Deviation from optimal CEO ownership and firm value

Zhenxu Tong*

University of Exeter

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* Address: Xfi Centre for Finance & Investment, School of Business and Economics, University of Exeter, Rennes Drive, Exeter EX4 4ST, United Kingdom. Telephone: +44 1392 263155. *E-mail address*: z.tong@exeter.ac.uk (Zhenxu Tong). This paper is based on the first chapter of my PhD dissertation completed at INSEAD in France. I would like to thank my dissertation committee: Professor Bernard Dumas, Professor Urs Peyer, Professor Massimo Massa, and Professor Theo Vermaelen. I would like to thank the seminar participants at Singapore Management University, National University of Singapore, HEC Montreal and University of Exeter for their comments and suggestions.

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Abstract

The transaction cost theory on managerial ownership and firm value predicts that a deviation from optimal managerial ownership reduces firm value. This paper empirically tests the transaction cost theory by studying the relation between the deviations on both sides of optimal CEO ownership and firm value. We find that both above-optimal and below-optimal deviations reduce firm value. We find that the change in CEO ownership is associated with a higher abnormal return if it moves CEO ownership towards the optimal level, and that the change in CEO ownership is associated with a lower abnormal return if it moves CEO ownership away from the optimal level. These findings are consistent with the transaction cost theory on managerial ownership and firm value.

The relation between managerial ownership and firm value is one of the central issues in corporate finance. Two main schools of thought exist with very different starting points. One assumes that managerial ownership is exogenously determined, while the other assumes that it is endogenously determined. Regarding the exogenous assumption, Morck, Shleifer and Vishny (1988), and McConnell and Servaes (1990) find a significant non-linear relation between managerial ownership and firm value, and argue that it is consistent with both the incentive alignment hypothesis and the managerial entrenchment hypothesis. Regarding the endogenous assumption, Demsetz and Lehn (1985), and Himmelberg, Hubbard and Palia (1999) find that the relation between managerial ownership and firm value is insignificant. They argue that this finding is consistent with the interpretation that firms optimally choose managerial ownership to maximize their value. In that case, no empirical relation between managerial ownership and firm value reflects the equilibrium outcome. As suggested by Core and Larcker (2002), the essential difference between these two viewpoints is the assumption regarding the adjustment cost required to correct sub-optimal contracts. For example, Morck et al. (1988) implicitly assume that firms are unable to re-contract optimally due to the tremendous adjustment cost involved, while Demsetz et al. (1985) implicitly assume that firms can re-contract without incurring any cost. Other studies generally take one of these two standpoints.

Core and Larcker (2002) try to reconcile these two schools of thought, and propose a transaction cost theory on managerial ownership and firm value. They begin with a new assumption that the adjustment cost is neither too large nor too small, so that firms only conduct periodical re-contracting. Firms choose optimal managerial ownership when they contract, but managerial ownership can deviate from the optimal level after contracting, and the firms periodically re-optimize ownership. A

new hypothesis arises from this assumption: Deviation from an optimal managerial ownership level to a sub-optimal level can reduce firm value. Core and Larcker (2002) have conducted empirical tests to explore their hypothesis in the research setting of a mandatory managerial ownership increase. They examined a sample of firms that had adopted a target ownership plan, under which managers were required to own a minimum amount of stock. They found that after the adoption of such a mandatory ownership increase, an improvement in firm performance had taken place. Thus, they conclude that the empirical evidence supports the transaction cost theory.

Although Core and Larcker (2002) propose a new transaction cost theory on managerial ownership and firm value, we have some concerns about how they draw their conclusions based on their empirical tests. Core and Larcker (2002) only conducted the empirical tests on one side of deviation from the optimal ownership, i.e., the below-optimal deviation, as the target ownership plan they utilize corresponds with the below-optimal deviation.[1] However, it is important to conduct empirical tests on both sides of optimal ownership when one attempts to test the transaction cost theory on managerial ownership and firm value. This is due to the fact that alternative explanations can be raised based on the findings in Core and Larcker (2002), which may potentially undermine their conclusion that the results support the transaction cost theory. Generally, Core and Larcker (2002) find an increasing relation between managerial ownership and firm value by studying the below-optimal situation. However, alternative theories may also predict an increasing relation between ownership and firm value. For example, Jensen and Meckling (1976) propose an incentive alignment hypothesis which predicts a strictly increasing relation between ownership and firm value. In this case, we cannot tell whether the results in Core and

[1] Core and Larcker explain that "… target ownership plans are designed to address the contention of some researchers and governance activists that stock ownership of senior-level executives is 'too small'…"(Core and Larcker, 2002, p320). Therefore, this corresponds to the below-optimal situation.

Larcker (2002) support the transaction cost theory or the incentive alignment hypothesis, as the empirical findings in their paper are consistent with the predictions of both theories.

The motivation of this paper is to test the transaction cost theory on managerial ownership and firm value by studying the relation between the deviations on both sides of optimal CEO ownership and firm value. By doing this, we will be able to differentiate between the transaction cost theory and alternative theories, as the predictions on both the above-optimal deviation and the below-optimal deviation are uniquely from the transaction cost theory.

We use the Execucomp database to get the panel data for a sample of 1058 firms over the period from 1995 to 2000. We focus on CEO ownership in this study.[2] Panel data have an advantage over cross-sectional data, as firm fixed effect regression can be used to control for unobservable heterogeneity in the firms' contracting environment, which mitigates the serious omitted variable problem in the cross-sectional analysis. We follow Himmelberg, Hubbard and Palia (1999), and use a firm fixed effect regression as the benchmark to estimate the determinants of optimal CEO ownership, and find that the ownership is determined by both unobservable and observable contracting parameters. We use the residuals in the firm fixed effect regression as the measure for the deviations from optimal CEO ownership, and study their relation with firm value. Since the residuals can be either positive or negative, they correspond with both above-optimal and below-optimal deviations. This methodology follows Harford (1999), and Dittmar and Mahrt-Smith (2006). Harford

[2] The Execucomp database provides data for the five most highly compensated executives in the firms. We use CEO ownership due to the data availability. The literature has used different definitions for managerial ownership: Morck, Shleifer and Vishny (1988), for example, define managerial ownership as the percentage of shares owned by the entire board, while McConnell and Servaes (1990) define it as the percentage of shares owned by insiders. Hermalin and Weisbach (1991) define managerial ownership as the percentage of shares owned by the CEO.

(1999) uses a firm fixed effect regression as the benchmark to estimate the optimal level of corporate cash holdings. He defines the predicted value as the measure for optimal cash holdings, and uses the residuals in the firm fixed effect regression as the measure for excess corporate cash holdings. He concludes that excess corporate cash holdings have a significant impact on firm performance through acquisitions. Dittmar and Mahrt-Smith (2006) use a similar methodology, and get the measure of excess corporate cash holdings from the residuals in a firm fixed effect regression as the benchmark for optimal corporate cash holdings.

We study the relation between the deviations from optimal CEO ownership and the level of firm value. We find that on average, a 1% deviation from optimal CEO ownership reduces firm value, measured as Tobin's Q, by 5.6%, and that the deviations on both sides of optimal CEO ownership reduce firm value. Moreover, we find no relation between CEO ownership and firm value, while both unobservable and observable contracting parameters are important determinants of firm value. These findings provide an important link between the two stands in the literature. Namely, if ownership adjustments are costly, firms can deviate from the equilibrium, leading to our finding that the deviations from optimal ownership are value reducing. At the same time, if the adjustment costs are similar in both directions, on average, firms are still at the equilibrium ownership that maximizes firm value, as the positive and negative deviations offset each other in the large sample.

We study the relation between deviations from CEO ownership and the change in firm value. We examine four events which change CEO ownership: insider selling, insider purchase, seasoned equity offerings and open market repurchases. We find that the change in CEO ownership is associated with a higher abnormal return if it moves CEO ownership towards the optimal level, while the change in CEO

ownership is associated with a lower abnormal return if it moves CEO ownership away from the optimal level.

These findings support the interpretation that the deviations on both sides of optimal CEO ownership reduce firm value. We conclude that they are consistent with the transaction cost theory on managerial ownership and firm value.

The paper is organized as follows. Section 1 reviews the literature and develops the hypothesis. Section 2 describes the sample and variables. Section 3 describes the methodology used for obtaining the measures of deviations from optimal CEO ownership. Section 4 examines the relation between the deviations and the level of firm value. Section 5 examines the relation between the deviations and the change in firm value. We conclude in Section 6.

1. Literature review and hypothesis development

1.1. Literature review

Two main schools of thought take very different starting points regarding the relation between managerial ownership and firm value. One assumes that managerial ownership is exogenously determined, while the other assumes that it is endogenously determined.

Regarding the exogenous assumption, Jensen and Meckling (1976) propose an incentive alignment hypothesis which predicts a strictly increasing relation between firm value and ownership. Stulz (1988) argues that managerial ownership may have either an incentive alignment effect or an entrenchment effect, depending on the level. Morck, Shleifer and Vishny (1988) find a piecewise linear relation between Tobin's Q and managerial ownership, where Q increases when ownership is below 5%, then

decreases to the 5%-25% range, and again turns positive when ownership is above 25%. McConnell and Servaes (1990) find an inverted-U shaped relation between Q and managerial ownership. The curve slopes upward until insider ownership reaches 40% to 50%, and then slopes downward. Hermalin and Weisbach (1991) corroborate the findings in Morck et al. (1988) by showing that Q increases with ownership up to 1%, the relation is negative in the 1%-5% range, becomes positive in the 5%-20% range, and turns negative again when ownership exceeds 20%. These studies interpret the positive relation between ownership and firm value as supportive evidence for the incentive alignment effect, and the negative relation supporting the entrenchment effect.

Regarding the endogenous assumption, Demsetz and Lehn (1985) argue that if firms choose managerial ownership optimally, there will be no relation between firm value and managerial ownership in the regression, once all the exogenous parameters are controlled for. They find no relation between accounting performance and the concentration of managerial ownership. Himmelberg, Hubbard and Palia (1999) extend the study by using panel data, and argue that both managerial ownership and firm performance are determined by exogenous changes in the firm's contracting environment. They find no direct relation between managerial ownership and firm performance. These studies interpret their findings as supportive evidence that firms are optimizing their ownership to maximize firm value. The literature on executive compensation (e.g., Murphy, 1985; Jensen and Murphy, 1990) and on the determinants of equity incentive and grants (e.g., Core and Guay, 1999, 2001) also supports the hypothesis that managerial equity incentive is endogenously determined by the firm characteristics.

1.2. Hypothesis development

Core and Larcker (2002) propose the transaction cost theory on managerial ownership and firm value, and try to reconcile these two different viewpoints. First, they argue that the essential difference between these two positions is the assumption regarding the adjustment cost of re-contracting. The exogenous assumption implicitly assumes that the adjustment cost is so large that firms are unable to re-contract, while the endogenous assumption implicitly assumes that firms can re-contract at no cost. Next, they make the new assumption that the adjustment cost is neither too large nor too small. As a result, firms choose optimal managerial ownership when they contract, but are prevented from continuous re-contracting by adjustment costs. Therefore, managerial ownership may deviate from the optimal level with firms only re-optimizing periodically.

The motivation of this paper is to test the transaction cost theory on ownership and firm value by studying the relation between the deviations on both sides of optimal CEO ownership and firm value. By doing this, we can differentiate the transaction cost theory on managerial ownership and firm value from alternative theories. For example, the incentive alignment hypothesis (Jensen and Meckling, 1976) predicts a strictly increasing relation between ownership and firm value. If we suppose we can find that the deviations on both sides of optimal ownership reduce firm value, we will be able to differentiate between the transaction cost theory and the incentive alignment hypothesis, because Jensen and Meckling (1976) do not predict such a decreasing relation between ownership and firm value. We test the following hypothesis:

Hypothesis 1: The deviations on both sides of optimal ownership reduce firm value.

2. Sample and variables

2.1. Data and sample

The data come from the following sources. Data on CEO stock and option holdings are obtained from the Execucomp database. Stock return data are from the CRSP database, and the Compustat database is used as the source for firms' financial data. Data on interest rates are obtained from the website of the Federal Reserve Bank.

The initial sample is obtained from the Execucomp database. We find firms that are continuously in the database from 1995 to 2000. We focus on balanced panel data, because the transaction cost theory on ownership and firm value can be viewed as a target-adjustment situation where firms periodically adjust CEO ownership to the optimal level. This follows literature on capital structure where balanced panel data are used in target-adjustment tests.[3] Although the data are available in Execucomp from 1993, we focus on the period starting from 1995. This is due to the fact that an important regulation, the Internal Revenue Code 162(m), came into effect at the beginning of 1994.[4] Perry and Zenner (2001) find that this regulation affects firms' practice on incentive compensation due to tax considerations. In our view, the period of 1993 and 1994 can be regarded as a 'confounding period', because it is difficult to tell whether firms adjusted CEO ownership for contracting reasons or due to the tax code change.[5] Moreover, we focus on the period before the year 2000, because executives were likely to hold underwater options due to the market downturn

[3] Jalilvand and Harris (1984), Titman and Wessels (1988), Auerbach (1985), and Shyam-Sunder and Myers (1999) eliminate firms for which continuous data are not available.

[4] The Internal Revenue Code 162(m) came into effect on January 1, 1994. It limits the tax deductibility of non-performance related compensation over one million dollars.

[5] In our view, the impact from tax code change exerted the strongest effect around the implementation of the code. While it is still possible that firms considered the tax effect when the CEO's non-performance pay exceeded one million dollars during the period in 1995-2000, this effect was much weaker because firms could have already made the adjustment around the tax code change in expectation of that.

beginning in 2001, while underwater options can distort the incentive.[6] We also exclude financial firms (SIC 6000-6999) and firms with incomplete data. After this screening process, we obtain the final sample of 1058 firms, with 6348 firm-year observations.

2.2. Variables

In this section, we describe the variables used in the analysis.

2.2.1. Firm value

We use Tobin's Q as the proxy for firm value. Morck, Shleifer and Vishny (1988) argue that since Tobin's Q is high when the firm has valuable intangible assets in addition to physical capital, it includes the impact of corporate governance. We calculate Tobin's Q as the market value of equity (#199 multiplied by #25)[7] minus the book value of equity (#60) plus the book value of assets (#6), divided by the book value of assets (#6).

In Section 5, we study how the deviations from optimal ownership affect the change in firm value by using event studies. We use cumulative abnormal return around a short window of the event date as the measure for the change in firm value. Cumulative abnormal return is calculated by using the market model with the CRSP equally weighted index as the market return.

2.2.2. CEO ownership

Following the definition in Palia (2001), and Aggrawal and Samwick (2003), we calculate CEO ownership as the sum of the proportion of shares outstanding held by the CEO plus the proportion of shares outstanding in options held by the CEO times the Black-Scholes hedge ratio (the delta). This can be expressed as:

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[6] Execucomp does not provide data on underwater options. This is another reason that we focus on the period up to the year 2000.
[7] We use # to denote the Compustat item number.

$$\text{CEO Ownership} = \frac{\#\text{Shares Held by CEO}}{\#\text{Shares Outstanding}} + \frac{\#\text{Options Held by CEO}}{\#\text{Shares Outstanding}} * \text{delta} \quad (1)$$

$$\text{with delta} = \frac{\partial(\text{Black - Scholes option value})}{\partial\,\text{Stock price}} = e^{-dT} * N(Z) \quad (2)$$

$$Z = [\log(S / X) + T(r - d + \sigma^2 / 2)] / \sigma T^{(1/2)} \quad (3)$$

where N = cumulative probability function for the normal distribution
S = price of the underlying stock
X = exercise price
σ = expected stock return volatility over life of option
r = risk-free interest rate
T = time to maturity of the option in years
d = expected dividend rate over life of option

Thus, our ownership proxy includes both stock and option ownership. We use the methodology in Core and Guay (1999, 2002) to calculate this measure. Core and Guay (2002) demonstrate that this methodology captures more than 99% of variation in option portfolio value and sensitivities. The details of the calculation are shown in Appendix B.

2.2.3. Control variables

The control variables are used to proxy for the exogenous parameters in the firm's contracting environment. These variables are related to the potential moral hazard and monitoring difficulty. However, as shown by Himmelberg, Hubbard and Palia (1999), a large part of the parameters are unobservable. It is therefore important to control for both unobservable and observable firm characteristics in the underlying contracting environment.

We use firm fixed effect regression, which can control for unobservable firm characteristics as long as they are constant over time. Moreover, previous research has found that CEO ownership can be affected by other corporate governance structures, such as the structure of the board (e.g., Core, Holthauren and Larcker, 1999), whether the CEO is the founder of the company (e.g., Hall and Liebman, 1998),

and control over corporate resources (e.g., Cheng, Nagar and Rajan, 2004).[8] However, since these corporate governance structures are relatively stable through time, they are captured by firm-specific intercepts. Therefore, using firm fixed effect regressions can account for the influence from these omitted variables.

We follow Himmelberg et al. (1999), and include other variables as determinants of CEO ownership. We use the natural logarithm of assets (#6) as the proxy for firm size. We use the growth rate of sales (#12) as a proxy for growth opportunities. We use the sum of the ratio of research and development expenses (#46) to total expenses (#189) and the ratio of advertising expenses (#45) to total expenses (#189) as the proxy for soft capital. We use the ratio of income before extraordinary items (#18) to assets (#6) as the proxy for cash flow. We use the ratio of plant, property and equipment (#8) to assets (#6) as the proxy for capital intensity. We use the standard deviation of the ratio of income before extraordinary items (#18) to assets (#6) in the prior three years, and the standard deviation of the natural logarithm of sales (#12) in the prior three years as proxies for volatility in the operating environment. We also include the square of size and the square of cash flow as control variables.[9]

[8] In the exogenous ownership framework, the control perspective of the ownership brings about the agency problem of managerial entrenchment (e.g., Stulz, 1988). However, in the endogenous ownership framework, the degree of control can also be regarded as one of the firm characteristics. Cheng, Nagar and Rajan (2004) find that managerial ownership changes around the anti-takeover legislation. In their study, managerial ownership is assumed endogenous, and determined by firm characteristics, including the degree of control and the variables in Demsetz and Lehn (1985).

[9] See Himmelberg et al. (1999) for a detailed explanation on the rationales for these variables.

3. Deviations from optimal CEO ownership

In this section, we describe the methodology used for obtaining the measures of deviations from optimal CEO ownership.

We need to find a benchmark specification for optimal CEO ownership. Following Himmerberg, Hubbard and Palia (1999), we use a firm fixed effect regression as the benchmark regression for the determinants of CEO ownership.

$$\begin{aligned}&\text{CEO ownership}_{it}\\&\quad = a_i + c_1(\text{Size}_{it}) + c_2(\text{Size square}_{it}) + c_3(\text{Cash flow}_{it}) + c_4(\text{Cash flow square}_{it})\\&\qquad + c_5(\text{Sales growth}_{it}) + c_6(\text{Plant, property and equipment}_{it})\\&\qquad + c_7(\text{R\&D and advertising}_{it}) + c_8(\text{Earnings volatility}_{it})\\&\qquad + c_9(\text{Sales volatility}_{it}) + \varepsilon_{it} \qquad (4)\\&\text{where Deviation}_{it} = |\,\varepsilon_{it}\,|\end{aligned}$$

In equation (4), a_i represents firm specific intercepts, capturing both unobservable parameters and observable, but omitted parameters in the contracting environment, as long as they are constant through time. The predicted value in this regression is used as the measure for optimal CEO ownership.

Equation (4) also generates the measure for the deviation from optimal CEO ownership, which will be used for later analysis. We use the absolute value of the residuals ε_{it} as our proxy for the deviations from optimal CEO ownership. The residuals are not explained by the firm's contracting environment, thus corresponding with the assumption of the transaction cost theory that managerial ownership can exogenously deviate from the optimal level.

This methodology follows Harford (1999), and Dittmar and Mahrt-Smith (2006). Harford (1999) uses a firm fixed effect regression as the benchmark to estimate the optimal level of corporate cash holdings. He defines the predicted value as the measure for optimal cash holdings, and uses the residuals in the firm fixed effect regression as the measure for excess corporate cash holdings. Harford (1999)

concludes that excess corporate cash holdings have a significant impact on firm performance through acquisitions. Dittmar and Mahrt-Smith (2006) use a similar methodology, and obtain the measure of excess corporate cash holdings from the residuals in a firm fixed effect regression.

4. Deviations and the level of firm value

4.1. Methodology

We test the main hypothesis by studying the relation between deviations from optimal ownership and the level of firm value. Since firm value is affected by the same contracting parameters as the determinants of ownership (Himmerberg, Hubbard and Palia, 1999), we use firm fixed effect regressions with the same control variables. We also include deviation from optimal CEO ownership in the regression.[10]

$$\begin{aligned}\text{Firm value}_{it} &= a_i + b_1(\text{Deviation}_{it}) + c_1(\text{Size}_{it}) + c_2(\text{Size square}_{it}) + c_3(\text{Cash flow}_{it}) \\ &\quad + c_4(\text{Cash flow square}_{it}) + c_5(\text{Sales growth}_{it}) + c_6(\text{Plant, property and equipment}_{it}) \\ &\quad + c_7(\text{R\&D and advertising}_{it}) + c_8(\text{Earnings volatility}_{it}) \\ &\quad + c_9(\text{Sales volatility}_{it}) + \eta_{it} \qquad (5)\end{aligned}$$

According to Hypothesis 1, we expect $b_1 < 0$ in equation (5).

In order to test whether the deviations on both sides of optimal CEO ownership reduce firm value, the deviation is interacted with a dummy variable indicating above-optimal deviation. The above-optimal dummy is one if actual CEO ownership is greater than optimal CEO ownership, i.e., the predicted ownership from equation (4), and is zero otherwise.

[10] Zhou (2001) questions the use of fixed effect regressions in studying the relation between managerial ownership and firm value, as managerial ownership changes slowly from year to year within a firm. However, this paper focuses on how the residuals in the fixed effect regression affect firm value. The time-invariant fixed effects are not included in the residuals.

$$\begin{aligned}\text{Firm value}_{it} &= a_i + b_2(\text{Deviation}_{it}) + b_3((\text{Deviation*Above-optimal dummy})_{it}) + c_1(\text{Size}_{it}) \\ &\quad + c_2(\text{Size square}_{it}) + c_3(\text{Cash flow}_{it}) + c_4(\text{Cash flow square}_{it}) + c_5(\text{Sales growth}_{it}) \\ &\quad + c_6(\text{Plant, property and equipment}_{it}) + c_7(\text{R\&D and advertising}_{it}) \\ &\quad + c_8(\text{Earnings volatility}_{it}) + c_9(\text{Sales volatility}_{it}) + \eta_{it} \qquad (6)\end{aligned}$$

According to Hypothesis 1, we expect $b_2 < 0$ and $b_2 + b_3 < 0$ in equation (6).[11]

4.2. Results

4.2.1. Univariate statistics

Table 1 presents univariate statistics of the variables. The data are winsorized at 1% and 99%. Panel A shows that the mean of CEO ownership is 3.50%, and the median is 1.05%. Panel A also indicates that the mean of Tobin's Q is 1.98, while the median is 1.48. The magnitudes of both CEO ownership and Tobin's Q are comparable to the findings in Aggrawal and Samwick (2003), which use a similar methodology and database. Panel B shows univariate statistics of other control variables.

4.2.2. The determinants of optimal CEO ownership

Table 2 presents the results of the determinants of optimal CEO ownership. We first compare the results between OLS and firm fixed effect regressions. Panel A shows that there are substantial differences in the estimates. For example, the estimate on earnings volatility is -0.135 in the OLS regression, but is -0.031 in the firm fixed effect regression. This suggests that in our sample, OLS regression may produce biased estimates due to an omitted variable problem. The firm fixed effect regression is shown to be a better specification for the determinants of optimal CEO ownership for two further reasons. First, Panel A shows that the adjusted R-square is 0.90 in the firm fixed effect regression. This magnitude is consistent with the findings in Himmelberg et al. (1999). Panel A also shows that the adjusted R-square is only

[11] In equation (6), b_2 represents the below-optimal situation, and $b_2 + b_3$ represents the above-optimal situation.

0.09 in the OLS regression. This marked difference in the adjusted R-square supports the position that unobservable contracting parameters are important determinants of optimal CEO ownership. Second, we conduct an F-test on the null hypothesis of equal intercepts across the firms. It rejects the null hypothesis at the 1% level. This therefore indicates that the intercepts in the firm fixed effect regression are indeed firm-specific. From these findings, we can conclude that the firm fixed effect specification is better suited as our benchmark model for optimal CEO ownership.

Panel B of Table 2 shows univariate statistics on predicted CEO ownership using the firm fixed effect specification. Predicted CEO ownership is used as the proxy for optimal CEO ownership. We find that the mean of optimal CEO ownership is 3.50%, while the median is 1.23%. The 5th percentile is 0.06%; and the 95th percentile is 16.49%. Compared with actual CEO ownership, this indicates that the parameters in firms' contracting environments can explain a large part of CEO ownership, while deviations only account for a relatively small proportion. Panel B also shows univariate statistics on the residuals from the firm fixed effect regression. The residuals are winsorized at 1% and 99%.

4.2.3. Deviation from optimal CEO ownership and the level of firm value

Table 3 presents the results on the deviation from optimal CEO ownership and the level of firm value using firm fixed effect regressions. The dependent variable is Tobin's Q. The deviation from optimal CEO ownership is defined as the absolute value of the residuals. In the first column, we find that the estimate on the deviation from optimal CEO ownership is -5.658, which is significant. This indicates that on average, a deviation from optimal CEO ownership reduces firm value. The results

show that the estimates on most of the observable contracting parameters are significant. [12]

The second column in Table 3 shows the results with the interaction term, which test explicitly whether the deviations on both sides of optimal CEO ownership reduce firm value. The second column shows that the estimate on deviation is negative (-5.998), and the sum of the estimate on deviation and the estimate on the interaction term between deviation and the above-optimal dummy (-5.998 + 0.851 = -5.147) is also negative. We conduct the F-test on the null hypothesis that the sum of the estimates on Deviation and Deviation * Above-optimal dummy is zero. It rejects the null hypothesis at the 1% level. These results therefore support the hypothesis that the deviations on both sides of optimal CEO ownership reduce firm value.

4.3. Size-adjusted deviations and firm value

We conduct the robustness check by using size-adjusted deviations, which are defined as deviations divided by firm size. This is due to the consideration that firm size may affect the magnitude of deviations. For example, since it is more costly for a CEO to purchase a certain fraction of ownership of a large firm than of a small firm, we may find more deviations from optimal ownership in large firms, because the CEO cannot afford to purchase enough shares to reach the optimal level. In this case, the magnitude of deviations may capture the size effect. Therefore, we conduct the robustness check by using size-adjusted deviations which are the deviations standardized by firm size.

In Table 4, we find similar results by using size-adjusted deviations. In the first column, the estimate on Size-adjusted deviation is -1.040, which is significant. The

[12] In the OLS regression for the first column of Table 3 (not shown in the table), the adjusted R-square is 0.48. Compared with the adjusted R-square 0.92 in the fixed effect regression, this indicates that the unobservable contracting parameters also have a substantial explaining power for firm value.

second column shows that the size-adjusted deviations on both sides of optimal CEO ownership reduce firm value.

4.4. CEO ownership and firm value

We study the relation between CEO ownership and firm value, as the transaction cost theory predicts that there is no overall cross-sectional relation between CEO ownership and firm value as firms re-optimize CEO ownership periodically. Table 5 presents the results of CEO ownership and firm value using a firm fixed effect regression. The estimate on CEO ownership is 0.369, which is insignificant. At the same time, the estimates on most of the contracting parameters are still significant in the regression. This suggests that, after controlling for exogenous contracting parameters, there is no relation between CEO ownership and Tobin's Q. These results are consistent with the transaction cost theory.

The results in Table 3 and Table 5 reveal another contribution of this paper. Previous papers in this literature (e.g., Demsetz and Lehn, 1985; Himmelberg et al., 1999) interpret the finding of no relation between ownership and firm value as the supportive evidence for the hypothesis that ownership always stays at the optimal level. However, the transaction cost theory gives a different interpretation. While Table 3 shows that the deviations on both sides of optimal ownership reduce firm value, Table 5 shows that there is no overall relation between firm value and CEO ownership itself. These results support the interpretation that since the deviations are random and symmetrically distributed on both sides of optimal ownership, we will not find an overall relation between firm value and CEO ownership itself, because the increasing relation and decreasing relation offset each other if we pool together the observations in the below-optimal situation and the above-optimal situation.

5. Deviations and the change in firm value

In this section, we study how changes in CEO ownership can affect changes in firm value. We use the same variable "Above-optimal dummy" in the previous analysis as the measure for deviations from optimal CEO ownership.

If there is a deviation from optimal CEO ownership, then we expect that the change in CEO ownership will increase firm value if it moves CEO ownership towards the optimal level, and decreases firm value if it moves CEO ownership away from the optimal level.

5.1. Data and methodology

We examine four events that can alter CEO ownership. First, we study insider selling and insider purchase, because they change the number of shares held by the CEO. Second, we study seasoned equity offerings and open market repurchases, because they change the total number of shares outstanding, which consequently changes the proportion of shares held by the firm's CEO.

5.1.1. Insider selling and insider purchase

We obtain data on insider selling and insider purchase from the Thomson Financial Insider database covering the period 1996 through 2000. In this sample period, insiders were required to report trading in their firms' shares to the Securities and Exchange Committee (SEC) by the 10th of the month following the trade. We focus on a subset of the reported trades. First, we include the trading of at least 10,000 shares. Second, we only consider open market selling and purchase. Finally, we only include the trading reported to the SEC by the 10th of the month following the trade, thus excluding the trading with lagged reporting.

Following McConnell, Servaes and Lins (2005), we set the date on which the insider trading is reported to the SEC (SEC receipt date) as the event date, as the

information becomes available to investors after insiders file their transaction to the SEC (e.g., Lakonishok and Lee, 2001). We use the cumulative abnormal return[13] in (-5, +10) days around the event date as the measure for the change in firm value for insider selling, and use the cumulative abnormal return in (-1, +4) days around the event date as the measure for the change in firm value for insider purchase.[14]

Since insider selling can be associated with option exercises, this may confound the analysis due to the intervals between option exercises and insider selling. Since the sample period in this paper is from 1996 to 2000, insiders were allowed to immediately sell shares after option exercises.[15] Ofek and Yermack (2000) find that managers sell nearly all the shares after the option exercises. Carpenter and Remmers (2001) study insider trading based on the assumption that insiders sell shares immediately after the option exercises. In the sample of insider selling, we exclude the events with longer intervals between option exercises and insider selling. We obtain the data on option exercises from Thomson Financial. Since we use the SEC receipt date as the event date, we only include the events in the sample if both option exercises and insider selling had already taken place before the SEC receipt date. This is to ensure that insider selling had already occurred when investors received the information.[16]

By using the above screening procedures, our sample contains 1266 insider selling events and 303 insider purchase events.

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[13] Cumulative abnormal return is calculated by using the market model with the CRSP equally weighted index as the market return. See Appendix A for a more detailed description.

[14] We find qualitatively similar results when we use the cumulative abnormal return in (-5, +10) days around the event date as the measure for the change in firm value for insider purchase.

[15] Insiders were allowed to sell shares immediately after option exercises after the year 1991. Before that, insider had been required to hold the shares obtained through option exercises for six months before selling them (Carpenter and Remmers, 2001).

[16] Since insider trading needs to be reported to the SEC by the 10th of the month following the trade, it means that the sample can include some events with short intervals between option exercises and insider selling, as long as they both take place before the SEC receipt date.

We expect that insider selling will be associated with a higher abnormal return for an above-optimal deviation than a below-optimal deviation. Since insider selling reduces CEO ownership, it moves CEO ownership towards the optimal level where there has previously been an above-optimal deviation, and moves CEO ownership away from the optimal level where there has been a below-optimal deviation. Similarly, we expect that insider purchase will be associated with a lower abnormal return for an above-optimal deviation than a below-optimal deviation.

We use the following regressions for insider selling and insider purchase. We use the change of various contracting parameters as control variables in the regressions, as both the change in firm value and the change in CEO ownership are driven by the change of contracting parameters in the contracting framework (e.g., Himmelberg, Hubbard and Palia, 1999). We also include a prior 6-month run-up in the regression. The run-up is used to control for potential overvaluation or undervaluation (e.g., Faccio and Masulis, 2005).

Insider selling:

$$\begin{aligned}\text{Abnormal return}_i &= a + b_4((\text{Above-optimal dummy t-1})_i) + c_1(\text{Size change}_i) \\ &\quad + c_2(\text{Cash flow change}_i) + c_3(\text{Sales growth change}_i) \\ &\quad + c_4(\text{Property, plant and equipment change}_i) + c_5(\text{R\&D change}_i) \\ &\quad + c_6(\text{Earning volatility change}_i) + c_7(\text{Sales volatility change}_i) \\ &\quad + c_8(\text{Run-up}_i) + \eta_i \end{aligned} \tag{7}$$

Insider purchase:

$$\begin{aligned}\text{Abnormal return}_i &= a + b_5((\text{Above-optimal dummy t-1})_i) + c_1(\text{Size change}_i) \\ &\quad + c_2(\text{Cash flow change}_i) + c_3(\text{Sales growth change}_i) \\ &\quad + c_4(\text{Property, plant and equipment change}_i) + c_5(\text{R\&D change}_i) \\ &\quad + c_6(\text{Earning volatility change}_i) + c_7(\text{Sales volatility change}_i) \\ &\quad + c_8(\text{Run-up}_i) + \eta_i \end{aligned} \tag{8}$$

According to Hypothesis 1, we expect $b_4 > 0$ in equation (7), and $b_5 < 0$ in equation (8).

5.1.2. Seasoned equity offerings and open market repurchases

Data on seasoned equity offerings (SEOs) and open market repurchases are obtained from the Securities Data Corporation (SDC) database over the period from 1996 to 2000. However, since firms are not obliged to repurchase shares after announcements, we only consider in our analysis the firms that actually repurchase shares. We use the data item for repurchases from the Compustat Quarterly database (#93) to identify the firms that actually repurchased shares. We define the firm as the one that actually repurchases shares, if it is reported in SDC and its data item for repurchases in Compustat is positive in the same year. As a result, the sample contains 267 seasoned equity offerings events and 1184 open market repurchases events.

We set the announcement date of SEOs or open market repurchases as the event date. We use the cumulative abnormal return in (-10, +10) days around the announcement date as the measure for the change in firm value for SEOs, and use the cumulative abnormal return in (-5, +5) days around the announcement date as the measure for the change in firm value for open market repurchases.[17]

We expect that SEOs will be associated with a higher abnormal return for an above-optimal deviation than a below-optimal deviation. An SEO increases the total number of shares outstanding, which consequently reduces the proportion of shares held by the CEO. Therefore, an SEO moves CEO ownership towards the optimal level where an above-optimal deviation has previously existed, and moves CEO ownership away from the optimal level where there has been a below-optimal deviation. Similarly, we expect that open market repurchases will be associated with a lower abnormal return for an above-optimal deviation than a below-optimal deviation.

[17] We find qualitatively similar results when we use the cumulative abnormal return in (-10, +10) days around the event date as the measure for the change in firm value for open market repurchases.

We use the following regressions for SEOs and repurchases. The changes of various contracting parameters and a prior 6-month run-up are also used as control variables.

SEOs:

$$\begin{aligned}\text{Abnormal return}_i &= a + b_6((\text{Above-optimal dummy t-1})_i) + c_1(\text{Size change}_i) \\ &\quad + c_2(\text{Cash flow change}_i) + c_3(\text{Sales growth change}_i) \\ &\quad + c_4(\text{Property, plant and equipment change}_i) + c_5(\text{R\&D change}_i) \\ &\quad + c_6(\text{Earning volatility change}_i) + c_7(\text{Sales volatility change}_i) \\ &\quad + c_8(\text{Run-up}_i) + \eta_i \end{aligned} \tag{9}$$

Repurchases:

$$\begin{aligned}\text{Abnormal return}_i &= a + b_7((\text{Above-optimal dummy t-1})_i) + c_1(\text{Size change}_i) \\ &\quad + c_2(\text{Cash flow change}_i) + c_3(\text{Sales growth change}_i) \\ &\quad + c_4(\text{Property, plant and equipment change}_i) + c_5(\text{R\&D change}_i) \\ &\quad + c_6(\text{Earning volatility change}_i) + c_7(\text{Sales volatility change}_i) \\ &\quad + c_8(\text{Run-up}_i) + \eta_i \end{aligned} \tag{10}$$

According to Hypothesis 1, we expect $b_6 > 0$ in equation (9), and $b_7 < 0$ in equation (10).

5.2. Results

5.2.1. Univariate statistics

Table 6 shows univariate statistics. Panel A shows that the median of the abnormal return of insider selling and insider purchase is -0.0040 and 0.0216, while the median of the abnormal return of SEOs and open market repurchases is -0.0172 and 0.0182. This is consistent with previous research, which finds a negative abnormal return for insider selling and SEOs, and a positive abnormal return for insider purchase and open market repurchases. Table 6 also reports univariate statistics of the prior 6-month run-up in Panel B.

5.2.2. Deviation from optimal CEO ownership and abnormal return

Table 7 illustrates the results of the relation between the deviation from optimal CEO ownership and the abnormal return associated with a change in CEO ownership. We conduct the univariate analysis in panel A. We divide the sample into two groups,

depending on whether CEO ownership is above or below the optimal level in the year t-1, and make comparisons between them.

Panel A shows that there is a significant difference in the abnormal return between these two sub-samples. For example, in the first row of panel A, we find that the mean of abnormal return for insider selling is -0.0127 for the sub-sample of below-optimal deviation, which is significant. However, the mean of abnormal return is -0.0012 for the sub-sample of above-optimal deviation, which is insignificant. This is consistent with the following interpretation. If there is a relation between CEO ownership and firm value through signaling (e.g., Leland and Pyle, 1977), then insider selling will reduce firm value, as it reduces CEO ownership. However, since insider selling also moves CEO ownership towards the optimal level in the situation of an above-optimal deviation, this can increase firm value. As a result, these two effects offset each other, so that we find no significant abnormal return in insider selling for the sub-sample of above-optimal deviation.

The rest of panel A shows similar patterns. We find that the sub-sample of above-optimal deviation has a higher abnormal return in SEOs, and a lower abnormal return in insider purchase and open market repurchases.

Panel B of Table 7 shows the results of the regressions. In the first column, we find that the estimate on Above-optimal dummy_{t-1} is 0.011 for insider selling, which is significant. This is consistent with the viewpoint that insider selling is associated with a higher abnormal return in the case of above-optimal deviation by moving CEO ownership towards the optimal level. The other columns in panel B illustrate a similar pattern. We find that the estimate on Above-optimal dummy_{t-1} is positive and significant for SEOs, and the estimates on Above-optimal dummy_{t-1} are negative and significant for insider purchase and open market repurchases.

In panel C of Table 7, we conduct a robustness check by including more control variables in the regressions. These variables are the lag of firm characteristics, which are used by previous papers in the literature. They can control for hypotheses based on the signaling theory and the agency theory. We find similar results in this panel. The estimates on Above-optimal dummy_{t-1} are positive and significant for insider selling and SEO regressions, while the estimates on Above-optimal dummy_{t-1} are negative and significant for insider purchase and repurchases regressions.

Therefore, the results in Table 7 are consistent with the hypothesis that both above-optimal and below-optimal deviations reduce firm value.[18]

5.3. Heckman two-stage estimation

Since firms may self-select themselves to undertake these events which change CEO ownership, it means that these events may not occur randomly. In this case, simple OLS regression is subject to an omitted variable problem with a non-randomly selected sample.[19] We use the Heckman two-stage estimation as the treatment for this self selection problem.

In the first stage, we use probit regressions to model the decision of the firms to undertake these events. In each regression, we include the dummy variable, which indicates an above-optimal deviation in the year t-1. This allows us to study whether a deviation from optimal CEO ownership will affect the firm's decision to alter CEO ownership. In the probit regressions of insider selling and insider purchase, we include various control variables, which are based on the literature about the

[18] McConnell, Servaes and Lins (2005) study changes in insider ownership and changes in firm value in the situation of insider purchase. They do not find evidence for the optimal ownership explanation. We believe that the difference in the results can be due to the different sample used in the study. While McConnell et al. (2005) use the sample of purchase by all the insiders, we only use the sample of purchase by the CEO. Since it is possible that the optimal contracting framework is more relevant to the top management in the firm (e.g., the CEO) than other lower-ranked insiders, this can potentially explain the difference in the results between this paper and McConnell, Servaes and Lins (2005).

[19] See Heckman (1979) for more details.

determinants of insider trading (e.g., Seyhun, 1986; Lakonishok and Lee, 2001). In the probit regressions of SEOs and open market repurchases, we include various control variables, which are based on the literature about the determinants of SEOs or repurchases (e.g., Jung, Kim and Stulz, 1996; Kahle, 2002).[20]

From the probit regressions, we obtain the inverse Mills ratio as the omitted variable. In the second stage, we run the regressions with the inverse Mills ratio as an additional control variable. This provides treatment for the omitted variable problem from the firm's self selection into these events.

Table 8 shows the results of the first stage of the Heckman two-stage estimation. The probit regressions are reported in the table. In the first column, we find that the estimate on Above-optimal dummy_{t-1} is 0.172 for insider selling, which is significant. This suggests that insider selling is more likely to take place in a firm whose CEO ownership is above the optimal level in the year t-1. In the last column, we find that the estimate on Above-optimal dummy_{t-1} is -0.073 for open market repurchases, which is significant, suggesting that open market repurchases are less likely to take place in a firm whose CEO ownership is above the optimal level in the year t-1.

Table 9 shows the results of the second stage of the Heckman two-stage estimation. The inverse Mills ratio, which is obtained from the first stage, is included in the regression. In panel A of Table 9, we find that the estimates on Above-optimal dummy_{t-1} have the same signs as in Table 7 while controlling for the inverse Mills ratio. Insider selling and SEOs are associated with a higher abnormal return for the above-optimal deviation by moving CEO ownership towards the optimal level, while insider purchase and open market repurchases are associated with a lower abnormal

[20] These control variables are used to control for other reasons that can affect the likelihood of these events. For example, Stock return_{t-1} can proxy for the potential overvaluation or undervaluation (e.g., Faccio and Masulis, 2005). We expect that if Stock return_{t-1} is higher, insider selling and SEO will be more likely to take place, while insider purchase and open market repurchases will be less likely to occur.

return for the above-optimal deviation by moving CEO ownership away from the optimal level. In panel B of Table 9, we find similar results by adding more control variables in the regressions. These results therefore suggest that, while controlling for a firm's self selection, both above-optimal deviation and below-optimal deviation reduce firm value.

5.4. Robustness Check about Option Exercises

Since insider selling can be associated with option exercises, the market reaction may be different depending on whether the insider selling is associated with option exercises. We conduct a robustness check and report the results in Table 10. In the regressions, we include an "Option exercise dummy", which is one if insider selling is associated with option exercises, and is zero otherwise. We find similar results in this robustness check.

6. Conclusion

This paper tests the transaction cost theory on managerial ownership and firm value by studying the relation between deviations on both sides of optimal CEO ownership and firm value. This enables us to differentiate between the transaction cost theory and alternative theories, as the predictions on both the above-optimal deviation and the below-optimal deviation are uniquely from the transaction cost theory. We obtain a measure of the deviation from optimal CEO ownership, and find that deviations on both sides of optimal CEO ownership significantly reduce the level of firm value. Moreover, we conduct four event studies to examine how the deviation from optimal CEO ownership affects firm value when there is a change in CEO ownership. We find that the change in CEO ownership is associated with a higher

abnormal return if it moves CEO ownership towards the optimal level, while the change in CEO ownership is associated with a lower abnormal return if it moves CEO ownership away from the optimal level.

These findings support the interpretation that deviations on both sides of optimal CEO ownership reduce firm value. We conclude that they are consistent with the transaction cost theory on managerial ownership and firm value.

Appendix A
Definition of the variables

Panel A. CEO ownership, Tobin's Q, and control variables

CEO ownership	CEO ownership is defined as the sum of the proportion of shares outstanding held by the CEO plus the proportion of shares outstanding in options held by the CEO times the Black-Scholes hedge ratio (the delta). Or: $\text{CEO ownership} = \frac{\#\text{Shares Held by CEO}}{\#\text{Shares Outstanding}} + \frac{\#\text{Options Held by CEO}}{\#\text{Shares Outstanding}} * \text{delta}$ with $\text{delta} = \frac{\partial(\text{Black - Scholes option value})}{\partial\,\text{Stock price}} = e^{-dT} * N(Z)$ $Z = [\log(S / X) + T(r - d + \sigma^2 / 2)] / \sigma T^{(1/2)}$ where N = cumulative probability function for the normal distribution S = price of the underlying stock X = exercise price σ = expected stock-return volatility over life of option r = risk-free interest rate T = time to maturity of the option in years d = expected dividend rate over life of option See Appendix B for more details on the calculation of this measure.
Tobin's Q	Tobin's Q is defined as the market value of equity (#25 multiplied by #199) plus the book value of assets (#6) minus the book value of common equity (#60), divided by the book value of assets (#6). We use # to denote the Compustat item number.
Size	Size is defined as the natural logarithm of the book value of assets (#6)
Cash flow	Cash flow is defined as the ratio of income before extraordinary items (#18) to assets (#6).
Sales growth	Sales growth is defined as the growth rate of sales (#12), calculated as the change in sales divided by the level of sales in the previous year.
Plant, property and equipment	Plant, property and equipment is defined as the ratio of plant, property and equipment (#8) to assets (#6).
R&D and advertising	R&D and advertising is defined as the ratio of the sum of research and development expenses (#46) plus advertising expenses (#45), divided by total expenses (#189). The missing value is set to zero.
Earnings volatility	Earnings volatility is defined as the standard deviation of the ratio of income before extraordinary items (#18) to assets (#6) in the prior three years.
Sales volatility	Sales volatility is defined as the standard deviation of the natural logarithm of sales (#12) in the prior three years.
Leverage	Leverage is defined as the ratio of long-term debt (#9) to assets (#6).
Cash holdings	Cash holdings are defined as the ratio of cash and marketable securities (#1) to assets (#6).
Stock return	Stock return is defined as one-year stock return. It is calculated as the sum of monthly return during the year.
Stock return volatility	Stock return volatility is defined as the annualized standard deviation of monthly return during the year.

Panel B. Abnormal return around the change in CEO ownership and run-up

Abnormal return for insider selling	Abnormal return for insider selling is defined as the cumulative abnormal return in (-5, +10) days around the event date, where the event date is the date that insider selling is reported to the SEC. Cumulative abnormal return is calculated by using the market model with the CRSP equally weighted index as the market return. In estimating the market model, we use the firm's daily return and the return on the CRSP equally weighted index over days -300 to -46, where date 0 is the event date.
Abnormal return for insider purchase	Abnormal return for insider purchase is defined as the cumulative abnormal return in (-1, +4) days around the event date, where the event date is the date that insider purchase is reported to the SEC. Cumulative abnormal return is calculated by using the market model with the CRSP equally weighted index as the market return. In estimating the market model, we use the firm's daily return and the return on the CRSP equally weighted index over days -300 to -46, where date 0 is the event date.
Abnormal return for seasoned equity offerings	Abnormal return for seasoned equity offerings is defined as the cumulative abnormal return in (-10, +10) days around the event date, where the event date is the announcement date. Cumulative abnormal return is calculated by using the market model with the CRSP equally weighted index as the market return. In estimating the market model, we use the firm's daily return and the return on the CRSP equally weighted index over days -140 to -20, where date 0 is the event date.
Abnormal return for open market repurchases	Abnormal return for open market repurchases is defined as the cumulative abnormal return in (-5, +5) days around the event date, where the event date is the announcement date. Cumulative abnormal return is calculated by using the market model with the CRSP equally weighted index as the market return. In estimating the market model, we use the firm's daily return and the return on the CRSP equally weighted index over days -300 to -46, where date 0 is the event date.
Run-up	Run-up is defined as the sum of the firm's monthly return in the interval -6 to -1 months.

Appendix B
The calculation of CEO ownership

We calculate CEO ownership as the sum of the proportion of shares outstanding held by the CEO plus the proportion of shares outstanding in options held by the CEO times the Black-Scholes hedge ratio (the delta). This can be expressed as:

$$\text{CEO Ownership} = \frac{\#\text{Shares Held by CEO}}{\#\text{Shares Outstanding}} + \frac{\#\text{Options Held by CEO}}{\#\text{Shares Outstanding}} * \text{delta} \qquad (1)$$

$$\text{with delta} = \frac{\partial(\text{Black - Scholes option value})}{\partial\,\text{Stock price}} = e^{-dT} * N(Z) \qquad (2)$$

$$Z = [\log(S / X) + T(r - d + \sigma^2 / 2)] / \sigma T^{(1/2)} \qquad (3)$$

where N = cumulative probability function for the normal distribution
S = price of the underlying stock
X = exercise price
σ = expected stock return volatility over life of option
r = risk-free interest rate
T = time to maturity of the option in years
d = expected dividend rate over life of option

We use the methodology in Core and Guay (1999, 2002) to calculate this measure. The incentive from stocks held by the CEO is calculated as follows: the stock holdings are obtained from Execucomp and divided by the number of shares outstanding.

The CEO option holdings are then divided into newly granted options and previously granted options. For newly granted options, all six elements are available for calculation: the exercise price of the option, time-to-maturity, the price of the underlying stock, expected dividend yield, expected stock return volatility, and risk-free interest rate. The exercise price of the option, time-to-maturity, and the price of the underlying stock are directly available from Execucomp. We use the dividend yield during the fiscal year as the proxy for expected dividend yield, which is also available from the Execucomp database. We use the annualized stock return volatility as the proxy for expected stock return volatility, calculated as the standard deviation of monthly stock return during the year multiplied by $\sqrt{12}$. We get 10-year treasury constant maturity rate at the fiscal year end as the measure for risk-free interest rate. These data are obtained from the website of the Federal Reserve Bank.

For previously granted options, two elements are unavailable in the current year proxy statement: the exercise price and time-to-maturity. We compute the average exercise price of exercisable and unexercisable options by using the current realizable value from Execucomp. Then we set the time-to-maturity of unexercisable options equal to one year less than the time-to-maturity of the grant in the most recent year, and set the time-to-maturity of the exercisable option equal to three years less than the time-to-maturity of the unexercisable option.

Core and Guay (1999, 2002) provide more details on this methodology.

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Table 1
Univariate statistics

This table reports univariate statistics on the variables. The sample consists of 1058 firms that are continuously in the Execucomp database from 1995 to 2000. Panel A reports univariate statistics on CEO ownership and Tobin's Q. *CEO ownership* is defined as the sum of the proportion of shares outstanding held by the CEO plus the proportion of shares outstanding in options held by the CEO times the Black-Scholes hedge ratio (the delta). *Tobin's Q* is the market value of equity plus the book value of assets minus the book value of common equity, divided by the book value of assets. Panel B reports univariate statistics on other variables. *Size* is the natural logarithm of the book value of assets. *Cash flow* is the ratio of income before extraordinary items to assets. *Sales growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Plant, property and equipment* is the ratio of PPE to assets. *R&D and advertising* is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. *Earnings volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Sales volatility* is the standard deviation of the natural logarithm of sales in the prior three years. Leverage is the ratio of long-term debt to assets. *Cash holdings* are the ratio of cash and marketable securities to assets. *Stock return* is one-year stock return. *Stock return volatility* is the annualized standard deviation of monthly return during the year.

Panel A. CEO ownership and Tobin's Q

Variable	Mean	Median
CEO ownership	0.0350	0.0105
Tobin's Q	1.9896	1.4867

Panel B. Other variables

Variable	Mean	Median
Size	21.3331	21.1677
Cash flow	0.0475	0.0468
Sales growth	0.1104	0.0886
Plant, property and equipment	0.4883	0.2417
R&D and advertising	0.1108	0.0000
Earnings volatility	0.0294	0.0154
Sales volatility	0.1038	0.0661
Leverage	0.1964	0.1830
Cash holdings	0.0952	0.0378
Stock return	0.1814	0.1902
Stock return volatility	0.3862	0.3437

Table 2
Determinants of CEO ownership

This table reports regressions on the determinants of CEO ownership. Panel A reports OLS and firm fixed effect regression on the determinants of CEO Ownership. The intercepts are not reported in this table. CEO ownership is defined as the sum of the proportion of shares outstanding held by the CEO plus the proportion of shares outstanding in options held by the CEO times the Black-Scholes hedge ratio (the delta). *Size* is the natural logarithm of the book value of assets. *Cash flow* is the ratio of income before extraordinary items to assets. *Sales growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Plant, property and equipment* is the ratio of PPE to assets. R*&D and advertising* is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. *Earnings volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Sales volatility* is the standard deviation of the natural logarithm of sales in the prior three years. Panel B reports univariate statistics on the predicted CEO ownership and the residuals. *Predicted CEO ownership* is the predicted CEO ownership from the firm fixed effect regression, which is reported in panel A. *Residuals* are the residuals from the firm fixed effect regression, which is also reported in panel A. The p-value is noted in brackets.

Panel A. Determinants of CEO ownership

	OLS	Firm fixed effect
	CEO ownership	CEO ownership
Size	-0.067	-0.053
	(0.01)	(0.01)
Size square	0.001	0.001
	(0.01)	(0.01)
Cash flow	0.053	0.016
	(0.01)	(0.01)
Cash flow square	-0.031	-0.069
	(0.57)	(0.02)
Sales growth	0.011	0.004
	(0.01)	(0.04)
Plant, property and equipment	-0.009	0.001
	(0.01)	(0.36)
R&D and advertising	-0.005	-0.009
	(0.35)	(0.17)
Earnings volatility	-0.135	-0.031
	(0.01)	(0.01)
Sales volatility	0.001	0.004
	(0.93)	(0.26)
Adjusted R-square	0.09	0.90
F-test on equal intercepts (p-value)		0.01

Panel B. Predicted CEO ownership and the residuals from the firm fixed effect regression

Variable	Mean	Median	5th percentile	95th percentile
CEO ownership	0.0350	0.0105	0.0005	0.1757
Predicted CEO ownership	0.0350	0.0123	0.0006	0.1649
Residuals	-0.0001	-0.0001	-0.0231	0.0234

Table 3
Deviation from optimal CEO ownership and firm value

This table reports firm fixed effect regressions on the deviation from optimal CEO ownership and firm value. The intercepts are not reported in this table. *Deviation* is the absolute value of the residuals, where univariate statistics of the residuals is reported in Table 2. *Above-optimal dummy* is one if actual CEO ownership is greater than optimal CEO ownership, and is zero otherwise. *Tobin's Q* is the market value of equity plus the book value of assets minus the book value of common equity, divided by the book value of assets. *Size* is the natural logarithm of the book value of assets. *Cash flow* is the ratio of income before extraordinary items to assets. *Sales growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Plant, property and equipment* is the ratio of PPE to assets. *R&D and advertising* is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. *Earnings volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Sales volatility* is the standard deviation of the natural logarithm of sales in the prior three years. *F-test* refers to the F test on the null hypothesis that the sum of the estimates on Deviation and Deviation * Above-optimal dummy is zero. The p-value is noted in brackets.

	Tobin's Q	Tobin's Q
Deviation	-5.658	-5.998
	(0.01)	(0.01)
Deviation * Above-optimal dummy		0.851
		(0.44)
Size	-1.839	-1.842
	(0.01)	(0.01)
Size square	0.042	0.043
	(0.01)	(0.01)
Cash flow	4.338	4.340
	(0.01)	(0.01)
Cash flow square	16.737	16.732
	(0.01)	(0.01)
Sales growth	0.375	0.376
	(0.01)	(0.01)
Plant, property and equipment	0.034	0.034
	(0.48)	(0.47)
R&D and advertising	0.489	0.489
	(0.01)	(0.01)
Earnings volatility	0.338	0.335
	(0.30)	(0.31)
Sales volatility	-0.197	-0.196
	(0.07)	(0.07)
F-test (p-value)		0.01
Adjusted R-square	0.92	0.92

Table 4
Size-adjusted deviation from optimal CEO ownership and firm value

This table reports firm fixed effect regressions on the deviation from optimal CEO ownership and firm value. The intercepts are not reported in this table. *Size-adjusted deviation* is the deviations divided by firm size, which is the natural logarithm of the book value of assets. *Above-optimal dummy* is one if actual CEO ownership is greater than optimal CEO ownership, and is zero otherwise. *Tobin's Q* is the market value of equity plus the book value of assets minus the book value of common equity, divided by the book value of assets. *Size* is the natural logarithm of the book value of assets. *Cash flow* is the ratio of income before extraordinary items to assets. *Sales growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Plant, property and equipment* is the ratio of PPE to assets. *R&D and advertising* is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. *Earnings volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Sales volatility* is the standard deviation of the natural logarithm of sales in the prior three years. *F-test* refers to the F test on the null hypothesis that the sum of the estimates on Size-adjusted deviation and Size-adjusted deviation * Above-optimal dummy is zero. The p-value is noted in brackets.

	Tobin's Q	Tobin's Q
Size-adjusted deviation	-1.040	-1.110
	(0.01)	(0.01)
Size-adjusted deviation * Above-optimal dummy		0.171
		(0.45)
Size	-1.851	-1.852
	(0.01)	(0.01)
Size square	0.043	0.043
	(0.01)	(0.01)
Cash flow	4.337	4.339
	(0.01)	(0.01)
Cash flow square	16.735	16.732
	(0.01)	(0.01)
Sales growth	0.376	0.377
	(0.01)	(0.01)
Plant, property and equipment	0.034	0.034
	(0.47)	(0.47)
R&D and advertising	0.490	0.491
	(0.01)	(0.01)
Earnings volatility	0.339	0.336
	(0.30)	(0.31)
Sales volatility	-0.197	-0.196
	(0.07)	(0.07)
F-test (p-value)		0.01
Adjusted R-square	0.92	0.92

Table 5
CEO ownership and firm value

This table reports a firm fixed effect regression on CEO ownership and firm value. The intercepts are not reported in this table. *CEO ownership* is defined as the sum of the proportion of shares outstanding held by the CEO plus the proportion of shares outstanding in options held by the CEO times the Black-Scholes hedge ratio (the delta). *Tobin's Q* is the market value of equity plus the book value of assets minus the book value of common equity, divided by the book value of assets. *Size* is the natural logarithm of the book value of assets. *Cash flow* is the ratio of income before extraordinary items to assets. *Sales growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Plant, property and equipment* is the ratio of PPE to assets. *R&D and advertising* is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. *Earnings volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Sales volatility* is the standard deviation of the natural logarithm of sales in the prior three years. The p-value is noted in brackets.

	Tobin's Q
CEO ownership	0.369
	(0.37)
Size	-1.737
	(0.01)
Size square	0.040
	(0.01)
Cash flow	4.329
	(0.01)
Cash flow square	16.769
	(0.01)
Sales growth	0.380
	(0.01)
Plant, property and equipment	0.034
	(0.47)
R&D and advertising	0.506
	(0.01)
Earnings volatility	0.354
	(0.28)
Sales volatility	-0.197
	(0.07)
Adjusted R-square	0.92

Table 6
Univariate statistics on the events of change in CEO ownership

This table reports univariate statistics on the events of change in CEO ownership. We obtain the data from the Thomson Financial database and the Securities Data Corporation database over the period from 1996 to 2000. We study four events that alter the proportion of CEO ownership: insider selling (1266 events), insider purchase (303 events), seasoned equity offerings (267 events), and open market repurchases (1184 events). Panel A reports abnormal return around the events. *Abnormal return* is calculated as the cumulative abnormal return by using the market model with the CRSP equally weighted index as the market return. Abnormal return for insider selling is calculated by using the window of (-5, +10) days around the date that the transaction is reported to the SEC. Abnormal return for insider purchase is calculated by using the window of (-1, +4) days around the date that the transaction is reported to the SEC. Abnormal return for SEOs is calculated by using the window of (-10, +10) days around the announcement date. Abnormal return for open market repurchases is calculated by using the window of (-5, +5) days around the announcement date. Panel B reports univariate statistics on run-up. *Run-up* is the sum of the firm's monthly return in the interval -6 to -1 months.

Panel A. Abnormal return around insider selling, insider purchase, seasoned equity offerings, and open market repurchases

	Abnormal return			
	Mean	Median	Mean test (p-value)	Median test (p-value)
Insider selling	-0.0067	-0.0040	0.03	0.02
Insider purchase	0.0269	0.0216	0.01	0.01
SEOs	-0.0178	-0.0172	0.03	0.01
Open market repurchases	0.0135	0.0182	0.01	0.01

Panel B. Univariate statistics on run-up

	Run-up	
	Mean	Median
Insider selling	0.3057	0.2554
Insider purchase	-0.1903	-0.1857
SEOs	0.3330	0.2649
Open market repurchases	0.0196	0.0429

Table 7
Deviation from optimal CEO ownership
and abnormal return around the change in CEO ownership

This table reports the deviation from optimal CEO ownership and abnormal return around the change in CEO ownership. We study four events that alter the proportion of CEO ownership: insider selling (1266 events), insider purchase (303 events), seasoned equity offerings (267 events), and open market repurchases (1184 events). Panel A reports the results of the univariate analysis. *Abnormal return* is calculated as the cumulative abnormal return by using the market model with the CRSP equally weighted index as the market return. Appendix A provides the details for the calculation of the cumulative abnormal return for each event. Panel B reports the results of regressions. *Above-optimal dummy t-1* is one if actual CEO ownership is greater than optimal CEO ownership in the year t-1, and is zero otherwise. *Size* is the natural logarithm of the book value of assets. *Cash flow* is the ratio of income before extraordinary items to assets. *Sales growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Plant, property and equipment* is the ratio of PPE to assets. *R&D and advertising* is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. *Earnings volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Sales volatility* is the standard deviation of the natural logarithm of sales in the prior three years. *Run-up* is the sum of the firm's monthly return in the interval -6 to -1 months. Panel C reports the results of regressions with more control variables. *Leverage* is the ratio of long-term debt to assets. *Cash holdings* are the ratio of cash and marketable securities to assets. The p-value is noted in brackets.

Panel A. Univariate analysis

	Mean of abnormal return (p-value)	
	Sub-sample: Below-optimal deviation in year t-1	Sub-sample: Above-optimal deviation in year t-1
Insider selling	-0.0127	-0.0012
	(0.01)	(0.78)
Insider purchase	0.0340	0.0189
	(0.01)	(0.01)
SEOs	-0.0342	-0.0013
	(0.01)	(0.92)
Open market repurchases	0.0171	0.0087
	(0.01)	(0.08)

Panel B. Regressions

	Abnormal return			
	Insider selling	Insider purchase	SEOs	Open market repurchases
Intercept	-0.022	0.030	-0.030	0.022
	(0.01)	(0.01)	(0.05)	(0.01)
Above-optimal dummy t-1	0.011	-0.020	0.036	-0.012
	(0.08)	(0.05)	(0.02)	(0.05)
Size change	0.033	-0.026	0.013	-0.035
	(0.02)	(0.28)	(0.64)	(0.04)
Cash flow change	0.077	0.066	0.211	0.088
	(0.11)	(0.33)	(0.19)	(0.11)
Sales growth change	0.033	0.015	0.053	0.023
	(0.04)	(0.48)	(0.08)	(0.13)
Property, plant and equipment change	0.011	0.014	-0.035	-0.012
	(0.65)	(0.50)	(0.20)	(0.68)
R&D and advertising change	0.027	-0.050	0.005	-0.065
	(0.63)	(0.58)	(0.97)	(0.19)
Earnings volatility change	0.262	0.207	-0.662	-0.226
	(0.01)	(0.15)	(0.04)	(0.06)
Sales volatility change	-0.001	0.006	-0.098	0.028
	(0.98)	(0.89)	(0.26)	(0.38)
Run-up	0.002	-0.035	-0.034	-0.001
	(0.76)	(0.02)	(0.13)	(0.93)
Adjusted R-square	0.02	0.02	0.04	0.01

Panel C. Regressions with more control variables

	Abnormal return			
	Insider selling	Insider purchase	SEOs	Open market repurchases
Intercept	-0.072	0.033	-0.107	0.027
	(0.09)	(0.69)	(0.45)	(0.52)
Above-optimal dummy t-1	0.010	-0.024	0.036	-0.012
	(0.09)	(0.02)	(0.03)	(0.04)
Size change	0.031	-0.073	0.061	-0.054
	(0.08)	(0.03)	(0.14)	(0.01)
Cash flow change	0.061	0.054	0.229	0.072
	(0.22)	(0.48)	(0.20)	(0.22)
Sales growth change	0.027	0.078	-0.040	0.052
	(0.26)	(0.03)	(0.48)	(0.04)
Property, plant and equipment change	0.015	0.030	-0.054	0.001
	(0.52)	(0.22)	(0.13)	(0.97)
R&D change	0.005	-0.083	-0.013	-0.055
	(0.92)	(0.39)	(0.91)	(0.27)
Earnings volatility change	0.235	0.645	-0.749	-0.235
	(0.01)	(0.01)	(0.04)	(0.08)
Sales volatility change	0.005	0.015	-0.048	0.023
	(0.89)	(0.74)	(0.60)	(0.48)
Run-up	0.003	-0.031	-0.046	0.001
	(0.71)	(0.05)	(0.06)	(0.94)
Size t-1	0.003	-0.002	0.004	-0.0002
	(0.15)	(0.66)	(0.49)	(0.93)
Cash flow t-1	-0.044	0.196	-0.158	-0.044
	(0.31)	(0.04)	(0.31)	(0.43)
Sales growth t-1	-0.006	0.076	-0.113	0.044
	(0.80)	(0.07)	(0.06)	(0.12)
R&D t-1	-0.017	-0.087	-0.042	0.012
	(0.31)	(0.01)	(0.43)	(0.53)
Earnings volatility t-1	-0.005	0.610	-0.022	-0.011
	(0.94)	(0.01)	(0.94)	(0.92)
Leverage t-1	-0.027	0.050	0.013	-0.024
	(0.29)	(0.14)	(0.82)	(0.30)
Cash holdings t-1	0.043	0.051	0.084	0.031
	(0.03)	(0.31)	(0.21)	(0.26)
Adjusted R-square	0.03	0.08	0.06	0.01

Table 8
Heckman two-stage estimation
First stage: Probit regressions

This table reports the first stage of the Heckman two-stage estimation. The probit regressions are reported in the table. The sample consists of 1058 firms that are continuously in the Execucomp database from 1995 to 2000. We study four events that alter the proportion of CEO ownership: insider selling (1266 events), insider purchase (303 events), seasoned equity offerings (267 events), and open market repurchases (1184 events). The dependent variable is 1 if the event takes place, and is 0 otherwise. *Above-optimal dummy t-1* is one if actual CEO ownership is greater than optimal CEO ownership in the year t-1, and is zero otherwise. *Size* is the natural logarithm of the book value of assets. *Sales growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *R&D and advertising* is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. *Stock return* is one-year stock return. *Stock return volatility* is the annualized standard deviation of monthly return during the year. *Leverage* is the ratio of long-term debt to assets. *Cash flow* is the ratio of income before extraordinary items to assets. *Earnings volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Cash holdings* are the ratio of cash and marketable securities to assets. The p-value is noted in brackets.

	The dependent variable is 1 if the event takes place, and is 0 otherwise.				
	Insider selling	Insider purchase		SEOs	Open market repurchases
Intercept	-2.872	-2.768	Intercept	1.497	-1.374
	(0.01)	(0.01)		(0.02)	(0.01)
Above-optimal dummy t-1	0.172	0.024	Above-optimal dummy t-1	0.100	-0.073
	(0.01)	(0.70)		(0.24)	(0.08)
Size t-1	0.061	0.036	Size t-1	-0.155	0.029
	(0.01)	(0.06)		(0.01)	(0.03)
Sales growth t-1	0.639	0.248	Sales growth t-1	1.105	-0.252
	(0.01)	(0.11)		(0.01)	(0.02)
R&D and advertising t-1	1.104	0.123	Leverage t-1	1.006	-0.529
	(0.01)	(0.52)		(0.01)	(0.01)
Stock return t-1	0.644	-0.591	Cash flow t-1	0.453	2.914
	(0.01)	(0.01)		(0.52)	(0.01)
Stock return volatility t-1	0.271	0.804	Earnings volatility t-1	-0.350	0.455
	(0.03)	(0.01)		(0.78)	(0.45)
			Cash holdings t-1	0.439	-0.142
				(0.27)	(0.44)
			Stock return t-1	1.073	-0.015
				(0.01)	(0.79)
			Stock return volatility t-1	0.448	-0.264
				(0.13)	(0.05)
Cox and Snell R-square	0.07	0.02	Cox and Snell R-square	0.14	0.03

Table 9
Heckman two-stage estimation
Second stage: Deviation from optimal CEO ownership and abnormal return

This table reports the second stage of the Heckman two-stage estimation. This table shows the deviation from optimal CEO ownership and abnormal return around the change of CEO ownership. We examine four events that alter the proportion of CEO ownership: insider selling (1266 events), insider purchase (303 events), seasoned equity offerings (267 events), and open market repurchases (1184 events). Panel A reports the regressions. Abnormal return is calculated as the cumulative abnormal return by using the market model with the CRSP equally weighted index as the market return. Appendix A provides the details for the calculation of the cumulative abnormal return for each event. *Above-optimal dummy t-1* is one if actual CEO ownership is greater than optimal CEO ownership in the year t-1, and is zero otherwise. *Size* is the natural logarithm of the book value of assets. *Cash flow* is the ratio of income before extraordinary items to assets. *Sales growth* is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. *Plant, property and equipment* is the ratio of PPE to assets. *R&D and advertising* is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. *Earnings volatility* is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. *Sales volatility* is the standard deviation of the natural logarithm of sales in the prior three years. *Run-up* is the sum of the firm's monthly return in the interval -6 to -1 months. Inverse Mills ratio is obtained from the first stage of the Heckman two-stage estimation, which is reported in Table 8. Panel B reports the regressions with more control variables. *Leverage* is the ratio of long-term debt to assets. *Cash holdings* are the ratio of cash and marketable securities to assets. The p-value is noted in brackets.

Panel A. Regressions

	Abnormal return			
	Insider selling	Insider purchase	SEOs	Open market repurchases
Intercept	-0.041	0.069	-0.004	0.026
	(0.03)	(0.13)	(0.91)	(0.32)
Above-optimal dummy t-1	0.013	-0.021	0.035	-0.011
	(0.05)	(0.04)	(0.03)	(0.07)
Size change	0.039	-0.017	0.001	-0.035
	(0.01)	(0.51)	(0.96)	(0.04)
Cash flow change	0.083	0.070	0.182	0.091
	(0.09)	(0.30)	(0.27)	(0.11)
Sales growth change	0.027	0.016	0.065	0.023
	(0.10)	(0.45)	(0.06)	(0.13)
Property, plant and equipment change	0.009	0.015	-0.030	-0.014
	(0.71)	(0.49)	(0.29)	(0.65)
R&D and advertising change	0.023	-0.054	0.005	-0.065
	(0.67)	(0.56)	(0.96)	(0.19)
Earnings volatility change	0.253	0.192	-0.641	-0.221
	(0.01)	(0.19)	(0.05)	(0.07)
Sales volatility change	-0.001	0.006	-0.114	0.028
	(0.98)	(0.89)	(0.21)	(0.38)
Run-up	0.005	-0.033	-0.042	-0.001
	(0.53)	(0.04)	(0.09)	(0.92)
Inverse Mills ratio	0.012	-0.019	-0.016	-0.003
	(0.28)	(0.39)	(0.44)	(0.88)
Adjusted R-square	0.02	0.02	0.04	0.01

Panel B. Regressions with more control variables

	Abnormal return			
	Insider selling	Insider purchase	SEO	Open market repurchases
Intercept	-0.191	0.091	-0.143	0.007
	(0.01)	(0.36)	(0.31)	(0.96)
Above-optimal dummy t-1	0.014	-0.025	0.029	-0.012
	(0.04)	(0.01)	(0.07)	(0.09)
Size change	0.035	-0.064	0.056	-0.046
	(0.07)	(0.06)	(0.18)	(0.03)
Cash flow change	0.069	0.071	0.137	0.078
	(0.19)	(0.36)	(0.45)	(0.19)
Sales growth change	0.032	0.078	-0.047	0.039
	(0.20)	(0.03)	(0.41)	(0.10)
Property, plant and equipment change	0.016	0.031	-0.053	-0.005
	(0.52)	(0.21)	(0.13)	(0.87)
R&D change	0.016	-0.094	-0.017	-0.056
	(0.77)	(0.34)	(0.89)	(0.26)
Earnings volatility change	0.264	0.635	-0.788	-0.234
	(0.01)	(0.01)	(0.03)	(0.09)
Sales volatility change	0.005	0.014	-0.065	0.027
	(0.89)	(0.75)	(0.47)	(0.40)
Run-up	0.008	-0.028	-0.064	0.001
	(0.37)	(0.07)	(0.01)	(0.96)
Size t-1	0.005	-0.002	0.012	0.0002
	(0.01)	(0.60)	(0.09)	(0.94)
Cash flow t-1	-0.040	0.221	-0.245	-0.023
	(0.38)	(0.02)	(0.13)	(0.88)
Sales growth t-1	0.015	0.075	-0.187	0.029
	(0.61)	(0.07)	(0.01)	(0.41)
R&D t-1	0.007	-0.092	-0.055	0.011
	(0.75)	(0.01)	(0.30)	(0.55)
Earnings volatility t-1	0.019	0.598	-0.109	-0.014
	(0.81)	(0.01)	(0.68)	(0.91)
Leverage t-1	-0.034	0.051	-0.022	-0.027
	(0.21)	(0.14)	(0.70)	(0.46)
Cash holdings t-1	0.046	0.057	0.051	0.033
	(0.03)	(0.26)	(0.45)	(0.27)
Inverse Mills ratio	0.034	-0.025	-0.062	0.009
	(0.04)	(0.27)	(0.03)	(0.89)
Adjusted R-square	0.03	0.08	0.08	0.01

Table 10
Deviation from optimal CEO ownership and abnormal return around insider selling: Robustness check

This table reports the regressions about the deviation from optimal CEO ownership and abnormal return around insider selling. We examine 1266 events of insider selling. Abnormal return is calculated as the cumulative abnormal return by using the market model with the CRSP equally weighted index as the market return. Abnormal return for insider selling is calculated by using the window of (-5, +10) days around the date that the transaction is reported to the SEC. Above-optimal dummy t-1 is one if actual CEO ownership is greater than optimal CEO ownership in the year t-1, and is zero otherwise. Size is the natural logarithm of the book value of assets. Cash flow is the ratio of income before extraordinary items to assets. Sales growth is the growth rate of sales, calculated as the change in sales divided by the level of sales in the previous year. Plant, property and equipment is the ratio of PPE to assets. R&D and advertising is the ratio of the sum of research and development expenses plus advertising expenses, divided by total expenses. Earnings volatility is the standard deviation of the ratio of income before extraordinary items to assets in the prior three years. Sales volatility is the standard deviation of the natural logarithm of sales in the prior three years. Run-up is the sum of the firm's monthly return in the interval -6 to -1 months. Leverage is the ratio of long-term debt to assets. Cash holdings are the ratio of cash and marketable securities to assets. Option exercise dummy is one if insider selling is associated with option exercises, and is zero otherwise. Inverse Mills ratio is obtained from the first stage of the Heckman two-stage estimation, which is reported in Table 8. The p-value is noted in brackets.

	Abnormal return	
	Insider selling	Insider selling
Intercept	-0.092	-0.203
	(0.03)	(0.01)
Above-optimal dummy t-1	0.011	0.013
	(0.07)	(0.06)
Size change	0.028	0.035
	(0.10)	(0.07)
Cash flow change	0.077	0.072
	(0.11)	(0.18)
Sales growth change	0.024	0.032
	(0.28)	(0.20)
Property, plant and equipment change	0.026	0.015
	(0.26)	(0.57)
R&D change	0.019	0.016
	(0.72)	(0.78)
Earnings volatility change	0.257	0.273
	(0.01)	(0.01)
Sales volatility change	0.001	0.003
	(0.98)	(0.95)
Run-up	0.008	0.009
	(0.30)	(0.28)
Size t-1	0.004	0.006
	(0.04)	(0.01)
Cash flow t-1	-0.020	-0.040
	(0.63)	(0.39)
Sales growth t-1	-0.006	0.013
	(0.81)	(0.66)
R&D t-1	-0.014	0.013
	(0.38)	(0.59)
Earnings volatility t-1	-0.006	0.034
	(0.94)	(0.66)
Leverage t-1	-0.026	-0.029
	(0.29)	(0.29)
Cash holdings t-1	0.035	0.045
	(0.06)	(0.03)
Option exercise dummy	-0.010	-0.012
	(0.09)	(0.07)
Inverse Mills ratio		0.034
		(0.05)
Adjusted R-square	0.03	0.03