

Sabotage in Promotion Tournaments

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This article studies the nature, determinants, and impact of “negative” activities in organizations. In competing for promotion, the members in organizations can work not only to enhance their own performances, but also to “sabotage” their opponent’s performances. It is worthwhile for them to engage in negative activities because promotion is generally based on relative, rather than absolute, performance, and its nature is winner take all. I find that abler members are subject to more attacks. Consequently, not only is there a double inefficiency in effort, but also members of the highest caliber might not have the best chance of being promoted. Finally, I discuss several institutional designs that might help to reduce the influence of negative activities.

1. Introduction

An often observed phenomenon in organizations—both political and economic—is that a rising “star,” who is widely believed to be the future leader of the team, slumps in midcareer and fails to succeed. On the contrary, it is often the one who tends to be obscure and deliberately keeps a low profile that eventually emerges as the leader. For example, before the Tiananmen Square incident, Zhao Ziyang was expected to be the leader of the Chinese Communist Party after Deng Xiao-Ping died. Instead, Jiang Zemin and Li Peng rose to power. Even in the early 1990s, Jiang was considered to be a weak leader. However, after the 15th Congress of the Chinese Communist Party, he emerged as a leader with strong power in hand.¹ Similar examples are seen in corporate life. At the time the merger plan for Time and Warner Communication was made public in 1989, there was an understanding that Michael Nicholas, the president of Time, and Warner’s chief executive officer (CEO) Steven Ross, were to become the co-CEOs of Time-Warner Inc., and when Steven Ross stepped down in 1994, the former would be the sole CEO. In the ensuing power struggle, however, Nicholas was ousted and replaced by his archrival Gerald Levin. After Ross’s death in 1992, Levin became Time-Warner’s chairman and

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1. One example in U.S. politics is Mario Cuomo, ex-governor of New York. For many years he had been considered a top contender for the U.S. presidency, but he eventually faded from the scene. Simply, too many people had seen him as a potential rival.

the final winner. Levin's early career path often crossed that of Nicholas and was often on the losing side. He was said to eschew displays of power, and as he rose in the hierarchy over the years, "he continued to marvel aloud at how unlikely it was that he should find himself in the aerie of corporate power" (Bruck, 1992:36).

Why has this so often occurred? The premise of this article is that it is not just a matter of envy from opponents or luck. Within an organization, besides working to improve performances, individual members can also work to decrease the performance of others, especially when payoffs or the chance of promotion depends on relative, rather than absolute, performance.² The situation is exacerbated by the fact that promotion is generally all or nothing:³ The winner receives all the benefits and the loser none, or even worse.⁴ The "negative" activities of members can take many forms, including noncooperation, spreading rumors, purposeful delay of execution, and transmission of false information. When a contestant is thought to be more able and more likely to be promoted, her opponents will be more likely to "sabotage" her in order to offset her advantage in ability or performance. Consequently, more negative effort will be directed against her. If the number of contenders is small, these negative efforts might not be enough to overturn the ablest contestant's advantage. However, when there are sufficiently many contenders, sometimes the total attacks might be so strong that the leading contender's performance can fall behind the less able ones. This result is in sharp contrast to the case when the contestants can only exert positive effort. In a traditional contest model (e.g., Lazear and Rosen, 1981; Green and Stokey, 1983), the one with the highest ability always has the greatest probability to win. This is no longer true when the contestants can also engage in negative activities. More recently, Milgrom (1988), Milgrom and Roberts (1988), and Prendergast and Topel (1996) studied the inefficiency arising from members in organizations wasting resources trying to convince their superiors of their abilities rather than engaging in productive activities. The picture in our model is even starker: Contestants not only expend resources to persuade their superiors, but also actively undercut the performance of their opponents.

The existence of "negative" activities, especially against the leading contestant, is pervasive in political and economic life. For example, the appointment of Semon Knudsen by Henry Ford II as president of Ford Motor Company, the subsequent power struggle between Knudsen and

2. The fact that promotion is based on past performance deserves some explanation. Generally performance is positively correlated with ability and effort. In that case, better past performance will signal better future performance. It can be argued, however, that in reality, management and political abilities might be equally important in considering promotion, if not more so. So we are discussing only one of the components on which promotion is based, and are thus concerned with nonleadership aspects of promotion. I thank a referee for pointing this out.

3. For more on this, see Frank and Cook (1995). For an excellent survey of promotion in firms, see Gibbons and Waldman (1999).

4. In political power struggles, winners almost always purge their enemies from the government or party after winning.

Lee Iacocca, and Knudsen's final resignation in the 1960s led Zaleznik (1970:51) to conclude that "the politics of corporations are fewer aberrations and more conditions of life in large organizations." In political competition, it is common to observe the use of negative campaigns against other candidates, especially by those who fall behind in the polls.⁵ In fact, negative activities exist not only in organizations, but in virtually every competitive environment. Brenner (1987:69) records that when it comes to business, as "people fall behind they may not only innovate, or follow an innovator, but also may compete by foul strategy." He goes on to record the perverse use of antitrust litigation by a series of rival companies to attack the leading firms, for example, IBM and Kodak, as a way of competition. Many competitors against Microsoft have developed products and filed antitrust suits simply to "stop Microsoft" as the dominant firm in the operating system industry (Levy, 1996).⁶ Consequently the context to which our results apply is potentially much broader.

Our article is related to recent literature regarding the multidimensional nature of the agent's effort. This literature studies the optimal allocation of a worker's effort when she is in charge of more than one task and the corresponding optimal compensation scheme in order to induce efficient levels of effort.⁷ Interpreted in terms of this literature, a contestant in our model has different "tasks" (for productive and destructive activities) and decides how much effort to allocate to each task. The model is also related to the rank-order tournament model of Lazear and Rosen (1981) and Green and Stokey (1983), with the additional feature that the contestants compete not only to outperform but also to undercut opponents. Lazear (1989), as far as the author is aware, is the first to investigate the impact of negative activities in the context of a firm. He concentrates, however, on the role of pay compression in reducing the levels of these efforts.

2. Model

There are n members in an organization and one of them is to be promoted to a higher position. A member's performance in the organization is influenced by two kinds of effort. The first is positive (or productive) effort, which can increase the performances of the members. The second kind of effort, negative effort, does not increase their performances; instead, it is used to attack (sabotage) opponents in order to decrease their performances.

Let e_i be the level of the positive effort of member i and a_{ij} be the level of negative effort member i exerts against j . As in the standard principal-agent model, e_i and a_{ij} are not observable to the principal. The performance of

5. For theoretical discussions of negative campaigning, see Skaperdas and Grofman (1995) and Harrington and Hess (1996).

6. Similarly Microsoft is also notorious for using threat of patent litigation to scare away potential (smaller) rivals.

7. See, for example, Hölmström and Milgrom (1991) and Itoh (1991) for theoretical discussions, and Slade (1996) and Drago and Garvey (1998) for empirical evidence.

member i is assumed to be $W_i \equiv t_i e_i - g(\sum_{j \neq i} s_j a_{ji}) + \varepsilon_i$, with $g' > 0$, $g'' < 0$, and $g(0) = 0$. The value of performance is assumed to be verifiable. $t_i > 0$ represents the ability of member i in the productive activity, and $s_i > 0$ is the “talent” of i at sabotage. A person who is talented in productive activity might not also be talented in negative activity. As a result, a greater value of t_i does not imply a greater, or smaller, value of s_i . However, we can define $r_i = t_i/s_i$ as the comparative ability of member i in productive activities. A greater value of r_i implies that i is relatively more skillful in productive activity than in negative activity. If $r_i > r_j$, we say that i has greater comparative ability in productive activity than j .⁸ We will call $\sum_{j \neq i} s_j a_{ji}$ the total attack member i receives. Note that positive and negative efforts are not symmetric: An increase in positive effort increases self-performance and helps only the one who exerts it; while an increase in negative activity against a particular member decreases the performance of that member, which not only helps the one who exerts the negative effort (and who bears its cost), but also all the other members.⁹

The function $g(\cdot)$ measures the effectiveness of attacks in destroying performance. For any $i \neq j$, ε_i and ε_j are i.i.d. with continuous density function $f(\cdot)$ and distribution function $F(\cdot)$. Suppose that $f(\cdot)$ is single-peaked and symmetric around 0, so that the expected value of ε_i is 0. Thus ε_i is a “neutral” noise on performance and can be interpreted as “luck,” which is out of human control. Technically it also (i) prevents the superior from inferring the value of any member’s ability by observing her performance, and (ii) ensures that there exists pure strategy equilibrium of our tournament game.¹⁰ The utility of promotion for a member is assumed to be u , and is 0 if she is not promoted.¹¹

8. In a more general setting, outputs can depend nonlinearly on both productive and negative efforts; for example, $W_i = h(t_i e_i) - g(\sum_{j \neq i} s_j a_{ji}) + \varepsilon_i$, with $h' > 0$. In this case we need to redefine comparative ability as $r_i = t_i h'(t_i e_i)/s_i$. This has the disadvantage that the value of r_i will change with effort level, making it difficult to say which member has greater comparative ability than another. However, Theorem 1 and all the comparative statics results go through. The only exception is that negative effort will no longer be independent of u as in Proposition 4 and in Section 3.3.

9. It might be instructive to compare our setup with that in Lazear (1989). In our model, the contestants have different abilities in both positive and negative activities, but have the same cost functions. In Lazear (1989), every member has the same ability but different disutility of effort. Our specification is more general in the specification of the member’s ability, but less general in the specification of performance (output) and cost functions. The reason why we use the present setup is that it enables us to define (absolute and comparative) ability unambiguously, and thus to investigate the members’ behavior as a function of ability; while in Lazear’s setup it is difficult to do so. In terms of results, he is mainly concerned with the effect of wage policy on the behavior of different types of contestants under various ways of pairing them, and the output of the firm thereof. We are more concerned with the general properties of negative activity and its effect on the promotion prospect of the contestants.

10. I thank Parimal Bag for suggesting this to me.

11. u should thus be more properly interpreted as the difference of utilities between one who is promoted and one who is not.

The expected utility of member i is assumed to be

$$p_i(W_1, \dots, W_n, Z)u - v\left(e_i + \sum_{j \neq i} a_{ij}\right) + q(W_1, \dots, W_n, Z),$$

where $p_i(\cdot)$ is i 's probability of promotion, Z is a vector of variables other than performance that might influence the pay and promotion chance of the members, $q(\cdot)$ is the reward for effort other than promotion, and $v(\cdot)$ is the disutility of effort, with $v' > 0$, $v'' > 0$. To emphasize the relative performance and all-or-nothing nature of promotion, we will presently assume that (i) promotion is the only reward for effort, and (ii) the member with highest performance (relative to others in the same organization) will be promoted. That is, we will for the time being ignore the vector Z and function $q(\cdot)$. There can be two reasons why promotion is based on output, even in light of sabotage. First, as is generally assumed in the principal-agent literature, efforts (in our model both productive and negative) are not observable. Despite the fact that sabotage also influences output, the latter is still highly correlated with productive effort and ability. Given that output is still a valuable instrument in controlling effort, it might not be unreasonable to assume that the firm uses performance as a base for promotion. The second, and obvious, reason is that output is what the firm intends to maximize (and not the promotion chance of able members). It is only natural that the firm should base promotion on the variable that it cares about most. Surely in reality there are other types of rewards associated with efforts. In these cases the effectiveness of sabotage might change. Its nature and effects remain the same, however.

Under the assumption that promotion is based on relative performance, $p_i(\cdot)$ is simply the probability that i outperforms all other members, that is, $W_i \geq W_j$ for all j . In Section 4 we will discuss cases when performance is not the only criterion for promotion, or when there are other rewards for effort than promotion. Let $W_i = t_i e_i - g(\sum_{j \neq i} s_j a_{ji})$ be the expected performance of member i . Since the one with the highest performance will be promoted, the utility of member i can be rewritten as

$$\begin{aligned} u_i(e, a) &= \Pr(W_i + \varepsilon_i \geq W_j + \varepsilon_j, \forall j)u - v\left(e_i + \sum_{j \neq i} a_{ij}\right) \\ &= \left[\int_{-\infty}^{\infty} f(\varepsilon_i) \left(\prod_{j \neq i} \int_{-\infty}^{\varepsilon_i - W_{ji}} f(\varepsilon_j) d\varepsilon_j \right) d\varepsilon_i \right] u - v\left(e_i + \sum_{j \neq i} a_{ij}\right), \quad (1) \end{aligned}$$

where $W_{ji} = W_j - W_i$ is the difference between i 's and j 's expected performances, $(e, a) = (e_1, \dots, e_n, a_1, a_2, \dots, a_n)$, and $a_i = (a_{i1}, a_{i2}, \dots, a_{ii-1}, a_{ii+1}, \dots, a_{in})$.¹² Member i chooses the values of e_i and a_i to maximize her

12. We will also denote $a_{-i} = (a_1, a_2, \dots, a_{i-1}, a_{i+1}, \dots, a_n)$.

total utility. This is a game played among the n contestants, and the Nash equilibrium is characterized by

$$t_i \left[\sum_{j \neq i} \int_{-\infty}^{\infty} f(\varepsilon_i) f(\varepsilon_i - W_{ji}) \left(\prod_{k \neq i, j} \int_{-\infty}^{\varepsilon_i - W_{ki}} f(\varepsilon_k) d\varepsilon_k \right) d\varepsilon_i \right] u - v' \left(e_i + \sum_{k \neq i} a_{ik} \right) = 0, \quad i = 1, \dots, n. \tag{2}$$

and

$$s_i g' \left(\sum_{k \neq j} s_k a_{kj} \right) \left[\int_{-\infty}^{\infty} f(\varepsilon_i) f(\varepsilon_i - W_{ji}) \left(\prod_{k \neq i, j} \int_{-\infty}^{\varepsilon_i - W_{ki}} f(\varepsilon_k) d\varepsilon_k \right) d\varepsilon_i \right] u - v' \left(e_i + \sum_{k \neq i} a_{ik} \right) = 0, \quad \text{for } i, j = 1, \dots, n, \quad j \neq i. \tag{3}$$

This is a set of n^2 simultaneous equations in n^2 unknowns, e_i and a_{ij} , $i, j = 1, \dots, n$, $i \neq j$. Three remarks regarding equilibrium are in order. First, we need to prove its existence. This can be shown as follows. Since the expected payoff of a member is bounded by u and that $v'' > 0$, we can actually restrict the values of efforts such that $0 \leq e_i \leq \bar{e}$ and $0 \leq a_{ij} \leq \bar{a}$ for all i, j , $i \neq j$, where \bar{e} and \bar{a} are upper bounds for possible equilibrium values of efforts. Moreover, since f is continuous and $[0, \bar{e}]$, $[0, \bar{a}]^{n-1}$ are compact sets, by standard fixed-point argument there exists a Nash equilibrium. Second, we must show that the equilibrium is actually characterized by the first- and second-order conditions. There is no guarantee for this and I am forced to simply assume it. I have, however, provided the sufficient conditions for the two-person case in Section 3.1. Third, we need to ensure the uniqueness of equilibrium and, if not, make qualifications for the comparative statics results that follow. This is discussed in note 13.

From Equation (3) we have

$$\left[\int_{-\infty}^{\infty} f(\varepsilon_i - W_{ji}) \left(\prod_{k \neq i, j} \int_{-\infty}^{\varepsilon_i - W_{ki}} f(\varepsilon_k) d\varepsilon_k \right) d\varepsilon_i \right] u = \frac{v'(e_i + \sum_{k \neq i} a_{ik})}{s_i g'(\sum_{k \neq j} s_k a_{kj})}.$$

Substituting it into Equation (2) and canceling $v'(\cdot)$, it follows

$$\sum_{j \neq i} \frac{1}{g'(\sum_{k \neq j} s_k a_{kj})} = \frac{1}{r_i} \quad \forall i = 1, \dots, n. \tag{4}$$

Solving for $g'(\sum_{k \neq j} s_k a_{kj})$ from Equation (4) we have

$$g' \left(\sum_{k \neq j} s_k a_{kj} \right) = \frac{n-1}{\sum_{\ell=1}^n r_{\ell}^{-1} - (n-1)r_j^{-1}}, \tag{5}$$

which implies that if $r_i > r_j$, then

$$\sum_{k \neq i} s_k a_{ki} > \sum_{k \neq j} s_k a_{kj}.$$

Theorem 1. A member with higher comparative ability in productive activity is subject to more total attack.

The reason behind Theorem 1 is as follows. Consider any two members i and k with $r_i > r_k$. Since the effectiveness of attack on a member depends only on total attack on her, the marginal returns of attacking any member j ($j \neq i, k$) are the same for i and k (e.g., the marginal return for attacking j is $g'(\sum_{\ell \neq j} s_\ell a_{\ell j})$ for both i and k). That means the difference in i 's and k 's marginal returns of total negative efforts is in fact the difference of returns in their mutual attacks, $g'(\sum_{\ell \neq i} s_\ell a_{\ell i})$ and $g'(\sum_{\ell \neq k} s_\ell a_{\ell k})$. Moreover, since efficient allocation of effort calls for the equality of the marginal returns in productive and negative efforts, $r_\ell = t_\ell/s_\ell$ is in fact the relative return of productive and negative effort for every member ℓ . This, combined with the fact that $r_i > r_k$, implies $g'(\sum_{\ell \neq i} s_\ell a_{\ell i}) < g'(\sum_{\ell \neq k} s_\ell a_{\ell k})$. By concavity of $g(\cdot)$, we know i is subject to more total attack.

Equation (5) contains much information of a contestant's behavior. Differentiating both sides of Equation (5) by s_i ($i \neq j$) we have¹³

$$g''\left(\sum_{k \neq j} s_k a_{kj}\right) \frac{\partial(\sum_{k \neq j} s_k a_{kj})}{\partial s_i} = -(n-1) \left[\sum_{\ell=1}^n r_\ell^{-1} - (n-1)r_j^{-1} \right]^{-2} t_i^{-1} < 0,$$

which implies $\partial(\sum_{k \neq j} s_k a_{kj})/\partial s_i > 0$. This means that when one member becomes more talented in negative activities, all her colleagues are subject to more attacks. The reason for this is a simple comparative advantage argument.

Differentiating both sides of Equation (5) by s_j we have

$$g''\left(\sum_{k \neq j} s_k a_{kj}\right) \frac{\partial(\sum_{k \neq j} s_k a_{kj})}{\partial s_j} = (n-1)(n-2) \left[\sum_{\ell=1}^n r_\ell^{-1} - (n-1)r_j^{-1} \right]^{-2} t_j^{-1} \geq 0.$$

As a result, $\partial(\sum_{k \neq j} s_k a_{kj})/\partial s_k \leq 0$, meaning that if a member becomes more talented in negative activity, she will be subject to less total attack. The reason

13. By deriving comparative statics results directly from the first-order conditions we have implicitly assumed that the equilibrium is unique. This is not guaranteed in our model. However, our results can be extended by using Theorem 3 in Milgrom and Roberts (1994:451). More specifically, it can be easily shown that the best response correspondence of the members, $BR(e, a) = (BR_1(e_{-1}, a_{-1}), BR_2(e_{-2}, a_{-2}), \dots, BR_n(e_{-n}, a_{-n}))$, satisfies the conditions in Theorem 3. Moreover, define an order $>$ on $R_+^{n \times n}$ so that $(e, a) > (e', a')$ if and only if the expected total output under (e, a) , $W(e, a) = \sum_{i=1}^n W_i(e, a)$, is greater than that under (e', a') , $W(e', a') = \sum_{i=1}^n W_i(e', a')$. In that case $(R_+^{n \times n}, >)$ is a lattice with a partial order on space of efforts (e, a) . Thus by that theorem, we know that in the case of multiple equilibria, our comparative statics results are still valid, at least for extreme equilibrium points.

for this is as follows. We already know that an increase in s_j will subject every i ($i \neq j$) to more total attack (i.e., $\sum_{\ell \neq i} s_\ell a_{\ell i}$ will increase). Thus by the concavity of $g(\cdot)$, for any member k ($k \neq j$), her marginal return of attacking any member i ($i \neq j$) decreases. Since at the optimum k 's marginal return of total negative activity should equal that of her productive activity (which is r_i), her marginal return in attacking j must increase. Again by concavity of $g(\cdot)$, this is possible only if j is subject to less total attack.

There are similar results for productive ability. Differentiating Equation (5) with respect to t_i ($i \neq j$) we have

$$g'' \left(\sum_{k \neq j} s_k a_{kj} \right) \frac{\partial \sum s_k a_{kj}}{\partial t_i} = (n-1) \left[\sum_{\ell=1}^n r_\ell^{-1} - (n-1)r_j^{-1} \right]^{-2} s_i t_i^{-2} > 0.$$

As a result, $\partial \sum s_k a_{kj} / \partial t_i < 0$. It can also be shown that $\partial \sum s_k a_{kj} / \partial t_j > 0$. This means that an increase in a contestant's ability in productive activity will make her subject to a greater amount of total attack, while an increase in that of her competitors will decrease the total attack she is subject to. The intuition for these results are straightforward. We summarize our results in the following proposition:

Proposition 1. The total attack a contestant receives (i) decreases in her own negative ability and her opponents' productive ability, and (ii) increases in the negative ability of any of her opponents and her own productive ability.

Since r_i is only a relative measure of productive ability, a natural consequence is that a person with the highest (absolutely or comparative) ability in productive activity will not necessarily have the greatest promotion chance. For example, if a contestant has a small value of t_i but is empowered with an infinite talent for attacking opponents, then just a small negative effort against her opponent will be enough to ensure that she beats all the others in performance. More specifically, from Proposition 1 we know that if $g(\cdot)$ is unbounded, then $g(\sum_{\ell \neq i} s_\ell a_{\ell i})$ will go to infinity and $g(\sum_{\ell \neq k} s_\ell a_{\ell k})$ to 0 as s_k ($k \neq i$) increases. Since both e_i and e_k are bounded above, we know that $W_{ki} = t_k e_k - g(\sum_{\ell \neq k} s_\ell a_{\ell k}) - t_i e_i + g(\sum_{\ell \neq i} s_\ell a_{\ell i})$ must be positive for all i if s_k is large enough. In other words, the performance of a member will be greater than that of anyone else when she is sufficiently talented in sabotage. Our results also imply that there is not a unique type of member who is most likely to be promoted. It depends on the composition of members. For example, we already know that the one very talented in sabotage is most likely to win. On the other hand, if a member has productive ability far surpassing that of the others, then although she is heavily attacked, her advantage in productive ability still rules. There might even be cases when a member who is mediocre (having moderate values of both productive and destructive activities) has the highest promotion chance.

In the special case when the talent in negative activity is the same across all contestants ($s_i = s_j \forall i$), the value of r_i will represent the (absolute) ability

of member i in productive activity. Theorem 1 thus implies that the abler member generates more total attack.

Corollary 1. If the members have the same ability in sabotage ($s_i = s_j \forall i, j$), then the contestant more skilled in productive activity will be subject to more total attack.

The message of Corollary 1 is clear: When a contestant has greater ability, although she can have higher performance for every unit of positive effort exerted, there is also an offsetting force coming from opponents. The greater one's ability, the more attack she is subject to. This is not a result of emotional factors such as envy (see, e.g., Mui, 1995), but a result of rational calculation.

A question relating to recruiting policy is to investigate how the members respond to an entrant in the organization. Suppose a person with relative ability $r_{n+1} = t_{n+1}/s_{n+1}$ joins the organization. Then the first-order condition of Equation (5) becomes

$$g' \left(\sum_{k=1}^{n+1} s_k a_{kj} \right) = n \left/ \left(\sum_{\ell=1}^{n+1} r_{\ell}^{-1} - n r_j^{-1} \right) \right.$$

Consequently

$$\begin{aligned} n \left/ \left(\sum_{\ell=1}^{n+1} r_{\ell}^{-1} - n r_j^{-1} \right) \right. &- (n-1) \left/ \left(\sum_{\ell=1}^n r_{\ell}^{-1} - (n-1) r_j^{-1} \right) \right. \\ &= \left(\sum_{\ell=1}^n r_{\ell}^{-1} - (n-1) r_{n+1}^{-1} \right) \left/ \left(\sum_{\ell=1}^{n+1} r_{\ell}^{-1} - n r_j^{-1} \right) \right. \left(\sum_{\ell=1}^n r_{\ell}^{-1} - (n-1) r_j^{-1} \right), \end{aligned}$$

which is positive if r_{n+1} is large and is negative if r_{n+1} is small. We thus have:

Proposition 2. Every member is subject to more (less) attack when a new member more (less) talented in sabotage joins the organization.

Consistent with Lazear (1989), Proposition 2 shows that “personality counts” in an organization in the sense that the contestants are forced to engage in more negative activities when a “hawk” enters, and will decrease the sabotage mutually inflicted to concentrate more on productive activity if, on the contrary, a “dove” joins it.

3. Special Cases

In this section we will consider several special cases that allow us to characterize the contestants' behavior more precisely.

3.1 Two-Person Case

Two-person tournaments are of special interest because in many situations a tournament essentially involves only two contestants.¹⁴ When there are only two contestants, the first-order conditions of Equations (2) and (3) reduce to

$$t_1 \left(\int_{-\infty}^{\infty} f(\varepsilon_1) f(\varepsilon_1 - W_{21}) d\varepsilon_1 \right) u = v'(e_1 + a_{12}), \tag{6}$$

$$t_2 \left(\int_{-\infty}^{\infty} f(\varepsilon_2) f(\varepsilon_2 - W_{12}) d\varepsilon_2 \right) u = v'(e_2 + a_{21}), \tag{7}$$

$$s_1 g'(s_1 a_{12}) \left(\int_{-\infty}^{\infty} f(\varepsilon_1) f(\varepsilon_1 - W_{21}) d\varepsilon_1 \right) u = v'(e_1 + a_{12}), \tag{8}$$

$$s_2 g'(s_2 a_{21}) \left(\int_{-\infty}^{\infty} f(\varepsilon_2) f(\varepsilon_2 - W_{12}) d\varepsilon_2 \right) u = v'(e_2 + a_{21}). \tag{9}$$

The second-order conditions require that the Jacobian matrix $|u_{ij}|$ be negative definite for both persons. Specifically, lengthy calculation yields the following requirements:

$$t_i^2 X_{ji} u - v''(e_i + a_{ij}) < 0, \\ s_i^2 g''(s_i a_{ij}) Y_{ji} u + s_i^2 g'^2(s_i a_{ij}) X_{ji} u - v''(e_i + a_{ij}) < 0, \text{ and} \\ s_i^2 g''(s_i a_{ij}) Y_{ji} (t_i^2 X_{ji} u - v''(e_i + a_{ij})) - (t_i - s_i g'(s_i a_{ij}))^2 X_{ji} v''(e_i + a_{ij}) > 0;$$

where $X_{ji} = \int_{-\infty}^{\infty} f(x) f'(x - W_{ji}) dx$ and $Y_{ji} = \int_{-\infty}^{\infty} f(x) f(x - W_{ji}) dx$. All can be satisfied if we assume that $v'(0) = 0$ and v'' is large enough.

While in the n -person case, Corollary 1 shows that ability in productive activity does not ensure a greater chance of promotion; in the two-person case the person with higher productive ability does have an advantage. Specifically, we will prove that if the two persons are equally talented in sabotage, then the one who has a higher productive ability will have a greater chance to win. For simplicity, assume that $s_1 = s_2 = 1$ and $r_1 = t_1 > r_2 = t_2$. Given the concavity of $g(\cdot)$, we have $(a_{21} - a_{12}) g'(a_{12}) > g(a_{21}) - g(a_{12})$. That is, $(a_{21} - a_{12}) > (g(a_{21}) - g(a_{12}))/r_1$. This implies that

$$0 > e_2 - e_1 + a_{21} - a_{12} > e_2 - e_1 + (g(a_{21}) - g(a_{12}))/r_1.$$

Multiplying both sides by r_1 and rearranging we have

$$r_1 e_1 - g(a_{21}) > r_1 e_2 - g(a_{12}) > r_2 e_2 - g(a_{12}).$$

In other words, $W_1 > W_2$, meaning that person 1 has a higher expected performance and promotion chance despite the fact that she is attacked more

14. For example, in the U.S. presidential election, the tournament is essentially between candidates from two major parties. In the competition within Time Inc., as mentioned in the introduction, the contest is essentially between Nicholas and Levin.

heavily. The reason for this is very intuitive. The more-able contestant can at least guarantee a greater winning chance by mimicking the effort level of her opponent. We thus have

Proposition 3. Suppose there are only two persons. If the persons have the same ability in sabotage, then the one more talented in productive activity has a greater chance to win.

We can also investigate the impact of promotion utility on how hard the members work.

Proposition 4. Suppose there are only two persons. An increase in the utility of promotion will increase the positive effort of both persons, but it has no effect on their negative effort levels. That is, $\partial e_i / \partial u > 0$ and $\partial a_{ij} / \partial u = 0$, $i, j = 1, 2, j \neq i$. As a result, the total effort of every person increases when the utility of promotion is increased.

Proof. See Appendix A. ■

The reason why the value of a_{ij} is independent of u requires explanation. Take person 1 as an example. The marginal contributions of her productive and negative activities are given by the left-hand side of Equations (6) and (8), respectively. In equilibrium they must equal each other. Since the ratio of the former to the latter is $t_1/s_1g'(s_1a_{12})$, and t_1 is independent of u , in equilibrium a_{12} must also be so. This result thus comes directly from the fact that output is linear in productive effort; that is, $W_1 = t_1e_1 - g(s_2a_{21})$. If instead we make the same specification as in note 8, then it can be easily shown that in equilibrium a_{ij} increases with u . As such, independence of a_{ij} on u is a special case, and is not a result we intend to emphasize. What should be emphasized, however, is that although Lazear (1989) suggests that in general a reduction of the pay between hierarchies (the value of u) has the effect of ameliorating the disruptive activities in organization, Proposition 4 shows that it also reduces the level of productivity effort. As a result, this practice will not necessarily increase the output of a firm. In fact, Proposition 4 shows that a reduction in u will not change the level of sabotage, but will reduce productive effort. Output thus decreases.

3.2 Three-Person Case

We have shown in the previous section that a member more skilled in productive activity might not have a greater chance for promotion if one of her opponents is very talented in negative activity. We have also shown that this outcome is impossible in a two-person case if both members have the same ability in negative activity. It will be shown in this section that the latter result does not extend to the three-person case. That is, the person most talented in productive activity might not have the highest promotion chance, *even if all members are equally talented in sabotage*. Since we mainly intend to contrast the fundamental difference between the two- and three-person cases, it is assumed throughout this section that $s_i = 1$ for all i and $t_1 > t_2 > t_3$.

With three contestants, the first-order conditions for the effort levels are for $i = 1, 2, 3$,

$$t_i \left[\int_{-\infty}^{\infty} f(\varepsilon_i) f(\varepsilon_i - W_{ji}) \left(\int_{-\infty}^{\varepsilon_i - W_{ki}} f(\varepsilon_k) d\varepsilon_k \right) d\varepsilon_i + \int_{-\infty}^{\infty} f(\varepsilon_i) f(\varepsilon_i - W_{ki}) \left(\int_{-\infty}^{\varepsilon_i - W_{ji}} f(\varepsilon_j) d\varepsilon_j \right) d\varepsilon_i \right] u = v' \left(e_i + \sum_{\ell \neq i} a_{i\ell} \right), \quad (10)$$

$$g' \left(\sum_{\ell \neq j} a_{\ell j} \right) \left[\int_{-\infty}^{\infty} f(\varepsilon_i) f(\varepsilon_i - W_{ji}) \left(\int_{-\infty}^{\varepsilon_i - W_{ki}} f(\varepsilon_k) d\varepsilon_k \right) d\varepsilon_i \right] u = v' \left(e_i + \sum_{\ell \neq i} a_{i\ell} \right), \quad (11)$$

where $j, k \in \{1, 2, 3\}$, $i \neq j \neq k \neq i$.

We first show that the most-able member cannot have the lowest promotion chance.

Proposition 5. In the case of three contestants, contestant 1 cannot have the lowest expected performance.

Proof. See Appendix A. ■

Although Proposition 5 shows that the member with the highest ability cannot have the lowest chance of promotion, she might end up coming in second. This is because unlike the two-person case, when there are more than two persons competing for promotion, the most-able member might become the “focal point” of attack, and the total attack on her might outweigh her advantage. Under the assumption that $s_i = 1$ for all i , $W_{21} = t_2 e_2 - t_1 e_1 - g(a_{12} + a_{32}) + g(a_{21} + a_{31})$. From Equation (5) we know that

$$\sum_{\ell \neq i} a_{\ell i} = g'^{-1} \left(2 / \left(\sum_{\ell=1}^3 t_{\ell}^{-1} - 2t_i^{-1} \right) \right), \quad i = 1, 2,$$

where g'^{-1} is the inverse function of $g'(\cdot)$. As a result,

$$W_{21} = t_2 e_2 - t_1 e_1 - z \left(\frac{2}{t_1^{-1} - t_2^{-1} + t_3^{-1}} \right) + z \left(\frac{2}{-t_1^{-1} + t_2^{-1} + t_3^{-1}} \right), \quad (12)$$

where $z \equiv g \circ g'^{-1}$. Moreover, $z'(x) = x/g''(g'^{-1}(x)) < 0$. If $|z'|$ is large, then the last two terms of Equation (12) are positive and large. Also note that the marginal return of e_i is given by the left-hand side of Equation (10). If $f(\cdot)$ is very flat, then the marginal return of e_i , and thus its optimal value, will be small. $t_2 e_2 - t_1 e_1$ will then be close to 0, and W_{21} will consequently be positive. Since $|z'|$ is likely to be large when $|g''|$ is small and g' is large, we thus know that if the marginal effectiveness of attack is high and does not diminish rapidly, and the signal:noise ratio is small, then it is more likely

that the most-able member does not have the greatest promotion chance. The intuition for this is straightforward.

In the following, we provide a numerical example to this theoretical claim.

Example. We will give a discrete example.¹⁵ Suppose that a_{ij} and e_i can only be 0 or 1. ε_i can take only two values: either 1 or -1 , each with probability $1/2$. The density function for $\varepsilon_i - \varepsilon_j$ is thus

$$\varepsilon_i - \varepsilon_j = \begin{cases} -2, & \text{with probability } 1/4 \\ 0, & \text{with probability } 1/2 \\ 2, & \text{with probability } 1/4. \end{cases}$$

Moreover, let $r_1 = 5$, $r_2 = 4$, and $r_3 = 1$. Also assume that $v(0) = 0$, $v(1) = 1$, $v(2) = 3$, $v(3) = 8$, $g(0) = 0$, $g(1) = 2.5$, and $g(2) = 4$. The expected utility of person i is thus¹⁶

$$\begin{aligned} u_i(e, a) = & \sum_{\ell=1,2} \Pr(\varepsilon_i = \ell) \left[\Pr(\varepsilon_i - \varepsilon_j > W_{ji} | \varepsilon_i = \ell) \Pr(\varepsilon_i - \varepsilon_k > W_{ki} | \varepsilon_i = \ell) u \right. \\ & + \Pr(\varepsilon_i - \varepsilon_j = W_{ji} | \varepsilon_i = \ell) \Pr(\varepsilon_i - \varepsilon_k > W_{ki} | \varepsilon_i = \ell) \frac{1}{2} u \\ & + \Pr(\varepsilon_i - \varepsilon_j > W_{ji} | \varepsilon_i = \ell) \Pr(\varepsilon_i - \varepsilon_k = W_{ki} | \varepsilon_i = \ell) \frac{1}{2} u \\ & \left. + \Pr(\varepsilon_i - \varepsilon_j = W_{ji} | \varepsilon_i = \ell) \Pr(\varepsilon_i - \varepsilon_k = W_{ki} | \varepsilon_i = \ell) \frac{1}{3} u \right] \\ & - v \left(e_i + \sum_{j \neq i} a_{ij} \right). \end{aligned}$$

We want to show that $e_1^* = e_2^* = 1$, $e_3^* = 0$; $a_{21}^* = a_{31}^* = a_{12}^* = 1$, $a_{13}^* = a_{23}^* = a_{32}^* = 0$ is a Nash equilibrium.

Table B1 records the payoffs of person 1 under all the possible values of e_1 , a_{12} , and a_{13} against the equilibrium behavior of persons 2 and 3. The first three columns list all of person 1’s possible actions, the fourth to seventh columns give the resulting values of W_{21} , W_{31} , $v(\cdot)$, and the expected payoffs. In order for the first row ($e_1^* = 1$, $a_{12}^* = 1$, $a_{13}^* = 0$) to be the equilibrium effort levels, the number in the seventh column of row 1 must be greater than

15. To give a continuous example, we will need to solve nine first-order conditions in nine variables, and presumably for a very complicated density function (generally involving exponentials), which is too complex even for Mathematica to solve. A discrete example is much easier to compute. It suffices to emphasize that the purpose of the example is to demonstrate our claim in an economical way, not as a general characterization of the tournament model. Also note that the result obtained in the example is not due to the assumption of a discrete actions choice. In a two-person case, even if the actions choice is discrete, the contestant with greater ability always has a greater chance of being promoted, simply by mimicking the action of her opponent.

16. Assume that those who have equal performances are equally likely to be promoted.

or equal to all the numbers in the same column. Tables B2 and B3 contain similar values and thus similar conditions for persons 2 and 3.

It can be seen clearly that e_1^* , a_{12}^* , and a_{13}^* are person 1's best responses against e_2^* , e_3^* , a_2^* , and a_3^* if $u \geq 12$. e_2^* and a_2^* are person 2's best responses if $16/3 \leq u \leq 40$. Finally, e_3^* and a_3^* are person 3's best responses if $16 \geq u \geq 8$. As a result, (e^*, a^*) constitutes a Nash equilibrium if $12 \leq u \leq 16$. However, now $W_2 - W_1 = 0.5$. This means that person 2 has a higher expected performance, and hence a higher chance for promotion, than person 1, although person 1 has the greatest ability.

This result might seem counterintuitive. One might reason that since the most-able member (1) receives the most attacks and that $g(\cdot)$ is concave, if she does not have the highest expected performance, the third member should be able to increase her own winning chance by redirecting the negative effort imposed on member 1 to the contestant currently having the highest expected performance. This intuition is, however, incorrect. As is explained in Section 2, attacks on an opponent help not only the member who uses them, but also all the other contestants. Thus in our example, a reallocation of attacks from member 1 to member 2 (who has the top performance) might inadvertently increase the promotion chance of member 1 (since attacking member 2 also helps member 1) by so much so that the promotion chance of member 3 actually *falls*. This is especially so when the function $g(\cdot)$ is very steep at the equilibrium point. The essence of this result is that the decision of how heavily to attack a member does not depend on the expected performance of the one being attacked, but on the marginal return of the member who utilizes it. As long as attacking an opponent produces the highest returns among alternatives, then a member will do it, regardless of how well (or poorly) that opponent performs. Put differently, the member with the highest expected performance might not be the one who is attacked most (the latter, by Theorem 1, is the member most able in productive activity). This is a result that cannot occur in a two-person case, and it is in sharp contrast to the traditional contest model (e.g., an all-pay auction or the traditional tournament model), in which the player with the greatest ability (or valuation of the object being auctioned) always has the highest winning probability.

3.3 The Case of Identical Contestants

If the contestants' abilities are not known (including self-abilities) to the members so that there is an identical prior on ability, then the members act as if every contestant has exactly the same ability. In this case, we can derive a far sharper characterization of the contestants' behaviors. The first-order conditions of Equations (2) and (3) are reduced to

$$(n - 1)t \left[\int_{-\infty}^{\infty} f(\varepsilon)^2 F(\varepsilon)^{n-2} d\varepsilon \right] u = v'(e + (n - 1)a), \tag{13}$$

and

$$sg'((n-1)sa) \left[\int_{-\infty}^{\infty} f(\varepsilon)^2 F(\varepsilon)^{n-2} d\varepsilon \right] u = v'(e + (n-1)a). \quad (14)$$

Consequently

$$g'((n-1)sa) = (n-1)r. \quad (15)$$

From Equation (15) we know that the level of negative effort, a , is independent of u and t , and decreasing in r and n . Also, $\partial a / \partial s = -s^{-1}(a + ts^{-2}/g''((n-1)sa))$, which can be either negative or positive. This is because an increase in s has two effects on the level of negative activity. The substitution effect will have the contestant exert more negative effort, while the income effect forces the contestant to exert less. As a result, the total effect is uncertain. However, if s is small, then negative activity is valuable so that its level increases with the member's ability in it. If s is large, then the income effect tends to dominate and the level of negative activity will decrease with the member's ability in it. From Equation (14) we know that the level of positive effort, e , is increasing in u . As a result, the members work harder in the sense that their total effort $e + (n-1)a$ increases when the utility of promotion increases. From Equation (13) we know that an increase in t increases the level of positive and total efforts exerted.

Differentiating Equation (13) with respect to s we have $0 = v''(e + (n-1)a) \left(\frac{\partial e}{\partial s} + (n-1) \frac{\partial a}{\partial s} \right)$. As a result, the total effort exerted by the members is not influenced by the value of s : positive effort always adjusts in a way to offset the change in the level of negative effort, which, as we know, can be either positive or negative. We summarize these results in the following proposition:

Proposition 6. When all contestants are identical, then (i) negative activity decreases (increases) in the members' abilities in sabotage when they are more (less) talented in it, and decreases in the number of contestants; (ii) the level of productive activity increases in promotion utility and the member's ability in it; and (iii) the total efforts exerted by the members increase (are unchanged) with their abilities in productive (negative) activity.

A comparison between the case when members engage in sabotage and the case when they do not is straightforward. The first-order conditions for the latter case can be easily shown to be

$$t(n-1) \left[\int_{\infty}^{\infty} f(\varepsilon)^2 F(\varepsilon)^{n-2} d\varepsilon \right] u = v(e^+), \quad i = 1, \dots, n.$$

Compare this with Equation (14): we know that $e^+ = e + (n-1)a$, that is, the contestants work exactly the same number of hours in the cases with and without sabotage. The difference is that in the former case, part of the working hours are devoted to sabotage. That is, when the contestants can engage in negative activity, not only do they exert less positive effort, but

also some of their performance is destroyed by opponents' negative effort. As a result, the outcome is less efficient than when the members engage in only productive activity. In fact, although the members' outputs decrease as a result of sabotage, their utilities remain the same. This is because both the total effort level and promotion probability remain the same. As such, the inefficiency of infighting is borne solely by the organization.

4. Alleviating the Impact of Negative Activities

Given that competition with negative effort, like a war of attrition, is a pure waste of resources, it is important to know how to design a promotion system that can reduce or eliminate the impact of this type of effort. We will consider several promotion systems here. These systems might not be originally designed solely to reduce the influence of sabotage, but their effect in reducing predatory behavior may often be one of the reasons these systems are adopted.

4.1 Pay Equality

One way to reduce negative activities is to compress the difference of payoffs between the winner and the loser. In our model this amounts to decreasing the value of u , and is what Lazear (1989) calls "industrial politics" in the context of tournaments within firms. With payoff compression, the members will find winning the contest less valuable and sabotage less rewarding. As a result, negative activities are reduced. This practice, as explained in Section 3.1, has the disadvantage of reducing the contestants' productive effort simultaneously, and sometimes output will drop despite less sabotage. In general, when the members' abilities in productive activity (t_i) are relatively small, then by argument of comparative advantage, they are more prone to engage in negative activity so that positive effort is small compared to negative effort. In this case the practice of pay compression is likely to decrease the level of negative effort more than that of positive effort. In other words, pay compression is more likely to be effective when the organization is plagued with predatory behavior.

4.2 Seniority Promotion System

In the seniority promotion system, age and service length are explicitly recognized as criteria for promotion. In our model, this amounts to assuming that $p_i(W_1, \dots, W_n, Z) = p_i(W_1, \dots, W_n, x_i, x_{-i})$, where x_i is the seniority of member i , and that $\partial p_i / \partial x_i > 0$, $\partial p_i / \partial x_j < 0$ ($j \neq i$). If income effort is positive, then this practice will result in lower values of a_{ij} in equilibrium.¹⁷ However, as in the case of pay compression, this practice also decreases the influence of e_i on the chance of promotion, and is thus detrimental to productive effort.

17. In Japanese firms, as argued by Leibenstein (1987), the practice of seniority promotion is part of a coherent body of values that emphasize cooperation, harmony, and consensus in management, which, in terms of our model, is essentially a reduction in negative activities.

4.3 Group and Incentive Compensations

If the member's payoff depends not only on her own performance, but also on the performance of the entire group she belongs to, then a member's negative effort against her colleagues not only decreases their promotion chance, but also decreases her own payoff. In our model, it means $q(W_1, \dots, W_n, Z) = q(\sum_{i=1}^n W_i)$ and $q' > 0$. Since $\partial q / \partial e_i > 0$ and $\partial q / \partial a_{ij} < 0$, group compensation will likely increase (decrease) productive (negative) activities. This practice has been widely used in the military, where developing esprit de corps is important. Members of the same group often receive the same award or punishment based on group performance during the training process as a means to help soldiers build loyalty to each other. Another example is the sports market. Even in a popular league like the NBA, only a few players receive top pay. Given that performance is evaluated on a relative basis, players should have very little incentive to cooperate. But since the performance of the team a player belongs to is also important for his payoff, cooperation on the court is the rule. The disadvantage of group compensation, however, is that the ever-present free-rider problem will lead members to exert suboptimal levels of positive effort.¹⁸

Another way to compensate workers that can reduce sabotage is the incentive payment, under which rewards for effort are provided not only through promotions but also by output-based payments. This is, of course, the tenet of the principal-agent paradigm, which studies the optimal way to control an agent's effort via verifiable signals (general output). In our model, it means $q(W_1, \dots, W_n, Z) = \sum_{i=1}^n q_i(W_i, Z)$, with $\partial q_i / \partial W_i > 0$. Since $\partial q_i / \partial e_i > 0$, the marginal return of productive (negative) effort increases (decreases). Consequently the level of productive (negative) effort increases (decreases). The available evidence suggests, however, that firms provide incentives primarily through the prospect of promotion rather than through incentive payments (Baker et al., 1994a,b). Surprisingly, there is almost no work explaining why this is so (Prendergast, 1999:36). Since incentive pay is not only a much more direct way to reward effort than promotion, and also incurs much less infighting, this constitutes a major puzzle that needs to be solved in the study of internal labor market.

4.4 Early Designation of a Successor

The early designation of a successor essentially makes $p_i = 1$ for some i . In Imperial China, the throne was usually inherited by one of the sons of the incumbent emperor. The competition between the princes to succeed to the throne was so fierce that murder between brothers was not uncommon.

18. In the absence of sabotage, Che and Yoo (2001) show that joint performance evaluation (under which a worker is paid more when her coworkers have better performance) is superior to relative performance evaluation (a worker is paid less when others perform better) in a repeated game setting. In Che and Yoo's article, a worker's effort is solely rewarded by current salary. If, however, effort is also rewarded by chance of promotion, which by nature can only be for a subset of workers, then the advantage of joint performance evaluation will be weakened.

To avoid such feuds, the heir to the throne was usually announced well in advance. By designating the successor early on, the cruel competition between potential heirs could be avoided. However, for this practice to be effective, there must be a strong commitment to stick to the decision. If this choice is not committed to, then competition, and thus negative activities, cannot be avoided.¹⁹

4.5 External Recruitment

The obvious reason why a firm fills a position by recruiting externally rather than promoting internally is an attempt to find the person whose expertise fits the needs of the firm most. However, external recruitment also serves to decrease the incidence of negative activities within the firm. The organization can commit to recruiting an outsider if no insiders perform better than a threshold \bar{W} . In our setup, the expected utility of a worker i becomes

$$\Pr(W_i + \varepsilon_i \geq W_j + \varepsilon_j \quad \forall j \text{ and } W_i + \varepsilon_i \geq \bar{W})u - v\left(e_i + \sum_{j \neq i} a_{ij}\right),$$

where \bar{W} is the performance threshold. Since it is almost impossible to sabotage potential competitors outside of the organization, the effectiveness of negative activity as a way to outperform competitors is reduced. While negative effort is useless in competing with potential outside competitors, productive effort is as useful in outperforming outside competitors as inside competitors. Chen (2002) uses this fact to show that if the value of \bar{W} is chosen appropriately, then the workers not only reduce sabotage (because its marginal return is lower), but also substitute sabotage for productive effort (so that productive activities increase). Consequently output increases.

Lazear (1995:chap. 3) explains that before the breakup of AT&T, its president was usually chosen from the presidents of the corporation subsidiaries rather than from the head office. This is because competition among contestants in the head office caused for greater damage than that between presidents in different subsidiaries.

All of the systems discussed above (except external recruitment), although helpful in mitigating the adverse effects of negative activities, can also lead to other problems. If it is impossible to decompose the performance of a member into two parts, one that comes from positive effort and one that comes from the negative activities of opponents, then a practice reducing the influence of negative activities will also likely decrease the incentive of

19. The Kangxi Emperor (1654–1722) of the Qing Dynasty, the longest ruling and one of the most admired emperors in Chinese history, designated and retracted his choice of a son as his heir several times during his lifetime. He was so distressed by the right choice for his heir, so torn by the fierce attacks on the designated heir by others and the competition among his sons, that he even lost control and wept in his court. If the incumbent cannot commit to the chosen successor, then the sabotage simply cannot be eliminated. His heir, the Youngzheng Emperor (1678–1735), learned the lesson and adopted the practice of designating the successor early but secretly. The identity was to be announced only when the incumbent emperor died.

members to exert positive effort. Whether such a practice should be adopted depends on its relative effects on each effort. It is also worth emphasizing that sabotage is sometimes directly observable or observable with noise. For example, negative advertising is highly explicit in political campaigns. In the corporate environment, it is sometimes possible to track down the source of negative rumors. This also acts as a check on negative activities.

5. Conclusion and Extension

In this article I have shown that negative activities have a profound impact on the behavior of members in an organization. These activities reduce the efficiency of an organization and are a pure waste of resources from a social point of view. I have also discussed some institutional designs which might be helpful in reducing the effects of negative activities. These designs generally cannot completely eliminate the mutual sabotage inflicted upon the members. Moreover, they usually have the adverse effect of reducing the level of productive effort at the same time. Given this, so long as there is competition for a limited resource (promotion, prize, . . . , etc.) in organizations, predatory behavior seems to be a natural part of life.²⁰

An undiscussed assumption that has played a very important role in reaching our results is that only one member can be promoted. While this is true in many situations, it is not always so. When more than one contestant can be promoted, the strategic interaction between the members will be much more complicated. In particular, a main result in our model, that the abler contestant will be subject to more sabotage, will no longer be true, even if all members have the same ability in negative activity. For example, if two members can be promoted, and the top contender is far superior to all the others, then in order to best allocate their efforts, the contestants might concentrate their attacks on the second most-able member. While this phenomenon is of great interest (and perhaps importance) by itself, it is of sufficient complexity that it must be reserved for future research.

The model can also be extended to study the case when contestants are not perfectly informed of the abilities of their opponents. In this case, we need a dynamic model in which ability is inferred through past performances. For example, we can imagine a two-period model in which abilities are private information, and the members with the best total performances in the two periods will be promoted. Since the members can observe the performances of all opponents at the end of the first period, they can condition the attacks in the second period on their values. As a result, the members with better performances in the first period will surely be subject to more sabotage later. This will lead the contestants purposefully to exert less positive effort early in

20. It should be emphasized, as a referee points out, that it is not totally negative for a firm to promote someone good at sabotage. Perhaps the leader of an organization must be able to withstand attacks to prevent wasteful efforts to oust her, and being talented in sabotage is a good way of doing that. Similarly a firm might need a leader good at negative activity to fend off attacks from outside the firm.

their careers in order to hide their abilities and avoid opponents' attacks. As a result, there would be even more sources of inefficiency in organizations: Contestants would not only allocate resources to engage in wasteful negative activities, as in our model, but they would also exert less positive effort in order to hide their abilities.²¹

Finally, as explained in the introduction, negative activities exist not only *within* organizations, but also *between* organizations. Competing firms also spend resources to engage in wasteful mutual attacks. As such, our model might be suitable not only for studying the behavior of members within an organization, but also for studying topics in industry organization.

Appendix A

Proof of Proposition 4. From Equations (6) and (7) we can see that $t_1 = s_1g'(s_1a_{12})$, implying a_{12} is independent of u . Similarly, a_{21} is also independent of u . Differentiating Equations (6) and (7) with respect to u , and using the fact that $\partial a_{12}/\partial u = \partial a_{21}/\partial u = 0$, we have

$$\frac{\partial e_1}{\partial u} = \frac{t_2 Y_{12} v''(e_1 + a_{12})}{\Delta} > 0,$$

$$\frac{\partial e_2}{\partial u} = \frac{t_1 Y_{12} v''(e_2 + a_{21})}{\Delta} > 0;$$

where $\Delta = (t_1^2 u X_{12} - u''(e_1 + a_{12}))(t_2^2 u X_{21} - u''(e_2 + a_{21})) - t_1^2 t_2^2 u^2 X_{12} X_{21}$, which is positive by the second-order condition. ■

Proof of Proposition 5. (a) If $W_2 \geq W_3 \geq W_1$, with at least one strict inequality holding, then since $W_{12} \leq W_{32} \leq 0$, it can be easily verified that $\int_{-\infty}^{\varepsilon_2 - W_{32}} f(\varepsilon_3) d\varepsilon_3 \leq \int_{-\infty}^{\varepsilon_2 - W_{12}} f(\varepsilon_3) d\varepsilon_3$ and $\int_{-\infty}^{\infty} f(\varepsilon_3) f(\varepsilon_3 - W_{12}) d\varepsilon_3 \leq \int_{-\infty}^{\infty} f(\varepsilon_2) f(\varepsilon_2 - W_{32}) d\varepsilon_2$, with at least one strict inequality holding. But this implies that

$$\int_{-\infty}^{\infty} f(\varepsilon_2) f(\varepsilon_2 - W_{12}) \left(\int_{-\infty}^{\varepsilon_2 - W_{32}} f(\varepsilon_3) d\varepsilon_3 \right) d\varepsilon_2 < \int_{-\infty}^{\infty} f(\varepsilon_2) f(\varepsilon_2 - W_{32}) \left(\int_{-\infty}^{\varepsilon_2 - W_{12}} f(\varepsilon_1) d\varepsilon_1 \right) d\varepsilon_2. \tag{A.1}$$

Setting $i = 2$ and $j = 1, 3$ in Equation (11), and using Equation (A.1), we will have $g'(a_{21} + a_{31}) > g'(a_{23} + a_{13})$, which implies that $a_{21} + a_{31} < a_{23} + a_{13}$, a contradiction to Theorem 1.

(b) If $W_3 \geq W_2 \geq W_1$, with at least one inequality holding, then $W_{13} \leq W_{23} \leq 0$, with at least one strict inequality holding. For exactly the same

21. As explained in the introduction, this is exactly why winners in political and economic organizations are often those who, in the beginning, did not seem like future leaders, as they might have purposefully hidden their own abilities. Early stars, on the other hand, become the targets of attacks and slump.

reason, we have $a_{12} + a_{32} > a_{31} + a_{21}$, which is also a contradiction. Combining (a) and (b), we know that W_1 cannot be smaller than both W_2 and W_3 at the same time. ■

Appendix B

Table B1. Utility Levels of Member 1

e_1	a_{12}	a_{13}	W_{21}	W_{31}	$v(e_1 + a_1)$	$u_1(a_1, e_1, a_{-1}^*, a_{-2}^*)$
1	1	0	0.5	-1	3	$\frac{1}{4}u - 3$
1	1	1	0.5	-3.5	8	$\frac{1}{4}u - 8$
1	0	1	3	-3.5	3	-3
1	0	0	3	-1	1	-1
0	1	0	5.5	4	1	-1
0	1	1	5.5	1.5	3	-3
0	0	1	8	1.5	1	-1
0	0	0	8	4	0	0

Table B2. Utility Levels of Member 2

e_2	a_{21}	a_{23}	W_{12}	W_{32}	$v(e_2 + a_2)$	$u_2(e_2, a_2; e_{-2}^*, a_{-2}^*)$
1	1	0	-0.5	-1.5	3	$\frac{5}{8}u - 3$
1	1	1	-0.5	-4	8	$\frac{3}{4}u - 8$
1	0	1	1	-4	3	$\frac{1}{4}u - 3$
1	0	0	1	-1.5	1	$\frac{1}{4}u - 1$
0	1	0	3.5	2.5	1	-1
0	1	1	3.5	0	3	-3
0	0	1	5	0	1	-1
0	0	0	5	2.5	0	0

Table B3. Utility Levels of Member 3

e_3	a_{31}	a_{32}	W_{13}	W_{23}	$v(e_3 + a_3)$	$u_3(e_3, a_3; e_{-3}^*, a_{-3}^*)$
0	1	0	1	1.5	1	$\frac{1}{8}u - 1$
0	1	1	1	0	3	$\frac{3}{16}u - 3$
0	0	1	2.5	0	1	-1
0	0	0	2.5	1.5	0	0
1	1	0	0	0.5	3	$\frac{3}{16}u - 3$
1	1	1	0	-1	8	$\frac{7}{16}u - 8$
1	0	1	1.5	-1	3	$\frac{1}{4}u - 3$
1	0	0	1.5	0.5	1	$\frac{1}{8}u - 1$

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