Tournaments with Managerial Discretion*

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Abstract

We study the optimal design of a two-player tournament in which one player (the manager) has discretion over hiring the other. The manager determines the new hire's ability and competes with him in a Lazer-Rosen-style tournament, in which the one with higher output wins a fraction of the total output. The principal determines the payout ratio and the head start (or handicap) to the manager—an advantage (or disadvantage) when comparing output. We find the head start has three effects on the output: (i) encouragement effect on the manager, (ii) discouragement effect on the new hire, and (iii) hiring effect through the increased ability of the new hire. The hiring effect dominates the discouragement effect until the best candidate is hired; once the best is hired, any further head start leads the discouragement effect to dominate the encouragement effect. Therefore, the optimal contract offers just enough head start to induce the manager to hire the best candidate. However, in a two-period model where the first-period winner is retained for the future, the optimal contract may allow the manager to hire a suboptimal candidate who must still have a higher ability than the manager.

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"[W]hen compensation is relative, and when the individuals who do the hiring are to be in the same pool with those hired, there is an incentive to hire people strategically. Incumbents do not want competition from good outsiders, and so they tend to hire lower-quality people than would otherwise be optimal for the firm."

—Edward P. Lazear, *Personnel Economics*

1 Introduction

Tournaments depict competitions in organizations whose reward structures are based on relative performance, such as accounting, law, and investment firms, where better performers are rewarded with bonuses and promotions. In these tournament-based firms, the incumbent manager often has the discretion over hiring (or promoting) a new employee to be in the same pool with her.[1] This creates an incentive for the incumbent manager to sabotage the hiring (or promotion) process by hiring (or promoting) a lower-ability employee than would otherwise be optimal for the firm to prevent competition (Carmichael, 1988; Lazear, 1995). In the 1990s, Sandy Weill, the then-CEO of Citigroup, fired his long-time friend and potential successor Jamie Dimon. In an interview years later, Weill remarked, "[Jamie] wanted to be the CEO and I didn't want to retire" (Carney, 2010). In a survey of 336 corporate executives in the U.S. across various industries, Zaman and Lakhani (2024) asked if respondents have "ever observed a colleague disapprove hiring of a high-ability candidate to avoid potential competition for himself or herself." Among those whose firms operated on RPE, over 30% answered in the affirmative.

A way to avoid hiring sabotage is to offer tenure to the incumbent manager to insulate her from competition from the new hire, which is commonly observed in academia (Carmichael, 1988; Siow, 1998). However, tenure is often too extreme: if it completely insulates the manager from competition and eliminates all incentives to sabotage hiring, the firm would no longer be operating under relative compensation (Lazear, 1995). In reality, firms usually only *partially* insulate the manager from competition by granting her implicit seniority or a bias in her favor in performance evaluation. Unlike tenure, seniority does not make the manager's compensation totally independent of the new hire. In other words, although the manager is granted an edge over the new hire, her wage and career path will still be affected if the new hire performs substantially better. In the tournament context, this weaker form of tenure can be interpreted as a "head start" to the manager, which is an advantage granted to the player when comparing output with her opponent (see, e.g., Lazear and Rosen (1981); O'Keeffe, Viscusi, and Zeckhauser (1984); Brown and Chowdhury

[1]For the purpose of this paper, hiring and promotion are the same thing, as long as the manager is to be in the same pool with the new employee she hires or promotes. We use "she" ("he") to refer to the manager (new hire).

(2017)).[2]

To address this issue, we develop a model of a two-player tournament in which one player, the manager, has discretion over hiring the other. The manager determines the new hire's ability and competes with him in a Lazer-Rosen-style tournament, where the player with higher output wins a fraction of the total output. The principal can design the head start (or handicap) to the manager—an advantage (or disadvantage) granted to her when comparing output.

We find that the head start has varying effects on the efforts of both the manager and the new hire. It biases the tournament in favor of the manager and motivates him to exert effort, thereby having an *encouragement effect*. However, the impact of the head start on the new hire's effort is rather mixed. On the one hand, the bias discourages the new hire from investing effort, thereby having a *discouragement effect*. On the other hand, it leads the manager to hire a higher-ability agent by mitigating career concerns, which enhances the new hire's effort relative to the situation where a lower-ability agent would have been hired. This positive *hiring effect* dominates the discouragement effect in equilibrium until the highest-ability agent is hired. Once the best agent is hired, any further head start discourages the new hire more than it encourages the manager, thereby decreasing the total output. Therefore, the optimal head start offers just enough head start to induce the manager to hire the best candidate.

In addition, we extend the model to two periods to account for succession planning in that the principal aims to maximize the total profit across both periods. We assume the winner in the first period is retained (or promoted) for the second period, which captures the role of tournaments in selecting high-ability agents (Clark and Riis (2001); Hvide and Kristiansen (2003); Münster (2007); Ryvkin and Ortmann (2008); Drugov and Ryvkin (2017)). Thus, the principal cares not only about the first-period profit but also the winner's ability because it affects the second-period profit. Moreover, the manager has career concerns (Holmström (1999); Name Correa and Yildirim (2024)), which not only incentivize him to exert more effort in the first period but also exacerbate hiring sabotage. Thus, the head start has an *extended hiring effect* that mitigates the manager's career concerns (by partially insulating him from competition) and encourages her to hire a higher-ability agent. We find the principal with succession concerns may allow hiring sabotage to prevail in equilibrium because too high a head start would increase the probability of retaining the manager in the second period, who may be less able than the new hire, thereby having a negative *succession effect* on the profit. Nevertheless, the head start level will ensure the manager hire someone who has a higher ability than herself because otherwise, the principal can always increase the head start to increase profit through a more able new hire without the fear of retaining the less able agent (i.e., succession effect).

[2] Head starts are equivalent to the handicaps in tournaments (Lazear and Rosen (1981); O'Keeffe, Viscusi, and Zeckhauser (1984)): granting a head start to one player is equivalent to handicapping her opponent.

This paper makes three important contributions to tournament theory and organizational economics. First, we study tournaments in a new setting where one player can determine the other's ability. In many organizations, the manager has the discretion to hire a new employee to the same pool, so they have incentives to sabotage the hiring process by hiring a low-ability agent to forestall competition. To the best of our knowledge, the literature has not studied tournaments with hiring or sabotage in hiring. This complements the prior literature on sabotage in tournaments, which has largely focused on peer-to-peer sabotage where players may exert effort to hurt the performance of others (Dye (1984); Lazear (1989); Chen (2003); Kräkel (2005); Münster (2007); Gürtler and Münster (2010); Brown and Chowdhury (2017)).

Second, we study the use of head start to mitigate hiring sabotage by partially insulating the manager from competition. This role of head starts or handicaps has not been explored in the tournament literature, which has largely focused on their role in providing incentives and restoring efficiency (Lazear and Rosen (1981); O'Keeffe, Viscusi, and Zeckhauser (1984); Drugov and Ryvkin (2017)). Beyond tournaments, the head start is conceptually similar to academic tenure (Carmichael, 1988) but not as extreme as guaranteeing the winning of the incumbent manager; instead, it grants an advantage to the manager in the performance evaluation.

Additionally, in the two-period model, we also consider the role of tournaments in selecting the higher-ability player (Clark and Riis (2001); Hvide and Kristiansen (2003); Münster (2007); Ryvkin and Ortmann (2008)) in addition to maximizing the first-period profit and incorporate career concerns into the tournament (Name Correa and Yildirim, 2024). This also accounts for succession planning for the organization as a going concern (Fremgen (1968)).

2 Literature Review

Economists contend that RPE enables tournaments to achieve the dual objective of incentivizing employees and reducing monitoring costs for firms (Lazear and Rosen (1981); Nalebuff and Stiglitz (1983); Malcomson (1984)). Soon after the advent of the theory, Dye (1984) discussed the shortcomings of tournament-based incentive schemes and highlighted the possibility of agents engaging in sabotage to outperform each other. Lazear (1989) himself explored the possibility of sabotage in tournaments, where "hawks" may outperform "doves" by substituting sabotage for productive effort when the former is less costly. Over the past 40 years, numerous articles have explored peer-to-peer sabotage in tournaments.[3] The literature suggests that sabotage is often directed at stronger opponents when their peers find it costly to outperform them via productive effort (Skaperdas and Grofman (1995); Chen (2003); Münster (2007); Gürtler and Münster (2010);

[3]For a literature review of tournaments, see Connelly et al. (2014). For a literature review on sabotage in tournaments, see Chowdhury and Gürtler (2015).

Vandegrift and Yavas (2010); Deutscher et al. (2013)). Prior literature also predicts that sabotage increases with the size of the tournament award (Lazear and Rosen (1981); Harbring et al. (2007); Harbring and Irlenbusch (2005, 2011); Vandegrift and Yavas (2010)).

By contrast, we consider a setting where the manager has the discretion to hire (or promote) a new employee to be in the same pool, and the manager may sabotage the hiring process to prevent competition from the new hire. Although remaining unexplored in the tournament literature, managerial authority in hiring and promotion has been explored in organizational economics by, among others, Carmichael (1988); Lazear (1995); Fishman (2000); Friebel and Raith (2004). Based on a survey-based study, Zaman and Lakhani (2024) find a significant positive association between hierarchical seniority and hiring sabotage for lateral hires.

We propose the use of head start to mitigate hiring sabotage, which is conceptually similar to academic tenure studied by Carmichael (1988) (see also Siow (1998)). However, in contrast to tenure, a head start in a tournament context does not guarantee the tournament award for the incumbent manager and only grants him some advantage when comparing output.

The tournament literature has considered the use of head starts or handicaps to mitigate unevenness among agents with heterogeneous abilities (Lazear and Rosen (1981); O'Keeffe, Viscusi, and Zeckhauser (1984)). The common wisdom is to give a head start to the weaker player (i.e., handicap the stronger player) to "level the playing field" as participant heterogeneity would otherwise discourage the weaker agent and diminish effort incentives for both agents.[4]

On the contrary, recent papers have challenged this common wisdom. Drugov and Ryvkin (2017) show that even when players have the same ability, biased contests (i.e., with head starts or handicaps) can be optimal for various objectives, such as maximizing total effort and selecting the higher-ability agent. Similarly, other recent papers have shown that a bias in favor of the stronger player that exacerbates the player heterogeneity can increase aggregate effort in generalized Tullock contests (Fu and Wu (2020)) and Lazear-Rosen-style tournaments (Drugov and Ryvkin (2022)). Consistent with these findings, we also find that in a Lazear-Rosen-style tournament where the award is a fraction of the total output, a head start to the stronger player can increase total output when it incentivizes the stronger player more than it discourages the weaker player.

Importantly, we differ from the literature in that the head start is offered to mitigate sabotage. To the best of our knowledge, the literature has not explored tournaments where an agent has the discretion to hire another, *a fortiori* the use of head starts to mitigate sabotage in this process.

[4]For the discouragement effect of player heterogeneity, see Hillman and Riley (1989); Schotter and Weigelt (1992); Nitzan (1994); Rapoport and Amaldoss (2000); Szymanski (2003); Casas-Arce and Martinez-Jerez (2009); Imhof and Kräkel (2016); Fu and Wu (2020); Drugov and Ryvkin (2022). For "leveling the playing field," see Schotter and Weigelt (1992); Fain (2009); Franke (2012b,a); Franke et al. (2013); Epstein, Mealem, and Nitzan (2011); Dukerich, Weigelt, and Schotter (1990); Lee (2013).

In the two-period model, the succession planning concerns for the principal and the career concerns for the manager are accounted for simultaneously. The career concerns not only incentivize both agents to work harder in the first period (Holmström (1999); Name Correa and Yildirim (2024)) but also increase the manager's incentives to engage in hiring sabotage. In addition to the role of tournaments as an incentive mechanism, a strand of literature has explored the use of tournaments to select high-ability agents (Clark and Riis (2001); Hvide and Kristiansen (2003); Münster (2007); Ryvkin and Ortmann (2008); Drugov and Ryvkin (2017)). In other words, the principal's objective is maximizing the ability of the winner instead of the total output. Münster (2007) considers both the tournament selection and peer-to-peer sabotage. By contrast, we focus on *hiring* sabotage and the use of the *head start* to mitigate hiring sabotage in a two-period model with succession planning.

3 The Model

3.1 Setup

Consider a one-period, two-player tournament in which a player, the manager m, has the discretion to hire another agent n. The manager of (ability) type $\theta_m \in \Theta \equiv [\underline{\theta}, \bar{\theta}]$ hires an agent of type $\theta_n \in \Theta$ from the candidate pool. We normalize $\bar{\theta} = 1$ and assume $\underline{\theta} \in (0, 1)$ is a sufficiently small number. Once the decision is made, the manager competes with the new hire in a Lazear-Rosen-style tournament. In the tournament, each agent $i \in \{m, n\}$ invests effort, e_i, towards production at the cost $c(e_i)/\theta_i$, where θ_i is the agent's type, and $c(\cdot)$ is twice continuously differentiable, strictly increasing and convex, and satisfies $c(0) = c'(0) = 0$. The output of each agent i is $y_i = e_i + \varepsilon_i$, where the noise term ε_i captures noise that is identically and independently distributed (i.i.d.) with zero mean. The agent with higher individual output wins the tournament prize $V = \alpha \cdot (y_m + y_n)$, where $\alpha \in (0, 1)$ is the payout ratio. In contrast to a fixed tournament prize, this compensation structure incentivizes the manager to hire an otherwise higher-ability agent.

In addition to the payout ratio α, the principal can also offer a *head start*, $h \in \mathbb{R}$, to the manager—an advantage granted to the manager when comparing outputs—to mitigate competition and to induce him to hire a higher-ability agent.[5] Given the head start h, the manager wins the prize V if and only if $y_m + h \geq y_n$.

Alternatively, the tournament scheme can be interpreted as a sharing contract in which each agent gets a share of the payout V equal to his expected payoff in the tournament. Under this interpretation, the head start h increases the manager's percentage share which is equivalent to his

[5] We allow for the possibility that $h < 0$, which makes it a *handicap*—a bias *against* the manager when comparing outputs. Alternatively, one can interpret the head start (handicap) as assigning the manager to an easier (harder) task.

probability of winning the tournament.

We begin with a benchmark model where the profit-maximizing principal designs a contract consisting of the payout ratio α and the head start h. The timing of the game is as follows. First, the principal commits to the contract $\{\alpha, h\}$. Next, the manager hires an agent $\theta_n \in \Theta$ to hire. Then, the manager and the agent choose their effort levels e_m and e_n, respectively. Finally, the output is realized and both agents are rewarded according to the contract $\{\alpha, h\}$. The solution concept we use is the pure-strategy subgame-perfect Nash equilibrium (SPNE).

3.2 Agent's Problem

Given the head start h to m, the manager m will outperform n if and only if

$$\Pr(y_m + h \geq y_n) = \Pr(e_m - e_n + h \geq \varepsilon_n - \varepsilon_m). \tag{1}$$

Let $\epsilon \equiv \varepsilon_n - \varepsilon_m$ be distributed according to a symmetric distribution $G(\cdot)$ with density $g(\cdot)$, which satisfies $G(\epsilon) + G(-\epsilon) = 1$ and $g(\epsilon) = g(-\epsilon)$.[6] Therefore, the probability that m will outperform n is $\Pr(y_m + h \geq y_n) = G(e_m - e_n + h)$. By symmetry, the probability that n will outperform m is $G(e_n - e_m - h) = 1 - G(e_m - e_n + h)$.

We use backward induction to derive the pure-strategy SPNE. In the tournament stage, given the new hire's type θ_n, the expected payoffs for m and n are

$$u_m(e_m, e_n, \theta_n) = \alpha \cdot G(e_m - e_n + h)(e_n + e_m) - c(e_m)/\theta_m, \tag{2}$$
$$u_n(e_m, e_n, \theta_n) = \alpha \cdot G(e_n - e_m - h)(e_n + e_m) - c(e_n)/\theta_n. \tag{3}$$

Both agents will choose the effort level e_i to maximize their expected payoffs. The first-order conditions yield

$$\frac{\partial u_m(e_m, e_n, \theta_n)}{\partial e_m} = \alpha[(e_n + e_m) \cdot g(e_m - e_n + h) + G(e_m - e_n + h)] - c'(e_m)/\theta_m = 0, \tag{4}$$
$$\frac{\partial u_n(e_m, e_n, \theta_n)}{\partial e_n} = \alpha[(e_n + e_m) \cdot g(e_m - e_n + h) + G(e_n - e_m - h)] - c'(e_n)/\theta_n = 0. \tag{5}$$

Following the standard practice in the tournament literature, we assume the cost function is sufficiently convex or the variance of G is sufficiently large so that the second-order conditions are satisfied and a pure-strategy equilibrium exists.[7]

At the hiring stage, the manager hires θ_n^* to maximize his expected payoff in the tournament

[6] The head start (or handicap) h essentially shifts the $G(\epsilon)$ to $G^h(\epsilon) \equiv G(\epsilon + h)$.
[7] See Lazear and Rosen (1981, p. 845, fn. 2) and Nalebuff and Stiglitz (1983)

stage (subgame). The first-order condition yields

$$\frac{du_m(e_m(\theta_n), e_n(\theta_n), \theta_n)}{d\theta_n} = \alpha e_n'(\theta_n)(G(e_m - e_n + h) - (e_m + e_n) \cdot g(e_m - e_n + h)) = 0. \quad (6)$$

Hence, in the subgame perfect Nash equilibrium (SPNE), the equilibrium efforts and hiring decision are given by equations (4)–(6), which simplify to

$$c'(e_n^*)/\theta_n^* = \alpha, \quad (7)$$

$$c'(e_m^*)/\theta_m = 2\alpha \cdot G(e_m^* - e_n^* + h), \quad (8)$$

$$G(e_m - e_n + h) = (e_m^* + e_n^*) \cdot g(e_m^* - e_n^* + h). \quad (9)$$

Following Konrad (2009), Ederer (2010), and Brown and Minor (2014), we assume

$$G \sim \text{Unif}[-M/2, M/2]$$

and $c(e) = e^2/2$ for tractability. The assumption of uniform distribution removes the strategic interdependence of agents' efforts so the optimal effort of either agent is independent of his opponent's ability. This makes it unnecessary to assume abilities are common knowledge, which allows for the situation where the new hire does not know the manager's ability.

Therefore, the equilibrium conditions in the subgame becomes

$$e_m(\theta_m, h) = \frac{M/2 + h}{M/\alpha\theta_m - 2}, \quad (10)$$

$$e_n(\theta_n, h) = \frac{M/2 - h}{M/\alpha\theta_n - 2}. \quad (11)$$

To ensure a pure-strategy equilibrium exists, we assume M is sufficiently large.[8]

In the unique SPNE, the manager's decision and the equilibrium efforts are

$$\theta_n^*(h) = \min\left(\frac{h + M/2}{2\alpha}, \bar{\theta}\right), \quad (12)$$

$$e_m^*(\theta_m, h) = \frac{M/2 + h}{M/\alpha\theta_m - 2}, \quad (13)$$

$$e_n^*(h) = \min\left(\frac{h + M/2}{2}, \frac{M/2 - h}{M/\alpha\bar{\theta} - 2}\right). \quad (14)$$

Equation (12) implies if $M > 4\alpha\theta_m$, even in the absence of a head start, the manager will hire

[8]Moreover, M needs to be sufficiently large such that the winning probability $G(e_m^* - e_n^* + h^*) \in (0, 1)$ in equilibrium, and each agent receives a nonnegative payoff. Using Proposition 1 (below), we can derive a sufficient condition that $M > (1 + \sqrt{2})\bar{\theta} \approx 2.41\bar{\theta}$.

an agent with higher ability $\theta_n^* \geq \theta_m$. This is because the increase in total output and payout due to a more competent agent outweighs the decrease in m's probability of winning (alternatively, m's percentage share of the total payout), thereby increasing m's expected payoff. When a sufficiently high head start level $h \geq 2\alpha\bar{\theta} - M/2$ is given to the manager, she will always hire the best agent $\theta_n^* = \bar{\theta}$.

3.3 Encouragement, Discouragement, and Hiring Effects of the Head Start

A head start has three effects on the equilibrium efforts:

1. Encouragement effect on e_m: $de_m^*/dh > 0$.
2. Discouragement effect on e_n: $\partial e_n(\theta_n, h)/\partial h < 0$.
3. Hiring effect on e_n (through θ_n^*): $\frac{\partial e_n(\theta_n,h)}{\partial \theta_n} \cdot \theta_n^{*\prime}(h) > 0$.

The head start increases the manager's probability of winning. Since the tournament prize is increasing in effort, it has an *encouragement effect* on the manager without leading to complacency by increasing the marginal return on effort. Analytically speaking, the manager's payoff is supermodular in his effort and the head start.[9] However, the impact of the head start on the new hire's effort is rather mixed. On the one hand, it reduces his marginal return on effort, thereby having a *discouragement effect*. On the other hand, the head start partially insulates the manager from competition and leads the manager to hire a higher-ability agent. This *hiring effect* results in greater effort on the part of the higher-ability new hire.

We denote by $\bar{h} = 2\alpha\bar{\theta} - M/2$ the head start just enough to induce the manager to hire the highest-ability candidate $\bar{\theta}$. We find that the hiring effect dominates the discouragement effect until the highest-ability agent is hired (i.e., when $\theta_n^*(h) < \bar{\theta}$) because

$$\frac{de_n^*}{dh} = \underbrace{\frac{\partial e_n(\theta_n, h)}{\partial h}\bigg|_{\theta_n = \theta_n^*(h)}}_{\text{Discouragement effect}} + \underbrace{\frac{\partial e_n(\theta_n, h)}{\partial \theta_n}\bigg|_{\theta_n = \theta_n^*(h)} \cdot \theta_n^{*\prime}(h)}_{\text{Hiring effect}} = 1/2 \text{ when } h < \bar{h}. \tag{15}$$

Recall that the encouragement effect $de_m^*/dh > 0$. Therefore, the head start increases the expected output $e_m + e_i$ until the best agent is hired (i.e., when $h < \bar{h}$). When $h > \bar{h}$, the highest-ability agent $\theta_n^*(h) = \bar{\theta}$ is already hired, so there is no more hiring effect. Then, the discouragement effect dominates the encouragement effect because

$$\frac{d(e_m^* + e_n^*)}{dh} = \underbrace{\frac{1}{M/\alpha\theta_m - 2}}_{\text{Encouragement effect}} - \underbrace{\frac{1}{M/\alpha\bar{\theta} - 2}}_{\text{Discouragement effect}} < 0 \text{ when } h > \bar{h}. \tag{16}$$

[9] In the appendix, we show that this also holds for general distributions as long as the cost is sufficiently convex.

In other words, once the highest-ability agent is hired by the manager, any further head start will only decrease the expected output.

Remark 1. The finding also implies that in the absence of the manager's discretion in hiring, it is optimal to give a head start to the higher-ability agent when the tournament prize is a fraction of the total output, in contrast to the common wisdom of "leveling the playground."

Lemma 1. *Given any $\alpha \in (0, 1)$, the aggregate effort $e_m^* + e_n^*$ (and profit $\Pi = (1 - \alpha)(e_m^* + e_n^*)$) is increasing in h when $h < \bar{h}$ (i.e., $\theta_n^*(h) < \bar{\theta}$) and decreasing in h when $h > \bar{h}$ (i.e., $\theta_n^*(h) = \bar{\theta}$).*

Consequently, given $\alpha \in (0, 1)$, the optimal head start is $h^*(\alpha) = 2\alpha\bar{\theta} - M/2$, which is just enough to induce the manager to hire the highest-ability agent.

3.4 Effects of the Payout Ratio

Given the optimal head start $h^*(\alpha) = 2\alpha\bar{\theta} - M/2$, an increase in the payout ratio α has a positive effect on the effort levels of both agents. From the new hire's perspective, since $\theta_n^* = \bar{\theta}$, an increase in α incentivizes his effort as $e_n^*(h^*(\alpha)) = \alpha\bar{\theta}$. From the manager's perspective, an increase in α creates a greater incentive for the manager to both exert effort and engage in sabotage. The higher incentive to sabotage leads to an increase in the optimal head start, which further incentivizes the manager because of the *encouragement effect* of the head start, as $e_m^*(h^*(\alpha)) = \frac{2\alpha\bar{\theta}}{M/\alpha\theta_m - 2}$.[10]

3.5 Principal's Problem

The principal chooses the head start, h, and payout ratio, α, to maximize profit $\Pi(\alpha, h) = (1 - \alpha)(e_n(\alpha, h) + e_m(\alpha, h))$. We solve the problem by two-step maximization and Lemma 1, i.e.,

$$\max_{\alpha \in [0,1], h} \Pi(\alpha, h) = \max_{\alpha} \Pi(\alpha, h^*(\alpha)) = \max_{\alpha}(1 - \alpha)(\alpha\bar{\theta} + \frac{2\alpha\bar{\theta}}{M/\alpha\theta_m - 2}). \tag{17}$$

The first-order condition yields

$$\alpha^* = \frac{M - \sqrt{M(M - 2\theta_m)}}{2\theta_m}. \tag{18}$$

Proposition 1. *The optimal payout ratio $\alpha^* = \frac{M - \sqrt{M(M-2\theta_m)}}{2\theta_m}$ and head start $h^* = 2\alpha^*\bar{\theta} - M/2$ are just enough to ensure the manager hires the highest-ability agent. In the unique SPNE, $\theta_n^* = \bar{\theta}$,*

[10] If the head start is fixed at a level that does not eliminate sabotage ($\theta_n < \bar{\theta}$), an increase in α still increases the manager's effort but does not affect the new hire's effort. In this case, the encouragement effect of the payout ratio on the new hire's effort is completely offset by the hiring effect (of the payout ratio) on his effort due to the increase in hiring sabotage.

$e_m^* = \frac{2\alpha\bar{\theta}}{M/\alpha\theta_m - 2}$, *and* $e_n^* = \alpha\bar{\theta}$. *The principal's profit is* $\Pi^* = \frac{M(M-\theta_m-\sqrt{M(M-2\theta_m)})}{2\theta_m^2}$.

Remark 2. To ensure the pure-strategy equilibrium exists, the winning probability $G(e_m^* - e_n^* + h^*)$ has to be in $(0, 1)$, and each agent receives a nonnegative payoff. By Proposition 1, a sufficient condition that $M > (1 + \sqrt{2})\bar{\theta} \approx 2.41\bar{\theta}$.

Corollary 1.1. *The following comparative statics hold:*

(i) The optimal head start h^* *is decreasing in* M *and increasing in the manager's type* θ_m, *and* $h^* > 0$ *if and only if* $M < \frac{8}{(4-\theta_m)}$.

(ii) The optimal payout ratio α^* *is decreasing in* M *and increasing in the manager's type* θ_m. *As* $M \to \infty$, $\alpha^* \to 0.5$. *As* $M \to 2\bar{\theta}$, $\alpha^* \to 1 - \sqrt{1 - \theta_m/\bar{\theta}}$. *As* $\theta_m \to 0$, $\alpha \to 0.5$.

(iii) The optimal profit Π^* *is decreasing in* M *and increasing in the manager's type* θ_m.

As we can see, the optimal payout ratio α^* and head start h^* depend on the manager's ability θ_m and the noise in the performance evaluation captured by M. As the manager's ability θ_m increases, the manager invests more effort because his marginal cost of effort decreases, so the principal's profit is higher. Meanwhile, when θ_m is higher, the payout ratio also has a greater marginal effect on the manager's effort, so the optimal payout ratio α^* is higher. The increase in payout ratio creates a greater incentive to sabotage, thereby requiring the principal to increase the optimal head start h^* to ensure that the new hire is of the highest ability.

In equilibrium, the principal offers a head start to the manager that ensures the highest-ability agent is hired. As the noise in performance evaluation increases, the noise begins to take over performance attribution. As a result, the manager becomes less fearful of competing against a higher-ability candidate. Thus, the manager has a lower incentive to sabotage, which allows the principal to reduce the optimal head start h^*.

Moreover, for a given *optimal* head start, the increase in noise makes the effort less important in determining the winner due to noise in performance measurement, thereby reducing the marginal effect of the payout ratio on the manager's effort.[11] In other words, for a marginal increase in payout ratio, the manager's effort increases less than it would if noise was lower. Therefore, under higher noise, the principal will lower the optimal payout ratio α^*, which in turn decreases the optimal head start even further. Furthermore, higher noise also reduces the manager's marginal return on effort and thus, has a demotivating effect on his equilibrium effort, thereby adversely impacting the principal's profit.

Additionally, our tournament scheme outperforms its piece-rate equivalent that pays α^* per unit if and only if the manager's ability is sufficiently high.

[11] This is because $e_m(h^*(\alpha), \theta) = \frac{2\alpha\bar{\theta}}{M/\alpha\theta_m - 2}$ is supermodular in M and α.

Proposition 2. *The tournament scheme results in higher output (and profit) than paying a piece rate α^* if and only if $\theta_m \geq \sqrt{M(8+M)}/4 + M/4 - 1$.*

Remark 3. Because $\theta_m \leq \bar{\theta} = 1$, for this region $\theta_m \geq \sqrt{M(8+M)}/4 + M/4 - 1$ to be nonempty, we need $\sqrt{M(8+M)}/4 + M/4 - 1 \leq 1 \iff M \leq 8/3$ (and $M > (1+\sqrt{2})$ by the previous remark to Proposition 1).

Because the tournament prize is a fraction α of the total output, it pays the same as setting a piece rate of α. However, the tournament can provide higher incentives to the agents, thereby leading to higher output and profit. Specifically, the new hire will invest the same effort as in the piece-rate scheme, given his ability level determined by the manager. Meanwhile, the manager's effort can be either higher or lower compared to the piece-rate scheme depending on his ability. Therefore, if the manager's ability is high, it is more profitable for the principal to operate on this tournament scheme than on piece rate.

4 Two-Period Model with Succession and Career Concerns

4.1 Setup

In the previous section, we derived the optimal contract for a profit-maximizing principal in a one-period model. We now extend the model to two periods to account for employee hiring and succession planning needs for a firm as a going concern. Since the winner of the tournament is retained (or promoted) for the next period, in addition to maximizing the profit in the tournament period, the principal now incorporates the winner's ability into her objectives (see Clark and Riis (2001); Hvide and Kristiansen (2003); Münster (2007); Ryvkin and Ortmann (2008); Drugov and Ryvkin (2017)), as retaining a higher-ability agent from the tournament is vital for future profitability.

To account for succession planning, we assume the principal's continuation payoff $\tilde{V}(\theta) > 0$ is increasing in the retained agent's ability θ, and each agent faces a constant continuation payoff $\tilde{v} > 0$ if retained. The continuation payoffs not only address the succession planning concerns for the principal but also lead to career concerns for both the manager and the new hire.

4.2 Agent's Problem.

Let $\delta \in (0,1)$ be the discount factor. Given the manager's hiring decision, θ_n, the expected payoff of m and n in the subgame are given by

$$u_m = \alpha \cdot (e_m + e_n)G(e_m - e_n + h) - \frac{1}{2}(e_m)^2/\theta_m + \delta G(e_m - e_n + h) \cdot \tilde{v}, \tag{19}$$

$$u_n = \alpha \cdot (e_m + e_n)G(e_n - e_m - h) \ - \frac{1}{2}(e_n)^2/\theta_n \ + \delta G(e_n - e_m - h) \cdot \tilde{v}. \tag{20}$$

Analogous to the one-period case, the equilibrium efforts in the tournament stage are

$$e_m = \frac{(M/2 + h) + \delta\tilde{v}/\alpha}{M/\alpha\theta_m - 2}, \tag{21}$$

$$e_n = \frac{(M/2 - h) + \delta\tilde{v}/\alpha}{M/\alpha\theta_n - 2}. \tag{22}$$

At the hiring stage in the first period, the manager chooses θ_n^* according to the first-order condition

$$\frac{du_m}{d\theta_n} = e_n'(\theta_n)[\alpha \cdot (G(e_m - e_n + h) - g(e_m - e_n + h)(e_m + e_n)) - \delta g(e_m - e_n + h) \cdot \tilde{v}] = 0. \tag{23}$$

Therefore, in the SPNE,

$$\theta_n^*(h) = \min\left(\frac{(M/2 + h) - \delta\tilde{v}/\alpha}{2\alpha}, \bar{\theta}\right), \tag{24}$$

$$e_n^*(h) = \alpha\theta_n^*(h). \tag{25}$$

The amount of head start necessary to induce the manager to hire the best candidate is

$$\bar{h} = 2\alpha\bar{\theta} - M/2 + \delta\tilde{v}/\alpha > 2\alpha\bar{\theta} - M/2, \tag{26}$$

which is larger than that in the one-period model where $\bar{h} = 2\alpha\bar{\theta} - M/2$.

As we shall see below, the *encouragement*, *discouragement*, and *hiring effects* observed in the one-period model remain for the agent, and Lemma 1 still holds.

4.3 Principal's Problem

The principal's problem is

$$\max_{\alpha\in[0,1],h\in[-M/2,M/2]} \tilde{\Pi}(\alpha, h) = \max_{\alpha\in[0,1],h} (1-\alpha)(e_n^* + e_m^*) + \delta\tilde{V}(\theta_m)G(e_m^* - e_n^* + h) \\ + \delta\tilde{V}(\theta_n^*(h))[1 - G(e_m^* - e_n^* + h)]. \tag{27}$$

Using two-step maximization again, the first-order condition for h is

$$\frac{d\tilde{\Pi}}{dh} = \underbrace{(1-\alpha)(\frac{de_n}{dh} + \frac{de_m}{dh})}_{\text{One-period aggregate effects } (>0 \text{ if } \theta_n^* < \bar{\theta})} + \delta \underbrace{(\tilde{V}(\theta_m) - \tilde{V}(\theta_n^*(h)))(\frac{de_m}{dh} - \frac{de_n}{dh} + 1)}_{\text{Succession effect}} + \delta \underbrace{\tilde{V}'(\theta_n^*(h))[1 - G(e_m - e_n + h)]\theta_n^{*\prime}(h)}_{\text{Extended hiring effect}}. \tag{28}$$

For simplicity, assume that the principal's continuation payoff is given by $\tilde{V}(\theta) = k\theta + b$ with $k, b > 0$, which captures the succession concern.

Succession and Hiring Effects. Until the best agent is hired (when $\theta_n^* < \bar{\theta}$), the head start increases the manager's effort because of the *encouragement effect* ($de_m^*/dh > 0$) and also increases the new hire's effort as the *hiring effect* still dominates the *discouragement effect* ($de_n^*/dh = 1/2$ as in equation (15)). Thus, they aggregate to a positive effect on the profit as long as $\theta_n^* < \bar{\theta}$ as in Lemma 1. However, in a model with succession concerns, a head start has two additional effects:

4. Extended hiring effect: $[1 - G(e_m - e_n + h)]k\theta_n^{*\prime}(h) > 0$.
5. Succession effect: $k(\theta_m - \theta_n^*(h))(\frac{de_m}{dh} - \frac{de_n}{dh} + 1)$, which is negative if and only if $\theta_n^*(h) > \theta_m$.

As observed in the one-period model, the head start partially insulates the hiring manager from competition and leads him to hire an otherwise higher-ability agent, who could be retained for the next period with positive probability. This *extended hiring effect* has a positive impact on the principal's continuation payoff. Conversely, the head start also increases the probability of retaining the manager for the future period. Such a *succession effect* can be detrimental to future profit if and only if the manager's ability is lower than the new hire's.

Proposition 3. *In the two-period model, the optimal head start may allow for hiring sabotage in equilibrium (i.e., $\theta_n^*(h^*) < \bar{\theta}$). However, the new hire is always better than the manager (i.e., $\theta_n^*(h^*) > \theta_m$).*

In sharp contrast to the benchmark one-period model, in the two-period model with succession and career concerns, the optimal head start may allow for hiring sabotage in equilibrium. This is driven by the *succession effect* of the head start. At the level of the head start that eliminates hiring sabotage (i.e., $h = \bar{h}$), if the (negative) succession effect dominates the sum of the aggregate positive effect on the first-period profit and the extended hiring effect on the continuation profit, the principal will lower the head start to increase the profit, which opens the room for hiring sabotage. This only happens when the manager's ability is lower than the new hire's because the succession effect would be positive otherwise. Therefore, regardless of the existence of hiring

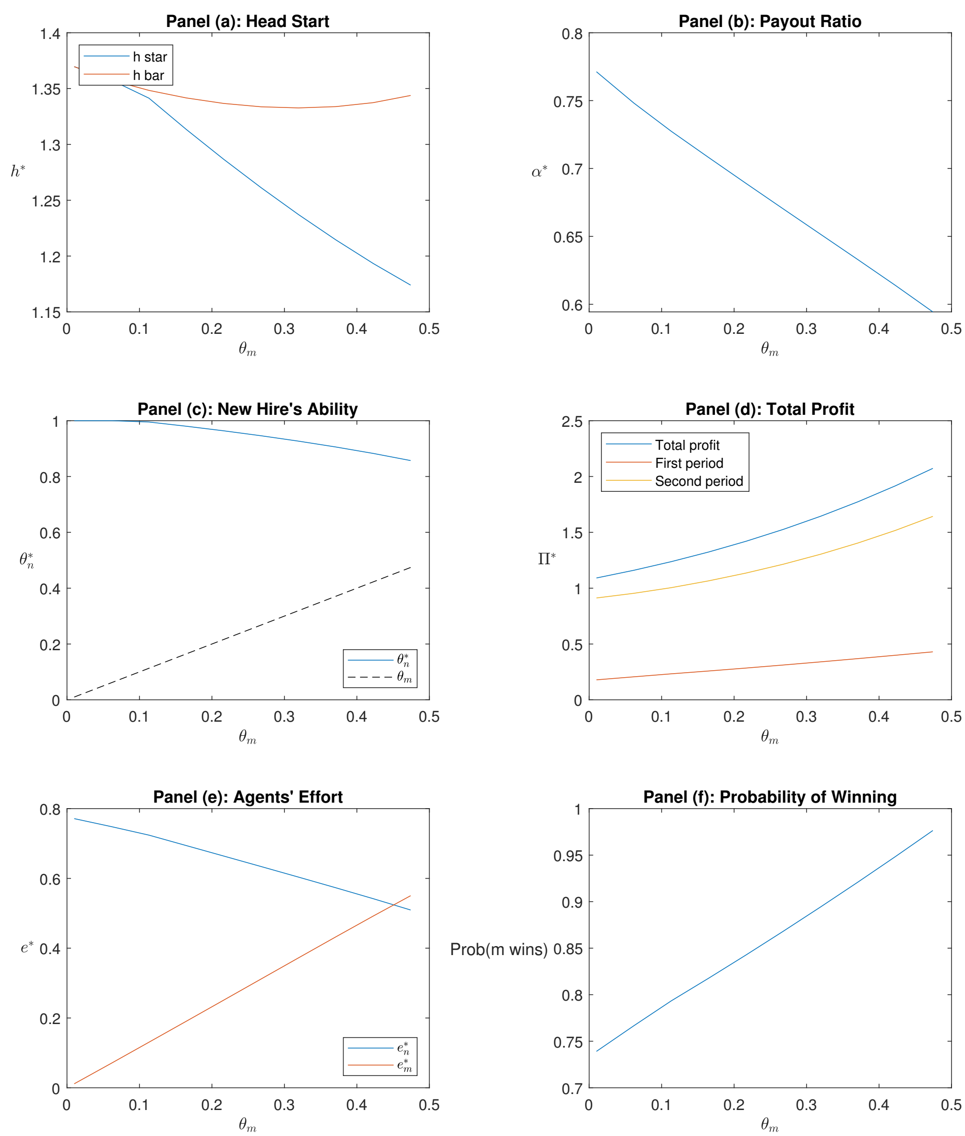

Figure 1: Hiring sabotage arises due to succession and career concerns

sabotage, the optimal contract ensures that the new hire is always of higher ability than the manager (i.e., $\theta_n^* \in (\theta_m, \bar{\theta}]$). [12]

Figure 1 illustrates the optimal head start h^*, optimal payout ratio α^*, and the new hire's ability θ_n^* as a function of the manager's ability $\theta_m \in (0, 0.5)$ when $\delta = 0.85$, $\bar{\theta} = 1$, $k = 4$, $M = 2.55$, and $\tilde{v} = 1$.[13] It can be seen in panel (a) that the optimal head start h^* (blue line) is smaller than the sabotage-free level $\bar{h}$ (red line), which allows for hiring sabotage—the new hire's ability θ_n^* (blue line), as shown in panel (c), is lower than $\bar{\theta} = 1$. However, it is still higher than the manager's ability ($45°$ dashed line).

Moreover, it can be deduced from panels (a) and (b) that an increase in the manager's ability θ_m *decreases* both the optimal head start h^* and the optimal payout ratio α^* (blue line), in contrast to the one-period model. This is because the agents now have *career incentives* (continuation payoffs v) in addition to the first-period tournament prize incentives. As the manager's ability increases, the career incentive encourages him to invest more effort, thereby allowing the principal to lower the optimal payout ratio α^*, which in turn, lowers the optimal head start h^*. As the manager's ability θ_m increases, the decrease in the optimal head start h^* and the optimal payout ratio α^* have opposite effects on hiring sabotage—the former exacerbates it and the latter mitigates it. In combination, the former dominates the latter, and they jointly lead to a decrease in the new hire's ability θ_n^*, as shown in panel (c). Nevertheless, the firm's total profit is still increasing in the manager's ability θ_m, as shown in panel (d), because the direct effect of a better manager on the profit outweighs the indirect effect due to the increase in hiring sabotage.

5 Conclusion

Tournament theory is useful for studying organizations based on relative performance incentives. However, the theory does not account for the possibility that one player can choose the other's ability, which is ubiquitous in organizations as the incumbent manager often has the discretion over hiring (or promoting) a new employee to be in the same pool with her. Consequently, the incumbent manager may hire a low-ability employee to forestall future competition. This paper fills this gap by studying the optimal design of a two-player Lazer-Rosen-style tournament in which the manager has discretion over hiring the new hire, and the one with higher output wins a fraction of the total output.

To mitigate hiring sabotage, the principal designs a head start (or handicap) to the manager—an advantage (or disadvantage) when comparing output—in addition to the payout ratio. This

[12] If the optimal contract allows for hiring sabotage, the new hire must be of higher ability than the manager. If it does not, then the new hire is $\theta_n = \bar{\theta}$. In either case, $\theta_n^* \in (\theta_m, \bar{\theta}]$.

[13] For $\theta_m > 0.5$, the probability of winning is 1, as shown in panel (f), so a pure-strategy equilibrium does not exist.

complements the literature on biased contests that consider the use of head starts or handicaps to provide incentives or restore efficiency in tournaments. We find the head start has three effects on the output: (i) encouragement effect on the manager, (ii) discouragement effect on the new hire, and (iii) hiring effect through the increased ability of the new hire. The hiring effect dominates the discouragement effect until the best candidate is hired; once the best is hired, any further head start leads the discouragement effect to dominate the encouragement effect. Therefore, the optimal contract offers just enough head start to induce the manager to hire the best candidate.

Finally, we extend the model to a two-period model where the first-period winner is retained for the future. The principal now has succession concerns in that she cares not only about the first-period profit but also the winner's ability because it affects the second-period profit. Due to the career concerns of the manager, the head start has an *extended hiring effect* that mitigates the manager's career concerns (by partially insulating him from competition) and encourages her to hire a higher-ability agent. We find the principal with succession concerns may allow hiring sabotage in equilibrium because too high a head start would increase the probability of retaining the manager in the second period, who might be less able than the new hire, thereby having a negative *succession effect* on the profit. Nevertheless, the head start level will ensure the manager hire someone who has a higher ability than herself because otherwise, the principal can always increase the head start to increase profit through a more able new hire without the fear of retaining the less able agent (i.e., succession effect).

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A Proofs

A.1 Proof of Lemma 1

Proof. When $h < \bar{h}$, because $de_m^*/dh > 0$ (encouragement effect) and $de_n^*/dh = 1/2$ (hiring effect dominates discouragement effect), $e_m^* + e_n^*$ (and profit $\Pi = (1-\alpha)(e_m^* + e_n^*)$) is increasing in h. When $h > \bar{h}$, we have $\theta_n^*(h) = \bar{\theta}$ (no hiring effect), and $\frac{d(e_m^*+e_n^*)}{dh} < 0$ (discouragement effect dominates encouragement effect). □

A.2 Proof of Corollary 1.1

Proof. For $\alpha^* = \frac{M-\sqrt{M(M-2\theta_m)}}{2\theta_m}$, because $M > 2\bar{\theta} \geq 2\theta_m$,

$$\frac{d\alpha^*}{dM} = \frac{\sqrt{M(M-2\theta_m)} - (M-\theta_m)}{2\theta_m\sqrt{M(M-2\theta_m)}} < 0. \tag{29}$$

$$\frac{d\alpha^*}{d\theta_m} = -\frac{\sqrt{M(M-2\theta_m)} - (M-\theta_m)}{2\theta_m\sqrt{M(M-2\theta_m)}}M > 0. \tag{30}$$

For $h^* = 2\alpha^*\bar{\theta} - M/2$,

$$\frac{dh^*}{dM} = \frac{d\alpha^*}{dM}\bar{\theta} - 1/2 < 0. \tag{31}$$

$$\frac{dh^*}{d\theta_m} = \frac{d\alpha^*}{d\theta_m}\bar{\theta} > 0. \tag{32}$$

Because $\Pi^* = \max_\alpha(1-\alpha)(\alpha\bar{\theta} + \frac{2\alpha\bar{\theta}}{M/\alpha\theta_m - 2})$, by the envelope theorem, $\frac{d\Pi^*}{dM} < 0$ and $\frac{d\Pi^*}{d\theta_m} > 0$. □

A.3 Proof of Proposition 2

Proof. In a piece-rate scheme that pays α^* per unit, the equilibrium effort levels (e_m^{PR}, e_n^{PR}) is given by

$$c'(e_n^{PR})/\theta_n^* = \alpha^*,$$
$$c'(e_m^{PR})/\theta_m = \alpha^*;$$

whereas in this tournament, the equilibrium effort levels are

$$c'(e_n^*)/\theta_n^* = \alpha^*,$$
$$c'(e_m^*)/\theta_m = 2\alpha^* \cdot G(e_m^* - e_n^* + h^*)$$

where $\alpha^* = \frac{M - \sqrt{M(M-2\theta_m)}}{2\theta_m}$ and head start $h^* = 2\alpha^*\bar{\theta} - M/2$. Thus, $e_m^* + e_n^* > e_m^{PR} + e_n^{PR}$ if and only if $G(e_m^* - e_n^* + h^*) > 1/2$, which is true if and only if $\theta_m \geq \sqrt{M(8+M)}/4 + M/4 - 1$. □

A.4 Proof of Proposition 3

Proof. To show the existence of hiring sabotage in equilibrium with the optimal head start, we show $\theta_n^*(h^*) < \bar{\theta}$ by numerical examples where $\delta = 0.85$, $k = 16.4$, $M = 2.55$, $\tilde{v} = 1$, and $\theta_m \in (0, 0.6)$, as illustrated in Figure 2.

Now we prove the second part that $\theta_n^*(h^*) < \bar{\theta}$ implies $\theta_n^*(h^*) > \theta_m$. Suppose by contradiction that $\theta_n^*(h^*) \leq \theta_m$. Then, the succession effect is nonnegative, and equation (28) implies $d\tilde{\Pi}/dh > 0$ for all $\theta_n^* < \bar{\theta}$, so we would have $\theta_n^* = \bar{\theta}$: a contradiction. □

B Additional Figures

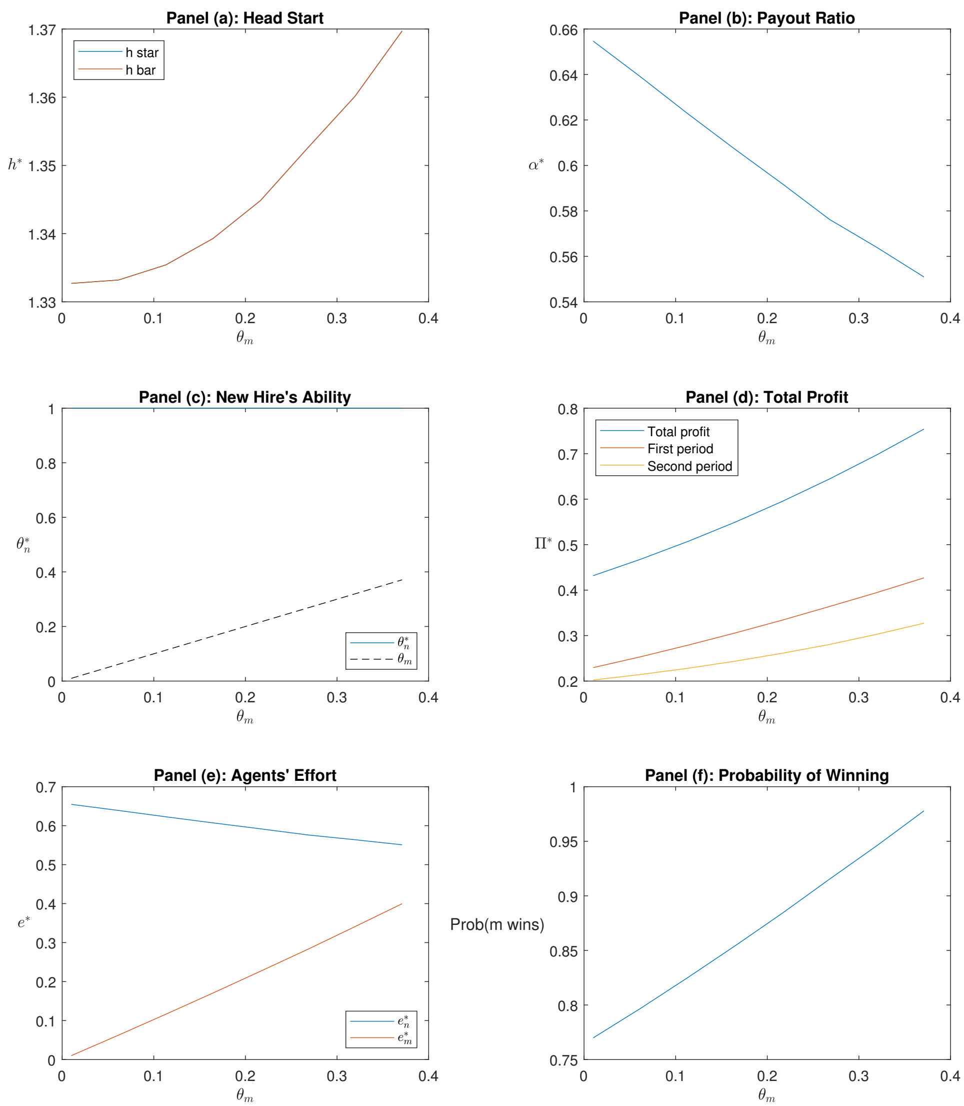

Figure 2: No sabotage when succession concern is small

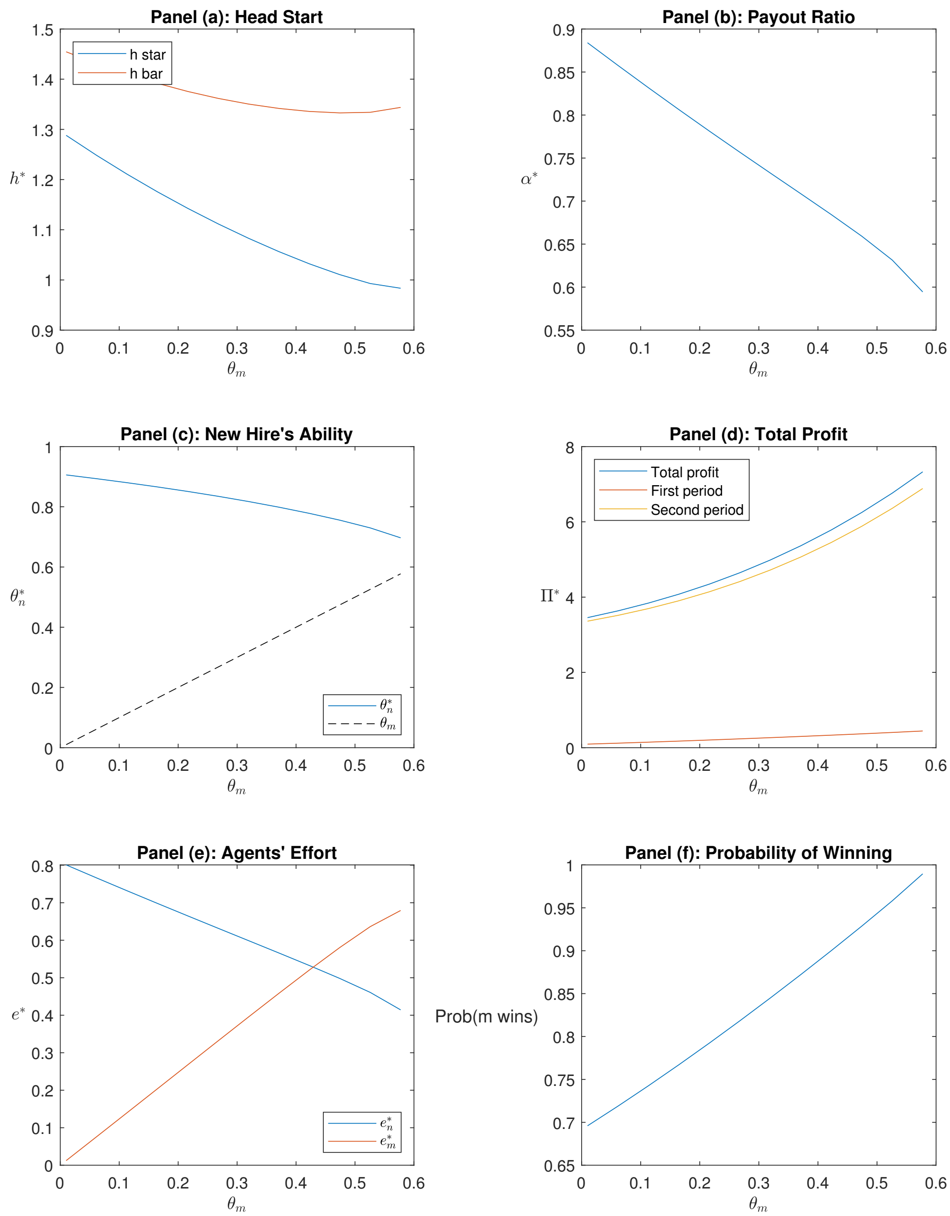

Figure 3: More sabotage when succession concern is large

C One-period model with general cost functions and distributions

We show that under some conditions, it is still optimal to offer $h = \bar{h}$ that ensures the best agent is hired for general cost functions and distributions.

Assumption 1. The cost function $c(\cdot)$ is sufficiently convex or the variance of $G(\cdot)$ is sufficiently large.

Assumption 2. The density function $g(\cdot)$ is unimodal (at zero).

Proposition 4. *Under Assumptions 1 and 2, for any given $\alpha \in (0,1)$, the optimal head start is $\bar{h}(\alpha)$ such that just enough to induce the manager to hire the highest-ability candidate maximizes total output if*

$$[g + (e_m^* + e_n^*)g'(e_m^* - e_n^* + h)]c''(e_n^*)/\bar{\theta} \leq [g - (e_m^* + e_n^*)g'(e_m^* - e_n^* + h)]c''(e_m^*)/\theta_m. \quad (33)$$

Proof. (i) When $\theta_n(h) < \bar{\theta}$, FOCs are

$$c'(e_n^*)/\theta_n^* = \alpha, \quad (34)$$

$$c'(e_m^*)/\theta_m = 2\alpha \cdot G(e_m^* - e_n^* + h), \quad (35)$$

$$G(e_m^* - e_n^* + h) = (e_m^* + e_n^*) \cdot g(e_m^* - e_n^* + h). \quad (36)$$

Denote

$$B \equiv (e_m^* + e_n^*) \cdot g'(e_m^* - e_n^* + h), \quad (37)$$

$$D_1 \equiv \frac{c''(e_m^*)}{\alpha\theta_m}(2g(e_m^* - e_n^* + h) - B) - 4g^2(e_m^* - e_n^* + h), \quad (38)$$

and

$$A \equiv \frac{c''(e_m^*)}{\alpha\theta_m} - 2g(e_m^* - e_n^* + h) > 0. \quad (39)$$

By Assumption 2, $B \leq 0$ if and only if $e_m^* - e_n^* + h \geq 0$ (i.e., m's winning probability is more than $1/2$). We assume the cost function $c(\cdot)$ is sufficiently convex (or the variance of $G(\cdot)$ is sufficiently large)[14] so that $A > 0$ and $D_1 > 0$.

[14] See Lazear and Rosen (1981, p. 845, fn. 2) and Nalebuff and Stiglitz (1983).

Hence,

$$\frac{de_m^*}{dh} = \frac{2}{A}\frac{g(e_m^* - e_n^* + h)^2}{D_1} > 0, \tag{40}$$
$$\frac{de_n^*}{dh} = \frac{D_1 - g(e_m^* - e_n^* + h)}{D_1} \in (0,1), \tag{41}$$
$$\frac{d\theta_n^*}{dh} = \frac{c''(e_n^*)}{\alpha}\frac{de_n^*}{dh} > 0. \tag{42}$$

(ii) When $\theta_n^*(h) = \bar{\theta}$, we have

$$\frac{de_m^*}{dh} = -\frac{u_{mh}v_{ii} - u_{mi}v_{ih}}{D_2} = \alpha\frac{-2\alpha g^2 + (B+g)c''(e_n^*)/\bar{\theta}_n}{D_2}, \tag{43}$$
$$\frac{de_n^*}{dh} = -\frac{u_{mm}v_{ih} - u_{mh}v_{im}}{D_2} = \alpha\frac{2\alpha g^2 - (g-B)c''(e_m^*)/\theta_m}{D_2}. \tag{44}$$

and

$$\frac{de_m^*}{dh} + \frac{de_n^*}{dh} = \alpha\frac{(g+B)c''(e_n^*)/\bar{\theta} - (g-B)c''(e_m^*)/\theta_m}{D_2}. \tag{45}$$

where[15]

$$D_2 \equiv u_{mm}v_{ii} - u_{mi}v_{ih} = u_{mm}v_{ii} + \alpha^2 B^2 > 0. \tag{46}$$

$$u_{mm} = \alpha(2g+B) - c''(e_m)/\theta_m < 0 \tag{47}$$
$$v_{ii} = \alpha(2g-B) - c''(e_i)/\theta_i < 0 \tag{48}$$

Thus, when $\theta_n^*(h) = \bar{\theta}$, $\frac{de_m^*}{dh} + \frac{de_n^*}{dh} \leq 0$ if and only if

$$(g+B)c''(e_n^*)/\bar{\theta} \leq (g-B)c''(e_m^*)/\theta_m. \tag{49}$$

□

[15] $D_2 > 0$ also implies the Nash equilibrium (e_m^*, e_n^*) in the subgame is stable.