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CEO discretionary power, unconstrained stock ownership, and stock trading: Theory and evidence☆

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ABSTRACT

This paper examines CEOs' holding and trading of unconstrained firm stock they own, i.e., vested and sellable firm shares. I first develop a theoretical model of why CEOs hold sellable shares in their own firm when doing so is riskier than holding a more diversified portfolio. In this model, greater stock ownership allows the CEO to exercise discretionary power more easily and extract rents from the company. My model predicts that CEOs desire to hold more firm stock and therefore are less likely to sell stock when they have greater discretionary power. This empirical prediction is supported by tests that measure discretionary power based on the principal component analysis of three proxies. Using stock trading data in S&P 1500 firms, I find that discretionary power is negatively (positively) associated with the CEO's stock sale (purchase). The results are weaker in industries where rent extraction is more difficult. Further, results hold for both founder and non-founder CEOs, and are robust to a battery of sensitivity tests. Overall, this study provides new insights concerning CEOs' decisions to own their companies' stock.

1. Introduction

CEOs commonly hold much more stock in their own firm than they are required to hold (Armstrong, Core, & Guay, 2015; Core & Guay, 2010) that represents a significant portion of their wealth.[1] For example, my sample CEOs in S&P 1500 firms between 1996 and 2014 on average (at the median) hold stock they are free to sell with a value of $40.5 ($5.7) million. Holding large amounts of unconstrained stock in the CEO's own firm may appear to be suboptimal because of the associated risk of holding an undiversified portfolio. If investors believe that the CEO will hold unconstrained stock and exert the corresponding higher level of effort, the firm's equilibrium stock price will reflect these expectations and be at a relatively higher point. However, faced with such stock price, the risk-averse CEO would have incentive to sell all of his[2] unconstrained stock in exchange for a diversified portfolio and reduce effort. Therefore, there must be other mechanisms that reward the CEO for unconstrained stock ownership.

My investigation of the CEO's decision to hold unconstrained stock is a two-step process. My first step is to analyze a theoretical model of conditions under which a CEO would voluntarily hold his own firm's stock that has no sale restriction. Based on this model, I then generate the empirical prediction regarding the CEO's stock trading. My second step is to conduct tests of the empirical prediction.

My one-period theoretical model considers a manager endowed with

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[1] Although CEOs' personal wealth is typically undisclosed, the literature generally agrees that a large fraction of a CEO's wealth is invested in his own firm through holding stock and options. Becker (2006) provides some statistics for the composition of CEO wealth in Sweden, where the disclosure of personal wealth is mandatory. He shows that in 1999 Swedish CEOs' median firm (non-firm) wealth is 5.4 (2.7) million SEK, suggesting that about 2/3 of these CEOs' wealth is related to their own firm.

[2] For expositional simplicity, throughout this paper I assume the CEO/manager is male.

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a certain fraction of the firm's unconstrained stock that he is free to sell in a stock market. The firm offers the manager a contract comprised of salary and an additional fraction of the firm that he is constrained to hold until the end of the period. Once he accepts the contract, the manager simultaneously decides the fraction of unconstrained stock to hold and the level of effort to exert, where this effort positively affects expected firm value at the end of the period. My model also considers the manager's benefit of holding unconstrained stock through extracting rents from the firm, which is a function of the manager's discretionary power and voting power based on retained unconstrained stock ownership.

In this environment, I demonstrate that the manager's decision to hold unconstrained stock is a tradeoff between the risk-aversion cost of holding stock and the benefit of rent extraction through the combination of discretionary power and stock ownership. The manager's equilibrium stock holding strategy is to sell a fraction of unconstrained stock that is a function of parameters related to risk aversion and rent extraction. If the rent-extraction benefit of holding stock through exercising discretionary power is higher (lower) relative to the cost due to risk aversion, the manager will hold more (less) unconstrained stock. Based on my theoretical model, I predict that a CEO will be less likely to sell stock when he has greater discretionary power.

The second part of my study provides empirical evidence consistent with my prediction. My empirical tests are based on a sample of CEOs from S&P 1500 firms between 1996 and 2014. I treat my sample CEOs' vested stock as unconstrained. CEOs in my sample hold vested stock with an average (median) dollar value of $40.5 ($5.7) million, equivalent to 1.92% (0.28%) of the firm's total shares. I measure the CEO's discretionary power by the principal component analysis of three proxies: (1) firm stock not owned by institutions (non-institutional ownership), (2) whether the CEO also holds the "Chairman" title, and (3) the fraction of the firm's board directors who are not independent. I then examine the relation between the computed composite discretionary power measure and the CEO's stock trading activity, including stock sale, stock purchase, and the net sale. My regression model includes firm-CEO fixed effect to control for time-invariant unobservables in the contracting environment between the firm and the CEO. I find that CEOs with greater discretionary power sell less and buy more firm stock. The magnitude of this effect is economically significant. For example, a one standard deviation increase in the discretionary power measure is associated with a 1.54% decrease in the fraction of vested stock that the CEO sells, equivalent to 35% of the baseline mean selling fraction at 4.4%.

To corroborate my findings, I perform additional empirical tests. First, I consider the impact of the firm's industry. Firm decisions that the CEO can make will be more limited in some industries due to government regulation and product market competition, leaving less opportunity for rent extraction. Thus, I expect the relation between discretionary power and stock trading to be weaker in these industries. Consistent with my expectation, my main results hold only for firms in non-regulated industries and less competitive industries. Second, I consider the special group of founder CEOs. I find that founder CEOs commonly own more firm stock and sell stock more frequently. Further, my main results hold for both founder and non-founder CEOs. And some evidence supports a more important role of discretionary power in founder CEOs' stock trading decisions. Finally, sensitivity tests suggest that my main results are robust to using alternative measures of stock trading activity and discretionary power, the results hold in periods of booming and non-booming stock market, and are robust to the consideration of some firms' minimum stock holding requirements for the CEO.

This study contributes to the literature in three ways. First, my study adds to the literature on the determinants of managers' decisions to hold unconstrained equity. Prior literature is relatively silent about why CEOs voluntarily hold large amounts of unconstrained equity that is clearly riskier than a well-diversified portfolio. One notable attempt to address this issue is Armstrong et al. (2015). They argue that implicit agreements between the board and the CEO could be the reason for the CEO's retention of unconstrained equity.[3] Jin and Kothari (2008) show that managers hold stock due to the burden to pay personal taxes for stock selling. Fabisik (2019) finds that some CEOs hold firm stock and use it as the collateral for personal loans. I provide an additional explanation for CEOs' stock holding decision. That is, to exercise their discretionary power and benefit themselves through rent extraction. My explanation also differs from that in Blonski and von Lilienfeld-Toal (2018), who derive an equilibrium in which the stock price is intentional set below a certain level to induce the manager to always hold unconstrained stock and to exert high effort. Their explanation relies on the existence of a large blockholder or coordination among investors. My explanation does not have these limitations and can be applied to a larger group of companies.

Second, this study provides an alternative view for the CEO's stock ownership. Traditionally, CEO stock ownership is viewed by the accounting and finance literature as an alignment between incentives of shareholders and the CEO (for example, Core & Guay, 1999; Kale, Reis, & Venkateswaran, 2009). However, my theoretical model and empirical results suggest that stock ownership could also help the CEO build up power. This is consistent with Finkelstein's (1992) view of stock holding as "ownership power" in the management literature.[4] Note that my sample includes both founder and non-founder CEOs. It appears that CEOs at various levels of stock ownership can gain power through retaining stock granted to them or even purchasing additional shares, especially when monitoring by institutions is weaker and when the CEO has more control of the board.

Finally, my study is related to the literature on insider trading. Prior studies on insider trading examine the information content of insiders' purchases and sales but do not address their decisions to hold stock. These studies assume that insiders' trading reveals information about the firm's fundamental value (for example, Fidrmuc, Goergen, & Renneboog, 2006; Lakonishok & Lee, 2001). In contrast, my analysis shows the manager could trade firm stock to balance the cost of holding existing ownership and the benefit of doing so.

Next, Section 2 provides prior literature and develops my theoretical model and empirical hypothesis; Section 3 describes my empirical sample and reports the results for my hypothesis testing; Section 4 provides results for additional empirical tests; Section 5 reports results for sensitivity tests; and Section 6 discusses the implications of my results and concludes.

2. Prior literature, theoretical model, and hypothesis

2.1. Prior literature

This study is first related to the literature that examines a CEO's sale of stock ownership. Some early studies examine CEO stock selling behavior and the reasons for the observed variation in this behavior. Ofek and Yermack (2000) examine managers' sale of vested restricted stock and stock acquired in exercising vested options during years 1995 to 1997. They find that executives often immediately sell the shares they convert from stock options. Also, managers with high stock ownership are more likely to sell restricted stock immediately after the vesting period, while low-ownership managers generally hold restricted stock longer after vesting. Jin and Kothari (2008) analyze the determinants of managers' decisions to sell their stock. They find that the tax burden from selling stock adversely affects stock selling. Prior literature also

[3] Although they do not provide explicit empirical evidence, Armstrong et al. (2015) argue that such implicit contracts might be reached through informal agreements between the board and the CEO.

[4] Finkelstein (1992) defines the CEO's power as having four dimensions: structural power, ownership power, expert power, and prestige power.

finds that CEOs tend to sell more of their firm's stock when recent stock returns are higher (Cheng & Warfield, 2005; Jin & Kothari, 2008).

Another stream of literature examines the link between CEOs' stock selling and earnings management. Cheng and Warfield (2005) examine the effect of equity incentives on the likelihood of reporting earnings that meet or just beat analysts' forecasts. They find that managers with high equity incentives subsequently sell larger amounts of stock. They further find that managers' ownerships of stock and unexercisable stock option are positively related to abnormal accruals and meeting/beating analysts' forecasts. McVay, Nagar, and Tang (2006) find that managers sell more shares subsequent to meeting and beating analysts' forecasts.

An emerging literature attempts to explain why managers voluntarily hold unconstrained equity. Armstrong et al. (2015) find that on average more than half of a CEO's equity holdings are unconstrained. The decision to hold unconstrained equity is puzzling because the manager bears the largely undiversified risk related to these holdings. Thus, if the firm's stock price incorporates the expected level of the manager's future productive effort, the manager could opportunistically sell these holdings and then exert minimum effort.

In this literature, some studies solve the puzzle through asset pricing models and show that one mechanism to ensure that the manager holds the firm's unconstrained stock and exerts effort is a rational equilibrium where the firm's stock price does not fully reflect the manager's future effort until it has been exerted (Blonski & von Lilienfeld-Toal, 2018; Gorton, He, & Huang, 2014). Consistent with this theory, von Lilienfeld-Toal and Ruenzi (2014) find that firms where the CEO has large ownership of vested stock earn positive future abnormal returns. Armstrong et al. (2015) empirically test various explanations for CEOs' holdings of large amounts of unconstrained equity and find that some of the CEO's unconstrained equity holdings might actually be constrained, and that the CEO's risk aversion and tax burden only provide limited explanation for the holdings. Hong (2017) analyzes a theoretical model in an environment where stock price reflects the CEO's effort level, and the risk-averse and effort-averse CEO simultaneously makes decisions on his effort level and whether to hold or sell all unconstrained stock. The study demonstrates that without other forces, the CEO's equilibrium stock holding decision is a mixed strategy that randomizes between holding and selling all unconstrained stock.[5] Fabisik (2019) finds that some CEOs hold firm stock in order to use it as the collateral for a personal loan.

This paper is also related to the literature that examines consequences of the CEO's discretionary power. Delegation of decision rights is a natural outcome of decentralization. CEOs, at the top of their firms' hierarchy, are given the power to make many corporate decisions. They normally exercise discretionary power through project selection and participation of board decisions. Prior literature generally finds that excess CEO power is linked to weaker board monitoring, resulting in various types of rent extraction such as higher CEO pay, reduced CEO pay-performance sensitivity, lower likelihood of CEO turnover, and weaker audit committee effectiveness (Bebchuk, Fried, & Walker, 2002; Cohen, Frazzini, & Malloy, 2012; Coles, Daniel, & Naveen, 2014; Hermalin & Weisbach, 1998; Krause, Semadeni, & Cannella Jr, 2014; Lisic, Neal, Zhang, & Zhang, 2016; Westphal & Zajac, 1995 and Zajac & Westphal, 1996).

In this study, I examine how the CEO's ability to exercise discretionary power and extract rents is related to his decision to hold unconstrained firm stock. In Section 2.2 I analyze a theoretical model of conditions under which the CEO would voluntarily hold his unconstrained stock ownership. In Section 2.3 I provide comparative statics from my model and generate the empirically testable hypothesis, which I test in Section 3.

2.2. Theoretical model

My one-period model uses the classic LEN (Linear compensation, negative Exponential utility, and Normally distributed performance measures) framework to analyze the effect of the manager's effort choice on firm outcome, but departs slightly in defining the manager's utility function to incorporate the multiplicative effects of managerial effort and the manager's relative risk aversion. The model also incorporates a stock market in which the manager can sell his stock.

A manager with outside wealth of w_0 manages a firm. The manager owns a fraction $\alpha > 0$ of the firm's stock that is vested and unconstrained from sale restriction.[6] In other words, the manager is free to sell his α ownership. The manager's compensation consists of a fixed salary $s \geq 0$ plus an additional fraction β of the firm's stock granted at the beginning of the period, where β vests and becomes unconstrained at the end of the period. This means the manager must hold the fraction β of firm stock during the period. Throughout the model I use terms "vested" and "unconstrained" interchangeably when referring to the manager's fractional ownership α, and "unvested" and "constrained" interchangeably for his fractional ownership β.

The manager chooses a private productive effort, e, at the beginning of the period that will affect the value of the firm's assets. With the manager's effort, the firm's value at the end of the period will be $e + \delta$, where e is the manager's effort exerted at beginning of the period, and δ is a random noise, $\delta \sim N(0,\sigma^2)$.[7]

At the same time as choosing his effort, the manager chooses a fraction $\theta \in [0,1]$ of his α vested stock to continue to hold until the end of the period. That is, among the α unconstrained share of the firm, the manager sells $(1-\theta)\alpha$ and continues to hold $\theta\alpha$. The manager keeps the proceeds of selling his fraction $(1-\theta)\alpha$ of the firm's stock as cash through the end of the period. In other words, outside investment opportunities provide a zero rate of return. At the end of the period, the firm liquidates, and the manager receives his remaining $\theta\alpha$ unconstrained share and the newly vested β share of the firm's assets in cash.

Immediately after the effort and stock selling decisions, the manager takes a rent-extraction action r to benefit himself at the expense of other shareholders.[8] This action needs approval from the firm and its chance of approval is positively related to the manager's voting power as reflected in his unconstrained stock ownership $\theta\alpha$.[9] If approved, manager's wealth will increase by r while the firm's value will decrease by r. Factor r captures the manager's discretionary power in the firm. For example, r

[5] The reason why selling all unconstrained stock can't be the equilibrium is because the stock market would set a price to reflect the CEO's low effort, inducing the CEO to hold stock instead and exert higher effort to benefit from the future increase in stock price.

[6] Throughout the model, I treat the firm as having one share and each shareholder owns a fraction of this share. As a result, the firm's stock price is the same as its total market value.

[7] Apart from the information advantage regarding his own effort level, the manager might also have additional private information about the true value of the company, i.e., the realization of δ. Thus, the manager's stock holding decision could also be an action to signal firm value (Fan, 2007; Leland & Pyle, 1977). However, modeling signaling normally requires discrete firm outcomes, which is difficult to incorporate into my model where the firm's outcome is continuous. Moreover, the two types of information asymmetry may interact and make the model intractable. As such, my model focuses on only one type of information asymmetry, the unobservable managerial effort, and assumes the manager does not have additional private information about firm value. Although analytically challenging to incorporate both types of private information, my empirical analysis later in this paper uses future stock return to control for the manager's signaling incentives.

[8] Examples of such rent extraction in the real world are: (1) the purchase of corporate jets that only benefits the manager, (2) the influence of the CEO over the compensation committee to give himself extra pay, and (3) the appointment of a director who is the CEO's friend and who will approve his future proposals.

[9] Because fraction β ownership has not vested, only the manager's holding of unconstrained stock, $\theta\alpha$, has voting power.

Table 1
Notation used in the model.

α	The manager's unconstrained ownership of the firm at the beginning of the period.
β	Constrained ownership that the firm grants to the manager at the beginning of the period, which vests at the end of the period.
θ	The fraction of unconstrained ownership that the manager holds until the end of the period.
δ	Random noise of the manager's production outcome, $\delta \sim N(0,\sigma^2)$.
ρ	The manager's factor of relative risk aversion.
τ	The manager's constant absolute risk aversion, $\tau = \rho / w_0$.
$c(e)$	Cost of effort, $c(e) = w_0 e^2/2$.
e	The manager's effort, exerted at the beginning of the period.
f	Wealth factor, $f = 1 + w_f / w_0 - e^2/2$.
$G(f)$	The manager's utility, $G(f) = -exp(-\rho f)$.
P	The firm's stock price at the beginning of the period.
r	The manager's rent-extraction factor that reflects his discretionary power beyond stock ownership.
s	The manager's salary, paid at the beginning of the period.
$U(w)$	The manager's utility, $U(w) = -exp(-\tau w)$.
w	The manager's firm-related wealth at the end of the period net of cost of effort.
w_a	The pay of the manager's outside alternative job that requires no effort.
w_f	The manager's firm-related wealth.

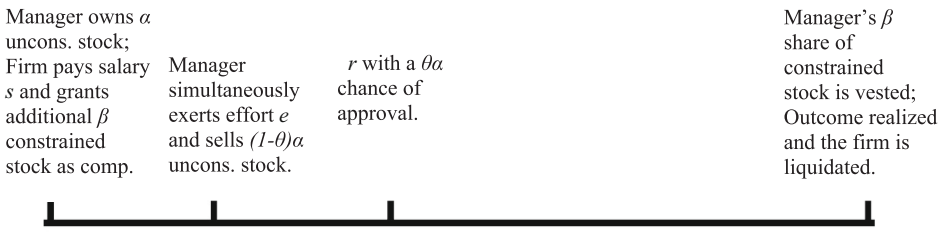

Fig. 1. Timeline of the model.

will be greater if the firm has weaker board oversight. Thus, the expected rent-extraction wealth transfer from the firm to the manager is $\theta\alpha r$, the product of the manager's voting power $\theta\alpha$ and rent extraction factor r.

The manager's utility is $U(w)$, where w is the manager's wealth at the end of the period net of his cost of productive effort $c(e)$. I assume the cost of effort has a quadratic functional form and follow Edmans, Gabaix, and Landier (2009) to model the manager's cost of effort as multiplicative in his outside wealth, $c(e) = w_0 e^2/2$.[10] Therefore, $w = w_0 + w_f - w_0 e^2/2$, where w_f is the manager's wealth related to the firm. The manager's utility is given by $U(w) = -\exp(-\tau w)$, where τ is the factor of constant absolute risk aversion. I follow Baker and Hall (2004) and assume that the manager's absolute risk aversion is a function of his outside wealth, $\tau = \rho/w_0$, where risk aversion factor ρ applies to all managers.[11] Thus $U(w) = -exp(-\rho w/w_0)$. Denote $f = w/w_0 = 1 + w_f/w_0 - e^2/2$ as the manager's wealth factor and rewrite the manager's utility as $U(w) = G(f) = -exp(-\rho f)$. Table 1 provides all notation used in my model and Fig. 1 provides a timeline of the model.

I solve my model assuming rational expectations of the stock market and the manager. Taking the firm's contract (s, β) as given, the firm's stock price P at the beginning of the period reflects shareholders' expectations of the manager's stock selling decision, θ, and his choice of effort level, e. In response to the firm's beginning stock price P, the manager chooses the levels of effort and stock sale, e and θ, to maximize his expected utility.[12]

In this setting, the manager's firm-related wealth at the end of the period, w_f, will have the following four components: (1) salary, s, (2) expected wealth transfer from the firm that only benefits the manager, $\theta\alpha r$, (3) cash proceeds from selling stock at the beginning of the period, $(1-\theta)\alpha P$, and (4) the manager's share of the firm's net assets at the end of the period when the firm liquidates, $(\theta\alpha + \beta)(e + \delta - s - \theta\alpha r)$. Thus, the manager's firm wealth w_f and wealth factor f as functions of effort e and stock holding decision θ, while taking stock price P and contract (s, β) as given, are

$$w_f(e,\theta|P,s,\beta) = s + \theta\alpha r + (1-\theta)\alpha P + (\theta\alpha+\beta)(e+\delta-s-\theta\alpha r)$$

and

$$\begin{aligned} f(e,\theta|P,s,\beta) &= 1 + \frac{w_f}{w_0} - \frac{e^2}{2} \\ &= 1 + \frac{s}{w_0} + \frac{\theta\alpha r}{w_0} + \frac{(1-\theta)\alpha P}{w_0} + \frac{(\theta\alpha+\beta)(e+\delta-s-\theta\alpha r)}{w_0} - \frac{e^2}{2} \end{aligned} \tag{2.1}$$

The manager's objective is to maximize his utility, $G(f)$. Because $G(f) = -exp(-\rho f)$ and $\delta \sim N(0,\sigma^2)$, the manager maximizes his certainty equivalent for $f(e, \theta\,|P, s, \beta)$, given by

$$\begin{aligned} CE(e,\theta|P,s,\beta) = 1 &+ \frac{s}{w_0} + \frac{\theta\alpha r}{w_0} + \frac{(1-\theta)\alpha P}{w_0} + \frac{(\theta\alpha+\beta)(e-s-\theta\alpha r)}{w_0} \\ &- \frac{e^2}{2} - \frac{(\theta\alpha+\beta)^2\sigma^2\rho}{2{w_0}^2} \end{aligned} \tag{2.2}$$

Proposition 1. Given stock price P and contract (s, β), there exists an

[10] Similar to Edmans et al. (2009), I treat the private benefit of shirking as a normal good. Edmans et al. (2009) argue that while leisure time remains constant, the value of leisure increases with the manager's wealth.

[11] This assumes that a manager with higher outside wealth, while still having constant absolute risk aversion, has a relatively lower degree of risk aversion when compared to a manger with lower outside wealth. This assumption allows me to stick to the convenient LEN framework while at the same time consider the effect of relative risk aversion. Under this utility function, the manager makes decisions to maximize the utility from the *percentage* change in his total wealth relative to his initial outside wealth, net of the cost of effort.

[12] This study focuses on the manager's actions and takes his initial unconstrained stock ownership and contract (s, β) as given. An extension of this model will include the firm's selection of contract parameters s and β that reflects its equilibrium expectations of e, θ, and P.

optimal unconstrained stock holding strategy θ* ∈ [0,1] that maximizes the manager's expected utility.

Proof: Suppose a pure strategy equilibrium exists in which the manager chooses a combination of stock holding fraction θ^* and effort level e^*, given stock price P and contract (s, β). From the manager's perspective, in equilibrium the following two inequalities must hold:

$$CE\ (e^*, \theta^* \mid P, s, \beta) \geq \mathrm{CE}\ (e', \theta^* \mid \mathrm{P}, \mathrm{s}, \beta), \forall e' \neq e^* \tag{2.3}$$

$$CE\ (e^*, \theta^* \mid P, s, \beta) \geq \mathrm{CE}\ (e', \theta' \mid \mathrm{P}, \mathrm{s}, \beta), \forall e', \theta' \tag{2.4}$$

Inequality (2.3) must hold because otherwise the manager would not choose $e = e^*$, given P, s, β and θ^*. Inequality (2.4) ensures that the manager is always better off by choosing the equilibrium holding strategy of θ^* and exerting e^*, as opposed to choosing any other combination of θ and e.

From (2.2) and (2.3),

$$\mathrm{e}^* = \mathrm{argmax}_{\mathrm{e}}\ \mathrm{CE}(\mathrm{e} \mid \mathrm{P}, \theta^*, \mathrm{s}, \beta) = \frac{\theta^*\alpha + \beta}{\mathrm{w}_0} \tag{2.5}$$

Now turn to (2.4), which states that given P and (s, β), the manager's choice of combination (e^*, θ^*) is the combination among all possible combinations of (e, θ) that gives him maximal expected utility. Following the same logic as (2.3) and (2.5), for any $\theta^{\sim} \in [0,1]$, the effort that maximizes the manager's expected utility is $e^{\sim} = \frac{\theta^{\sim}\alpha+\beta}{w_0}$. Thus (2.4) can be rewritten as.

$$CE\ (\theta^* \mid P, e^*, s, \beta) \geq \mathrm{CE}\ (\theta^{\sim} \mid \mathrm{P}, \mathrm{e}^{\sim}, \mathrm{s}, \beta), \forall \theta^{\sim} \tag{2.6}$$

In other words, the optimal θ^* should maximize the manger's certainly equivalent among all possible values of $\theta^{\sim}$ and the corresponding utility-maximizing $e^{\sim}$ given $\theta^{\sim}$. Substituting for $e^{\sim} = \frac{\theta^{\sim}\alpha+\beta}{w_0}$ and after some algebra, the certainty equivalent in (2.2) for $\theta^{\sim}$ and $e^{\sim}$ becomes

$$CE\ (\theta^{\sim} | P, e^{\sim}, s, \beta) = 1 + \frac{s}{w_0} + \frac{\theta^{\sim}\alpha r}{w_0} + \frac{(1-\theta^{\sim})\alpha P}{w_0} - \frac{(\theta^{\sim}\alpha+\beta)(s+\theta^{\sim}\alpha r)}{w_0} + \frac{(\theta^{\sim}\alpha+\beta)^2(1-\sigma^2\rho)}{2{w_0}^2} \tag{2.7}$$

The first order derivative of $CE\ (\theta^{\sim} \mid P, e^{\sim}, s, \beta)$ with respect to $\theta^{\sim}$ when valued at θ^* is:

$$\left.\frac{\partial CE\ (\theta^{\sim}|P, e^{\sim}, s, \beta)}{\partial \theta^{\sim}}\right|_{\theta^{\sim}=\theta^*} = \frac{\alpha r}{w_0} - \frac{\alpha P}{w_0} - \frac{\alpha s}{w_0} - \frac{2\theta^*\alpha^2 r + \alpha r\beta}{w_0} + \frac{\alpha(\theta^*\alpha+\beta)(1-\sigma^2\rho)}{{w_0}^2} \tag{2.8}$$

Further, with $\theta = \theta^*$ and $e = \frac{\theta^*\alpha+\beta}{w_0}$ being the equilibrium, the firm's stock price will be the expected firm value from the manager's effort, net of his salary and the expected wealth transfer related to rent extraction: $P = e^* - s - \theta^*\alpha r = \frac{\theta^*\alpha+\beta}{w_0} - s - \theta^*\alpha r$. Substituting for this stock price and after some algebra, (2.8) becomes

$$\left.\frac{\partial CE\ (\theta^{\sim}|P, e^{\sim}, s, \beta)}{\partial \theta^{\sim}}\right|_{\theta^{\sim}=\theta^*} = \frac{\alpha r(1-\theta^*\alpha-\beta)}{w_0} - \frac{\alpha(\theta^*\alpha+\beta)\sigma^2\rho}{{w_0}^2} \tag{2.9}$$

(2.9) reflects the manager's marginal net benefit from holding more unconstrained stock. The first term in (2.9), $\frac{\alpha r(1-\theta^*\alpha-\beta)}{w_0}$, is the marginal benefit of holding stock through rent extraction at the expense of other shareholders. The second term, $-\frac{\alpha(\theta^*\alpha+\beta)\sigma^2\rho}{{w_0}^2}$, is the manager's cost of holding stock due to risk aversion. Depending on the values of r, σ, and ρ, the optimal total stock holding, $\theta^*\alpha + \beta$, will take one of three forms.

Case 1: when r is sufficiently high or $\sigma^2\rho$ is sufficiently low, (2.9) will always be positive, leading θ^* to take its largest possible value of 1. In other words, the benefit of holding unconstrained stock through rent extraction will always exceed the cost of holding the firm's risky unconstrained stock when (1) the manager's discretionary power is sufficiently high, when (2) the firm's outcome volatility is sufficiently low, or when (3) the manager's risk-aversion is sufficiently low. The manager's optimal strategy will be holding all unconstrainted stock ($\theta^* = 1$ and total stock held is $\alpha + \beta$).

Case 2: when r is sufficiently low or $\sigma^2\rho$ is sufficiently high, (2.9) will always be negative, leading θ^* to take its smallest possible value of 0. In this case, the cost of holding unconstrained stock due to the manager's risk aversion will always exceed the rent-extraction benefit of doing so. The manager's optimal strategy will be selling all unconstrainted stock ($\theta^* = 0$ and total stock held is β).

Case 3: when r and $\sigma^2\rho$ take values such that first order condition (2.9) = 0 can hold, then an optimal stock holding strategy $\theta^* \in (0,1)$ will maximize the manager's expected utility. This is because the second order derivative of $CE\ (\theta^{\sim} \mid P, e^{\sim}, s, \beta)$ is always negative:

$$\frac{\partial^2 CE\ (\theta^{\sim}|P, e^{\sim}, s, \beta)}{\partial {\theta^{\sim}}^2} = -\frac{r\alpha^2}{w_0} - \frac{\alpha^2\sigma^2\rho}{{w_0}^2} < 0$$

Solving (2.9) = 0, the manager's optimal total stock ownership is

$$\theta^*\alpha + \beta = \frac{r}{r + \sigma^2\rho/w_0} \tag{2.10}$$

In other words, the manager's optimal total stock ownership is a function of rent extraction factor r and risk-aversion factor $\sigma^2\rho/w_0$.

2.3. Empirical hypothesis

This section provides comparative static results and the empirical hypothesis in the context of a CEO's decision to sell unconstrained stock. From (2.10), the optimal fraction of unconstrained stock that the manager will *sell* is

$$\theta^* = 1 - \frac{1}{\alpha}\left(\frac{r}{r + \sigma^2\rho/w_0} - \beta\right)$$

The first order derivative of the fraction to sell, $1 - \theta^*$, with respect to the manager's discretionary rent extraction power, r, is

$$\frac{\partial(1-\theta^*)}{\partial r} = -\frac{\sigma^2\rho}{\alpha w_0 (r + \sigma^2\rho/w_0)^2} < 0$$

Thus, for equilibrium values of $\theta^* \in (0,1)$, the increase of r will result in the manager selling less unconstrained stock. For the two other cases of optimal θ^* at the boundary of 0 or 1, as r increases, the rent-extraction benefit of holding all constrained stock will be more likely to exceed the risk-aversion cost of doing so (case 1 in the proof for Proposition 1 where $\theta^* = 1$), again leading to the manager's decision to hold more unconstrained stock and sell less stock. Again, the main driver of the CEO's decision to hold stock in my theoretical model is the opportunity to extract rents from the firm at the expense of other shareholders. When the CEO has greater discretionary power to complement his voting power from unconstrained stock ownership, holding stock becomes a more appealing option because it provides greater marginal benefit of rent extraction relative to the cost of under-diversification. Taken together, my empirical hypothesis is:

H1. The greater the CEO's discretionary power, the less likely he is to sell stock.

3. Empirical evidence

3.1. Empirical research design, measurement of variables, and data source

I test H1 using the OLS regression model in Eq. (3.1).

$$\begin{aligned} DepVar = &\beta_0 + \beta_1\, DiscPower + \beta_2\, Options + \beta_3\, NewVestedStk \\ &+ \beta_4\, TaxRate + \beta_5\, FutureRet + \beta_6\, AROA + \beta_7\, Return + \beta_8\, Size \\ &+ \beta_9\, Volatility + \beta_{10}\, MtB + \beta_{11}\, Leverage + \beta_{12}\, PaySlice \\ &+ \beta_{13}\, Log(Tenure) + \beta_{14}\, Log(Age) + Year\ fixed\ effect \\ &+ Firm - CEO\ fixed\ effect + \varepsilon \end{aligned} \tag{3.1}$$

The dependent variables are the six measures of the CEO's stock trading activity. First, *SalePer* is the fraction of vested stock that the CEO sells in a year.[13] This is calculated as shares sold divided by total available shares of vested stock. I obtain the CEO's stock selling transactions from *Thomson Reuters Insider Filing* data. I exclude stock sales that occur within the (−1 day, +1 day) window of stock option exercises because the involved shares are newly obtained in option exercises while my study concerns the CEO's selling decisions on stock directly granted by the firm. Data of CEOs' vested stock is from *ExecuComp*. I calculate total available vested stock as the sum of vested stock at the beginning of the year and stock newly vested during the year. Prior to 2006, companies do not disclose the number of newly vested shares. In these years, I infer newly vested shares using the following equation: *Beginning restricted shares* + *Newly granted restricted shares* – *Newly vested shares* = *Ending restricted shares*.

The second measure of the CEO's stock trading decision is *BuyPer* that measures the CEO's stock purchase activity. Stock purchase is a type of frequently observed insider trading activity (Lakonishok & Lee, 2001). Consistent with the rationale of holding stock, incorporating stock purchase into my theoretical model will lead to the prediction that more stock purchase occurs when the CEO has greater discretionary power.[14] *BuyPer* is calculated as the number of firm shares the CEO purchases during the year divided by the CEO's total available vested shares. The third dependent variable, *NetSalePer*, measures the CEO's net stock selling activity and is calculated as *SalePer* – *BuyPer*. Using the linear probability regression model, the remaining three dependent variables, *Sale_Dum*, *Buy_Dum*, and *NetSale_Dum*, are indicator variables based on the first three measures of the CEO's trading activity.[15] They take the value of one when the corresponding percentage measure is positive, and zero otherwise.

The main test variable in (3.1) is *DiscPower*, the CEO's discretionary power. Based on H1, I expect the coefficient for *DiscPower* to be negative for dependent variables *SalePer*, *NetSalePer, Sale_Dum*, and *NetSale_Dum*, and positive for *BuyPer* and *Buy_Dum*. I measure *DiscPower* based on the principal analysis of three proxies related to the CEO's power of making discretionary decisions. First, institutional ownership has been shown by the prior literature as a monitoring mechanism that mitigates the CEO's myopic behavior (Bushee, 1998) and is a proxy of *lower* CEO discretionary power. Thus, I first use *NonInstOwn* (non-institutional ownership, i.e., percent of firm shares not owned by institutions), calculated as one minus the company's institutional ownership based on *Thomson Reuters Institutional Holdings* (13f) data, to proxy the CEO's discretionary power. My second and third proxies, *Chairman* and *PerNonInd*, capture the CEO's discretionary power toward board decisions. *Chairman* is based on CEO duality, i.e., whether (*Chairman* = 1) or not (*Chairman* = 0) the CEO's title in *ExecuComp* suggests that he is also the chairman of the board. *PerNonInd* is the percentage of the firm's non-independent directors, calculated as the number of non-independent directors divided by board size. I obtain the information about director independence from *ISS* and supplement with *BoardEx* data when a firm match is not found in *ISS*.

Panel A of Table 2 reports summary statistics for each of the three discretionary power proxies in a sample of 17,469 firm-CEOs between

Table 2
CEO's discretionary power measure.

Panel A: Summary statistics for discretionary power proxies (17,469 Obs.)

	Mean	Median	Lower Quartile	Upper Quartile	Std. Dev.
NonInstOwn	0.302	0.278	0.151	0.432	0.196
Chairman	0.619	1.000	0.000	1.000	0.486
PerNonInd	0.278	0.250	0.143	0.375	0.161

Panel B: Correlation among proxies

	NonInstOwn	Chairman	PerNonInd
NonInstOwn	1.000	0.053 (<0.0001)	0.216 (<0.0001)
Chairman	0.067 (<0.0001)	1.000	−0.041 (<0.0001)
PerNonInd	0.198 (<0.0001)	−0.047 (<0.0001)	1.000

Panel C: Principal Component Analysis

	NonInstOwn	Chairman	PerNonInd
Loadings	0.784	0.044	0.775
Scores	0.645	0.036	0.637
Proportion explained	0.406		
Eigenvalue	1.216		

This table reports the measurement of CEO discretionary power through principal component analysis. The sample includes 17,469 firm-years between 1996 and 2014 in ExecuComp for whom all three proxies used in the analysis can be calculated based on available data. Panel A reports summary statistics of the three discretionary power proxies. Panel B reports Pearson (above the diagonal) and Spearman (below the diagonal) correlations among discretionary power proxies. Panel C reports results of the principal component analysis. Definitions for all variables are in Appendix A.

[13] My empirical tests treat a CEO's entire vested stock ownership as unconstrained. I make this choice for two reasons despite the recent trend in compensation practice involving companies adopting stock ownership policies to limit their executives' ability to cash out vested stock (Core & Larcker, 2002; Armstrong et al., 2015; Shilon, 2015;). First, companies that have a specified ownership policy often allow their executives to count time-vesting restricted stock toward the ownership requirement, which enables executives to unload virtually all vested shares given that they already hold large amounts of restricted stock (Equilar Inc, 2013; Shilon, 2015). Second, there is large variation in specific detail of these ownership policies and other firm-specific trade restrictions, which companies do not always fully disclose (Shilon, 2015). Including ownership requirement information is likely to introduce measurement errors that will add noise to my analysis. In Section 5, I recalculate percentage measures of stock trading using unconstrained stock after considering firm policies to hold additional stock to meet minimum stock holding requirements.

[14] This will relax the requirement that θ has an upper bound and allow it to take a value >1. The first case of the model's equilibrium will change to one where the manager purchases firm stock to balance the rent-extraction benefit and risk-aversion cost related to his existing unconstrained stock ownership and newly purchased stock. The manager will desire to purchase more stock when greater discretionary power makes owning stock more appealing.

[15] The linear probability model helps avoid the incidental parameters problem in nonlinear probit or logit models (Greene, 2004).

1996 and 2014 with non-missing values for all three proxies. In this sample, the mean (median) non-institutional ownership is 30.2% (27.8%), CEOs hold the "Chairman" title in 61.9% firm-years, and on average 27.8% board members are not independent. In Panel B, Pearson (above the diagonal) and Spearman (below the diagonal) correlations indicate significant positive correlations among the three proxies except for the small negative correlation between *Chairman* and *PerNonInd*. Panel C provides results for the principal component analysis. The identified component with the highest eigenvalue has an eigenvalue of 1.216 and explains 40.6% of the total variance. I then standardize each proxy to a mean of 0 and a standard deviation of 1, and create a composite *DiscPower* measure by summing the product of each proxy's standardized value with its score in Panel C. This measure assigns relatively more weight to *NonInstOwn* and *PerNonInd*, and less weight to *Chairman*.

Now turn to the control variables in Eq. (3.1). First, CEOs' option holdings represent a significant component of their equity ownership (Armstrong et al., 2015; Core & Guay, 2010; Hong, 2017). Thus, I include variable *Options* to control for the effect of options on the CEO's stock trading decisions. *Options* is calculated as the sensitivity of the CEO's vested and unvested options' Black and Scholes (1973) value to stock price, i.e., option delta, converted to a fraction of the firm (Murphy, 1999). Second, Jin and Kothari (2008) show that the CEO is less likely to sell stock when tax burden is greater. I consider this tax effect using two control variables. I first control for the CEO's newly vested stock (*NewVestedStk*) because when restricted stock vests, the CEO might need to exchange existing shares of firm stock for cash to pay income taxes for the vested shares. I also include variable *TaxRate* to measure the CEO's tax burden. *TaxRate* equals the CEO's combined federal and state income tax rates in the current year for long-term capital gains.

In addition, I include variable *FutureRet*, the company's average annual stock return in the subsequent three years, for two reasons. First, prior theoretical studies show that managers could retain stock ownership to signal private information regarding firm value (Fan, 2007; Leland & Pyle, 1977). Including *FutureRet* controls for the CEO's signaling incentives. Second, prior literature on insider trading suggests that managers might buy or sell firm stock to benefit from private information regarding future firm stock performance (Lakonishok & Lee, 2001; Lin & Howe, 1990 and Marin & Olivier, 2008). *FutureRet* controls for the CEO's informed trading. Both mechanisms predict a negative (positive) association between stock sale (purchase) and *FutureRet*.

I further control for firm and manager characteristics and fixed effects. I expect the coefficients for the firm's current-year industry-adjusted ROA and Stock Return to have a positive (negative) sign for stock sale (purchase) because prior literature shows that managers sell more stock in years of better performance (Cheng & Warfield, 2005; Jin & Kothari, 2008). Firm size, stock volatility, market to book, and leverage are included to control for the firm's contracting environment. CEO pay slice, tenure and age are included to account for the impact on stock trading from the CEO's specific characteristics. Finally, I include year fixed effect to control for time-varying patterns in stock trading and firm-CEO fixed effect to control for other unobservables in the contracting environment.[16] All variables are winsorized at the top and bottom 1 % to mitigate the impact of outliers. Definitions for all variables are provided in Appendix A.

3.2. Sample and summary statistics

The sample selection process is summarized in Table 3. I start from 24,823 S&P 1500 firm-year observations covered by *ExecuComp*, *CompuStat*, and *CRSP* between 1996 and 2014 that involve 5234 CEOs whose stock trading data is also available in *Thomson Reuters Insider Filing* data. From *ExecuComp* I collect information about the CEO's stock holdings. I exclude 1595 observations with a negative number of shares for vested stock, calculated by subtracting the number of unvested shares (*STOCK_UNVEST_NUM* in *ExecuComp*) from total number of shares the CEO owns (*SHROWN_EXCL_OPTS* in *ExecuComp*).[17] I next delete 4395 observations that are missing institutional ownership data and 1435 observations that are missing board independence data. Finally, I drop 3739 observations with missing control variables in my regression models. The final sample I use to test my hypothesis includes 13,659 observations that involve 3181 CEOs in 1951 firms in the period between 1996 and 2014.

Table 3
Sample selection process.

Firm-years covered by ExecuComp, CompuStat, and CRSP with a CEO whose trading data is also available in Thomson Reuters Insider Filing data	24,823
Less: firm-years where the CEO's calculated number of vested shares is negative	(1595)
Less: firm-years that are missing institutional ownership data	(4395)
Less: firm-years that are missing director independence data	(1435)
Less: firm-years with missing control variables	(3739)
Main sample for hypothesis testing	13,659

This table reports my sample selection process. Starting from 24,823 firm-years among S&P 1500 firms over the period between 1996 and 2014 that involve 5234 CEOs, I screen and identify 13,659 observations as the main sample for testing my hypothesis, which involve 3181 CEOs in 1951 firms over the period from 1996 to 2014.

Descriptive statistics for variables related to the CEO's stock trading are reported in Table 4, Panel A. The CEO's mean (median) available vested stock is 1.919% (0.281%) of the firm's total shares, with a dollar value of $40.456 ($5.678) million. Thus, over my sample period CEOs commonly hold large amounts of unconstrained firm stock. On average, CEOs sell stock infrequently. The mean fraction of vested stock sold by the CEO is 4.4% and the average net sale after considering stock purchase is 2.4% of available vested stock. In fact, stock selling transactions only occur in 21.4% firm-years in my sample according to indicator variable *Sale_Dum*. CEOs on average purchase stock equivalent to 2.0% of their holdings of vested shares and stock purchase occurs in 12.4% firm-years. Based on *NetSale_Dum*, CEOs have positive net sale of firm stock in 21.1% firm-years.

Panel B of Table 4 reports summary statistics for independent variables used in my regressions. *DiscPower*, the main measure of CEO discretionary power calculated based on principal component analysis in Table 2, has a mean (median) value of −0.053 (−0.200). For the control variables, the incentives provided by the CEO's stock options, measured by option delta, on average (at the median) are equivalent to 0.903% (0.562%) of the firm's total shares. The CEO's mean newly vested stock is 0.036% of the firm's total shares. The mean (median) combined federal and state capital gain tax rate is 22.457% (22.8%). The average CEO tenure and age are 8 years and 55.9, respectively. Table 5 provides correlations for all variables in my regression model, where Pearson correlations are above the diagonal and Spearman correlations are below the diagonal. Consistent with my prediction, *DiscPower* is negatively correlated with *SalePer*, *NetSalePer*, *Sale_Dum*, and *NetSale_Dum*, and positively correlated with *BuyPer* and *Buy_Dum*. In addition, an untabulated variance inflation factor (VIF) analysis shows that the VIFs across *DiscPower* and all control variables in model (3.1) are below 2, with a mean value of 1.24. Thus, multicollinearity does not appear to be

[16] For example, Armstrong et al. (2015) argue that firms might have implicit agreements with the CEO to require the CEO to hold additional shares, which are difficult to measure empirically but tend to be invariant across all years for each firm-CEO pair.

[17] These negative numbers might be due to the firm reporting vested stock ownership incorrectly as total ownership, the firm reporting the CEO's total ownership as of proxy statement date instead of year-end date, or data input error.

Table 4
Summary statistics.

Panel A. CEO trading activity

Variable	Mean	Median	Q1	Q3	Min	Max	Std. Dev.
Vested Stock as % firm shares	1.919%	0.281%	0.086%	1.079%	0	31.966%	4.847%
Vested Stock ($000 s)	40,456	5678	1728	19,864	0	1,032,239	130,921
Stock sale as % firm shares	0.047%	0	0	0	0	1.817%	0.194%
Stock purchase as % firm shares	0.007%	0	0	0	0	0.286%	0.033%
SalePer (Sale / Vested Stk.)	0.044	0	0	0	0	0.992	0.144
BuyPer (Purchase / Vested Stk.)	0.020	0	0	0	0	0.726	0.093
NetSalePer (SalePer – BuyPer)	0.024	0	0	0	−0.714	0.965	0.171
Sale_Dum	0.214	0	0	0	0	1	0.410
Buy_Dum	0.124	0	0	0	0	1	0.329
NetSale_Dum	0.211	0	0	0	0	1	0.408

Panel B. Discretionary power proxies and control variables

Variable	Mean	Median	Q1	Q3	Min	Max	Std. Dev.
DiscPower	−0.053	−0.200	−0.794	0.552	−1.642	2.763	0.974
Options (% firm total shares)	0.903	0.562	0.184	1.248	0.000	7.172	1.024
NewVestedStk (% firm total shares)	0.036	0.000	0.000	0.036	0.000	0.461	0.077
TaxRate (%)	22.457	22.800	20.000	25.550	15.000	29.500	4.007
FutureRet	0.090	0.063	−0.041	0.186	−0.478	1.011	0.236
AROA	0.047	0.028	−0.001	0.079	−0.354	0.470	0.112
Return	0.153	0.107	−0.121	0.348	−0.749	2.010	0.459
Size	14.642	14.519	13.437	15.693	10.848	19.048	1.649
Volatility	0.414	0.365	0.270	0.501	0.144	1.194	0.204
Market to Book	3.016	2.183	1.437	3.517	−4.240	19.945	3.162
Leverage	0.362	0.336	0.153	0.523	0.000	0.956	0.255
PaySlice	0.380	0.383	0.316	0.447	0.101	0.662	0.108
Tenure	8.0	6	3	11	1	26	6.129
Age	55.9	56	51	61	40	70	6.743

This table reports summary statistics for variables used in this study. Panel A reports summary statistics for the CEO's stock trading activity. Panel B reports summary statistics for control variables. The sample consists of 13,659 observations of firm-years, described in more detail in Section 3.1 and Table 3. Definitions for all variables are in Appendix A.

Table 5
Variable correlations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SalePer (1)	1.000	−0.022	0.832	0.587	−0.071	0.585	−0.066	0.058	0.058	0.017
		(0.010)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.048)
BuyPer (2)	−0.127	1.000	−0.566	−0.082	0.561	−0.097	0.025	0.045	−0.041	0.022
	(<0.0001)		(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.004)	(<0.0001)	(<0.0001)	(0.009)
NetSalePer (3)	0.840	−0.624	1.000	0.532	−0.364	0.541	−0.069	0.023	0.071	0.002
	(<0.0001)	(<0.0001)		(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.006)	(<0.0001)	(0.835)
Sale_Dum (4)	0.990	−0.127	0.830	1.000	−0.125	0.992	−0.038	0.037	0.096	0.027
	(<0.0001)	(<0.0001)	(<0.0001)		(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.002)
Buy_Dum (5)	−0.125	0.997	−0.619	−0.125	1.000	−0.145	0.063	0.025	0.000	0.006
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)		(<0.0001)	(<0.0001)	(0.003)	(0.956)	(0.481)
NetSale_Dum (6)	0.984	−0.147	0.847	0.992	−0.145	1.000	−0.041	0.040	0.096	0.027
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)		(<0.0001)	(<0.0001)	(<0.0001)	(0.002)
DiscPower (7)	−0.053	0.062	−0.074	−0.042	0.064	−0.044	1.000	0.010	−0.174	0.282
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)		(0.266)	(<0.0001)	(<0.0001)
Options (8)	0.040	0.016	0.024	0.036	0.012	0.038	−0.045	1.000	0.013	0.094
	(<0.0001)	(0.067)	(0.005)	(<0.0001)	(0.161)	(<0.0001)	(<0.0001)		(0.130)	(<0.0001)
NewVestedStk (9)	0.081	−0.037	0.085	0.078	−0.035	0.079	−0.328	−0.145	1.000	−0.105
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)		(<0.0001)
TaxRate (10)	0.027	0.006	0.018	0.028	0.006	0.028	0.280	0.101	−0.188	1.000
	(0.002)	(0.479)	(0.031)	(0.001)	(0.475)	(0.001)	(<0.0001)	(<0.0001)	(<0.0001)	
FutureRet (11)	0.003	0.036	−0.019	0.006	0.034	0.005	0.026	0.058	−0.030	0.028
	(0.702)	(<0.0001)	(0.030)	(0.468)	(<0.0001)	(0.576)	(0.002)	(<0.0001)	(0.001)	(0.001)
AROA (12)	0.140	−0.121	0.175	0.137	−0.119	0.139	−0.035	0.123	−0.099	0.087
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Return (13)	0.095	−0.129	0.142	0.092	−0.127	0.095	−0.047	0.040	0.020	−0.008
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.020)	(0.366)
Size (14)	−0.106	−0.085	−0.039	−0.102	−0.081	−0.103	−0.112	−0.457	0.094	−0.099
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Volatility (15)	0.084	0.105	0.011	0.080	0.101	0.080	−0.044	0.325	−0.028	0.002
	(<0.0001)	(<0.0001)	(0.207)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.001)	(0.798)
Market to Book (16)	0.146	−0.155	0.198	0.146	−0.153	0.149	−0.011	0.094	−0.097	0.091
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.186)	(<0.0001)	(<0.0001)	(<0.0001)
Leverage (17)	−0.137	0.056	−0.138	−0.135	0.057	−0.137	−0.007	−0.263	0.113	−0.121
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.443)	(<0.0001)	(<0.0001)	(<0.0001)
PaySlice (18)	0.003	−0.066	0.039	−0.001	−0.065	0.002	−0.213	0.128	0.200	−0.054
	(0.685)	(<0.0001)	(<0.0001)	(0.941)	(<0.0001)	(0.806)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Tenure (19)	0.170	−0.093	0.182	0.180	−0.083	0.181	0.009	0.154	0.019	0.015
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.320)	(<0.0001)	(0.030)	(0.071)
Age (20)	0.002	−0.035	0.018	0.007	−0.031	0.007	−0.007	−0.114	0.061	−0.038
	(0.833)	(<0.0001)	(0.032)	(0.408)	(<0.001)	(0.396)	(0.407)	(<0.0001)	(<0.0001)	(<0.0001)

	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
SalePer (1)	−0.006	0.068	0.073	−0.092	0.066	0.071	−0.101	0.008	0.034	−0.026
	(0.450)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.340)	(<0.0001)	(0.002)
BuyPer (2)	0.066	−0.081	−0.072	−0.086	0.093	−0.044	0.013	−0.040	−0.107	−0.049
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.129)	(<0.0001)	(<0.0001)	(<0.0001)
NetSalePer (3)	−0.040	0.101	0.101	−0.030	0.004	0.083	−0.090	0.029	0.086	0.005
	(<0.0001)	(<0.0001)	(<0.0001)	(0.001)	(0.608)	(<0.0001)	(<0.0001)	(0.001)	(<0.0001)	(0.589)
SalePer (4)	−0.003	0.100	0.096	−0.102	0.067	0.095	−0.130	0.001	0.167	0.005
	(0.748)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.888)	(<0.0001)	(0.546)
BuyPer (5)	0.066	−0.103	−0.106	−0.081	0.097	−0.087	0.066	−0.060	−0.060	−0.026
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.003)
NetSalePer (6)	−0.005	0.102	0.097	−0.103	0.068	0.097	−0.132	0.004	0.168	0.005
	(0.592)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.653)	(<0.0001)	(0.538)
DiscPower (7)	0.080	−0.040	−0.035	−0.130	0.020	0.018	−0.012	−0.209	0.062	−0.020
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.017)	(0.034)	(0.177)	(<0.0001)	(<0.0001)	(0.018)
Options (8)	0.049	0.054	0.067	−0.417	0.288	0.046	−0.228	0.119	0.123	−0.107
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
NewVestedStk (9)	−0.015	−0.085	0.013	−0.111	0.089	−0.051	−0.007	0.157	0.036	0.031
	(0.077)	(<0.0001)	(0.144)	(<0.0001)	(<0.0001)	(<0.0001)	(0.398)	(<0.0001)	(<0.0001)	(<0.001)
TaxRate (10)	0.047	0.092	−0.003	−0.086	0.028	0.093	−0.102	−0.047	0.025	−0.044
	(<0.0001)	(<0.0001)	(0.714)	(<0.0001)	(0.001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.003)	(<0.0001)
FutureRet (11)	1.000	0.018	−0.061	−0.119	0.098	−0.007	−0.076	−0.035	0.012	−0.029
		(0.031)	(<0.0001)	(<0.0001)	(<0.0001)	(0.418)	(<0.0001)	(<0.0001)	(0.147)	(0.001)
AROA (12)	0.050	1.000	0.130	−0.053	−0.080	0.285	−0.283	0.028	0.034	−0.022
	(<0.0001)		(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.001)	(<0.0001)	(0.009)
Return (13)	−0.037	0.133	1.000	−0.040	0.088	0.254	−0.059	0.041	0.001	−0.014
	(<0.0001)	(<0.0001)		(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(0.912)	(0.094)
Size (14)	−0.085	−0.173	0.013	1.000	−0.394	−0.043	0.528	0.130	−0.118	0.145
	(<0.0001)	(<0.0001)	(0.121)		(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Volatility (15)	0.051	−0.002	−0.014	−0.446	1.000	0.007	−0.220	−0.105	0.054	−0.156
	(<0.0001)	(0.776)	(0.109)	(<0.0001)		(0.446)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)

(*continued on next page*)

Table 5 (*continued*)

	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Market to Book (16)	−0.005	0.486	0.331	−0.060	−0.067	1.000	−0.147	0.010	0.000	−0.063
	(0.576)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)		(<0.0001)	(0.249)	(0.972)	(<0.0001)
Leverage (17)	−0.075	−0.427	−0.038	0.534	−0.299	−0.259	1.000	0.055	−0.091	0.114
	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)		(<0.0001)	(<0.0001)	(<0.0001)
PaySlice (18)	−0.019	0.039	0.063	0.165	−0.110	0.062	0.075	1.000	0.007	0.065
	(0.024)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)		(0.394)	(<0.0001)
Tenure (19)	0.016	0.041	−0.003	−0.100	0.065	0.019	−0.087	0.043	1.000	0.327
	(0.059)	(<0.0001)	(0.714)	(<0.0001)	(<0.0001)	(0.024)	(<0.0001)	(<0.0001)		(<0.0001)
Age (20)	−0.014	−0.056	0.007	0.145	−0.149	−0.072	0.118	0.072	0.304	1.000
	(0.110)	(<0.0001)	(0.392)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	

This table reports correlations among variables used in this study. Pearson correlations are reported above the diagonal and Spearman correlations are reported below the diagonal. *P*-values are shown in parentheses. The sample consists of 13,659 observations of firm-years, described in more detail in Section 3.1 and Table 3. Definitions for all variables are in Appendix A.

a serious problem.

3.3. The CEO's stock trading activity (test of H1)

The results of regressions using model (3.1) to test H1 are provided in Table 6. Consistent with my expectations, *DiscPower* has negative coefficients in Columns (1) and (3) where the CEO's fraction of vested stock sold, *SalePer*, and fraction of stock sale net of stock purchase, *NetSalePer*, are the dependent variables, and in Columns (4) and (6) where the corresponding stock sale and net sale indicators are the dependent variables. Further, in Columns (2) and (5) that use the CEO's stock purchase activity (*BuyPer* and *Buy_Dum*) as dependent variables, *DiscPower* has positive coefficients. In all six columns but Column (2), these coefficients are statistically significant at $p < 0.05$. These effects are also economically significant. For example, a one standard deviation increase in *DiscPower* (0.974) is associated with a 1.54% decrease in *SalePer* (calculated as -0.0159×0.974), equivalent to 35% of *SalePer*'s baseline mean value (1.54%/4.4% = 35%). Similarly, with a one standard deviation increase in *DiscPower*, the odds that a CEO has net positive stock sale (*NetSale_Dum*) will on average decrease by 2.63% (0.0270×0.974), equivalent to 12.5% of *NetSale_Dum*'s baseline mean value (2.63%/21.1% = 12.5%).

The coefficients for control variables are generally consistent with expectations. The CEO's newly vested unconstrained stock,

Table 6
CEO stock trading activity.

	SalePer (1)	BuyPer (2)	NetSalePer (3)	Sale_Dum (4)	Buy_Dum (5)	NetSale_Dum (6)
DiscPower	−0.0159***	0.0037	−0.0195***	−0.0273***	0.0159**	−0.0270***
	(<0.001)	(0.140)	(<0.001)	(0.003)	(0.039)	(0.004)
Options	−0.0017	−0.0010	−0.0002	−0.0154	−0.0025	−0.0139
	(0.667)	(0.737)	(0.975)	(0.107)	(0.744)	(0.150)
NewVestedStk	0.0086	−0.0591***	0.0687**	0.1780**	−0.0539	0.1721**
	(0.733)	(<0.001)	(0.020)	(0.018)	(0.318)	(0.022)
TaxRate	−0.0033	−0.0009	−0.0024	−0.0120	−0.0098	−0.0111
	(0.340)	(0.613)	(0.537)	(0.243)	(0.197)	(0.277)
FutureRet	−0.0094	0.0294***	−0.0382***	−0.0493**	0.0920***	−0.0514**
	(0.192)	(<0.001)	(<0.001)	(0.023)	(<0.001)	(0.018)
AROA	0.0840***	−0.0649***	0.1469***	0.2576***	−0.2194***	0.2611***
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Return	0.0125***	−0.0076***	0.0201***	0.0405***	−0.0491***	0.0403***
	(0.001)	(0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Size	−0.0079	0.0006	−0.0080	−0.0076	0.0015	−0.0054
	(0.175)	(0.859)	(0.232)	(0.620)	(0.912)	(0.729)
Volatility	0.0093	0.0087	−0.0009	0.0803	0.0968**	0.0755
	(0.610)	(0.491)	(0.967)	(0.127)	(0.016)	(0.149)
MtB	0.0020***	0.0003	0.0016**	0.0035*	−0.0009	0.0038*
	(0.005)	(0.447)	(0.045)	(0.069)	(0.518)	(0.054)
Leverage	−0.0267	0.0058	−0.0328	−0.1280**	0.0517	−0.1297**
	(0.162)	(0.632)	(0.146)	(0.014)	(0.244)	(0.013)
PaySlice	−0.0153	−0.0114	−0.0040	0.0333	−0.0847**	0.0346
	(0.349)	(0.364)	(0.842)	(0.463)	(0.023)	(0.447)
Log(Tenure)	0.0152***	−0.0242***	0.0390***	0.0680***	−0.0514***	0.0653***
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
Log(Age)	0.0110	−0.0147	0.0168	0.3785	−0.3832	0.3571
	(0.940)	(0.859)	(0.919)	(0.473)	(0.359)	(0.506)
Constant	0.1919	0.1505	0.0678	−1.0279	2.0176	−0.9859
	(0.752)	(0.665)	(0.921)	(0.648)	(0.258)	(0.667)
Year Fixed Effect	Y	Y	Y	Y	Y	Y
Firm-CEO Fixed Effect	Y	Y	Y	Y	Y	Y
Observations	13,659	13,659	13,659	13,659	13,659	13,659
Number of firm-CEOs	3227	3227	3227	3227	3227	3227
R-squared	0.021	0.039	0.044	0.031	0.047	0.032

This table reports the results of regressions using the model in Eq. (3.1) where dependent variables are the CEO's stock sale, purchase, and net sale measured as percentages of available vested stock and as indicator variables. The sample consists of 13,659 observations of firm-years, described in more detail in Section 3.1 and Table 3. Definitions for all variables are in Appendix A. P-values based on robust standard errors are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for two-tailed tests.

NewVestedStk, is negatively associated with stock purchase measures and positively associated with stock sale and net sale measures. Consistent with prior literature (Cheng & Warfield, 2005; Jin & Kothari, 2008), current year firm performance, *AROA* and *Return*, are positively associated with stock sale and net sale, and negatively associated with stock purchase. Further, CEOs with longer tenure sell more stock and buy less stock, consistent with them diversifying their wealth when they are closer to the end of career. I also find that *FutureRet*, the firm's average annual stock return in the subsequent three year, is negatively associated with stock selling and positively associated with stock purchase. This evidence supports CEOs' incentives to signal private information regarding firm value (Fan, 2007; Leland & Pyle, 1977) and their trading on private information to receive personal benefits (Lakonishok & Lee, 2001; Lin & Howe, 1990 and Marin & Olivier, 2008).

Overall, my results in Table 6 support H1 that the CEO is less likely to sell firm stock when he has greater discretionary power. And consistent with my expectation, CEOs with greater discretionary power are more likely to increase stock ownership by purchasing firm shares.

4. Additional empirical tests

This section provides additional empirical results to support my main hypothesis. First, I consider how the relation between discretionary power and CEO stock trading varies across industries. In my theoretical model, the CEO's decision to hold stock is driven by the opportunity to extract rents from the company. If the company is in an industry where rent extraction is more difficult, then the CEO's discretionary power should matter less in his stock trading. To test this conjecture, I differentiate firms based on two measures for the difficulty of rent extraction. First, some industries are more regulated by government agencies than others, resulting in the limitation on the CEO's set of actions. Thus, I first separate firms in my sample into regulated versus non-regulated firms. Following Reeb, Zhang, and Zhao (2014), I classify 809 of the 3227 sample firms as regulated firms that are in the financial industry (SIC 6000–6799), pharmaceutical industry (SIC 2830, 2831, 2833, and 2836), or utilities industry (SIC 4812, 4813, and 4911–4991).

Panel A of Table 7 provides results for the comparison of *DiscPower*'s coefficients across regulated and non-regulated industries. In this analysis, I replace *DiscPower* in model (3.1) with two new variables, *DiscPower_Regulated* and *DiscPower_NonReg*. *DiscPower_Regulated* equals *DiscPower*'s original value for firms in regulated industries and zero otherwise, and *DiscPower_NonReg* equals *DiscPower*'s original value for firms in non-regulated industries and zero otherwise. Using these two new variables to replace *DiscPower* in model (3.1), the coefficient of *DiscPower_Regulated* (*DiscPower_NonReg*) will measure *DiscPower*'s effect for firms in regulated (non-regulated) industries. Other independent variables and year dummies in model (3.1) are also replaced with pairs of new variables in the same fashion. Panel A shows that the coefficients for *DiscPower_NonReg* but not *DiscPower_Regulated* are statistically significant with predicted signs for all dependent variables. Further, F-tests

Table 7
Subsample analysis: regulated versus non-regulated industries.

Panel A. Regulated versus non-regulated industries

	SalePer (1)	BuyPer (2)	NetSalePer (3)	Sale_Dum (4)	Buy_Dum (5)	NetSale_Dum (6)
DiscPower_Regulated (β_1)	0.0016	−0.0054	0.0071	0.0167	−0.0126	0.0191
	(0.716)	(0.147)	(0.225)	(0.323)	(0.503)	(0.254)
DiscPower_NonReg (β_2)	−0.0198***	0.0058**	−0.0255***	−0.0370***	0.0235***	−0.0372***
	(<0.001)	(0.047)	(<0.001)	(0.001)	(0.005)	(0.001)
Control Variables	Y	Y	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y
Firm-CEO Fixed Effect	Y	Y	Y	Y	Y	Y
Observations	13,659	13,659	13,659	13,659	13,659	13,659
Number of firm-CEOs	3227	3227	3227	3227	3227	3227
R-squared	0.024	0.042	0.048	0.035	0.050	0.036
F-test p-value: $\beta_1 = \beta_2$	<0.001***	0.016**	<0.001***	0.008***	0.079*	0.005***

Panel B. Most competitive versus less competitive industries

	SalePer (1)	BuyPer (2)	NetSalePer (3)	Sale_Dum (4)	Buy_Dum (5)	NetSale_Dum (6)
DiscPower_MostComp (β_1)	−0.0053	0.0032	−0.0078	−0.0198	−0.0039	−0.0148
	(0.363)	(0.426)	(0.270)	(0.201)	(0.811)	(0.337)
DiscPower_LessComp (β_2)	−0.0190***	0.0038	−0.0229***	−0.0303***	0.0234***	−0.0315***
	(<0.001)	(0.199)	(<0.001)	(0.007)	(0.006)	(0.005)
Control Variables	Y	Y	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y
Firm-CEO Fixed Effect	Y	Y	Y	Y	Y	Y
Observations	13,659	13,659	13,659	13,659	13,659	13,659
Number of firm-CEOs	3227	3227	3227	3227	3227	3227
R-squared	0.024	0.044	0.048	0.034	0.052	0.035
F-test p-value: $\beta_1 = \beta_2$	0.055*	0.909	0.092*	0.584	0.140	0.382

This table reports the results of regressions using the model in Eq. (3.1) where dependent variables are the CEO's stock sale, purchase, and net sale measured as percentages of available vested stock and as indicator variables. The sample consists of 13,659 observations of firm-years, described in more detail in Section 3.1 and Table 3. In Panel A, *DiscPower_Regulated* (*DiscPower_NonReg*) equals *DiscPower* for firms in regulated (non-regulated) industries, and zero otherwise. Regulated industries are the financial industry (SIC 6000–6799), pharmaceutical industry (SIC 2830, 2831, 2833, and 2836), and utilities industry (SIC 4812, 4813, and 4911–4991). In Panel B, *DiscPower_MostComp* (*DiscPower_LessComp*) equals *DiscPower* for the most competitive (less competitive) firms, and zero otherwise. Firms in the most competitive industries are identified with the following steps. First, for each industry in the Fama-French 48 industry classification, I calculate its yearly Herfindahl–Hirschman index. Second, I rank all firms in each year based on their industry's Herfindahl–Hirschman index. Finally, I classify firms with an average annual rank of Herfindahl–Hirschman index at the bottom tercile (middle and top terciles) as being in the most competitive (less competitive) industries. In both panels, each of the control variables and year dummies in Eq. (3.1) is similarly separated into two variables that correspond to each industry-type in the analysis. P-values based on robust standard errors are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for two-tailed tests.

Table 8
Founder CEOs versus non-founder CEOs.

Panel A. Summary statistics for trading activity of each CEO type

	Founder CEOs	Non-Founder CEOs	Difference
# CEOs	326	2650	
# Firm-years	1623	11,453	
Vested Stock as % firm shares (mean)	7.193%	1.188%	6.006%***
Vested Stock as % firm shares (median)	3.094%	0.227%	2.867%***
SalePer (mean)	0.054	0.042	0.012
BuyPer (mean)	0.009	0.021	−0.011***
NetSalePer (mean)	0.044	0.021	0.023***
Sale_Dum (mean)	0.389	0.190	0.199***
Buy_Dum (mean)	0.116	0.124	−0.007
NetSale_Dum (mean)	0.386	0.187	0.199***

Panel B. Regression analysis

	SalePer (1)	BuyPer (2)	NetSalePer (3)	Sale_Dum (4)	Buy_Dum (5)	NetSale_Dum (6)
DiscPower_Founder (β_1)	−0.0222***	0.0157**	−0.0375***	−0.0090	0.0562***	−0.0072
	(0.003)	(0.017)	(0.001)	(0.696)	(0.005)	(0.756)
DiscPower_NonFounder (β_2)	−0.0138***	0.0007	−0.0144***	−0.0271***	0.0066	−0.0269***
	(<0.001)	(0.800)	(0.003)	(0.008)	(0.430)	(0.009)
Control Variables	Y	Y	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y
Firm-CEO Fixed Effect	Y	Y	Y	Y	Y	Y
Observations	13,076	13,076	13,076	13,076	13,076	13,076
Number of firm-CEOs	2976	2976	2976	2976	2976	2976
R-squared	0.026	0.047	0.049	0.039	0.055	0.040
F-test p-value: $\beta_1 = \beta_2$	0.317	0.034**	0.058*	0.474	0.022**	0.439

This table reports the analysis of stock trading activity by founder CEOs and non-founder CEOs. The sample consists of 13,076 observations of firm-years based on the full sample described in more detail in Section 3.1 and Table 3, that also have information in BoardEx to determine whether the CEO is the founder of the firm. Panel A provides summary statistics for trading activity of founder CEOs and non-founder CEOs. Panel B reports the results of regressions using the model in Eq. (3.1) where dependent variables are the CEO's stock sale, purchase, and net sale measured as percentages of available vested stock and as indicator variables. *DiscPower_Founder* (*DiscPower_NonFounder*) equals *DiscPower* for founder CEOs (non-founder CEOs), and zero otherwise. Each of the control variables and year dummies in Eq. (3.1) is similarly separated into two variables that correspond to each CEO type. P-values based on robust standard errors are shown in parentheses in Panel B. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for two-tailed tests.

indicate that the two coefficients are significantly different from each other in all columns. These suggest that the main results in Table 6 that CEOs with more discretionary power sell less and buy more firm stock hold only for firms in non-regulated industries.

In addition to regulation, product market competition can similarly result in the limitation on what decisions the CEO can make. In more competitive industries, the CEO will need to focus on how to differentiate the firm's products from competitors, and therefore has less opportunity for rent extraction.[18] I identify 841 firms in the most competitive industries using the following steps. First, for each industry in the Fama-French 48 industry classification, I calculate its yearly Herfindahl–Hirschman index. A lower value of Herfindahl–Hirschman index would suggest more competition within the industry. Second, I assign an annual percentile rank for each firm in the same year based on its industry's Herfindahl–Hirschman index. Finally, I classify firms with an average annual rank of Herfindahl–Hirschman index at the bottom tercile (middle and top terciles) as being in the most competitive (less competitive) industries. In Panel B of Table 7, I employ the same methodology as in Panel A to compare *DiscPower*'s coefficients for more competitive versus less competitive industries. Consistent with my expectations, the main results in Table 6 only hold for firms in less competitive industries. F-tests, however, show that *DiscPower_LessComp* is significantly different from *DiscPower_MoreComp* in only two out of the six columns. Overall, the results in Table 7 provide some additional support for my H1 regarding the relation between CEO discretionary power and stock trading.

Next, I consider the unique group of founder CEOs. These CEOs normally hold larger fractions of their firms and therefore bear great amounts of risk related to under-diversification. It is unclear whether the predicted relationship in H1 between discretionary power and the tendency to hold stock will be stronger or weaker for founder CEOs. On the one hand, founders might be reluctant to sell their firm stock to retain control of the firm. This control concern could lead to weaker results in testing H1. On the other hand, being a founder of the firm gives the CEO more opportunities of rent extraction, which will lead to stronger results in testing H1. In Table 8, I obtain the information on each CEO's detailed employment history from the *BoardEx* employment history data and classify a CEO as a founder CEO if the text description of the CEO's role includes the word "founder". Following this procedure, I classify 326 (11%) CEOs in the sample as founder CEOs among the 2976 CEOs with founder information.

Panel A of Table 8 provides summary statistics for the trading activity of each CEO type. Founder CEOs' mean (median) vested stock is 7.193% (3.094%) of their firms' total shares, much higher than the corresponding stock ownership of 1.188% (0.227%) for non-founder CEOs. Further, founder CEOs in general engage in more stock selling and less stock buying than non-founder CEOs. For example, founder CEOs' average net stock selling percentage is 4.4% and they have net positive stock selling in 38.6% firm-years, greater than the corresponding percentages of 2.1% and 18.7% for non-founder CEOs. In Panel B, I follow the same methodology in Table 7 and first find that results for *DiscPower* generally hold for both founder CEOs and non-founder CEOs. Further, in Columns (1) to (3) and (5), the coefficient of *DiscPower_Founder* has greater magnitude than that of *DiscPower_NonFounder* and the difference is statistically significant in

[18] This is similar to the view by Giroud and Mueller (2011) that product market competition serves as a substitute for other mechanisms of corporate governance.

Table 9
Sensitivity tests – alternative variables.

Panel A. Alternative dependent variables

	$\text{Log}\left(\frac{1+\text{SalePer}}{1-\text{SalePer}}\right)$ (1)	$\text{Log}\left(\frac{1+\text{BuyPer}}{1-\text{BuyPer}}\right)$ (2)	$\text{Log}\left(\frac{1+\text{NetSalePer}}{1-\text{NetSalePer}}\right)$ (3)
DiscPower	−0.0678***	0.0085	−0.0631***
	(<0.001)	(0.166)	(<0.001)
Control Variables	Y	Y	Y
Year Fixed Effect	Y	Y	Y
Firm-CEO Fixed Effect	Y	Y	Y
Observations	13,659	13,659	13,659
Number of firm-CEOs	3227	3227	3227
R-squared	0.015	0.036	0.032

Panel B. Individual discretionary power proxies

	SalePer (1)	BuyPer (2)	NetSalePer (3)	Sale_Dum (4)	Buy_Dum (5)	NetSale_Dum (6)
NonInstOwn	−0.0924***	0.0299**	−0.1227***	−0.2087***	0.1314***	−0.2067***
	(<0.001)	(0.036)	(<0.001)	(<0.001)	(0.003)	(<0.001)
Chairman	−0.0141**	0.0043	−0.0182**	−0.0291*	0.0197	−0.0293*
	(0.023)	(0.209)	(0.011)	(0.072)	(0.153)	(0.068)
PerNonInd	−0.0336**	0.0015	−0.0341*	−0.0212	−0.0010	−0.0204
	(0.039)	(0.891)	(0.092)	(0.656)	(0.977)	(0.668)
Control Variables	Y	Y	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y
Firm-CEO Fixed Effect	Y	Y	Y	Y	Y	Y
Observations	13,659	13,659	13,659	13,659	13,659	13,659
Number of firm-CEOs	3227	3227	3227	3227	3227	3227
R-squared	0.023	0.039	0.046	0.032	0.047	0.034

This table reports two sensitivity tests for my main results in Table 6. Panel A reports the results of regressions for the full sample using the model in Eq. (3.1) where dependent variables are the CEO's stock sale, purchase, and net sale alternatively calculated based on log-transformation. Panel B reports the results of regressions for the full sample using a modified model based on Eq. (3.1), where *DiscPower* is replaced with the three individual discretionary power proxies. P-values based on robust standard errors are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for two-tailed tests.

Columns (2), (3), and (5) based on F-tests, consistent with a stronger effect of discretionary power for founder CEOs.[19] Overall, the results in Table 8 are consistent with the main results in Table 6 holding for both founder and non-founder CEOs, and provide some support for the idea that discretionary power plays a more important role in stock trading decisions for founder CEOs.

5. Sensitivity tests

This section provides sensitivity tests for my results in Table 6. First, my main regression model in (3.1) is an OLS model that assumes unbounded dependent variables, but all my dependent variables have an upper bound of 1 and a lower bound of 0. Panel A of Table 9 reports regression results based on a modified model where the dependent variables become unbounded using log-transformation. For each percentage measure of stock trading, I rerun the regression in Table 6 using the logarithm of (1 + percentage value)/(1 – percentage value) as the dependent variable. Results are qualitatively similar to those in Table 6. Second, the *DiscPower* measure based on the principal component analysis of three discretionary power proxies might not fully capture each proxy's relation with the CEO's true discretionary power. Thus, in Panel B of Table 9, I rerun the regressions in Table 6 using the three individual proxies simultaneously to replace *DiscPower*. The results are generally consistent with expectations, with *NonInstOwn* showing the strongest relationship with stock trading activity, followed by *Chairman* and *PerNonInd*.

Third, I consider how the overall stock market condition affects my results. In periods of booming markets, CEOs might be more willing to hold firm stock because they know their holdings' value will grow for sure.[20] This could lead to *DiscPower* playing a less important role when the market is booming. In Panel A of Table 10, I create an indicator variable *Booming* and code it as one for the periods of booming stock market from 1996 to 1999 and from 2010 to 2014, and zero for the period between 2000 and 2009 when the stock market experiences more fluctuation. I then add *Booming* and the interaction between *Booming* and *DiscPower* into the regression model and rerun Table 6 regressions. Results show that *Booming* is related to more stock sale in general and the coefficient of *DiscPower*Booming* is not statistically significant in any of the six columns. Further, the sensitivity of stock trading over discretionary power in non-booming years (the coefficient of *DiscPower*) and booming years (the combined coefficients of *DiscPower* and *DiscPower*Booming*) are both significant in almost all columns. These suggest that my main results hold in both booming and non-booming years.

Finally, in recent years, many firms start to implement stock ownership policies for their executives that specify minimum stock holding requirements (Equilar Inc, 2013; Shilon, 2015), making a portion of executives' vested stock ownership unsellable. In Panel B of Table 10, I recalculate the percentage measures of the CEO's stock trading activity by replacing vested stock with unconstrained stock after considering such firm policies. Results for the 4124 observations with available ownership policy data are similar to those in Table 6.

[19] *DiscPower_Founder*'s coefficient has smaller magnitude in Columns (4) and (6) relative to *DiscPower_NonFounder*. While this appears to be inconsistent with results in other columns, it could be due to *Sale_Dum* and *NetSale_Dum* being poor proxies of stock selling for founder CEOs. These CEOs hold much more firm stock and will be more likely to have any stock selling activity (see summary statistics in Panel A of Table 8). However, the indicator variables do not differentiate CEOs based on their amount of stock sale.

[20] Note that this is still irrational because holding one stock is still riskier than holding a diversified portfolio.

Table 10
Sensitivity tests – consideration of overall market conditions and ownership policies.

Panel A. Consideration of overall market conditions

	SalePer (1)	BuyPer (2)	NetSalePer (3)	Sale_Dum (4)	Buy_Dum (5)	NetSale_Dum (6)
DiscPower (β_1)	−0.0142***	0.0042	−0.0182***	−0.0241**	0.0153*	−0.0241**
	(<0.001)	(0.109)	(<0.001)	(0.015)	(0.070)	(0.015)
Booming (β_2)	0.0488**	0.0019	0.0461*	0.1124	0.0119	0.1175*
	(0.030)	(0.860)	(0.062)	(0.104)	(0.811)	(0.090)
DiscPower*Booming (β_3)	−0.0052	−0.0017	−0.0040	−0.0098	0.0016	−0.0089
	(0.136)	(0.536)	(0.375)	(0.368)	(0.876)	(0.419)
Control Variables	Y	Y	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y
Firm-CEO Fixed Effect	Y	Y	Y	Y	Y	Y
Observations	13,659	13,659	13,659	13,659	13,659	13,659
Number of firm-CEOs	3227	3227	3227	3227	3227	3227
R-squared	0.021	0.039	0.044	0.031	0.047	0.032
F-test p-value: $\beta_1 + \beta_3 = 0$	<0.001***	0.406	<0.001***	0.004***	0.088*	0.006***

Panel B. Consideration of ownership policies

	Modified measures based on unconstrained stock					
	SalePer (1)	BuyPer (2)	NetSalePer (3)	Sale_Dum (4)	Buy_Dum (5)	NetSale_Dum (6)
DiscPower	−0.0160**	0.0023	−0.0184	−0.0574***	0.0210	−0.0526***
	(0.018)	(0.793)	(0.145)	(0.001)	(0.142)	(0.002)
Control Variables	Y	Y	Y	Y	Y	Y
Year Fixed Effect	Y	Y	Y	Y	Y	Y
Firm-CEO Fixed Effect	Y	Y	Y	Y	Y	Y
Observations	4124	4124	4124	4124	4124	4124
Number of firm-CEOs	1145	1145	1145	1145	1145	1145
R-squared	0.025	0.037	0.040	0.034	0.053	0.034

This table reports two sensitivity tests for my main results in Table 6. Panel A reports the results of regressions for the full sample using a modified model in Eq. (3.1) that adds the following independent variables: (1) indicator variable *Booming* that equals one for years 1996–1999 and 2010–2014, and zero for other years, and (2) the interaction between *DiscPower* and *Booming*. Panel B reports the results of regressions using a modified model based on Eq. (3.1), where stock trading percentage measures are calculated based on unconstrained stock after considering firm policies to hold additional stock to meet minimum holding requirements. The sample includes 4124 firm-years for which firm ownership policy data is available. P-values based on robust standard errors are shown in parentheses. *, ** and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, for two-tailed tests.

6. Conclusion and discussion

This paper examines how the CEO's discretionary power affects his stock trading decisions. I first develop a theoretical model to characterize conditions under which the CEO will voluntarily hold sellable shares of their firm. I predict and find that as the CEO has greater discretionary power, he will sell less and buy more firm stock. In other words, my evidence is consistent with discretionary power inducing the CEO to hold more firm stock even if doing so could appear risky. The rationale behind the observed patterns is, by retaining greater stock ownership to complement discretionary power, the CEO's opportunity to extract rents from the firm could benefit him more than the cost of under-diversification. My study provides a new explanation of why CEOs commonly hold large amounts of unconstrained equity.

Traditionally, CEO stock ownership is viewed as an alignment mechanism to incentivize the CEO to take actions consistent with shareholders' preference (for example, Core & Guay, 1999; Kale et al., 2009). Recent studies start to examine other implications of this ownership. Yost (2018), Armstrong, Glaeser, Huang, and Taylor (2019), and Brisley, Cai, and Nguyen (2021) find that the accumulation of CEO stock ownership and the related tax burden unintendedly affect the firm's investment decisions. My study suggests that stock ownership could also help the CEO build up power, especially when the CEO can exercise more discretion. My results are consistent with Finkelstein's (1992) view of CEO stock holdings as one dimension of power, the "ownership power".

One limitation of my theoretical model is I do not endogenize the firm's contracting decision and treat the CEO's constrained and unconstrained stock ownership as given. In all my empirical analysis, I include firm-CEO fixed effect to control for time-invariant unobservables in the contracting environment. This allows me to interpret the CEO's trading activity as the result of year-over-year change in his discretionary power that comes from the changes in institutional ownership, the chairman position, and the fraction of directors who are not independent.[21] The relation I find between CEO discretionary power and stock trading is unlikely to be driven by the difference in CEO contracts across firms.

Declaration of Competing Interest

None.

[21] In an untabulated analysis using a modified model based on Eq. (3.1) where each dependent variable, *DiscPower*, and all control variables are replaced with their changes from the previous year to the current year, results are similar to those in Table 6.

[21] In an untabulated analysis using a modified model based on Eq. (3.1) where each dependent variable, *DiscPower*, and all control variables are replaced with their changes from the previous year to the current year, results are similar to those in Table 6.

Data availability

Data will be made available on request.

Appendix A. Definitions for variables used in empirical tests

Dependent Variables	
SalePer	The number of shares the CEO sells in a year outside (−1 day, +1 day) window of stock option exercises, divided by the sum of the CEO's year-beginning vested shares and newly vested shares in the current year. Year-beginning vested shares = Total # Shares the CEO Owns – # Shares in Restricted Stock, measured at the end of the previous year. The number of newly vested shares in the pre-2006 period is calculated as # Beginning restricted shares + Value of restricted stock grant / Year-end stock price – # Ending restricted shares.
BuyPer	The number of shares the CEO purchases in a year, divided by the sum of the CEO's year-beginning vested shares and newly vested shares in the current year. Year-beginning vested shares = Total # Shares the CEO Owns – # Shares in Restricted Stock, measured at the end of the previous year. The number of newly vested shares in the pre-2006 period is calculated as # Beginning restricted shares + Value of restricted stock grant / Year-end stock price – # Ending restricted shares.
NetSalePer	= *SalePer* – *BuyPer*.
Sale_Dum	=1 if *SalePer* > 0, =0 otherwise.
Buy_Dum	=1 if *BuyPer* > 0, =0 otherwise.
NetSale_Dum	=1 if *NetSalePer* > 0, =0 otherwise.
Discretionary Power Measures	
NonInstOwn	Non-institutional ownership, measured as 1 – institutional ownership.
Chairman	=1 if the CEO holds the Chairman title at the end of the year, =0 otherwise.
PerNonInd	Percentage of non-independent directors, calculated as the number of non-independent directors / total number of directors.
DiscPower	Linear combination of the above three discretionary power proxies - standardized to have a mean of 0 and a standard deviation of 1 - multiplied by the proxy's score that corresponds to the highest eigenvalue in the principal component analysis.
Control Variables	
Options	Incentives provided by vested stock options, measured as 100 * *(Σ # Vested or unvested options in an outstanding award * Option Delta) / Firm total shares,* where *Option Delta* is calculated using the Black-Scholes model (1973). Vested Options held prior to 2006 are treated as one grant and valued following Core and Guay (2002).
NewVestedStk	100 times the number of newly vested shares divided by the firm's total shares. The number of newly vested shares in the pre-2006 period is calculated as # Beginning restricted shares + Value of restricted stock grant / Year-end stock price – # Ending restricted shares.
TaxRate	= State income tax rate + Federal tax rate for long-term capital gain. State is determined by the location of the firm's headquarters.
FutureRet	Average annual stock return in the three year following the current year.
AROA	Industry-adjusted ROA. Calculated as income after depreciation divided by average assets, adjusted by the Fama-French 48 industry median in the same year.
Return	Stock return of the firm's stock, measured as cumulative return for the firm's stock over the twelve months in a given year.
Size	Firm size, measured as the natural log of the firm's total assets.
Volatility	Stock volatility, measured as the standard deviation of the firm's monthly stock returns over the past 60 months, then converted to annual volatility.
MtB	Market value of equity divided by book value of equity.
Leverage	Leverage of the firm, calculated as long-term debt divided by total assets.
PaySlice	The CEO's pay slice among top-five executives. Measured as the CEO's total pay divided by the total pay of all top-five executives or the total pay of all disclosed executives when the firm discloses compensation information for less than five executives.
Tenure	The CEO's tenure, which equals 1 for the CEO's first year in office and increases by 1 for each additional year in office.

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