level of insider ownership - - at a low initial level of insider ownership, the value of the firm increases; at a high initial level of inside ownership, the value of the firm falls. In many respects, these results are powerful evidence in support of the hypothesis that changes in share ownership by insiders can and do increase corporate value up to a point after which "too much" insider ownership can and does reduce value. The evidence is powerful because announcement period returns are notoriously noisy such that discovery of any statistically significant relationship between announcement period excess returns and a pre-specified independent variable can be cause for celebration. Holding aside that observation, however, the results are not perfect. The fly in the ointment is the comparative magnitudes of the point estimates of b_2 and b_3. As shown in the table, the point estimate of b_3 is actually less than the point estimate of b_2. Obviously, either a lower estimated value for b_2 or a higher estimated value for b_3 or a combination of the two would make for even more compelling evidence.

A visceral indication of the relationship implied by the estimated coefficients can be seen in Figure 1 which shows the effect on firm value of 1% and 5% increases in insider ownership given different levels of initial ownership. The results are displayed net of the reporting-day

fixed effects (i.e., net of the reporting-day indicator variables). The graph illustrates that the stock price reaction to a purchase of additional shares by insiders is positive at low levels of insider ownership, but declines as initial inside ownership increases and is negative at high initial levels of insider ownership. The inflection point of the implied relationship between firm value and insider ownership is around 50% insider ownership.

5.   Other Specifications

As is the case with most empirical studies, implementation of our tests required that we make decisions regarding the data and sample as we progressed. In this section, we examine the sensitivity of our results to alternative choices.

5.1.   Trimming the distribution of announcement period excess returns

In our initial regression, we trimmed the distribution of six-day APERs at three standard deviations from the mean. We did so because the full distribution includes several extreme observations - - the highest APER is +95.93% and the lowest is −71.24%. In the second column of Table 2, we estimate the regression using the full distribution of APERs. In certain respects, these results are stronger than those in the first column. In particular, each of the estimated coefficients has the predicted sign so that the basic structure of the model is the same as in the base case, however, the p-values of the estimated coefficients are smaller. That is, b_1 is positive and significantly different from zero (p-value < 0.001); b_2 is negative and significantly different from zero (p-value = 0.01); and b_3 is negative and significantly different from zero (p-value = 0.01). But, with $b_2 = -2.75$ and $b_3 = -1.91$, it is now possible to reject the hypothesis that $b_3 = 2b_2$ at the 10% level of significance (p-value = 0.10). Thus, although the signs of the coefficients

are consistent with the basic "story" behind equation (1), b_2 is 'too big' in absolute terms and/or b_3 is 'too small' to support a literal interpretation of (1).

In our third regression, we go in the opposite direction. Here we trim the distribution further. Specifically, we remove APERs if they lie outside of two standard deviations of the mean APER. In this case, the results are very similar to those in the base case regression. As shown in the third regression of Table 2, b_1 is positive and significantly different from zero (p-value = 0.02); b_2 is negative and significantly different from zero (p-value = 0.10); and b_3 is negative and significantly different from zero (p-value = 0.03). Additionally, b_2, with a value of -1.21, is not significantly different from $2b_3$, with a value of -1.14 (p-value for the difference = 0.43). Still, b_3 is stubbornly less than b_2. Thus, although the results continue to be consistent with the theory behind (1), they do not perfectly support all of its nuances.

5.2 Other announcement period intervals

In our base case regression, we use the six-day interval including the announcement day and the following five days to calculate APERs. We experimented with APERs calculated over other intervals between 4 and 10 days around announcements of insider share purchases. Because the results are essentially the same as those in column 1 of Table 2, we do not report them in a table.

5.3. Other reporting lags

In our base case regression, we only included trades if they were reported within 90 days of the reporting deadline. Or, to put it slightly differently, we allowed purchases to be included even if they were reported with a lag of up to 90 days. We experimented with allowing trades to be included with longer and shorter lags between the required reporting date and the actual

reporting date. Regardless of the cut-off for the allowable reporting lag, the unreported results of these regressions are essentially the same as those in column 1 of Table 2.

5.4. *Trimming the distribution of share ownership*

In our various regressions, the third explanatory variable is the cross product of the initial level of insider share ownership and the change in insider share ownership from that initial level. We attach substantial importance to the magnitude of the coefficient of this variable which depends, perhaps critically, on the pre-purchase level of insider share ownership. To assure that our results do not come about because of purchases by just a few large-block shareholders, we remove observations in which the initial level of insider ownership is more than three standard deviations above the mean. This trims the distribution of pre-purchase insider ownership at 75.38% and drops 54 observations from the sample. As shown in the fourth column of Table 2, with this specification, the coefficient estimates are nearly identical to those in the base case regression of column 1.

Although we have less concern about the bottom tail of the distribution causing a peculiar outcome, we remove firms that comprise the bottom 1% of the distribution of insider ownership along with firms with ownership more than three standard deviations above the mean.[2] We then re-estimate the regression. These results are given in the fifth column of Table 2. Again, the results are nearly identical to those in our base case regression.

5.5. *Forcing b_3 to equal $2b_2$*

Although our results are consistent with equation (1), b_2 is 'too big' and/or b_3 is 'too small' for the fit to be considered perfect in every way. One way to determine whether the data actually fit a curvilinear relationship is to estimate a constrained regression in which b_3 is forced

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[2] We cannot cut off ownership at three standard deviations below the mean because three standard deviations is less than zero.

to be equal to $2b_2$. If this forced relationship does not fit the data, the regression coefficients will, then, not be statistically significant. As shown in the sixth column of Table 2, such is not the case. Each of coefficients is significant and each has the predicted sign: b_1 is 0.38 (p-value = 0.08); b_2 is –0.49 (p-value = 0.04); and, of course, at –0.98 (p-value = 0.04), b_3 is precisely twice b_2.

This regression also pays a bonus. With this specification, when we calculate the inflection point implied for equation (1), it occurs at 40% insider ownership - - a level very close to the inflection points estimated by McConnell and Servaes (1990, 1995). One possible interpretation is that when the change in ownership data are forced into conformity with the quadratic relationship in (1), the results are very much in line with findings based on levels of insider share ownership.

5.6.   *Piecewise linear specification*

Our findings support the general prediction by MSV (1988) of a nonlinear relation between firm value and insider ownership. However, MSV also report a specific piecewise linear relation between ownership and value. For completeness, we attempt to replicate their findings using our changes in share ownership data. We define explanatory variables that allow us to estimate a piecewise linear relation by identifying whether the change in ownership occurs for a firm with pre-purchase insider ownership in the range of 0% to 5% (930 observations), above 5% and below 25% (1973 observations), and above 25% (1238 observations). We then estimate a regression in which the APER is the dependent variable and the three change in insider ownership variables of equation (3) plus the reporting day indicator variables are the independent variables. The coefficient of the change in ownership for the 0% to 5% ownership range is positive, 0.50, with a p-value = 0.59; the coefficient of the change in ownership for the

5% to 25% ownership range is also positive, 0.50, with a p-value= of 0.05; and the coefficient of the change in ownership for the above 25% ownership range is negative, –0.17, with a p-value of 0.17. The positive coefficients on the changes in ownership up to 25% and the negative coefficient on change in ownership above 25% ownership are consistent with the curvilinear relationship of McConnell and Servaes (1990).

6.   Optimal insider ownership

6.1.   *Overview*

As we noted at the outset, a major concern regarding the cross-sectional regressions of MSV (1988), McConnell and Servaes (1990, 1995) and others derives from Demsetz' (1983) argument that ownership is determined endogenously and all firms are at their optimal ownership structures all the time. If so, no relationship should be observed in a cross sectional regression of performance against ownership and, if one is, it must be spurious. This observation leaves unanswered the question of why insiders trade at all and, if they do trade, why such trades are associated with an increase in stock prices (at least over low ranges of initial insider ownership). That is, if all firms are at their optimal ownership structures, arguably any trading should be associated with negative stock price reactions. We do, of course, observe some negative stock price changes when insiders buy more shares. But those negative stock price changes tend to be concentrated over a specific range of share ownership. That is, negative stock price reactions occur systematically when initial inside ownership is already high. These results are difficult to reconcile with the proposition that all firms are at their optimal ownership structures all the time.

A variation of the Demsetz argument is proposed by Core and Larcker (2002). In particular, they propose that ownership structures tend to be at their optimal levels most of the

time, but, because there are costs of adjustment, ownership structures sometimes drift away from their optima. When this occurs, and when the cost/benefit calculus makes it worthwhile to do so, executives either voluntarily purchase more shares or they are forced to do so by the company's board of directors. In support of this proposition, Core and Larcker (2002) study 195 firms that adopted "target ownership plans" over the period 1992 through 1997. They report that these firms had low managerial equity ownership relative to peers and poor performance relative to peers prior to plan adoption. After the plan adoptions, managers increased their share ownership, and the firms' accounting and stock price performance improved as well.

As the size of the Core and Larcker sample indicates, adoptions of formal target ownership plans are relatively rare. That does not mean, however, that these are the only instances in which boards have exerted pressure on management to purchase additional shares. Indeed, it is possible that many of the cases of insider share purchases that we study represent instances in which the board has informally coerced top-level managers into buying more stock. It is possible that the board recognized that insider ownership was 'too low' and urged officers to purchase more shares. Thus, the purchases by insiders that we observe may simply be trades pushing insider ownership back toward its optimal level.

In this section, we address the question of whether share purchases by insiders should be viewed as moving firms toward their optimal insider ownership levels. We undertake this investigation from several perspectives. First, we use the model proposed by HHP (1999) to determine whether the firms in our sample can be viewed as experiencing insider share purchases because their pre-purchase levels of insider share ownership were "too low." We use the HHP model for this purpose because of its relatively recent vintage and because it is widely recognized. In particular, we use the HHP model to estimate each firm's optimal equilibrium

level of insider ownership. We then ask whether the firms in our sample have an insider ownership "deficit" relative to their optimal equilibrium levels such that the insider share purchases that we observe can be viewed as moving these firms towards their optimal insider ownership levels. Second, we ask whether announcement period excess stock returns are correlated with the equilibrium ownership deficit as determined by the HHP model. That is, does the market respond as if the purchases were moving the firms towards their optimal insider ownership levels. Third, we step away from a specific equilibrium model of optimal insider share ownership and ask whether insider purchases, regardless of whether they can be viewed as purchases that move the firm toward a specified optimal ownership level, are correlated with announcement period stock price changes, ignoring the squared term and the cross-product of the two terms in equation (3).

6.2. *An empirical model of the optimal level of insider ownership*

To construct their model, HHP gather share ownership data from proxy statements for a random sample of 600 *Compustat* firms as of 1982. These firms are tracked through 1992 with ownership data being collected each year from proxy statements. Regression models of (a transformation of) management share ownership as a function of certain firm characteristics are estimated. The transformation of management share ownership is:

transformed inside share ownership = log (inside ownership / (1- inside ownership)). (4)

The explanatory variables in their models are listed in our appendix. HHP estimate their model using OLS regression. They estimate the model with and without 3-digit SIC code industry fixed effects and with and without firm fixed effects.

Using all firms available on both *Compustat* and the *Compact Disclosure* databases over the period 1993 through 1999, we replicate the HHP procedure. We employ the resulting

regression model to compute the optimal level of inside ownership for the firms in our sample that experience insider purchases. The results of this regression allow us to determine whether the insider purchases move firms towards or away from their optimal inside ownership levels according to this model of optimal ownership. In judging whether insider purchases move the firms toward or away from their optimal levels of insider ownership, we employ two estimations of the model - - one without and one with industry fixed effects. We report the coefficients of the estimated models in the Appendix. [3]

For both models, we compare pre-purchase insider ownership with the "optimal" level of ownership in the year before the purchase and the year of the purchase. There are eight comparisons: (1) the actual year-before-purchase level of insider ownership v. the predicted level estimated without industry fixed effects; (2) the actual year-before-purchase level of insider ownership v. the predicted level estimated with industry fixed effects; (3) the actual year-of-purchase level of insider ownership v. the predicted level estimated without industry fixed effects; and (4) the actual year-of-purchase level of insider ownership v. the predicted level estimated with industry fixed effects. These are calculated for each purchase and for the average purchase per year for each firm. We consider the mean and median values of the differences when the actual pre-purchase fraction of insider share ownership is subtracted from the optimal (or predicted) fraction of insider share ownership. We refer to this difference as the insider share ownership deficit. The results are presented in Panel A of Table 3.

Regardless of which regression specification we consider, the mean difference between the predicted (i.e., optimal) level of insider ownership and the actual pre-purchase level of

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[3] We do not use a firm fixed effects model for this analysis because with a fixed effects model estimated over the sample period, the firm fixed effect captures the degree to which the firm's ownership structure differs from other firms' ownership with the same characteristics, on average. Because the post-trade ownership level is actually used to estimate the fixed effect model, it would not be surprising to find that firms have "too little" ownership before insider purchases.

insider ownership is negative and statistically significantly different from zero (all p-values < 0.001). Thus, on average, insiders have "too much" ownership in these firms prior to purchases, with the excess being between 2.02% and 3.43% percent depending upon which regression specification is considered. These results are inconsistent with an argument that the insider share purchases are moving these firms toward their optimal insider ownership levels.

When we consider the medians of the difference between the actual levels of insider ownership and the predicted levels, a slightly different picture emerges. The median ownership deficit is positive (i.e., insiders have 'too little' ownership), albeit the difference is frequently not statistically significantly different from zero. If the median firm is considered to be a "typical" firm, an argument might be made that the typical firm is close to its optimal inside ownership level. If so, that still does not offer support for an argument that insider purchases are moving these firms toward their optimal ownership levels. That is, because the typical firm did not have a significant insider ownership deficit to begin with, there was little need for insiders to purchase additional shares. Thus, the medians of the differences between the pre-purchase level of insider share ownership and the optimal level of insider share ownership do not indicate that these firms would have been expected to experience additional share purchases by insiders. As such, they do not support the argument that these firms had too little insider share ownership.

On balance, the results in Panel A of Table 3 indicate that the purchases do not appear to be aimed at restoring insider ownership to its optimal level, but it could be that consideration of only the means and medians of the distributions is masking a correlation between the size of the deficit and the size of the purchase. That is, it could be that firms with the largest ownership deficit experience the largest insider share purchases. To examine that possibility, we estimate a simple regression with the change in the fraction of shares owned by corporate insiders as the

dependent variable and the pre-purchase fraction of shares owned by insiders subtracted from the predicted fraction of insider ownership as the explanatory variable. That is, we regress the change in ownership on the deficit. We use the same four measures of the ownership deficit as in Panel A. Panel B of Table 3 contains the results.

The findings are the opposite of what would be expected if the purchases were meant to move firms toward their optimal levels of insider ownership. The relation between the amount of the purchase and the ownership deficit is negative. This implies that insiders in firms with "too much" ownership actually buy more shares than insiders in firms with "too little" insider ownership.

6.3. *The change in the value of the firm and the insider ownership deficit*

We now consider whether the APERs around the announcements of insider purchases are consistent with the interpretation that insider share purchases are moving firms toward their optimal ownership structures. For this analysis, we regress APERs against three independent variables: (1) the change in inside ownership, (2) the insider ownership deficit, and (3) the interaction between the change in insider ownership and the insider ownership deficit. We include the ownership deficit in the regression to examine whether the change in the value of the firm depends on whether the purchases occur in firms with "too much" rather those in those with "too little" insider ownership. Further, we interact the size of the purchase with the size of the deficit. Our reasoning for doing so goes as follows: when insiders buy shares to make up a larger deficit, the stock price reaction should be especially large.

The optimal ownership hypothesis predicts positive coefficients for each of the variables. The results of the regression are displayed in Panel C of Table 3. All the coefficients have the predicted sign, but only the coefficient of the deficit is marginally significant, with a p-value of

0.09, and in only two of the four specifications. This result could be considered weak evidence in support of the optimal ownership explanation. However, before embracing that interpretation too enthusiastically a note of caution is appropriate.

When a firm has too little inside ownership according to the optimal ownership model (i.e., the deficit is large), it is also the case that such a firm is likely to have a low level of pre-purchase actual ownership. Indeed, the correlation between the deficit and pre-purchase actual ownership is –0.83 when the deficit is computed without industry fixed effects and –0.87 when the deficit is computed with industry fixed effects. Further, the curvilinear relationship of equation (1) implies that share purchases by insiders have a smaller APER when pre-purchase insider ownership is large. Thus, the apparent significance of the positive coefficients on the deficit in Panel C of Table 3 may have come about because the deficits are correlated with the level of pre-purchase insider ownership. To consider that possibility, we insert the level of pre-purchase insider ownership into the regression in place of the deficit and re-estimate the regressions. In each of the four regressions, the pre-purchase level of insider ownership has a negative coefficient and a p-value less than 0.05. We then include both the pre-purchase level of insider ownership along with the deficit. In three of the four regressions, the sign of the deficit coefficient is reversed and none of the coefficients of the deficit are significant. As regards the level of pre-purchase inside ownership, the signs of the coefficients continue to be negative and two of the four have p-values less than 0.05. Thus, this analysis further weakens the already limited support for the hypothesis that the stock price response that accompanies share purchases by insiders represents a movement toward an optimal ownership structure.

While some of the tests in this section provide support for the argument that purchases by insiders can be viewed as moving firms toward an optimal ownership structure, taken as a whole,

the support is modest and the counter evidence is plentiful: The average insider purchase occurs in firms that already have "too much" insider ownership, the relationship between the ownership deficit and the magnitude of the share purchases is negative, and the stock price response around announcements of the purchases is not correlated with the deficit.

6.4. *A simple model of insider share purchases and optimal insider ownership*

An argument might be made that our failure to find a significant relationship between the APERs and the change in insider ownership occurs because we have used a specific, and incorrect, model of equilibrium optimal ownership. Thus, our failure is not due to the lack of a correlation, but due to model misspecification. One way to address such a concern is to abandon a specific model and to merely search for correlation between the change in ownership and the stock price change.

Assuming that the purchases are not anticipated by market participants, all else equal, larger purchases should have a more substantial stock price response than smaller purchases because, presumably, they correct a more substantial deviation from the optimum. To investigate whether larger purchases do have a larger impact, we regress APERs around announcements of insider share purchases against the associated increase in the fraction of insider share ownership. We continue to include indicator variables for every trade reporting day, but we exclude the other explanatory variables employed previously.

The results of this simple regression are reported in Panel D of Table 3. The coefficient on the increase in insider ownership is negative, albeit not significantly different from zero (p-

value = 0.71). This result contradicts the proposition that increases in share ownership by insiders typically represent movements toward an optimal level of share ownership.[4]

7.   Insider share purchases as signals about the value of the firm

A further possibility is that purchases by the insiders are simply a signal that the firm is undervalued (Seyhun (1986)) and the positive stock price reaction to the announcement is merely a reflection of this signal. As we demonstrated in section 6, we do not find a positive relation between the size of the purchase and the stock price response. Thus, we need to develop a more elaborate signaling explanation to explain the observed stock price reaction.

One possibility is that the marginal information conveyed by the signal is decreasing in the size of the purchase such that the stock price reaction declines as the size of the purchase increases. This explanation is consistent with the APER being positively correlated with the size of the share purchase as a fraction of total shares outstanding and negatively correlated with this fraction squared, as reported in Table 2. However, this signaling explanation has no implication for the coefficient of the cross-product of initial ownership with the change in ownership. To investigate this version of a signaling story, we regress APERs against the change in insider ownership and the change in insider ownership squared but we omit the cross-product term. We also include the reporting-day indicator variables.

The results of the regression are reported in the first column of Table 4. The signs of the coefficients are positive and negative as the signaling story would predict, but with p-values of 0.32 and 0.12 neither coefficient is significantly different from zero at traditionally acceptable levels. Furthermore, while the signaling story can reasonably predict a declining marginal effect

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[4] We emphasize that this result occurs only when the purchases are unanticipated because if market participants can determine the optimal equilibrium ownership level, presumably, they can also determine how much firms deviate from that optimum, and they can anticipate when and by how much those deviations will be rectified.

of the signal as the size of the purchase increases, it is difficult to envision a signaling story that predicts a negative stock price reaction and the coefficients of this regression imply a negative stock price reaction for purchases of more than 13.5% of outstanding shares. This result cannot be reconciled with a signaling explanation.

We employ a variety of other specifications to examine other versions of the signaling explanation. For example, an argument can be made that the dollar amount of a purchase is more informative than the fraction of shares purchased. For that reason, we estimate a regression in which the dollar amount of the purchase is the independent variable along with the reporting-day indicators. As shown in the second column of Table 4, the coefficient of the dollar purchase amount is positive, but not significantly different from zero (p-value = 0.62). In the third column of Table 4, we report the results of a regression in which the independent variables are the change in the fraction of inside share ownership and the interaction between this change and the market value of the firm. We estimate this regression because an argument might be made that a given percentage increase in share ownership will have a greater impact on a smaller firm because there is less available information about such firms. However, as shown in column three, this proposition is not supported by the data. Both the coefficients of the change in ownership and the interaction term are insignificant (p-values of 0.63 and 0.56). Finally, Leland and Pyle (1977) argue that one cost of signaling with stock ownership by insiders is the possible resultant reduction in diversification on the part of the manager's portfolio. This cost should be higher for firms with more volatile stock prices. We would, therefore, expect the stock price response to a given share purchase to be stronger for firms with more volatile stock prices. In column four of Table 4, we present the results of a regression in which the independent variables are the change in insider ownership and the interaction of the change in ownership with the stock

return volatility, where stock return volatility is computed using daily returns over the one year prior to the announcement of the purchase. In this specification as well, neither of the independent variables is statistically significant.

We should emphasize that we are not arguing that the market does not interpret purchases by insiders as signals. The fact that the market responds to the trades clearly indicates that purchases provide information to market participants. But the way in which the market interprets the information is consistent with a curvilinear relation between firm value and insider ownership specified in equation (1) and is not just an indication that the firm is undervalued.

8.   Conclusion

In this study we examine stock price responses to announcements of share purchases by corporate insiders for a sample of US firms over the interval 1994 through 1999. In particular, we investigate whether the stock price reaction is consistent with the curvilinear relationship between insider ownership and firm value documented by McConnell and Servaes (1990, 1995). They estimate a quadratic relationship in which the standardized value of the firm is positively correlated with the fraction of shares owned by insiders up to a point, after which additional insider share ownership is associated with a reduction in the value of the firm. Although we use the McConnell and Servaes study to motivate our investigation, as we have noted, their study is not the only one that documents a non-linear relationship between the level of share ownership by insiders and the value of the firm.

One interpretation of the relationship estimated by McConnell and Servaes (1990) and others is that insider ownership can be used to increase firm value up to a point, after which additional ownership actually reduces firm value. Such an interpretation has been criticized

because it ignores the endogeneity that might arise when other factors cause both value and ownership to evolve optimally and in harmony one with one another. This study seeks a way around the endogeneity problem by directly examining instances in which changes in share ownership are observed. We ask whether the changes in firm value that occur when share purchases by insiders are announced are consistent with the model of the non-linear relationship between share ownership and firm value documented by prior studies. We do so by regressing announcement period excess returns when insiders purchase shares against the change in the fraction of shares owned by insiders, the square of the change in the fraction of shares owned, and the interaction of the change in insider ownership and the pre-purchase level of insider ownership. Consistent with the curvilinear relation between insider ownership and firm value, we find that the coefficient of the change in ownership is positive, the coefficient on the change in insider ownership squared is negative, and the coefficient on the interaction is negative. These results are consistent with the causal interpretation of the relation between insider ownership and firm value.

We also examine two alternative interpretations of our results, but find little evidence to support either one. First, we examine whether insiders purchase shares because they do not hold enough stock according a model of optimal ownership. This is not the case. If anything, the firms in our sample have too much ownership to begin with, and those firms with too much ownership actually experience the largest purchases. Moreover, the stock price change is not significantly related to the fraction of shares purchased or the size of the empirically estimated ownership deficit. Second, we study whether the stock price response is consistent with a signaling interpretation where insiders purchase shares to inform the market that the share price is too low. Our tests do not support this interpretation either.

A causal interpretation of our results is certainly not at odds with the existence of an optimal ownership structure. However, the causal interpretation is at odds with the argument that firms are at their optimal ownership structures all the time. It is also inconsistent with the argument that all changes in insider ownership are aimed at moving the firm toward an optimal ownership structure. One concern with the causal interpretation of our empirical results is that it implies that managers, the board and other shareholders do not jointly maximize the value of the firm with respect to ownership structure. In some cases, insiders own "too much" stock and in other cases, they do not own enough. In those cases where managers own too much stock, they may be doing so to enhance their entrenched positions. It such cases, forcing insiders to sell shares would be very difficult for the board to implement. In those cases where managers do not own enough stock, capital may be a barrier to increased insider ownership. For whatever the reason, our results indicate that share ownership by insiders matters.

Appendix

Regression models explaining insider ownership

Two regression models are estimated over the period 1993-1999. For each model, the dependent variable is log (insider ownership / (1 – insider ownership)). Explanatory variables for each model include: (1) log (sales), (2) log (sales) squared, (3) property, plant, and equipment (PP&E), divided by sales, (4) PP&E / sales, squared, (5) the residual standard deviation of a market model estimated annually for each firm using daily data, (6) an indicator variable set equal to one if data are available to estimate the residual standard deviation – when this indicator variable is zero, the residual standard deviation is set equal to zero, (7) operating income to sales, (8) the ratio of R&D to PP&E, (9) an indicator variable set equal to one if data on R&D are available and zero otherwise – when this indicator variable is zero, the ratio of R&D to PP&E is set equal to zero, (10) the ratio of advertising expenditures to PP&E, (11) an indicator variable set equal to one if data on advertising are available and zero otherwise – when this indicator variable is zero, the ratio of advertising to PP&E is set equal to zero, (12) the ratio of capital expenditures to PP&E, and (13) an indicator variable set equal one if capital expenditures are available – when this indicator variable is zero, the ratio of capital expenditures to PP&E is set equal to zero. The following variables have been winsorized at the 99th percentile: PP&E/Sales, Residual standard deviation, Operating income/sales, R&D expenditures/PP&E, Advertising expenditures/PP&E, Capital expenditures/PP&E. Operating income/sales has also been winsorized at the first percentile. All models include year indicator variables. The first regression model does not contain industry controls. The second regression contains industry fixed effects which are modeled as industry indicator variables, with industry defined at the three-digit SIC code level. P-values are in parentheses.

Explanatory variables	OLS	Industry Fixed Effects
Intercept	-0.785 (0.00)	-0.094 (0.43)
Log(sales)	0.068 (0.01)	0.132 (0.64)
$(Log(sales))^2$	-0.048 (0.00)	-0.044 (0.00)
PP&E / sales	-0.956 (0.00)	-0.502 (0.00)
$(PP\&E / sales)^2$	0.175 (0.00)	0.083 (0.00)
Residual standard deviation	22.427 (0.00)	10.171 (0.13)
Indicator if residual standard deviation is available	-0.272 (0.00)	-0.205 (0.00)
Operating income / sales	-0.149 (0.03)	0.127 (0.07)
R&D expenditures / PP&E	-0.246 (0.00)	-0.123 (0.00)
Indicator if R&D expenditures are available	-0.171 (0.00)	-0.231 (0.00)
Advertising expenditures / PP&E	-0.069 (0.12)	-0.020 (0.66)
Indicator if advertising expenditures are available	0.275 (0.00)	0.109 (0.00)
Capital expenditures / PP&E	0.441 (0.00)	0.409 (0.00)
Indicator if capital expenditures are available	0.505 (0.00)	-0.215 (0.02)
Adjusted r squared	0.27	0.34
Number of observations	21,802	21,802

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Table 1

Summary statistics on open market purchases by corporate insiders

Summary statistics for open market insider purchases of at least 10,000 shares as reported by *Thomson Financial* over the period 1994 through 1999. Insiders are defined as officers and members of the board of directors. Insider purchases are excluded from the sample if any of the following occurs: (1) insider sales activity is reported on the same day as the purchase; (2) the purchase is reported more than 90 days after the required reporting deadline; (3) the share price is below $2 at the time of the announcement; or (4) the price at which the insider bought differs by more than 20% from the closing price on the day of the purchase. Insider ownership data are from *Compact Disclosure* and proxy statements. Announcement period excess returns (APERs) are computed as the sum of a firm's market-adjusted returns on the reporting day and five subsequent days, where the CRSP value-weighted index is employed as a proxy for the market. Trades are removed from the analysis if the corresponding APER is not within three standard deviations of the mean APER for all purchases in the sample. P-values for tests that the mean and median APERs are equal to zero are in parentheses.

Variable	Mean	Median
Shares purchased	61,158	20,000
Fraction of ownership purchased	0.42%	0.15%
Insider ownership before purchase	19.88%	13.83%
Market value of equity in purchase month (in $ millions)	1,123	139
Amount of purchase (in $)	898,783	213,750
Announcement period excess return	0.94%	0.35%
	(0.00)	(0.00)

Year	Number of purchases	Number of companies
1994	712	450
1995	627	438
1996	711	509
1997	624	412
1998	898	577
1999	569	391
Total	4141	

Table 2

Regressions of announcement period excess returns (APERs) on the change in insider ownership, the change in insider ownership squared, and the cross-product of the change in insider ownership and the level of insider ownership before the insider share purchase

The dependent variable is the announcement period excess return (APER) associated with open market purchases of at least 10,000 shares by officers and directors over the period 1994 through 1999. The APER is computed as the sum of a firm's market-adjusted returns on the reporting day and five subsequent days, where the CRSP value-weighted index is employed as a proxy for the market. Insider purchases are excluded from the sample if any of the following occurs: (1) insider sales activity is reported on the same day as the purchase; (2) the purchase is reported more than 90 days after the required reporting deadline; (3) the share price is below \$2 at the time of the announcement; or (4) the insider purchase price differs by more than 20% from the closing price on the day of the purchase. Insider ownership is the fraction of shares owned by officers and directors. Pre-purchase ownership refers to ownership before the share purchase. All regression models contain reporting-day fixed effects. Column (1) is the base case regression which excludes APERs outside three standard deviations of the mean APER. The other columns contain sensitivity tests. P-values are in parentheses.

Variable	Base case regression	Including all APERs	Excludes APERs outside two standard deviations of the mean APER	Excludes insider ownership > 3 standard deviations above the mean	Excludes insider ownership < 1st percentile and > 3 standard deviations above the mean	Constrained regression: $b_3 = 2b_2$
	(1)	(2)	(3)	(4)	(5)	(6)
Change in ownership (b_1)	0.58 (0.04)	1.16 (0.00)	0.60 (0.02)	0.60 (0.04)	0.62 (0.03)	0.38 (0.08)
Change in ownership squared (b_2)	-1.58 (0.07)	-2.75 (0.01)	-1.21 (0.10)	-1.55 (0.08)	-1.59 (0.07)	-0.49 (0.04)
Pre-purchase ownership x change in ownership (b_3)	-1.10 (0.07)	-1.91 (0.01)	-1.14 (0.03)	-1.21 (0.06)	-1.24 (0.05)	-0.98 (0.04)
P-value on test: $2 b_2 = b_3$	0.26	0.10	0.43	0.30	0.29	
Adjusted r-squared	0.07	0.05	0.07	0.07	0.07	
Number of observations	4141	4211	4004	4087	4044	4141
Number of reporting day indicators	934	941	917	931	927	934

Table 3

Tests to determine whether the insider purchases move ownership to an optimal level

The Appendix presents the models employed to calculate the optimal level of ownership. For each purchase, the pre-purchase ownership level is subtracted from the optimal ownership level and the resulting value is called the "ownership deficit." A positive number indicates that a firm has "too little" insider ownership before the purchase. Year refers to the year relative to the purchase: year −1 indicates that the optimal level of ownership is computed at the end of the year before the purchase; year 0 indicates that the optimal level of ownership is computed at the end of the year of the purchase. "Without industry fixed effects" indicates that the optimal ownership level is estimated using OLS regressions that do not include industry fixed effects. "With industry fixed effects" indicates that the optimal level of ownership is estimated using OLS regressions with industry fixed effects defined at the three-digit SIC code level.

Panel A reports mean and median values for the ownership deficit in which the optimal level of insider ownership is computed with and without industry fixed effects for both the end of the year prior to the purchase and the end of the year in which the purchase occurred. These statistics are reported using all purchases in a given year and using the average purchase per firm-year. P-values of t-tests for means and sign rank tests for medians are in parentheses. Panel B reports regressions in which the change in ownership associated with a purchase is the dependent variable and one of the four different computations of the ownership deficit using all purchases is the independent variable. Panels C and D report regressions in which the announcement period excess return (APER) is the dependent variable and the explanatory variables are the change in ownership, the ownership deficit, and an interaction between the change in ownership and the ownership deficit. The regressions include reporting day indicator variables. APERs are defined in Tables 1 and 2. For Panels B, C, and D, p-values of the t-tests of significance of the regression coefficients are in parentheses.

Panel A: Ownership deficit measured as predicted optimal insider ownership less actual pre-purchase insider ownership

Optimal level of insider ownership computed using	Ownership deficit (all purchases)			Ownership deficit (average purchase per firm-year)		
	Mean	Median	N	Mean	Median	N
Without industry fixed effects year −1	-0.0306 (0.00)	0.0094 (0.00)	3766	-0.0258 (0.00)	0.0135 (0.33)	2522
Without industry fixed effects year 0	-0.0343 (0.00)	0.0057 (0.00)	3151	-0.0299 (0.00)	0.0097 (0.04)	2095
With industry fixed effects year −1	-0.0237 (0.00)	0.0098 (0.35)	3766	-0.0202 (0.00)	0.0126 (0.68)	2522
With industry fixed effects year 0	-0.0287 (0.00)	0.0056 (0.00)	3151	-0.0256 (0.00)	0.0075 (0.12)	2095

Panel B: OLS regression of the relation between the change in ownership associated with the purchase and the ownership deficit

	Ownership deficit is computed based on OLS:			
	Without industry fixed effects year –1 (1)	Without industry fixed effects year 0 (2)	With industry fixed effects year –1 (3)	With industry fixed effects year 0 (4)
Intercept	0.0038 (0.00)	0.0039 (0.00)	0.0038 (0.00)	0.0039 (0.00)
Ownership deficit	-0.0078 (0.00)	-0.0080 (0.00)	-0.0071 (0.00)	-0.0073 (0.00)
Adjusted r-squared	0.01	0.01	0.01	0.01
Number of observations	3766	3151	3766	3151

Panel C: Explaining announcement period excess returns using the change in ownership, the ownership deficit, and the cross-product of the change in ownership and the ownership deficit

	Ownership deficit is computed based on OLS:			
	Without industry fixed effects year –1 (1)	Without industry fixed effects year 0 (2)	With industry fixed effects year –1 (3)	With industry fixed effects year 0 (4)
Change in ownership	0.05 (0.73)	-0.02 (0.89)	0.04 (0.76)	-0.01 (0.94)
Ownership deficit	0.01 (0.31)	0.02 (0.09)	0.01 (0.36)	0.02 (0.09)
Change in ownership * Ownership deficit	0.50 (0.47)	0.19 (0.80)	0.65 (0.39)	0.39 (0.64)
Adjusted r-squared	0.06	0.06	0.06	0.06
Number of observations	3708	3111	3708	3111
Number of reporting day indicators	900	766	900	766

Panel D: Explaining announcement period excess returns using the change in ownership

Variable	
Change in ownership	-0.04 (0.71)
Adjusted r-squared	0.06
Number of observations	4141
Number of reporting day indicators	934

Table 4

Regressions models used to examine alternative interpretations of the results
The dependent variable is the announcement period excess return (APER) associated with open market insider purchases of at least 10,000 shares by officers and directors over the period 1994 through 1999. APER is defined in Tables 1 and 2. Insider purchases are removed from the sample if the corresponding APER is not within three standard deviations of the mean APER for all purchases by insiders. Insider purchases are also excluded from the sample if any of the following occurs: (1) insider sales activity is reported on the same day as the purchase; (2) the purchase is reported more than 90 days after the required reporting deadline; (3) the share price is below $2 at the time of the announcement; or (4) the price at which the insider bought differs by more than 20% from the closing price on the day of the purchase. Stock price volatility is computed as the standard deviation of monthly returns over the year before the year in which the insider purchase took place. All regression models contain reporting-day fixed effects. P-values of the t-tests of significance of the regression coefficients are in parentheses.

Variable	(1)	(2)	(3)	(4)
Change in ownership	0.18 (0.32)		-0.06 (0.63)	-0.46 (0.20)
Change in ownership squared	-1.37 (0.12)			
Dollar amount of purchase (in $ millions)		0.0001 (0.62)		
Change in ownership x market value of firm			0.0001 (0.56)	
Change in ownership x stock price volatility				3.65 (0.13)
Adjusted r-squared	0.06	0.06	0.06	0.07
Number of observations	4141	4134	4141	3927
Number of reporting day indicators	934	933	934	915

Figure 1

Illustration of stock price change associated with a share purchase by a corporate insider

This graph is based on model (1) in Table 2. Announcement period excess returns (APERs) are computed for open market insider purchases of at least 10,000 shares by officers and directors over the period 1994 through 1999. The APER is computed as the sum of a firm's market-adjusted returns on the reporting day and five subsequent days, where the CRSP value-weighted index is employed as a proxy for the market. Insider purchases are removed from the sample if the corresponding APER is not within three standard deviations of the mean APER for all trades. Insider purchases are also excluded from the sample if any of the following occurs: (1) insider sales activity is reported on the same day as the purchase; (2) the purchase is reported more than 90 days after the required reporting deadline; (3) the share price is below $2 at the time of the announcement; or (4) the price at which the insider bought differs by more than 20% from the closing price on the day of the purchase.