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Changes in insider ownership and changes in the market value of the firm ☆

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Abstract

The empirically-observed cross-sectional relation between the *level* of insider share ownership and the *level* of firm value has often been interpreted to mean that a change in share ownership can lead to a change in firm value. Such an interpretation has been criticized for ignoring potential endogeneity. In this paper, we perform two sets of tests to circumvent this alleged endogeneity. First, we measure *changes* in value over the 6-day interval around announcements of insider share purchases and find that the cross-sectional variability in changes in value is described by a curvilinear relation between firm value and insider ownership where the value of the firm first increases, then decreases, as insider share ownership increases. Second, we conduct tests to determine (1) whether the insider purchases are a response to changes in firm characteristics that require a new optimal equilibrium ownership level or (2) whether insiders are purchasing shares to signal that the firm is undervalued. We find no evidence to support these interpretations. Overall, our results are consistent with a causal interpretation of the empirical relation between insider ownership and firm value.

JEL classifications: G32; G34
Keywords: Insider ownership; Firm value; Equity ownership structure; Governance

1. Introduction

Morck, Shleifer, and Vishny (MSV) (1988), McConnell and Servaes (1990, 1995), Hermalin and Weisbach (1991), Holderness et al. (1999), Anderson and Reeb (2003), Adams and Santos (2006) and others document a statistically

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significant cross-sectional correlation between the level of 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.[1] 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 follow the Demsetz (1983) argument 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 is 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 relation 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 (HHP) (1999), and Coles et al. (2003) support Demsetz' criticism empirically.

In particular, in an effort to control for the alleged endogeneity in regressions using levels of insider ownership and firm value, HHP estimate a firm fixed effects regression in which the dependent variable is a proxy for firm value and the key independent variable is insider share ownership. With this procedure, they find no relation and, thereby, conclude that the significant relations reported in earlier studies are spurious. However, Zhou (2001) points out that a fixed effects estimation has shortcomings of its own when used with annual panel data of the type employed by HHP. He argues that in annual panel data with firm fixed effects it would be difficult to detect a meaningful relation between ownership and performance, even if one exists, because such tests have little power.

Specifically, Zhou observes that insider ownership typically changes slowly from year to year and in most years, for an individual firm, no change occurs at all; whereas, for the same firm, value can change dramatically over the course of a year for a host of reasons unrelated to insider ownership. That is not to say that a fixed effects analysis has no merit. In particular, a fixed effects model does control for unobserved firm-specific heterogeneity. The fixed effects model accomplishes this by, in essence, considering changes in ownership and changes in value rather than levels. When changes are considered, any firm fixed effect cancels and, therefore, any relation that remains cannot be due to endogeneity that arises from such an effect.

In this study, we employ a methodology that preserves the virtues of a firm fixed effects analysis while overcoming the concerns raised by Zhou. Specifically, we estimate the relation between changes in insider share ownership and changes in stock prices over the 6-day interval commencing with the announcement of share purchases by corporate insiders. By conducting the analysis using changes in share ownership and changes in value, we control for any unobserved firm-specific fixed effect. Furthermore, by design, each of the firms in our sample experiences a change in insider ownership over the interval of analysis, thereby addressing the problem caused by many zero change observations encountered with annual panel data. Finally, because the stock price change is observed over a short time interval, the firm value observations embed less "noise," thereby increasing the ability of the tests to detect a relation if one exists. To put this last point a bit differently, over the 6-day interval of analysis, other factors that are likely to affect corporate value are unlikely to be changing in a systematic way across firms.

As the starting point of our analysis, we employ the curvilinear relation reported by McConnell and Servaes (1990):

$$\begin{aligned}\text{Tobin's } Q = {} & b_0 + b_1(\text{INOWN}) + b_2(\text{INOWN})^2 + c_1(\text{BLKOWN}) + c_2(\text{INSTOWN}) \\ & + c_3(\text{Control variables})\end{aligned} \tag{1}$$

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

[1] These studies are based on U.S. firms. Studies with cross country data are conducted by La Porta et al. (2002), Claessens et al. (2002), and Lins (2003).

Starting from Eq. (1), if insiders increase their ownership by ΔINOWN (and blockholder/institutional ownership along with the control variables is stable over a short interval) then subtracting the initial level of Tobin's Q from the new level of Tobin's Q gives:

$$\Delta Q = b_1(\Delta\text{INOWN}) + b_2(\Delta\text{INOWN})^2 + 2b_2(\Delta\text{INOWN} \times \text{INOWN}) \quad (2)$$

where the initial level of insider ownership is measured before the change in ownership.[2]

If the alleged endogeneity in a regression of the level of firm value on the level of insider ownership is due to a firm fixed effect, all explanatory variables in the change regression of Eq. (2) will be insignificant. If the relation is causal, however, the predicted sign of b_1 will be positive and the predicted sign of b_2 will be negative. In addition, the predicted sign of the coefficient of the third term will be negative and its magnitude will be twice that 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 Eq. (2) 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 initial level of insider ownership matters. In particular, the increase in corporate value due to an increase in share ownership by insiders becomes progressively smaller the higher the initial level of insider ownership, and can be negative for sufficiently high initial levels of insider ownership. It is therefore of critical importance to include this third term in any empirical specification.

To test the predictions of Eq. (2), we use 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). When these announcement period 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 pre-purchase level of insider ownership, the results are largely consistent with a causal interpretation of the relationship between insider ownership and firm value. 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. Further, in none of the tests we conduct can we 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 $b_3 = -1.10$. This result dampens an interpretation of Eq. (1) as being a literal description of the relation between firm value and insider ownership, but the data are still consistent with a causal interpretation that can generally be described by Eq. (1).

While the announcement period valuation results are consistent with a causal interpretation of the relation between firm value and insider ownership, it is also possible that they come about because insiders are trading as underlying firm characteristics are changing, requiring an adjustment to the optimal level of insider ownership. To address this concern, we test whether insider purchases appear to be moving firms toward "optimal" ownership structures. Given an independently specified model of optimal ownership,[3] insider share purchases are not consistent with movement toward such an optimum. Additionally, when announcement period abnormal returns are regressed against the "ownership deficit" as determined by this model of optimal ownership, the coefficients are not statistically significant.

Finally, we conduct tests to determine whether the abnormal returns associated with announcements of insider share purchases are more consistent with a signaling explanation in which insider purchases convey information about the intrinsic value of the firm. These tests reject such an interpretation.

In sum, after conducting a battery of tests, the only explanation that survives is that of a causal relation between the fraction of shares held by corporate insiders and the value of the firm, where firm value first increases and then decreases as insiders own more shares.

[2] Adding ΔINOWN to INOWN yields:

$$Q + \Delta Q = b_0 + b_1(\text{INOWN} + \Delta\text{INOWN}) + b_2(\text{INOWN} + \Delta\text{INOWN})^2 + c_1(\text{BLKOWN}) + c_2(\text{INSTOWN}) + c_3(\text{Control variables})$$

Solving the squared term yields:

$$Q + \Delta Q = b_0 + b_1(\text{INOWN}) + b_1(\Delta\text{INOWN}) + b_2(\text{INOWN})^2 + b_2(\Delta\text{INOWN})^2 + 2b_2(\Delta\text{INOWN} \times \text{INOWN}) + c_1(\text{BLKOWN}) + c_2(\text{INSTOWN}) + c_3(\text{Control variables})$$

Subtracting Eq. (1) from the above equation yields Eq. (2).

[3] Specifically, we use the model of ownership developed by HHP (1999).

The remainder of this paper is organized as follows. The next section describes the data. Section 3 studies the relation between ownership changes and abnormal announcement period returns. Section 4 presents various tests of robustness of these results. Section 5 assesses whether the insider share purchases should be viewed as moving firms toward their optimal equilibrium levels of insider share ownership. Section 6 analyzes 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 7 summarizes our findings and sets forth our conclusions.

2. Data

Data on insider purchases are from *Thomson Financial* for 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.

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 of shares 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. (Hereafter we refer to the fraction of shares owned by management and the board as insider ownership.) 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 insider share ownership are obtained from *Compact Disclosure*. *Compact Disclosure* gathers such data from annual corporate proxy statements. These share ownership figures also include options that can be exercised within 6 months. 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 these data, we selected 200 firms at random across all years and sought to hand collect ownership data for them from corporate proxies. We were able to collect data for 172 firms.[4] 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 collected data from proxies, we use the proxy data. For all others, we use the *Compact Disclosure* data.

The announcement period abnormal return (APAR) 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 abnormal returns are summed to give the APAR for the relevant insider share purchase. We use this 6-day interval because the 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 APAR that is not within three standard deviations of the mean APAR. 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 only if they are reported within 90 days of the reporting deadline.

Table 1 provides summary statistics of the data. Our sample includes 4141 different purchases by insiders representing 1700 different companies, or about 2.5 trades per company. The mean and median purchases are 61,158

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

Table 1
Summary statistics on open market purchases by corporate insiders

Variable	Mean	Median	25th Percentile	75th Percentile
Shares purchased	61,158	20,000	11,000	40,000
Fraction of ownership purchased	0.42%	0.15%	0.06%	0.35%
Insider ownership before purchase	19.88%	13.83%	5.65%	28.85%
Market value of equity (in $ millions)	1,123	139	49	522
Amount of purchase (in $)	898,783	213,750	98,175	503,200
Abnormal return	0.94%	0.35%	−3.47%	4.82%
	(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	

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. Announcement period abnormal returns (APARs) 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 APAR is not within three standard deviations of the mean APAR for all purchases in the sample. *P*-values for tests that the mean and median APARs are equal to zero are in parentheses. The market value of equity is computed at the end of the month before the trade.

and 20,000 shares, respectively, which represent 0.42% and 0.15% of the company's outstanding stock. In dollar value terms, the mean and median purchases are $898,783 and $213,750, respectively. Thus, the typical purchase in our sample is not small. Before the purchase, mean and median insider ownership levels were a substantial 19.88% and 13.83% of total outstanding shares. The final row of the top panel of Table 1 gives the mean and median 6-day APARs of 0.94% and 0.35%, respectively. Both are highly statistically significant with p-values < 0.001.

3. A direct test of the relation between insider purchases and changes in firm value

Our goal in undertaking this study is to circumvent the possible spurious correlation that may arise when firm value is regressed against the level of insider ownership. To do so, we estimate the following regression model:

$$\text{APAR} = b_1(\Delta\text{INOWN}) + b_2(\Delta\text{INOWN})^2 + b_3(\Delta\text{INOWN} \times \text{INOWN}) + e. \quad (3)$$

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 pre-purchase level of insider ownership, is negative and twice the size of b_2. 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 held by insiders squared, and the cross product of the initial level of insider ownership and the increase in the fraction of insider share ownership. As we noted, insider trades must be reported by the 10th day of the month after the trade. Not surprisingly, many trades for many different companies are reported on the 10th of each month. Additionally, trades in more than one firm are sometimes reported on the same day even when it is not the 10th. Because the abnormal 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

Table 2
Regressions of announcement period abnormal returns (APARs) 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

Variable	Base case	Including the change in INSTOWN	Piece-wise regression	Removing confounding events	Including all option ownership for 1645 firms	Excluding option ownership for 1645 firms	Constrained regression: $b_3=2b_2$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔINOWN (b_1)	0.58 (0.04)	0.58 (0.06)	0.70 (0.02)	0.56 (0.06)	0.59 (0.06)	0.56 (0.07)	0.38 (0.08)
ΔINOWN squared (b_2)	−1.58 (0.07)	−1.61 (0.05)		−1.43 (0.08)	−1.59 (0.05)	−1.55 (0.05)	−0.49 (0.04)
ΔINOWN × Pre-purchase INOWN (b_3)	−1.10 (0.07)	−1.07 (0.06)		−1.18 (0.06)	−1.29 (0.05)	−1.05 (0.06)	−0.98 (0.04)
ΔINSTOWN		0.06 (0.02)					
Indicator if institutional ownership is missing		−0.00 (0.19)					
ΔINOWN if INOWN > 13.83% (b_4)			−0.83 (0.01)				
P-value on test: $2b_2=b_3$	0.26	0.16	–	0.35	0.26	0.18	–
Adjusted *r*-squared	0.07	0.07	0.07	0.06	0.07	0.07	–
# of observations	4141	4141	4141	3739	4141	4141	4141
# of reporting day indicators	934	934	934	893	934	934	934

The dependent variable is the announcement period abnormal return (APAR) associated with open market purchases of at least 10,000 shares by officers and directors over the period 1994 through 1999. The APAR is computed as the sum of a firm's market-adjusted returns on the reporting day and five subsequent days. 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. INOWN 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 APARs outside three standard deviations of the mean APAR. The other columns contain sensitivity tests: column (2) includes two additional explanatory variables: the change in INSTOWN over the quarter surrounding the announcement of the trade, obtained from *Thomson Financial*, and an indicator variables, set equal to 1 if INSTOWN is not available for that firm; if the indicator is set equal to 1, the change in INSTOWN is set equal to zero; column (3) contains a piece-wise model, with explanatory variables ΔINOWN and ΔINOWN interacted with a dummy variable equal to 1 if INOWN is larger than the sample median (13.83%); column (4) contains the model estimated after possibly confounding events have been removed; column (5) includes ownership of options that cannot be exercised within 6 months for 1645 firms with these data available from *Execucomp*; column (6) excludes all option ownership for 1645 firms with these data available from *Execucomp*; column (7) constrains the relative magnitudes of the coefficients of b_2 and b_3. *P*-values are in parentheses.

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 causal interpretation of Eq. (1). In particular, an increase in share ownership by insiders can 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 insider 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. 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. 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.

4. Other specifications

In this section, we examine the sensitivity of our base-case results to alternative specifications.[5]

[5] Additional sensitivity analysis and robustness tests are reported in a manuscript titled "Changes in Market Values and Analysts' EPS Forecasts around Insider Ownership Changes" posted on the authors' websites.

4.1. Institutional and block ownership

The starting point for our tests is Eq. (2) which evolves as the first difference in Eq. (1) with respect to a change in insider ownership, assuming that institutional and block ownership along with the control variables are stable or have no effect on ΔQ. As reported in McConnell and Servaes (1990), estimation of Eq. (1) yields an insignificant coefficient for block ownership and a positive and significant coefficient for institutional ownership. In their estimation, the control variables include debt/assets, R&D/assets, advertising expense/assets, and assets. The coefficient of each of these is also statistically significant.

Clearly, given a change in insider ownership, there must be an offsetting change in share ownership by other investors. The omitted ownership category in Eq. (1) is ownership by atomistic outsiders. If we assume that the insider trades with atomistic outsiders, then blockholder ownership and institutional ownership fall out when we take the first difference of (1). If this is not the case, the McConnell and Servaes (1990) findings imply that a trade with blockholders would have no effect on firm value, while a trade with an institution could have an effect. As a result, failing to include the change in institutional ownership could lead to biased results. For example, suppose that purchases by insiders are actually always received positively by the market, while sales by institutions are associated with a negative stock price response. Suppose further that insider purchases are from small atomistic investors when insider ownership is small, while they are from institutional investors when insider ownership is large. If this is the case, our empirical findings could well emerge, even though the relation between insider ownership and firm value is positive over the entire ownership range; the stock price reaction to an insider purchase would be positive when insider ownership is low, but negative when insider ownership is high because this purchase leads to a reduction in institutional ownership. Thus, it is important to determine whether insiders are trading with institutions.

Unfortunately, daily ownership positions by institutional investors are not available. We can, however, investigate changes in institutional ownership on a quarterly basis. That is what we do. Specifically, from *Thomson Financial*, we download institutional ownership for each company for the quarter-ends just prior to the announcement and just after announcement of the insider share purchase. We then compute the change in institutional ownership over this period. We do, indeed, find a decline, on average, in institutional ownership in the quarter in which the insider traded (mean decline is 0.95% and median decline is 0.43%).

We investigate whether our results could be due to changes in institutional ownership. To do this, we re-estimate Eq. (3) and, when the data are available, include the change in institutional ownership as an explanatory variable. When the institutional ownership data are not available, we include an indicator variable and set the change in institutional ownership to zero. The results of this model are reported in column 2 of Table 2. The coefficient of the change in institutional ownership during the quarter is positive and significant.[6] However, the coefficients of the insider ownership variables are nearly identical to those reported in column 1. Thus, controlling for changes in institutional ownership does not affect our findings.

4.2. Piece-wise regression

There is a high correlation between the explanatory variables in Eq. (3). The correlation between the change in ownership and the change in ownership squared is 0.77, and the correlation between the change in ownership and the initial level of ownership is 0.87. These high correlations could give rise to problems with multicollinearity. The standard test for multicollinearity is to investigate whether the variance inflation factors for any of the variables exceed 10, and we do not find that this is the case. Nevertheless, we also estimate a piece-wise linear regression model to determine whether the change in value around insider purchases depends on the initial level of insider ownership. One concern with piece-wise models is that the choice of the number of pieces and the exact range in each piece is arbitrary. We therefore decided to use the most parsimonious specification, which is to just split the sample at the median level of insider ownership (13.83%). In particular, we estimate the following model:

$$\text{APAR} = b_1(\Delta\text{INOWN}) + b_4(\Delta\text{INOWN if INOWN}>13.83\%) + e \tag{4}$$

[6] Note that these results do not imply that changes in institutional ownership over the quarter affect the stock price reaction around the 6-days over which we measure abnormal returns. It is possible that institutions simply purchase shares when prices have increased and vice versa.

If firm value first increases and then decreases as insider ownership increases, we expect b_1 to be positive and b_4 to be negative. As illustrated in column 3 of Table 2, this is indeed the case: b_1 is equal to 0.71 (p-value = 0.02) and b_4 is equal to −0.83 (p-value = 0.01).

4.3. Contaminating announcements

To ensure that there were no major changes in other variables that could influence firm value, we searched *Factiva* for contaminating announcements during the 6-day announcement period. We search for announcements involving recapitalizations, mergers, acquisitions, dividends, share repurchases, equity issuances and other events related to corporate financing and investment decisions for each of the 4141 insider share purchases. In those cases where we identified an event that could be contaminating, we exclude that observation from the sample and re-estimate our base case regression. This requires that we drop 402 observations from the analysis. The results, reported in column 4 of Table 2, are very similar to those in the base case model.

4.4. Trimming the distribution of announcement period abnormal returns

In our base case regression, we trimmed the distribution of 6-day APARs at three standard deviations from the mean. We also estimate the regression using the full distribution of APARs, and after removing APARs if they lie outside of two standard deviations of the mean. The results are similar to those in our base regression in column 1. We do not report them here for sake of brevity.

4.5. Option ownership

As we noted above, our insider share ownership data include all options that can be exercised within 6 months. Ideally we would like to investigate whether our findings are different if we remove option ownership or if we include all option ownership. Unfortunately, the source for executives' stock option data, *Execucomp*, has less extensive coverage than *Thomson Financial*. Thus, we are able to obtain data for total insider option holdings for only 1645 purchases (out of 4141 in our sample). As a fraction of total shares outstanding, ownership of options is modest. For the sample of 1645 observations, option ownership averages 2.7%, of which 1.37% cannot be exercised within 6 months and 1.33% can. Median option ownership is 1.48% (0.77% cannot be exercised within 6 months and 0.71% can be). This compares with an average insider share ownership of 19.88% and a median of 13.83% for the sample. We repeat our base case regression including and excluding all option ownership for those insider purchases for which such data are available. The results (reported in columns 5 and 6 of Table 2) are essentially the same as those in column 1.

4.6. Other announcement period intervals

In our base case regression, we use the 6-day interval including the announcement day and the following 5 days to calculate APARs. We experimented with APARs calculated over other intervals ranging from 4 to 10 days around announcements of insider share purchases. The results are essentially the same as those in column 1 of Table 2. Because we have a number of these regressions, we do not report the results here.[7]

4.7. Other reporting lags

In our base case regression, we include purchases only if they were reported within 90 days of the reporting deadline. We experimented with allowing purchases 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 results of these regressions are essentially the same as those in column 1 of Table 2. We do not report the results here.

[7] These results are available from the authors upon request.

4.8. Forcing b_3 to equal $2b_2$

Although our results are consistent with Eq. (1), b_2 is "too big" and/or b_3 is "too small" for the fit to be considered perfect. One way to determine whether the data actually fit a curvilinear relation is to estimate a constrained regression in which b_3 is forced to be equal to $2b_2$. If this forced relation does not fit the data, the regression coefficients will, then, not be statistically significant. As shown in column 7 of Table 2, such is not the case. Each of the 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.

4.9. Controlling for selection

When a sample selected in an event study is based on a choice, coefficients estimated using OLS can be biased (see Heckman, 1979). This problem is pervasive in event studies in corporate finance, but it is often not addressed. We tackle this problem by estimating a regression model with a Heckman correction for selection. Two selection variables are employed in this specification: the logarithm of the dollar amount of insider ownership and the stock price volatility measured with daily returns over the calendar year prior to the purchase. We expect fewer insider purchases in firms with a more volatile stock price because the cost of the lack of diversification is higher in these firms (see Leland and Pyle, 1977). Similarly, we expect fewer insider purchases when insiders have already invested large sums in their firms.[8]

The results of the abnormal return regression with self-selection correction are similar to the ones reported previously. If anything, the coefficients are larger in absolute magnitude and they are more significant: b_1 is 0.73 (p-value = 0.00), b_2 is −1.55 (p-value = 0.03) and b_3 is −1.60 (p-value = 0.01).[9]

4.10. Summary of other specifications

In short, the results in our base case regression are robust to a variety of alternative decisions regarding sample selection, measurement of the dependent and independent variables, screens for confounding events, and estimation methods. The one constancy of our analysis is the time period considered. As with any economic analysis, a question can arise as to whether the results for one time period are representative of those that would occur in a later or earlier time period. However, the time period that encompasses our analysis does not appear to be unique in any obvious ways that would affect our results. For example, the mean insider share ownership for our time period is 19.9%. In comparison, the mean insider ownership reported by Fahlenbrach and Stulz (2007) is 23.1% for 1988 and 19.1% for 2003, with an average of 22.4% across 1988–2003. Holding aside this one caveat, our results are consistent with a causal interpretation of the empirically observed relation between insider share ownership and firm value. We now turn to a consideration of other possible explanations of these results.[10]

5. Optimal insider ownership

5.1. Overview

As we noted, 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 at all times. Taken to the extreme, this observation raises the question of

[8] We estimate the selection equation for all firms with data available on the cross-section of *CRSP*, *Compustat*, and the *Compact Disclosure* databases.

[9] As an alternative, we estimate selection models using the difference between the optimal level of insider ownership and the actual level of insider ownership as the selection variable. Estimation of these models of optimal ownership is discussed in Section 5 of the paper. The base case results continue to hold when we use this difference in selection equations.

[10] In unreported tests, we have also studied whether the revisions in analyst EPS forecasts surrounding the insider purchase announcements are consistent with the pattern in abnormal returns. We find this to be the case: analysts revise their forecasts upward after share purchases by insiders when insider ownership is low and downward when insider ownership is high. These results are available in a paper titled: "Changes in Market Values and Analysts' EPS Forecasts around Insider Ownership Changes," which is posted on the authors' websites.

why insiders trade at all and, if they purchase, why such trades are associated with an increase in stock prices on average. 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 tend to occur when initial insider 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 less extreme variation of the Demsetz argument is proposed by Core and Larcker (2002). 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 this section, we address the question of whether share purchases by insiders are potentially moving firms toward their optimal insider ownership levels. This analysis is complementary to that of Sections 3 and 4. In Sections 3 and 4, we analyze whether the endogeneity is due to unobservable firm-specific effects. In this section, we analyze whether the endogeneity could come about because observable firm characteristics have changed, and these changes in characteristics could lead to changes in both insider ownership and firm value.

We undertake this investigation from two 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." In particular, we use the HHP model to estimate each firm's optimal equilibrium level of insider ownership.[11] 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 are moving these firms toward their optimal insider ownership levels. Second, we ask whether APARs are correlated with the equilibrium ownership deficit as determined by the HHP model. That is, does the market respond as if the purchases are moving the firms toward their optimal insider ownership levels?

5.2. 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) insider share ownership as a function of certain firm characteristics are estimated. The transformation of insider share ownership is:

$$\text{transformed insider share ownership} = \log\left(\text{insider ownership}/(1 - \text{insider ownership})\right). \quad (5)$$

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

We initially estimate the HHP model with firm fixed effects and use the model to predict the "optimal" level of insider ownership for the firms in our sample. We place quotes around optimal to denote that we employ the HHP model to predict ownership structure.

To estimate the HHP model, we use annual data for the years preceding the announcement dates of the insider purchases. To begin, we estimate the model using all firms available on both the *Compustat* and *Compact Disclosure* databases for the years 1987 through 1992. We use this estimation to predict the optimal insider ownership for firms with insider purchases in 1993. To predict subsequent years, we add 1 year of data as we move through subsequent years so that, by the final year of our analysis, the model is estimated with data from 1987 through 1998 to predict insider ownership in 1999.

To determine whether the insider purchases move firms toward or away from their "optimal" insider ownership levels, for each firm with an insider purchase we subtract pre-purchase insider ownership from predicted ownership for the year of the purchase, and refer to these differences as the insider share ownership "deficit." Deficits are calculated in two ways. First, we calculate the deficit for each purchase. Second, we calculate the deficit based on the average purchase during the year for each individual firm for which there is a purchase.

[11] We use the HHP model for this purpose because of its relatively recent vintage and because it is widely recognized.

Table 3
Tests to determine whether insider purchases move ownership to an optimal level

Panel A: INOWN deficit measured as predicted optimal INOWN less pre-purchase INOWN

	Mean	Median	*N*
INOWN deficit (all purchases)	−0.0021 (0.24)	−0.0013 (0.04)	3109
INOWN deficit (average purchase per firm-year)	0.0025 (0.21)	−0.0002 (0.46)	2069

Panel B: OLS regression estimating the relation between the change in INOWN associated with the purchase and the INOWN deficit

Intercept	0.0041 (0.00)
INOWN deficit	−0.0078 (0.00)
Adjusted *r*-squared	0.01
Number of observations	3109

Panel C: OLS regression estimating the relation between the APARs and the change in INOWN, the INOWN deficit, and the cross-product of the change in INOWN and the INOWN deficit

ΔINOWN	−0.04 (0.74)
INOWN deficit	−0.01 (0.71)
ΔINOWN × INOWN deficit	0.43 (0.60)
Adjusted *r*-squared	0.06
Number of observations	3069
Number of reporting day indicators	766

A model of "optimal" insider ownership is estimated using data for the period 1987 until the year prior to the announcement of the insider purchase, using the explanatory variables of HHP, as listed in the Appendix. The model is estimated using OLS with firm fixed effects. For each purchase, the pre-purchase insider ownership is subtracted from the optimal insider ownership and the resulting value is called the "INOWN deficit." A positive number indicates that a firm has "too little" insider ownership before the purchase.
Panel A reports mean and median values for the INOWN deficit in which the optimal level of insider ownership is computed for 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 during the year. *P*-values of *t*-tests for means and sign rank tests for medians are in parentheses. Panel B reports a simple regression in which the change in INOWN associated with a purchase is the dependent variable and the INOWN deficit, computed for each purchase, is the independent variable. Panel C reports a regression in which the announcement period abnormal return (APAR) is the dependent variable and the explanatory variables are the change in INOWN, the INOWN deficit, and an interaction between the change in INOWN and the INOWN deficit. The regressions include reporting day indicator variables. APARs are defined in Tables 1 and 2. For panels B and C, *p*-values of the *t*-tests of significance of the regression coefficients are in parentheses.

In Panel A of Table 3, we give the means and medians of these deficits. The mean deficit is not significantly different from zero regardless of whether we consider individual purchases or whether we consider the average purchase for an individual firm. The median deficit, when we consider individual purchases, is significantly different from zero, but it is negative indicating "too much" rather than "too little" insider ownership. When we consider the average purchase for an individual firm, the median deficit is not significantly different from zero.

We also experimented with a host of variations in calculating the ownership deficit. For example, we compared the predicted level of insider ownership to insider ownership in the year prior to the purchase instead of the year of the purchase. We also employed predictions based on HHP's model estimated without any fixed effects and with only industry fixed effects (and no firm fixed effects). As with the median deficit based on individual purchases, most of these variations imply that the firms in our sample had too much rather than too little insider ownership when the insider purchase took place.[12]

Our analysis considers the means and medians of the distributions. It could be that consideration of only the means and medians 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 deficits 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 ownership deficit as the explanatory variable. We use the same measure of the ownership deficit as in panel A. Panel B of Table 3 contains the result: there is a negative relation between the amount of the purchase and the deficit, which is the opposite of what would be expected if the purchases were meant to move firms toward their optimal levels of insider ownership, and further undermines an argument that insider purchases are aimed at moving firms toward their new optimal ownership structures.

[12] These results are available from the authors upon request.

Given that our tests find no evidence of an ownership deficit at the time of the purchase, and that there is a negative correlation between the size of the deficit and the size of the purchase, the results are inconsistent with an argument that the insider share purchases are moving firms toward their optimal ownership levels (as described by a model using the explanatory variables discussed in the Appendix).

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

We report in Section 3 that the market does not always react positively to announcements of insider share purchases. It is therefore possible that the market reacts positively when the purchase moves the level of insider ownership toward the optimum, but negatively when the purchase moves insider ownership away from the optimum. To examine this possibility, we relate the APARs to the size of the deficit. We regress APARs against three independent variables: (1) the change in insider 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 little" rather than "too much" insider ownership. Further, we interact the size of the purchase with the size of the deficit. Our reasoning is as follows: when insiders buy shares to make up for a larger deficit, the stock price reaction should be higher.

The hypothesis that insider purchases are moving firms toward an optimal ownership structure predicts positive coefficients for each of the variables. The ownership deficit is measured using the firm fixed effects regression described in Section 5.2. The results of the regression are displayed in panel C of Table 3. None of the coefficients in this model are statistically significant. As with our other tests, this result does not support the idea that insider share purchases are moving firms toward an "optimal" ownership structure.

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

A further possibility is that purchases by insiders are simply a signal that the firm is undervalued and the positive stock price reaction to the announcement is merely a reflection of this signal (Seyhun, 1986).

As a first test of the signaling explanation, we simply regress APARs against the size of the purchase (and reporting day indicators). The signaling explanation would predict a positive coefficient. The results of the regression are reported in column 1 of Table 4. The coefficient of the change in insider ownership is negative and insignificant (p-value = 0.71), which is inconsistent with the signaling story. This simple regression model also provides an additional piece of evidence to reject the argument that the insider trades restore ownership to their optimal levels. In the previous section, we estimated models of optimal ownership to determine the ownership deficit. It is, of course, possible that such models are not properly specified because we cannot accurately model the determinants of the optimal ownership structures. One way to address such a concern is to investigate whether "raw" insider purchases, which can be thought of as un-benchmarked changes in ownership, are correlated with changes in the value of the firm. If insider purchases

Table 4
Regression models used to examine alternative interpretations of the results

Variable	(1)	(2)	(3)	(4)
ΔINOWN	−0.04 (0.71)	0.18 (0.32)		−0.06 (0.63)
ΔINOWN squared		−1.37 (0.12)		
Dollar amount of purchase (in $ millions)			0.0001 (0.62)	
ΔINOWN × market value of the firm				0.0001 (0.56)
Adjusted r-squared	0.06	0.06	0.06	0.06
Number of observations	4141	4141	4134	4141
Number of reporting day indicators	934	934	933	934

The dependent variable is the APAR associated with open market insider purchases of at least 10,000 shares over the period 1994 through 1999. APAR is defined in Table 1. Insider purchases are removed from the sample if the corresponding APAR is not within three standard deviations of the mean APAR 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. All regression models contain reporting-day fixed effects. P-values of the t-tests of significance of the regression coefficients are in parentheses.

are not anticipated by market participants, larger purchases should have a more substantial stock price response than smaller purchases because they will correct a more substantial deviation from the optimum. The lack of such a relation as reported in column 1 of Table 4 does not support the view that insider trades move ownership to the optimal level.

While the lack of a relation between the APAR and the change in insider ownership is inconsistent with a simple signaling story, more elaborate signaling arguments may be at work. 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 APAR 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 APARs 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 column 2 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. Furthermore, while the signaling story can reasonably predict a declining marginal effect 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 might 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 column 3 of Table 4, the coefficient of the dollar purchase is positive, but not significantly different from zero (p-value=0.62).

In column 4 of Table 4, we report the results of a regression in which the independent variables are the change in the fraction of insider share ownership and the interaction between this change and the market value of the firm. We estimate this regression because an argument may be made that a given percentage increase in share ownership will have a greater impact on a smaller firm because there is less information available about such firms. However, as shown in column 4, 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).[13]

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 Eq. (1) and is not just an indication that the firm is undervalued.

7. Conclusion

In this study we examine stock price responses to announcements of share purchases by corporate insiders for a sample of U.S. 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) and others.

One interpretation of this relation 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 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 relation between share ownership and firm value documented by many prior studies. We do so by regressing announcement period abnormal returns when insiders purchase shares against the change in the fraction of shares owned by insiders, the square of the change

[13] We also explore a specification where we interact the change in insider ownership with stock price volatility. According to Leland and Pyle (1977), the cost of signaling increases with share price volatility. The coefficient on this interaction term is not significantly different from zero, which is inconsistent with this signaling explanation.

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 of the change in insider ownership squared is negative, and the coefficient of the interaction is negative. These results are consistent with a causal interpretation of the relation between insider ownership and firm value.

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 all firms are at their optimal ownership structures all the time. One implication of the causal interpretation of our empirical results is 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. In such cases, forcing insiders to sell shares would be difficult for the board to implement. In those cases where managers do not own enough stock, boards may wish to consider targeted share ownership plans of the type studied by Core and Larcker (2002). We conclude that changes in share ownership by insiders can (and do) affect firm value.

Appendix A. Explanatory variables employed in the HHP models explaining insider ownership

This Appendix contains the definitions of the explanatory variables employed in the HHP (1999) model. The variables are: (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.

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