РАЗДЕЛ 4
УГОЛОК ПРАКТИКА

SECTION 4
PRACTITIONER'S
CORNER

HOW INDEPENDENT SHOULD THE BOARD BE? CORPORATE BOARD STRUCTURE FROM A VOTING PERSPECTIVE

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Abstract

This paper proposes a model of corporate voting in which private information and individual preferences of board directors drive the board decisions. The optimal board structure and optimal firm value are solved numerically and their dependence on director and firm characteristics are studied. The optimal board structure is determined by outside and inside directors' relative informedness about the firm, insiders' bias, outsiders' advisory ability as well as the characteristics of the projects that the firm have. Voting rules other than the majority voting rule are considered. It is found that the majority rule often is not the optimal rule and it is optimal for a firm to have more inside directors while adopting a tougher voting rule. By studying strategic voting equilibria theoretically, insights about how board directors vote strategically are also provided.

Keywords: Board Composition, Private Information, Heterogeneous Preferences, Voting Rule, Sincere Voting, Strategic Voting.

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1. Introduction

When the residual claims to a corporation are diffused among many people, it becomes hard for the shareholders to exert their control right on the management of the firm, due to both the difficulty in communication and coordination and the possible conflict of interests. Therefore, as clearly explained in Fama and Jensen (1983), it is the common practice for the shareholders of public modern firms to delegate most of their decision control rights to boards of directors. Corporate boards take on their shoulders such great responsibilities as steering the direction of the corporation, making decisions in mergers and acquisitions and other strategic plans, and firing and hiring of CEO's. For this reason, both researchers and practitioners have been interested in the problem that how corporate boards should be structured so that they protect the best interests of shareholders and maximize the valuation of companies.

Corporate defaults and scandals in 2002 renewed the debates on the functioning of corporate boards. The Congress, through the Sabanes-Oxley act (SOX), and organizations such as the National Association of Corporate Directors and the Business Roundtable, through their publications, made requirement and recommendations on the structure of corporate boards, with one of the best-known recommendation being that corporate boards have a majority of independent directors.

Empirical evidence on the effectiveness of majority-independent boards has been mixed (see endnote 1). In fact, despite the scandals, there are still debates of the effectiveness of the U.S. corporate governance system. Weidenbaum (2005) points out "When it comes to regulating corporate governance, the 'magic of the marketplace' will work just fine". Holmstrom and Kaplan (2003) also casts doubt on the claim that the scandals imply failure of the US corporate governance system.

Theoretical studies on the board structure are therefore useful in clarifying questions about how the board should be constituted. In this work, I construct a model of corporate board based on the following observations.

First, insiders are needed on the board due to their superior knowledge of the firms' operations and projects proposed by CEO's. This is reflected in the model by letting insiders have more accurate private information than outsiders. Secondly, independent directors (outsiders) can provide valuable advice to the CEO, (e.g., see Baker and Gompers (2003) and Lehn, Patro and Zhao (2003)), thanks to their diverse background and expertise. This is reflected in the model by assuming outsiders can improve the distribution of the project that the CEO may propose. Furthermore, outsiders are not influenced by the CEO and their interests are better aligned with shareholders than insiders. This is reflected in the different utility functions of outsiders and insiders. Finally, the board holds a vote to aggregate information and preferences of all directors.

Our first results are about the dependence of optimal board structure and maximum firm value on the characteristics of directors and the firm. These results come with intuitive explanations. For example, the more knowledgeable outsiders are, the more outsiders are needed in the optimal board composition, and the greater the firm value is.

The next result is about the optimal voting rule. Instead of assuming only majority rule, the model can be used to study what is the optimal voting rule for the board. It turns out that majority rule is often not the best. It is often optimal to have a tougher voting rule, which would require more directors to vote yes for the CEO-proposed project to be accepted. And under such a voting rule, the number of insiders are more than that under the majority rule and the firm value increases substantially.

Finally, I carry out a preliminary study of strategic voting for corporate boards. In spirit, the last part is related to theories of games with private information and the strategic voting literature in economics and political sciences (e.g., Austen-Smith and Banks (1996) and Feddersen and Pesendorfer (1997)). I obtain existence of equilibrium and show that in a strategic voting equilibrium, insiders will take a more biased stand and outsiders will take a tougher stand toward the CEO.

In a theoretical and experimental study, Gillette, Noe and Rebello (2003) constructs an information revealing equilibrium by introducing penalties on insiders if their votes differ. Another theoretical work by Raheja (2004) introduces the possibility to succeed the current CEO as an incentive for insiders to reveal information. Their models all assume that insiders have full information and outsiders have no information.

What's new in my approach is that private information of both outsiders and insiders are quantified and are both valuable to the firm. Furthermore, each director votes individually based on private information. So my model put more emphasis on the role of the voting procedure in aggregating information both from insiders and outsiders. This focus is motivated by the observation that no deliberation before voting can eliminate the differences in opinions and preferences of the directors (for example, think about legal or political debates) and thus individual voting is ultimately an important way to express specific opinions. My model also considers the advisory role together with the independence of outsiders.

In an interesting paper, Hermalin and Weisbach (1998) formulate a model that gives board structure as the result of negotiations of existing directors with CEO's, where the bargaining power of the CEO comes from his perceived ability relative to replacement candidates. My model focuses on the internal interactions of the board, instead of the relation between the board and the CEO and thus is complementary to their study.

The structure of this paper is as follows. Section 2 introduces the model setup. Section 3 presents the main results on optimal board composition and optimal voting rules. Section 4 introduces the concept of strategic voting. Section 5 gives theoretical results on strategic voting equilibria. Section 6 concludes.

2. The Model

I will consider a model of the board making a decision on a project proposed by the CEO (see endnote 2). This will cover many of the typical board tasks. This is a two-period model. For simplicity, I assume that everyone (directors and shareholders) is risk-neutral and the interest rate is 0. In the first period, the CEO proposes a project, which will generate a cash flow $s > 0$ in the second period. S is not known precisely to any person. However, in the first period, each director i receives a private signal ti about s. The board then meets together to make decision on the project, each member casting her vote based on her individual information and preference. The decision is then made according to the majority rule (see endnote 3): if at least half of the directors accept the project, then the project is passed; otherwise, it is rejected.

Before I go into further details of the model, I want to plot out the main features of the model here. Aside from the CEO himself, the other directors are divided into two classes: outsiders (or independent directors) and insiders (or inside directors). From the perspective of firm value maximization, outside and inside directors both have their advantages and drawbacks.

Outside board directors can offer important advice to the management based on their specific expertise, and they are the key in ensuring an independent opinion of the board from the CEO; their disadvantage is that they lack the in-depth knowledge of the firm that insiders and CEO have. Having a superior knowledge of the firm's operations and prospects than outsiders, insiders in the board can contribute to a sensible decision of the board; however, their positions in the firm imply that they would generally not want to ruffle the feathers of CEO's and that will be a problem when the CEO proposes a money-losing project (which can bring private benefits to the CEO either through perks, empirebuilding motives or career embellishments). Since outsiders and insiders have distinct objectives and furthermore, each director has her individual private information, it is only through the voting procedure that their information and preferences are aggregated into a decision of the board as a whole (see endnote 4).

The questions are: given the above consideration, what will be the optimal composition of a board? How the optimal composition is affected by the various factors? Answers to these questions will not only shed light on how regulators should make corporate governance laws, but also provide predictions for empiricists to test. The following gives details of the model setup.

2.1. The Project and the CEO

A project generates a deterministic cash flow *s* if the project is accepted and implemented. If the project is rejected, the firm has cash flow 0. The project proposed by the CEO has distribution

$$s \sim N(\mu_0, \sigma_0^2),$$

i.e., the CEO may have proposed a project with any cash flow *s* from the normal distribution. μ_0 is the expected payoff among all the projects. The cash flow *s* can be either positive or negative, reflecting the CEO's ability and private preference. The standard deviation σ_0 reflects the range of possible projects that the CEO may propose. Assume that ¹0 has the the following form,

$$\mu_0 = m_0(1 - \frac{1}{1+n_B}),$$

where *m*0 > 0 is a constant and *nB* is the number of outsiders. Note here μ_0 is increasing with *nB*, but the marginal increase to μ_0 becomes smaller as *nB* gets larger. This is motivated by the following. Outside board members can make advice that complements the CEO's knowledge. This advisory role of outsiders increases the "goodness" of the projects that the CEO may propose by increasing μ_0. However, as the number of outsiders get larger, the increase to project value due to advisory roles of outsiders are likely to decrease. The constant *m*0 can be thought of as the indicator of outsiders' advisory abilities.

2.2. Insiders

There are *nA* insiders (in addition to the CEO) (see endnote 5), labeled by $i \in \{1, \ldots, n_A\}$. Each insider has a private signal *ti* of the project

$$t_i = s + \varepsilon_i, \quad \varepsilon_i \sim N(0, \sigma_A^2)$$

Hence an insider's information is unbiased and the noisiness of the signal is σ_B. The smaller σ_B is, the more knowledgeable the insider is about the project. Let *{Accept;Reject}* denote the events that the project gets accepted, or rejected respectively. Although they receive unbiased signals, insiders have biases toward the CEO, which is reflected in their utility functions. Insider *j*'s utility function is given by.

$$U_i(Accept; t_i) = E[s + b|t_i] = b + E[s|t_i],$$

$$\text{and } U_i(Reject; t_i) = 0$$

Here *b* > 0 is a constant and represents the bias of insiders toward the CEO. An insider will OK the CEO's project as long as his perception of the expected cash flow $\bar{s} = E[s|t_i] \geq -b$, i.e., if he thinks that the project will not lose money by more than *b* dollars.

2.3. Outsiders

There are *nB* independent directors, labeled by $j \in \{n_A + 1, \ldots, n_A + n_B\}$. $n = n_A + n_B$ is the

total number of directors in addition to the CEO. Each outsider receives a private signal *tj* about the project

$$t_j = s + \varepsilon_j, \quad \varepsilon_j \sim N(0, \sigma_B^2)$$

In general, $\sigma_B > \sigma_A$ so that insiders have more accurate information about the project than outsiders.

Outsiders' utilities are completely aligned with those of shareholders, i.e., they maximize firm values (see endnote 6). The utility function of outsider *i* is

$$U_j(Accept; t_j) = E[s|t_j], \quad \text{and } U_j(Reject; t_j) = 0$$

In contrast with insiders, an outsider will OK the project only if her estimate of the expected cash flow $E[s|t_j] \geq 0$. In addition to being unbiased in judgment, outsiders contribute to the firm in their advisory role, as summarized in (1).

2.4. Valuation of the Firm

Without loss of generality, assume the firm has a single project and the project is the only source of cash flow of the firm. In making decision on the project, the directors cast votes simultaneously and each director votes according to his/her own private information. Therefore, from above and the Bayesian updating formula for normal distributions, an insider *i* votes for the project if and only if

$$E[s|t_i] = \frac{\sigma_0^2 t_i + \sigma_A^2 \mu_0}{\sigma_0^2 + \sigma_A^2} \geq -b$$

i.e.

$$t_i \geq \mu_A = -\mu_0 \frac{\sigma_A^2}{\sigma_0^2} - b(1 + \frac{\sigma_A^2}{\sigma_0^2})$$

Similarly, an outsider *j* will vote for the project if and only if

$$t_j \geq \mu_B = -\mu_0 \frac{\sigma_B^2}{\sigma_0^2}$$

The project is accepted if and only if at least half of the directors vote for the project (see endnote 7). Hence the event the project getting accepted is

$$Accept(t_1, \ldots, t_n) = \{\#\{i : t_i \geq \mu_A, 1 \leq i \leq n_A\} + \#\{j : t_j \geq \mu_B, n_A+1 \leq j \leq n = n_A+n_B\} \geq \frac{n}{2}\}$$

The firm's value is then given by (as there is no cash flow if the project is rejected)

$$U = U(n_A, n_B; \sigma_A, \sigma_B, b, m_0, \sigma_0) = E[s \cdot \mathbf{1}_{Accept(t_1,\ldots,t_n)}]$$

3. Optimal Board Composition

After setting up the model of a corporate board, the central question that concerns us is to find the optimal board composition that maximizes the firm value. To be precise, we want to solve the following problem.

$$U^* = U^*(n, \sigma_A, \sigma_B, b, m_0, \sigma_0) = \max_{n_A} U(n_A, n_B; \sigma_A, \sigma_B, b, m_0, \sigma_0)$$
$$\text{s.t. } n_A + n_B = n$$

Let $n_A^* = n_A^*(n, \sigma_A, \sigma_B, b, m_0, \sigma_0)$ be the optimal number of inside directors, fixing other parameters and the size of the board (see endnote 8). The analytical expression of the firm value in (6) is a very complicated multiple integral as the cash flow *s* and the private signals *ti* are correlated random variables. This expression can be written down explicitly but solving the optimization problem (7) using this formula seems impossible. However, the firm value is an expected value and the Monte Carlo method is well-suited to find such values when there are no easy-to-calculate explicit formula.

Therefore, for a set of parameters $(n, \sigma_A, \sigma_B, b, m_0, \sigma_0)$, I solve problem (7) by computing the firm value *U* for each choice of composition *nA* by Monte Carlo methods and then finding the maximum value U^* at $n_A = n_A^*$.

In the following, I first report the optimal board composition for a typical set of parameters. Then, I investigate the effects of changing the characteristics of the firm and the directors on the optimal board. Throughout the analysis, we should keep in mind that an optimal board composition will balance the benefits and costs of having insiders and outsiders.

3.1. Choice of Parameters and Methodology

The following table gives my choice of the parameters for the base case and the solution to the optimal board composition problem (7).

U^*	n_A^*	n	σ_A	σ_B	b	m_0	σ_0
0.852	4	10	0.5	2	0.5	0.2	2

The board size *n* (excluding the CEO) is fixed at 10, based on the fact that an average corporate board in the U.S. has 11 members. The accuracy of insiders' and outsiders' information are fixed by setting $\sigma_A = 0.5 < \sigma_B = 2$, meaning insiders have better information about the project than outsiders. The bias of the insider is set at *b* = 0:5 (if *b* is too large, then insiders are of no use to the board, as we shall see later). The prior distribution of projects have mean $\mu_0 = m_0(1 - \frac{1}{n_B+1}) = 0.2(1 - \frac{1}{n_B+1})$ and variance $\sigma_0 = 2$. Here *m*0 is taken at a value so that outsiders have reasonable advisory abilities and $\sigma_0 = 2$ is close to σ_A and σ_B so that the prior distribution have some effects but will not have too much effects on the decision of directors (see endnote 9).

For each *nA*, I simulate *N* = 100000 observations of the cash flow and directors' private information $\{s, t_1, t_2, \ldots, t_3\}$ based on their joint distribution. In each observation $1 \leq k \leq N$, whether the project is accepted or not (1*Accept;k*) is computed and then by Monte Carlo method, the firm value is computed as

$$U(n_A) = E[\mathbf{1}_{Accept} s] = \frac{1}{N} \sum_{k=1}^{N} s_k \cdot \mathbf{1}_{Accept,k}$$

U¤ and *n*¤*A* are then computed by maximizing *U*(*nA*) over *nA* = 0*; : : : ;* *n* = 10. Next, I will present the effects of changes in firm and director characteristics on the optimal board composition and optimal firm value.

3.2. Informedness of outsiders

More knowledge about the firms' operations of outsiders increases the attractiveness of having more outsiders sitting on board. Outsiders may be more informed about the firm's operations if they work or have worked in related industries, have sat in the board of other firms in related industries, or have related education background. On the other hand, if outsiders have never had experiences directly related to the firm's specialized field, they will have less knowledge about projects of the firm.

Figure 1 shows the optimal board composition and optimal firm value at different levels of informedness of the outsiders. First, clearly, the firm value (*U*¤) and the optimal number of outsiders (10 - *n*¤*A*) increase with the informedness of outsiders $(1/\sigma_B)$. Second, note that it is optimal to have no insiders on the board if outsiders have comparable knowledge about the project with insiders. In fact, in Figure 1, if $\sigma_B < 1.4$ (recall that $\sigma_A = 0.5$), the optimal board would be all outsiders. The intuition is simple: when outsiders are about as knowledgeable as insiders, insiders are strictly worse than outsiders due to their biases in preferences.

Third, note that although when outsiders get less informed (σ_B increases), the optimal number of outsiders decreases, it does not decrease to zero. This is because outsiders have advisory abilities, which cannot be replaced by insiders' more accurate information, no matter how many insiders we add.

3.3. Informedness of insiders

Insiders' knowledge about the firm's operations are likely to be better than outsiders in general. The extent of an insider's informedness about the firm may depend on the number of years he has worked in the firm or related firms, his rank and position in the company, his educational background as well as his particular capabilities and achievements. Figure 2 displays the effects of insiders' knowledge about the project on the optimal board composition and the firm value. Firms with more knowledgeable insiders, *ceteris paribus*, would have an optimal board structure with a higher proportion of insiders. Firm's value also increases with the extent of knowledge of insiders, everything else equal. Intuitions for these facts are similar to those for the effects of outsiders' informedness.

3.4. Bias of insiders

The tendency of insiders to uphold the decision of the CEO can depend on the degree of entrenchment of the CEO, the private benefits to insiders from the project, the concern about the overall health of the company, and the moral characters of insiders. Figure 3 shows the dependence of optimal board composition and firm value on the bias of insiders. The more biased insiders are, the less insiders the optimal board will include, and the less the firm value will be. This is because if the inside board directors are more biased, the CEO's proposal will get passed with higher probability. While some good projects get passed more frequently, which is good for the company, the increase in the probability that a bad project get passed is greater. Thus, the overall effect of increased insiders' biasedness on the firm value is negative and this will cause the optimal board to admit fewer insiders.

3.5. Advisory ability of outsiders

Outsiders have stronger advisory abilities if they have expertise in specialized fields related to the project. By providing advice to the CEO before he make decisions, outsiders can increase the expected profitability of the proposed project. Figure 4 presents the influence of outsiders' advisory function on optimal board structure and the firm's value. The optimal board include more outsiders if they are more capable advisors. However, since the value-enhancing effects of outsiders' advisory role has decreasing returns on the number of outsiders, insiders' superior information is useful when there are already a significant number of outsiders and we do not usually see a board that consists fully of outsiders (see endnote 10).

3.6. Range of available projects

A young, growth, or R&D intensive firm might have a greater range of potential projects to choose from than a mature firm. A wider range of selectable projects can mean both challenge and opportunity. With a capable CEO and an effective board, more profitable projects can be sieved from a wider selection and the firm value is enhanced.

Figure 5 displays the dependence of optimal board composition and firm value on the range of potential projects. The first relationship is not monotone. When the range of projects is very small, the prior knowledge about the project is so precise that insiders' superior information is of little use. Therefore, when the range (σ_0) is small, optimal number of insiders increases with the range. When the range of projects becomes bigger, insiders' information advantage to outsiders becomes less important while insider's bias and outsider's advisory function persist; hence the optimal number of insiders is eventually decreasing with the range. Insiders' superior information is most useful when the range (σ_0) has a moderate value (here around $0.7 \sim 0.8$). Note also from Figure 5 that the firm value is increasing with the range of projects, due to the wider selection of projects offered by a greater range σ_0 (see endnote 11).

3.7. Flexible voting rules

Majority voting rule is most commonly used in corporate boards. However, other voting rules are not uncommon in reality, e.g., the two-thirds rule in major U.S. Senate decisions and the unanimous rule in jury decisions. So a natural question is, what is the optimal voting rule for corporate boards? Does changing the voting rule help to make the board more effcient? I define a *voting rule* to be a number $0 \leq \lambda \leq 1$. The board makes its decision according to voting rule λ if the project is accepted if and only if at least fraction λ of the board members (aside from the CEO) vote for the project. For example, the majority voting rule would be the voting rule given by $\lambda = 0.5$. And a voting rule $\lambda = 0.6$ in a 10-member board (excluding the CEO) would mean that for the project to get accepted, at least 6 board members should vote for the project. This will be a tougher rule than the majority rule from the CEO's point of view. In the flexible voting rules setting, the optimal voting rule λ^* together with the optimal board composition n_A^* are solved. Figure 6 compares the optimal board composition and optimal firm value under the majority voting rule, and under the flexible voting rules. First, we see that the optimal voting rule λ^* is 0.6 for $\sigma_B > 1$, so that the majority voting rule is not optimal when outsiders are not very well informed.

Second, in the optimal board structure, there are more insiders with flexible voting rules than with the majority voting rule. This comes from the following intuition. Under a voting rule $\lambda > 0.5$, the outsiders can veto the project more easily than under the majority rule. Therefore, the negative impact of having more biased insiders on the board are diminished. And due to the positive effect of having more informed insiders, the optimal board will consist of more insiders. Instead of requiring a majority of independent directors on board, we may recommend companies to have a tougher voting rule against the CEO and have more tolerance on the proportion of inside directors. According to the results here, such recommendation will suit the interests of shareholders better. From the second figure in Figure 6, the increase in firm value due to flexible voting rules can be substantial (see endnote 12).

The author also considers the possibility that assigning more voting weights to outsiders than insiders, while maintaining the majority rule, i.e., one vote from an outsider counts more than one vote. This will have somewhat similar effects as the flexible voting rules and indeed produce similar results to above in certain setups (unreported here). However, giving more weight to a director than another seems to be unfair and induce greater incentives for collusion. So it is less practical than allowing flexible voting rules.

4. Strategic Voting

In the setup of the board model, the board members' utility depend on their own private information (see (2) and (3)), but not on the private information of other board members. In other words, we assume board members vote *sincerely*, in the terminology of the voting literature. These assumptions were made to avoid the consideration of complicated equilibrium strategies in games with private information (see endnote 13). In this section, I will consider the possibility that directors use all available information strategically. To be precise, redefine the utility functions of outsiders and insiders as follows. For an insider *i*,

$$U_i(Accept; t_i) = E[s + b|Accept, t_i] = b + E[s|Accept, t_i], \quad \text{and } U_i(Reject; t_i) = 0$$

For an outsider *j*,

$$U_j(Accept; t_j) = E[s|Accept, t_j], \text{ and } U_j(Reject; t_j) = 0$$

Definition A collection of voting strategies of the board of directors is a *strategic voting equilibrium* if these strategies form a Bayesian Nash Equilibrium, with the utility functions given by (8) and (9).

In strategic voting (pivotal voting), the board members consider the consequences of their voting on the final decision and then on their own utility through the final decision and maximize their expected utility given other members' strategies. Thus, in strategic voting, a board member only cares about the case when he/she is *pivotal*, i.e., when his/her vote changes the final result, given others' votes, because only then his/her action will affect his/her utility. Feddersen and Pesendorfer (1997) shows that strategic voting can fully aggregate information when the number of players goes to infinity and sincere voting does not always aggregate information fully. Therefore, I would like to look at strategic voting equilibrium in the board (see endnote 14).

5. Some results on strategic voting equilibria

In this section I will focus on the existence and properties of the strategic voting equilibria, rather than on the optimal board composition (see endnote 15). The basic assumptions are essentially the same as those in Section 2, except that here I make different assumptions about the distributions of the project's cash flow and private signals of board directors for theoretical convenience. The firm has a project *s* with distribution $s \sim F(s)$. There are $n_A \geq 1$ insiders and $n_B \geq 1$ outsiders on the board and the board votes by majority rule (see endnote 16).

Assumption 1 1) $t_1, t_2, \ldots, t_n$ are independent conditional on *s*.

2) $s, t_1, t_2, \ldots, t_n \in T$, where $T \subset \mathbb{R}$ is bounded.

3) For each *i*, *s* and *ti* satisfy Monotone Likelihood Ratio Property (MLRP).

These are standard assumptions in the theoretical literature. Note that 2) requires that the distributions have bounded support, which is not satisfied by the normal distribution. A (mixed) strategy of director *i* is a function $\pi_i : T \to [0, 1]$. $\pi_i(t_i) = p$ means that *i* vote for the project with probability *p*. A *monotone pure strategy* is a strategy π_i such that

$$\pi_i(t_i) = \begin{cases} 0, & t_i \le c \\ 1, & t_i > c \end{cases}$$

for some constant c. c is called the cutoff point of the strategy.

Theorem 1 *With Assumption 1, there exists a monotone pure strategy strategic voting equilibrium.*

The proof uses the usual fixed point theorem. I'll omit it here and refer the reader to the proof in Feddersen and Pesendorfer (1997). A slight modification of their proof will suffice.

Recall that with full information, outsiders will vote for the project if and only if $s \ge 0$, and insiders will vote for the project if and only if $s \ge -b$. For our next result, we need

Assumption 2: There exists $0 < a < b/4$ such that for all i, $|t_i - s| < a$.

This assumes that directors have sufficiently accurate signals.

Theorem 2 *(1) If nA > nB, then there exists a monotone pure strategy equilibrium in which outsiders always vote sincerely, and insiders use a monotone strategy with a cutoff point* $c_A \in (-b-a, -b)$.

(2) If nA < nB, then there exists an equilibrium in which insiders always vote sincerely, and outsiders use a monotone strategy with a cutoff point $c_B \in (0, a)$.

(3) If nA = nB, then there exists an equilibrium in which insiders use a monotone strategy with cutoff point $c'_A \in (-b-a, -b)$ *and outsiders use a monotone strategy with a cutoff point* $c'_B \in (0, a)$.

Proof. 1) Suppose that *nA* > *nB*. Consider an outsider *j*. If *j*'s signal *tj* is not in (- *a; a*), then by Assumption 2, *j* knows with certainty the sign of *s* (which is the same as the sign of *tj*). Hence *j* will vote according to the sign of *tj* as she needs no further information about the true state *s*. If on the contrary $t_j \in (-a, a)$, then by Assumption 2 *j* knows that $s \in (-2a, 2a)$. And *j* also knows that any insider *i*'s signal $t_i > s - a > -3a > -b + a$. Hence *j* knows that *i* will know with certainty that *s* > ¡*b* and *i* will vote for the project. Now *nA* > *nB*, so *j* knows the project will get passed and *j*'s vote doesn't matter. Hence we may assume *j* votes sincerely in this case without harm. In summary, sincere voting will be a best response strategy for *j*.

Now consider an insider *i*. By Assumption 2, he votes sincerely (according to the sign of *ti* +*b*) if *ti* is not in (- *b* - *a*;- *b* + *a*). When $t_i \in (-b-a, -b+a)$, similar to above, *i* knows that all *nB* outsiders vote against the project. So *i* is pivotal only when $n_B + k - 1$ or $n_B + k$ other insiders vote for the project and *k* other insiders vote against it. Here $k = [(n_A - n_B)/2]$. But this tells *i* that more insiders voted for than against the project and there is no information from outsiders' voting since they all vote no here. Hence *i* should accept the project more readily with this additional information and would use a voting strategy with a cutoff point *cA* < - *b*.

On the other hand, the cutoff point *cA* > - *b* - *a*, because at *ti* = - *b* - *a*, *i* knows with certainty that the true state $s \le -b$ and sometimes is greater than *b*, hence he would vote against the project.

2) and 3) may be proved in a similar way. Intuitively, the theorem says that with strategic consideration, the directors adopt a modified voting strategy. Outsiders will adopt a tougher stand in accepting the project and insiders will adopt an easier stand in accepting the project. This kind of phenomena is similar to what happens in negotiations, where both parties of the negotiation initially take stands biased away from their opponents' preferences (see endnote 17).

6. Conclusion

The current work serves as an effort in theoretically modeling the key features of corporate board and study the optimal board composition problem. For further research, it would be interesting to test the predictions of the current model. Indeed, many predictions of this model can already be checked with previous empirical work, e.g., Lehn, Patro and Zhao (2003). One main difficulty in testing such models lies in that we do not know whether firms in the real world choose optimal board structure or not. This problem is partially solved by the methodology of Lehn, Patro and Zhao (2003), in which they look at long-lived firms, which presumably have better governance.

Another difficulty is the measurement and control of the parameters of the model. Suitable proxies should be considered for the various characteristics of board directors and the firm. While the current model incorporate many important factors of corporate board, it is far from complete. The most notable omission is the interaction between the board and the CEO. A natural next step could be to extend the current model to a dynamic model with interactions with CEO, borrowing the ideas of Hermalin and Weisbach (1998). Another possible direction of theoretical extension is further investigation in strategic voting equilibrium, including dynamic models. It is the hope that this work and potential future work in this area will help us, in particular, regulators and business leaders, to understand better the problem of board composition and makebetter regulations and policies.

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Endnotes

1. See Bahgat and Black (1999) for example.
2. While one can imagine that it might be better for the CEO to propose several alternatives and the board selects the best of them, it is more commonly the case that CEO makes a proposal and the board then makes a yes-or-no decision.
3. The majority rule seems to be the norm for most board decisions. Later I will discuss the possibility of allowing flexible voting rules and its implications.
4. One can imagine other mechanisms of decision-making, say, a game of information revealing and negotiation, and equilibria can be studied in that setting. However, in reality, voting is the preferred mechanism. Voting also has the benefit of being a simple and clean mechanism in multi-person decision making.
5. Since the CEO always vote yes for the project he proposed, we exclude the CEO in the following consideration.
6. Here I ignore the possible agency conflicts between debtholders and shareholders. With such agency conflicts, the board, in maximizing shareholder values, may not be maximizing the firm value. However, this is a secondary issue when we consider optimal board composition and will not affect my argument.
7. For simplicity, assume that $n = nA + nB$ is even, so when there is a tie, the CEO will break the tie and pass the project. The assumption about tie-breaking does not affect the results.
8. In fact, I do not consider any size related costs here, hence a bigger board is always better than a smaller board in my model as there will be more accurate information aggregation. As pointed out in other theoretical and empirical studies (e.g., Lehn et al (2003) and Reheja (2004)), there are size-related costs, such as coordination and free-riding costs. It is easy to extend my model to consider such costs and study optimal board sizes. Such studies are likely to confirm the stylized results. For simplicity, I focus on the composition of board here and keep board size $n = nA+nB$ fixed.
9. Despite the arbitrary nature of the choice of the base parameters, the qualitative results on board composition do not depend on these particular choices.
10. An all-outsider board can be optimal if insiders are too biased to be of any benefits to the board; such a situation may happen but is likely to be rare.
11. Here σ_0 should not be confused with the volatility of a project's cash flow. In fact, each project's cash flow is deterministic, and σ_0 (roughly) represents the range of *all* possible projects.
12. Of course, such recommendations have to be based on relating the parameters in my model to realistic settings. Nevertheless, this points to the possibility of increasing the effectiveness of corporate boards by relaxing the requirements on boards, e.g., by SOX.
13. See Austen-Smith and Banks (1996) for a very nice introduction to strategic voting.
14. However, we should keep in mind that sincere voting is more robust than strategic voting; each board member's decision depends only on his/her opinion and hence is not subject to errors of estimation of parameters of the game. So in reality, considering the difficulty of measuring the parameters precisely, the board of directors may well be voting sincerely. This is also the reason why this paper is mainly focused on sincere voting results. Whether home strategic voting behaviors actually happen in the board room is an empirical issue.
15. The optimal board composition under strategic voting is a more tricky problem as there could be multiple equilibria.
16. Note that in a board with all insiders or all outsiders, everyone will vote sincerely in the equilibrium as they have the same preferences. Hence to study strategic voting I assume there are both outsiders and insiders on the board.
17. Although Assumption 2 is required in the proof of Theorem 2, there is reason to believe that this kind of phenomenon is quite common in strategic voting equilibrium. This is confirmed by unreported Monte Carlo computation of the strategic equilibria.

Appendices

Figure 1: **Effects of informedness of outsiders**

This figure examines the dependence of the optimal number of insiders (n_A^*) and the optimal firm value (U^*) on the informedness (σ_B) of outsiders about the firm's project. The other parameters of the model are the same as in the base case (see Section 3.1), $(n, \sigma_A, b, m_0, \sigma_0) = (10, .5, .5, .2, 2)$.

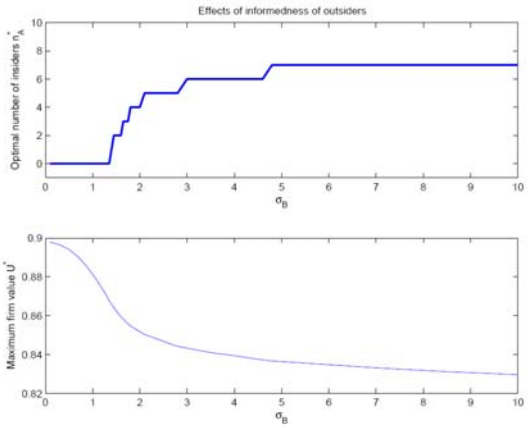

Figure 2: **Effects of informedness of insiders**

This figure examines the dependence of the optimal number of insiders (n_A^*) and the project value (U^*) on the informedness of insiders (σ_A). The other parameters of the model are the same as in the base case (see Section 3.1), $(n, \sigma_B, b, m_0, \sigma_0) = (10, 2, .5, .2, 2)$.

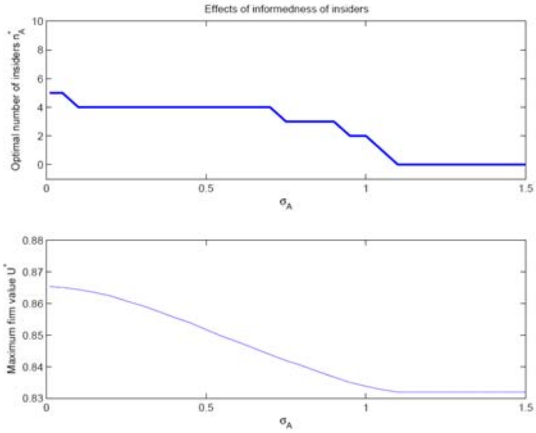

Figure 3: **Effects of insiders' bias**

This figure examines the dependence of the optimal number of insiders (n_A^*) and the project value (U^*) on the bias of insiders (b). The other parameters of the model are the same as in the base case (see Section 3.1), $(n, \sigma_A, \sigma_B, m_0, \sigma_0) = (10, .5, 2, .2, 2)$.

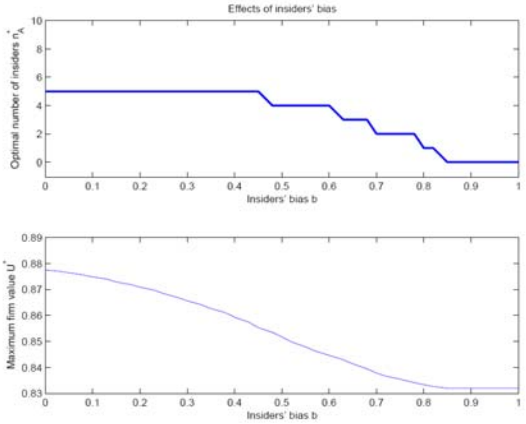

Figure 4: **Effects of advisory ability of outsiders**

This figure examines the dependence of the optimal number of insiders (n_A^*) and the project value (U^*) on the advisory ability of outsiders (m_0). The other parameters of the model are the same as in the base case (see Section 3.1), $(n, \sigma_A, \sigma_B, b, \sigma_0) = (10, .5, 2, .5, 2)$.

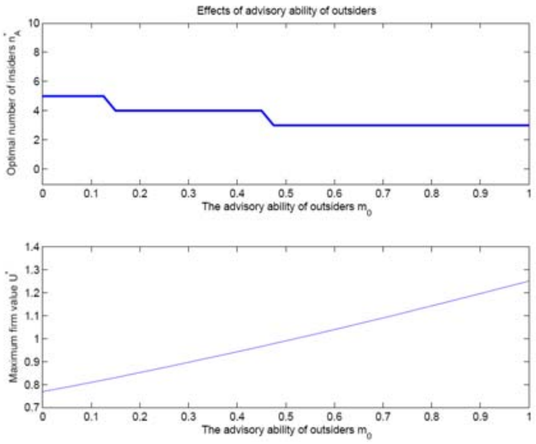

Figure 5: **Effects of range of selectable projects**

This figure examines the dependence of the optimal number of insiders (n_A^*) and the project value (U^*) on the range of possible projects (σ_0). The other parameters of the model are the same as in the base case (see Section 3.1), $(n, \sigma_A, \sigma_B, b, m_0) = (10, .5, 2, .5, .2)$.

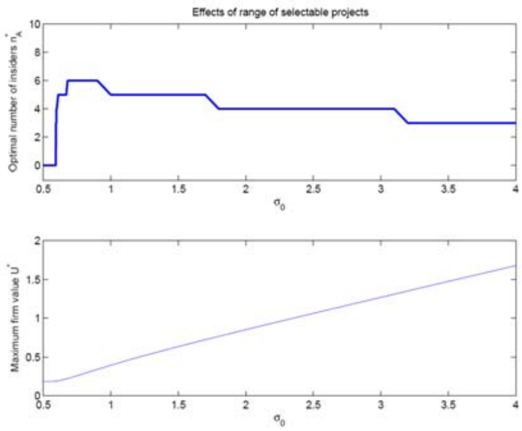

Figure 6: **Comparing the majority voting rule with flexible voting rules**

This figure compares the dependence of the optimal board composition and optimal firm value on the informedness of outsiders σ_B, under the majority voting rule and flexible voting rules settings. The other parameters of the model are the same as in the base case, $(n, \sigma_A, b, m_0, \sigma_0) = (10, .5, .5, .2, 2)$.