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Externalities in recruiting☆

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ABSTRACT

External recruiting at least weakly improves the quality of the pool of applicants, but the incentive implications are less clear. Using a contest model, this paper investigates the pure incentive effects of external recruiting. Our results show that if workers are heterogeneous, opening up a firm's career system may lead to a homogenization of the pool of contestants and thus encourage the firm's high-ability workers to exert more effort. If this positive effect outweighs the discouragement of low-ability workers, the firm will benefit from external recruiting. If, however, the discouragement effect dominates the homogenization effect, the firm should disregard external recruiting. In addition, product market competition may mean that opening up the career system becomes less attractive for a firm since it increases the incentives of its competitors' workers and hence strengthens the competitors.
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1. Introduction

External recruiting of workers is frequently applied by firms. At first, this observation may seem puzzling since, contrary to outsiders, internal candidates have accumulated firm-specific human capital. In addition, by recruiting externally, the firm harms its reputation of honoring good performance of its workers via job promotion to higher hierarchy levels. As a consequence, career incentives of internal workers may be destroyed so that the workers optimally react by reducing their efforts or even deciding to quit. Practitioners like the human resource expert John Sullivan, former Chief Talent Officer at Agilent and responsible for over 40,000 employees, question this view. He speculates that external recruitment may have positive incentive effects: "It keeps our employees on the edge because they know they must compete against outsiders for jobs" (Sullivan, 1999). Moreover, expanding the pool of applicants by external job candidates at least weakly improves the pool's average quality and, therefore, leads to a better staffing than without external applicants.

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Whereas the last argument – improving the pool of applicants – seems indisputable, the incentive implications of external recruiting are not clear. In our paper, we use a contest model to investigate these incentive effects. In a first step, the firm decides on whether allowing external workers to apply or not and then chooses optimal contest prizes. Thereafter, the relevant pool of workers – either only internal workers or internal as well as external workers – competes for a vacant position in a recruitment contest. To focus on the pure incentive view, we assume that external candidates do not have superior talents. Thus, if a firm admits such candidates, the well-known benefit of improving the pool of applicants will not play a role.

The results of the model show when, i.e., under which conditions, a firm profits from opening up its career system to outsiders and when it does not. If the firm's current workforce is heterogeneous, a pure internal competition for vacant positions can be rather weak. For example, if workers have widely differing talents, internal career competition will be rather low since everybody knows the presumable winner. We show that allowing external workers to apply in such a situation can make the competition stronger. Expanding the pool of applicants leads to a discouragement of a firm's workforce but possibly also to a more homogeneous pool of applicants, which increases incentives. If this advantage dominates discouragement, the firm will optimally decide in favor of external recruiting. Furthermore, firms may not have enough appropriate candidates for an effective career contest (e.g., there is only one candidate that has sufficient occupational skills to fill a certain vacancy). Allowing external workers to compete for the vacant position can revive competition. However, if the discouragement effect dominates the homogenization effect, external recruitment will harm overall incentives and, therefore, be disregarded.

In the first part of the paper, we consider two firms employing heterogeneous workers. These have either a high or low ability. If a firm has to fill a vacancy and considers external recruiting, it must keep the following externalities in mind[3]: since the number of workers competing for the vacant position increases, external recruiting discourages own high- and low-ability workers. If the ability difference between the two types of workers is sufficiently large and the number of high-ability workers exceeds a critical value, the low-ability workers will be completely discouraged and remain passive. Only the high-ability workers will hence be active in the competition. These workers' incentives are boosted by the homogenization of the effective set of players. If this advantage outweighs the lost incentives of the low-ability workers, the hiring firm will admit external applicants from a pure incentive perspective. Otherwise, disregarding external candidates will be optimal for the firm.

This paper focuses exclusively on incentives. Including the quality of the recruiting decision (i.e., the ability of the worker assigned to the vacant position) would further strengthen the argument for external recruiting, even if external candidates do not have superior talents: without external candidates, both internal low-ability and internal high-ability workers may have a positive probability of being promoted. If, as in the situation described above, allowing external workers to apply discourages low-ability workers, the vacant position is certain to be filled with a high-ability worker.

Our results offer some testable implications with regard to inside promotion versus outside recruiting. Given our findings, we expect that firms with a more homogeneous workforce will less likely need to rely on external recruiting since internal competition for promotion is already strong. A more homogeneous workforce could, for instance, be the result of extensive screening in the recruiting of junior employees. Industries like top management consulting and large law firms are well known for their scrutiny in entry-level screening. We thus expect to find less recruitment from outside in these industries, a prediction supported by empirical evidence (see, e.g., Wilkins and Gulati (1998) on promotion-to-partnership tournaments in large law firms). Furthermore, our model predicts that an outsider who enters the firm should have a higher ability than the average inside worker. The reason is that only high-ability external workers will enter the competition, while inside the firm there are both, low- and high-ability workers. There exists anecdotal evidence that, indeed, external recruits are, on average, more productive than internal hires (see, e.g., Baker et al., 1994). In addition, we offer testable predictions regarding the influence of skill development and discuss recruitment strategies for different hierarchical levels.

In the final part of the paper, we address those externalities in recruiting that arise if firms serve the same product market. If the two firms, A and B, compete for the same customers but only firm A has a vacant position, this firm is less likely to allow for external applications compared to the basic model with separate product markets. Under product market competition, opening up A's career system to external workers generates a positive externality for the other firm, B. The workforce of firm B receives incentives for free, which makes B a stronger competitor to A in the product market. Consequently, external recruiting becomes less attractive for firm A.

Our theoretical result predicts that hiring from outside will be less frequent if product market competition is more intense. This theoretical finding is supported by the empirical study of Bayo-Moriones and Ortín-Ángel (2006), who analyze the recruitment and promotion decisions of 653 Spanish firms. They find that the degree of competition has a positive and statistically highly significant impact on the use of internal promotions. The authors conclude: "Further theoretical research is needed to understand why product market competition so strongly enhances the use of internal promotions" (p. 466). Our model offers a possible explanation: firms focus on internal promotions under intense product market competition to avoid positive externalities on rival firms.

[3] See Konrad (2009), Chapter 5, on other externalities in contests.

The remainder of the paper is organized as follows: We start with a brief overview of the related literature. Section 3 introduces our basic model. Section 4 presents its solution and some of its empirical predictions. Section 5 considers product market competition. Section 6 concludes.

2. Related literature

Our paper is related to the previous work on contests,[4] in particular to those contest papers that also address competition between heterogeneous contestants. For such a setting, Lazear and Rosen (1981), Nalebuff and Stiglitz (1983), O'Keeffe et al. (1984) have argued that handicapping the more able contestants can increase overall incentives. However, this kind of handicap is only possible when the ability of each worker is known to the firm. In our setting, the firm cannot observe workers' individual abilities, which renders the use of handicaps impossible. We show that the firm has another possibility to create a more balanced contest when only the distribution of types inside and outside the firm is known: by allowing external candidates to apply, internal low-ability workers will be discouraged and incentives for the remaining high-ability workers are increased.

Chen (2005) highlights an alternative argument for allowing external workers to participate in a recruitment contest. He shows that external recruitment can be optimal from a pure incentive perspective if internal workers can choose between productive activities and sabotage. Allowing external competition reduces the effectiveness of sabotage so that workers will substitute productive effort for sabotage. A similar argument applies for preventing workers' collusion. Our paper does not allow for sabotage or collusion among workers. We show that external recruitment can nevertheless be optimal for pure incentive reasons if it leads to a leveling of contestants.

Cornes and Hartley (2005) and Franke et al. (2013) analyze asymmetric contests, applying a general form of the Tullock contest-success function. They show that, depending on the degree of heterogeneity among the players, only the strongest contestants are active in equilibrium. As Baye et al. (1996) and Siegel (2009, 2010) point out, a similar finding also holds for the all-pay auction with complete information. In equilibrium, only the strongest contestants choose positive efforts with a positive probability.

This intuitive finding, i.e., that a more homogeneous pool of contestants leads to stronger competition and higher efforts in equilibrium, has also been confirmed empirically. For instance, the importance of a "competitive balance" in sports leagues has been widely acknowledged. This can be seen, e.g., from the prevalence of policies which aim at achieving that balance. Examples include the "rookie draft system" in sports leagues such as the NFL, which gives weaker teams an advantage in hiring new talent and in the elaborate revenue sharing rules for broadcasting revenues found in many sports. See Szymanski (2003) and Szymanski and Késenne (2004) for details on these and other examples.

The contest literature has studied many ways to homogenize the pool of contestants, such as head starts, bid-caps, handicaps, or excluding (strong) contestants.[5] We contribute to this literature by giving a converse to the exclusion results of, e.g., Baye et al. (1993). We show that including additional contestants whose efforts do not count toward overall efforts increases competition to the designer's advantage. Yet unlike excluding particular contestants, including them does not require knowledge of contestants' identities by the designer. We consider a contest that is not perfectly discriminating, concretely, a Tullock-type contest (Tullock, 1980). Our results can, however, be expected to be robust with respect to the choice of contest model. Consider, for instance, an all-pay auction as in Baye et al. (1993); where contestants have unit effort costs and the two strongest contestants have valuations v_H and $v_L < v_H$ for winning. In this case, overall efforts are given by

$$\frac{v_L}{2}\left(1+\frac{v_L}{v_H}\right) \in \left[\frac{v_L}{2}, v_L\right].$$

Then, by an effect parallel to the one in our model, including another contestant with valuation v_H whose efforts do not benefit the designer leads to total efforts of $v_H/2$ by the previous contestants which is an improvement if $v_H - v_L$ is sufficiently large.

Franke et al. (2013) also address the problem of leveling competition between heterogeneous contestants. They analyze the optimal design of the contest-success function by a contest organizer who wants to maximize total effort. In their approach, the contest organizer can fine-tune the weighting of each player's impact on the contest outcome. Interestingly, it turns out that complete homogenization of the contestants will not be optimal if more than two active players exist in equilibrium.

3. The basic model

We consider two adjacent hierarchy levels in two firms, A and B. There is a total number of n workers working at the lower hierarchy level in both firms. Workers are either of high-ability type H or of low-ability type L. A total of $n_F = n_{FH} + n_{FL} \geq 2$ workers are employed at the lower level of firm $F = A, B$ with n_{FT} denoting the number of workers of type $T = L, H$ at firm F. The total workforce is thus $n = n_A + n_B$. The numbers n_{FT} are common knowledge of all players, but only the individual worker knows his own type. In other words, apart from each worker knowing his own type, firm and workers have symmetric

[4] For an overview see Konrad (2009).

[5] See, e.g., Baye et al. (1993), Che and Gale (1998), Kirkegaard (2008, 2012), and the references therein.

information: they know the distribution of types internally and externally, but not the individual type of any specific other worker.[6] The two firms and all workers are assumed to be risk neutral. Workers are protected by limited liability so that their wages must be nonnegative. Furthermore, each worker has a zero reservation value.

Nature chooses one of the two firms randomly to have a vacant position at the higher hierarchy level that must be filled.[7] The respective firm, F, can either promote one of its n_F internal candidates or fill the vacancy with an external hire. Thus, the two firms have comparable technologies in the sense that working at the lower level of either firm qualifies a worker to fill a vacancy at the higher level of both firms.

The n workers choose nonnegative efforts e_i at personal cost e_i/t_i, with $t_i \in \{t_L, t_H\}$, $t_H > t_L > 0$ reflecting worker i's talent or ability. Hence, firm F has n_{FL} (n_{FH}) workers of talent t_L (t_H). Let N_F denote the set of workers employed at firm F. Workers' efforts e_i lead to the value $v\left(\sum_{i\in N_F} e_i\right)$ for employer F with $v > 0$, $v' > 0$, $\lim_{x\to\infty} v'(x) = 0$, and $v'' < 0$. In words, the value function is monotonically increasing, strictly concave with vanishing increments as well as strictly positive for all feasible arguments. Neither efforts e_i nor the value $v\left(\sum_{i\in N_F} e_i\right)$ are directly observable by the employer. For example, the firm's value of workers' efforts will be realized in the future, or it corresponds to a rather complex good or service whose quality cannot be directly determined.[8]

However, an employer can use a coarse signal on relative performance for filling the vacant position. With probability $p_i(e_1, \ldots, e_i, \ldots, e_m)$, this signal tells firm F that worker i has performed best so that worker i receives the contract offer for the vacant position. Here, m denotes the number of workers included in the employer's chosen career system – i.e., either $m = n$ or $m = n_F$. In any case, the firm does not have information on who has performed second best and so on. This kind of coarse signal particularly holds for those situations where the m workers compete against each other in the same market with only the winner becoming visible. For example, we can think of competition between salesmen for a certain key customer where the only public information is the identity of the salesman who is accepted by the customer. As a second example, we can think of a situation with different industrial researchers competing in the same innovation race.[9] Competition immediately stops when one of them has made the innovation. In that situation, it is difficult to know who would have succeeded next. Given these examples, the value function $v\left(\sum_{i\in N_F} e_i\right)$ indicates that, from the firm's point of view, finishing the observable task (e.g., acquiring a key customer or making an innovation) is only one valuable aspect of workers' effort choices.

To simplify matters, we adopt the signal structure frequently used in the literature on innovation races (e.g., Loury, 1979; Dasgupta and Stiglitz, 1980; Denicolo, 2000; Baye and Hoppe, 2003):

$$p_i(e_1, \ldots, e_i, \ldots, e_m) = \begin{cases} \dfrac{e_i}{\sum_{j\in M} e_j} & \text{if } \sum\limits_{j\in M} e_j > 0 \\ \dfrac{1}{m} & \text{otherwise,} \end{cases}$$

with M denoting the set of competing workers. In order to focus on different firms that compete with their career systems in the same labor market, we assume that each firm can credibly commit to assign the best performer to the higher hierarchy level in case of a vacancy.[10] Moreover, we neglect other possible incentive schemes. The only possibility for a firm to generate incentives is to design a recruitment contest for the vacant position at the higher level. Here, firm F can either restrict competition to internal candidates or widen worker competition by accepting external candidates as well. To install a recruitment contest, the firm announces a wage $w \geq 0$ that is attached to the vacant job.[11] The best performing worker is given the job. All other workers receive zero wages as optimal contest loser prizes since workers are protected by limited liability and have zero reservation values.[12] We concentrate on incentive issues and, at the end of Section 4, briefly comment on the consequences of job assignment on firm profits.

We can summarize the time schedule of the basic model as follows:

[6] Our model would also work in a setting where all individual types are common knowledge. We impose the assumption that only the distribution of types need to be known in order to strengthen our result: while handicapping is not possible in this situation, the firm has another possibility to create a more balanced contest. By allowing external candidates to apply, internal low ability workers will be discouraged and incentives for the remaining high ability workers are increased.

[7] For an extension to simultaneous vacancies see Kräkel et al. (2014).

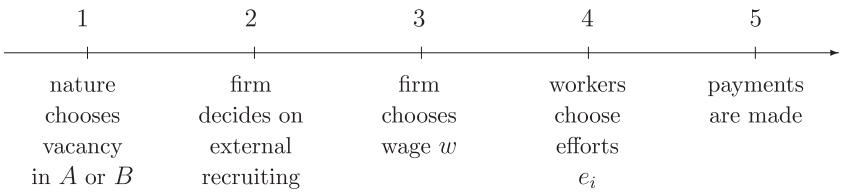
[8] See MacLeod (2003), p. 219, on this point.

[9] If an industrial researcher is hired from outside, such employee poaching can be interpreted as a form of knowledge spillover, which is very successful in high-technology industries; see, e.g., Levin (1988). However, in our setting employee poaching is used as a pure incentive device.

[10] For example, the signal on the best performer is verifiable.

[11] Note that the wage does not depend on whether an insider or an outsider fills the vacancy. First, large corporations often use wages being attached to jobs to avoid a huge number of individual negotiations with their workers. Second, in the given setting workers do not differ from the viewpoint of the two firms and a third party so that equal opportunity laws would prohibit unequal behavior of internal and external workers; see Schotter and Weigelt (1992) on contests and equal opportunity laws.

[12] In other words, since the firm does not have more information on workers' ranking, any positive loser prize would only increase the firm's labor costs and decrease workers' incentives.



At the first stage of the game, nature randomly selects one of the firms, A or B, to have a vacancy at the higher hierarchy level. At stage 2, this firm F has to make the policy decision whether to accept external candidates or not. For the chosen career system – with or without external recruiting – the firm solves

$$\max_{w \geq 0} \; v\left(\sum_{i \in N_F} e_i(w)\right) - w \tag{1}$$

at stage 3. Here, $e_i(w)$ denotes worker i's anticipated equilibrium effort, which depends on the firm's wage policy. The optimal wage attached to the vacant job also describes the contract offered to each of the internal workers at the lower hierarchy level. Any worker will accept a feasible contract with $w \geq 0$ since workers have zero reservation values but a nonnegative payoff when participating in the career game and choosing zero effort. Thus, we do not have to take into account the workers' participation constraints when solving the game. At stage 4, all n workers observe the firm's recruitment policy (including w) and simultaneously choose efforts to compete for the vacant position. Finally, the best performing worker that is assigned to the vacant higher level job receives w, whereas the other workers receive zero. The firm F that has filled its vacancy earns profit (1) and the other firm $\hat{F} \neq F$ receives $v\left(\sum_{i \in N_{\hat{F}}} e_j\right)$. After solving the game of the basic model, we turn to the case of both firms competing in the same product market.

4. Main results

In this section, we first solve the model and then address some of the empirical predictions of the results.

4.1. Solution to the basic model

We solve the game by backwards induction starting with stage 4 where the m workers simultaneously choose their efforts. Let m_H denote the number of H-type workers and m_L the number of L-type workers allowed to apply for the vacancy. Of course, if the workers of firm $\hat{F}$ cannot apply for the vacant position since firm F has excluded candidates from outside, they will optimally choose zero efforts in order to save effort costs. However, workers of firm F are always included in the recruitment contest. Let e_L denote the effort of an L-type worker and e_H that of a H-type worker. Then the L-type worker maximizes expected utility

$$EU_L(e_L) = \frac{e_L}{\sum_{j \in M} e_i} w - \frac{e_L}{t_L},$$

whereas the H-type worker chooses effort e_H to maximize

$$EU_H(e_H) = \frac{e_H}{\sum_{j \in M} e_i} w - \frac{e_H}{t_H}$$

for a given wage $w > 0$. The respective best response functions of all m workers characterize the equilibrium of the contest game at stage 4.

Proposition 1. *There exists a unique and symmetric equilibrium in which workers of the same type choose identical effort levels. If $t_H(m_H - 1) \geq m_H t_L$, L-type workers choose $e_L^* = 0$ in equilibrium and H-type workers $e_H^* = \frac{m_H - 1}{m_H^2} t_H w$, otherwise*

$$e_L^* = w \frac{t_H t_L (m-1)(m_H t_L - (m_H - 1) t_H)}{(m_H t_L + m_L t_H)^2} \quad \textit{and} \tag{2}$$

$$e_H^* = w \frac{t_H t_L (m-1)(m_L t_H - (m_L - 1) t_L)}{(m_H t_L + m_L t_H)^2}. \tag{3}$$

Proof. See Appendix. □

Proposition 1 shows that we have two possible outcomes at the contest stage. Either outcome is symmetric in the sense that both H-type workers choose identical efforts and L-type workers choose identical efforts. If the H-type workers are sufficiently more able than the L-type workers, the latter will be completely discouraged and drop out of the competition

by choosing zero efforts.[13] The larger the number of H-type workers, the more likely this outcome will be. In particular, for $m_H \to \infty$ the L-type workers will even drop out if the H-type workers have only a marginally higher ability since condition $t_H \geq \frac{m_H}{m_H-1} t_L$ becomes $t_H \geq t_L$. The number of H-type workers also discourages the high-ability workers. They will not drop out, but their equilibrium effort level monotonically decreases in m_H. Recall that either $m_H = n_{AH} + n_{BH}$ or $m_H = n_{FH}$. Hence, if L-type workers drop out under pure internal competition, they will also drop out if firm F opens its career system to external hires, whereas the opposite result does not necessarily hold. Altogether, opening up the career system to outsiders can generate strong externalities by discouraging the weak internal workers.

If $t_H(m_H - 1) < m_H t_L$, the recruitment contest will have an equilibrium with both types of workers exerting positive efforts. From (2) and (3) we can see that equilibrium efforts increase in wage w and that $e_H^* > e_L^*$ since $m_L t_H - (m_L - 1)t_L > m_H t_L - (m_H - 1)t_H$. Moreover, the level of a worker's equilibrium effort crucially depends on two factors – the number of contestants and the degree of heterogeneity between the workers. To highlight these two factors, we consider them separately. To point out the impact of the number of contestants, let $m_H = m_L = \overline{m}$. In that case, we obtain

$$e_L^* + e_H^* = \frac{w t_H t_L (2\overline{m} - 1)}{\overline{m}^2 (t_L + t_H)},$$

which is clearly decreasing in $\overline{m}$. Thus, analogously to the case of a corner solution considered in the previous paragraph, each worker is discouraged if the number of opponents increases.

To emphasize the role of heterogeneity let, for illustrating purposes, $m_H = m_L = 1$.[14] The sum of equilibrium efforts boils down to

$$e_L^* + e_H^* = w \frac{t_H t_L}{t_L + t_H}.$$

Hence, for a given amount of collective talent, $t_L + t_H$, workers' efforts are maximized if heterogeneity diminishes (i.e., $t_L = t_H$). This finding is intuitive and also in line with results in other contest models: the closer the race between the contestants the more effort each player will choose in equilibrium. Both effects – discouragement by a larger number of contestants and encouragement by a small degree of heterogeneity among the workers – are crucial for firm F's decision whether to allow external recruiting or not.

Anticipating workers' behavior in the recruitment contest at stage 4, firm F has to decide on external recruiting and the optimal wage w^* at stages 2 and 3. First, the firm chooses whether to allow external workers to apply for the vacancy and then solves

$$\max_{w \geq 0} \quad v(n_{FL} \cdot e_L^*(w) + n_{FH} \cdot e_H^*(w)) - w,$$

with $e_L^*(w)$ and $e_H^*(w)$ being the workers' equilibrium efforts summarized in Proposition 1.

Let $n_T = n_{AT} + n_{BT}$ $(T = L, H)$. Then we obtain the following results:[15]

Proposition 2. *Firm F allows external workers to apply for the vacancy iff*

$$t_H \frac{n_{FH} - 1}{n_{FH}} < t_L \leq t_H \frac{n_H - 1}{n_H} \quad \textit{and} \tag{4}$$

$$\frac{(n_F - 1) n_H^2}{n_{FH}(n_H - 1) n_{FL}} - \frac{n_{FH}}{n_{FL}} < \frac{t_H}{t_L}. \tag{5}$$

In all other cases, F does not admit external applications. If $v'(0)$ is sufficiently large, F will choose $w^* > 0$.

Proof. See Appendix. □

Remark *There exist feasible parameter constellations that satisfy (4) and (5) at the same time. Consider, for example, $n_{\hat{F}H} = n_{FL} = \eta > 0$ and $n_{FH} = 1$, with $\hat{F}$ denoting the other firm. For this parameter constellation, conditions (4) and (5) boil down to*

$$0 < t_L \leq t_H \frac{\eta}{1 + \eta} \textit{ and } t_L < t_H \frac{\eta}{(\eta + 1)^2 - 1}.$$

There are feasible values of t_L and t_H that satisfy both inequalities for any positive integer η.

From Proposition 1 we know that L-type workers will drop out and choose zero effort if the number of H-type workers is sufficiently large. Hence, from the perspective of firm F, we can differentiate between three cases – (1) the number of internal H-type workers is so large that L-type workers drop out even without external competition; (2) L-type workers only drop out if F opens the career system to external candidates but not under pure internal competition; (3) L-type workers never drop

[13] Note that this result is not specific to the Tullock contest-success function. It is due to the fact that marginal effort costs are positive at zero. If marginal effort costs were zero at zero effort, workers would not drop out, but the discouragement effect would be qualitatively the same.

[14] Since by assumption of the basic model, $n_{FL} + n_{FH} \geq 2$, we are in a situation where external workers are excluded.

[15] See the proof of the proposition for the exact values of w^* in the different cases.

out. Proposition 2 shows that only in case (2) may firm F be interested in allowing external applications. In that case, F strictly benefits from the strong externalities induced by the outsiders. F will prefer an open career system if the increased effort levels of its H-type workers exceed the lost efforts of its L-type workers who become completely discouraged and drop out. In particular, three effects are at work that crucially influence firm F's decision to allow external recruiting. First, since the L-type workers drop out of the competition, there is pure homogeneous competition among H-type workers. As equilibrium efforts are higher the more homogeneous the players are, F strictly profits from an active homogeneous workforce. Second, firm F loses the valuable efforts of its L-type workers who exert zero efforts. Third, allowing external candidates changes the number of active contestants. In general, a single worker will be discouraged and, hence, supply less effort, the larger the number of opponents. Whereas F strictly benefits from the first effect and suffers from the second, the direction of the third effect is not clear. On the one hand, the number of active players decreases when L-type workers drop out, which encourages each remaining H-type worker. On the other hand, additional H-type workers from the other firm enter the competition, which increases the number of active players.

We can identify these three effects when looking at condition (5).[16] This inequality is more likely to be satisfied if t_H is rather large and t_L rather small. The larger t_H, the more F will profit from enhanced competition between its H-type workers. The smaller t_L, the smaller will be F's losses from its L-type workers, who become completely passive. A similar interpretation can be derived for n_{FL}: Condition (5) is equivalent to

$$\frac{t_L(n_{FH}+n_{FL}-1)}{(n_{FH}t_L+n_{FL}t_H)} < n_{FH}\frac{n_H-1}{n_H^2}.$$

Differentiating the left-hand side with respect to n_{FL} gives

$$\frac{\partial}{\partial n_{FL}}\left(\frac{t_L(n_{FH}+n_{FL}-1)}{(n_{FH}t_L+n_{FL}t_H)}\right) = \frac{n_{FH}t_L\left(t_L-\frac{n_{FH}-1}{n_{FH}}t_H\right)}{(t_Ln_{FH}+n_{FL}t_H)^2},$$

which is strictly positive according to (4). Hence, the smaller n_{FL}, the smaller will be F's losses from completely discouraging all its L-type workers and the more F will tend to open its career system to external workers. Finally, the left-hand side of (5) is non-decreasing (and strictly increasing for $n_H > 2$) in n_H. This finding is intuitive, following the third effect described above. Recall that n_H also contains the number of H-type workers of the other firm, $n_{\hat{F}H}$. The larger this number, the larger will be the number of active contestants when external candidates are allowed to apply. Since the equilibrium effort level of a single H-type worker decreases in the number of opponents when the pool of players is completely homogeneous (see Proposition 1), a larger value of $n_{\hat{F}H}$ makes opening up the career system to firm F less attractive.

The argument given at the end of the last paragraph exactly explains why firm F does not open its career system in case (1) described above. The only effect of such an opening would be a discouragement of the internal H-type workers since m_H increases from $m_H = n_{FH}$ to $m_H = n_{FH} + n_{\hat{F}H}$. The remaining case (3) deals with the scenario where L-type workers never give up by choosing zero efforts. At first sight, it is not clear whether opening up the career system may be profitable for F. Of course, allowing external applications unambiguously increases the number of contestants, discouraging each internal worker. However, the additional contestants may lead to a better mixture of workers so that the pool becomes more homogeneous. Proposition 2 shows that this possible advantage is not strong enough to justify opening up the career system in case (3).

In this paper, we do not address the firm's consequences of assigning a worker with a certain talent t to the vacant position at the higher hierarchy level. However, since the vacant position is typically accompanied by greater responsibility and influence on firm profits, the firm should prefer $t = t_H$ to $t = t_L$ for the new job holder. Note that, given this preference, the firm additionally profits in case (2) from ensuring the assignment of an H-type worker to the higher position. Since all L-type workers drop out of the competition and thus have a zero probability of winning the contest, opening up the career system guarantees optimal selection of workers as a by-product.

So far we have assumed that firm F can observe the actual composition of $\hat{F}$'s workforce (i.e., the distribution of H-type and L-type workers) at zero cost. It may be more realistic to assume that F only has some prior information on the composition of $\hat{F}$'s workforce and must incur cost $C > 0$ to acquire additional information. In that case, firm F has two alternatives. On the one hand, it can, based on the prior information, decide whether to open its career system or not. This alternative would lead to zero additional costs but uses quite imprecise information. On the other hand, F can invest C to acquire more information on $\hat{F}$'s composition and, thereafter, decide on external recruitment based on its posterior information. However, in either case the fundamental decision problem of external recruiting based on expected profits would be qualitatively the same.

4.2. Empirical predictions

In the following we derive some empirical predictions based on the findings in Propositions 1 and 2. Naturally, we can only consider industries and firms where the main conditions of our model are satisfied: First, promotions must play an important role in providing incentives. Second, firm-specific human capital should not be a main driver when staffing a

[16] Condition (4) only states that we are in case (2).

vacancy. Third, firms and workers must have a good intuition for the distribution of types inside the firm and on the relevant external labor market. For instance, these conditions are likely to hold in consulting firms, law firms, and in investment banking. In addition, depending on the circumstances, they can hold for industrial or academic researchers, salespeople for industrial goods (where piece-rates are often not feasible) and for general functions inside the firm where the external competition is geographically restricted and known.

Recall from Proposition 2 and the remark following it that opening up the career system for incentive reasons will prove valuable only when the low type workers drop out under external competition but not under internal competition. In light of these results, opening up the career system is more likely if (i) the spread between high- and low-ability types is large (t_H is high and t_L is low); (ii) there are not too many low-ability workers (n_{FL} small); and (iii) there are not too many external competitors ($n_{\hat{F}H}$ small). Given these findings, the following factors can be predicted to have an influence on the recruitment policy.

Skill development: If skill development of internal workers is aimed at enhancing the skills of low-ability employees (increasing t_L), external recruitment will decrease; if skill development is aimed at enhancing the skills of high-ability employees (increasing t_H), external recruitment will increase.

Hierarchical levels: External recruiting is more likely to occur for lower level jobs compared to higher level jobs. The reason is that firms that employ external recruiting at lower levels (due to incentive and/or sorting considerations) will have a more homogeneous workforce at higher levels, thus decreasing the spread between t_H and t_L. This prediction is in line with findings in Lazear and Oyer (2004). Using data from Sweden from 1970 to 1990, they find that the proportion of internal promotions increases with the hierarchical level. For four-level firms, this proportion is 51% for level 2, 69% for level 3, and 76% for the highest level 4. Similar proportions can be found for firms with more or fewer levels. For instance, for seven-level firms the corresponding proportions are 32% for level 2 and 85% for level 7.

Screening for entry-level jobs: Firms with a more homogeneous workforce are less prone to recruit higher level positions from outside. The reason is that in these firms internal competition for promotion is already strong. A more homogeneous workforce could, for instance, be the result of extensive screening when junior employees are recruited. Such scrutiny in the selection of juniors can be found in industries like top management consulting and large law firms. We would thus expect to find less recruitment from outside in these industries, a prediction that is supported by empirical evidence (see, e.g., Wilkins and Gulati (1998) on promotion-to-partnership tournaments in large law firms). Clearly, this prediction can be diluted if outsiders offer additional benefits such as bringing with them an important client base.

Ability levels of insiders and outsiders entering the firm: Our model predicts that an outsider entering the firm should have a higher ability than the average inside worker. The reason is that opening up a firm's career system to outsiders only attracts high-ability external workers to compete with insiders. Thus, any external candidate who wins the competition will be of high ability, whereas inside the firm there are both low- and high-ability workers. There exists anecdotal evidence that, on average, external recruits are indeed more productive than internal hires (see, e.g., Baker et al., 1994).

Our model is also in line with data presented in Murphy and Zábojnik (2004). For the U.S., they find that in the 1970s 15% of all CEO replacements for companies listed in the Forbes 800 were hired externally. In the 1980s the corresponding percentage was 17%, and in the 1990s it was higher than 26%. They argue that during this time general management skills became more important as opposed to firm-specific human capital, and they highlight the sorting effect of external recruitment. However, a further reason for this increase in external recruiting could be that the shift from firm-specific to general knowledge allowed the incentive effect of external recruiting to unfold.

5. Product market competition

We now turn to the case where both firms compete in the same product market. Again, firm F has to fill a vacancy and needs to decide whether or not to open its career system to workers of its competitor $\hat{F}$.

The basic structure of the model remains the same as in Section 3. However, under product market competition the profit of firm F does not only depend on its own workers' effort but also on the effort exerted by the workforce of the rival firm, $\hat{F}$. The higher the total effort of the rival firm's workforce, the lower should be F's profit. This effect seems to be natural if firms compete against each other. To model this effect, firm F is assumed to maximize profit

$$\pi\left(\sum_{i\in N_F} e_i - \sum_{j\in N_{\hat{F}}} e_j\right) - w \tag{6}$$

where function π is monotonically increasing.

Since the contest game between the workers remains the same, equilibrium efforts for a given wage w are still described by Proposition 1. As can be seen from (6), the introduction of product market competition renders external recruiting less attractive. The reason is that the recruitment contest gives incentives to all participating workers, which includes the workforce of the competing firm in case of external recruiting. Therefore, we can only expect new insights for the case where the firm would open its career system to external workers in the absence of competition, as described by conditions (4) and (5) of Proposition 2. We obtain the following result:

Proposition 3. *Suppose that conditions (4) and (5) hold. F still allows external workers to apply despite product market competition iff* $n_{FH} > n_{\hat{F}H}$ *and*

$$\frac{(n_F - 1)n_H^2}{(n_{FH} - n_{\hat{F}H})(n_H - 1)n_{FL}} - \frac{n_{FH}}{n_{FL}} < \frac{t_H}{t_L}. \tag{7}$$

Otherwise, F does not admit external applications.

Proof. See Appendix. □

Proposition 3 shows that with product market competition two additional conditions – $n_{FH} > n_{\hat{F}H}$ and inequality (7) – need to hold for F to open up its career system. Firm F now has to consider the negative externalities in form of the career incentives for the workers in firm $\hat{F}$. These externalities only arise for H-type workers since the L-type workers in both firms will be completely discouraged and drop out of the job competition. Firm F thus has to consider the number of H-type workers $n_{\hat{F}H}$ in the competing firm, which yields the two additional conditions. If $n_{FH} < n_{\hat{F}H}$, firm $\hat{F}$ will gain more from career incentives than firm F since $\hat{F}$ employs more H-type workers. In that case, firm F would unambiguously harm itself by opening up its career system to external hires. Thus, $n_{FH} > n_{\hat{F}H}$ describes a necessary condition for F to admit external candidates.

In addition, opening up the career system requires condition (7) to hold. Again, the number of H-type workers of the other firm $\hat{F}$ turns out to be crucial. The larger $n_{\hat{F}H}$ the more the H-type workers in both firms will be discouraged since the equilibrium effort level of the H-type workers,

$$e_H^* = \frac{(n_{FH} + n_{\hat{F}H}) - 1}{(n_{FH} + n_{\hat{F}H})^2} t_H w,$$

decreases in $n_{\hat{F}H}$. This effect should harm firm F more than firm $\hat{F}$ because of $n_{FH} > n_{\hat{F}H}$. Thus, the larger $n_{\hat{F}H}$ the less likely it is that condition (7) is satisfied. The comparison of conditions (5) and (7) shows that this conjecture is correct. The only difference between (5) and (7) is the replacement of n_{FH} by $n_{FH} - n_{\hat{F}H}$ in the denominator of the first expression on the left-hand side. Hence, condition (7) is stricter than condition (5) so that under product market competition firm F will open its recruitment system less often to external applicants than without competition. Since the left-hand side of (7) is monotonically increasing in $n_{\hat{F}H}$, (7) is less likely to be satisfied for large values of $n_{\hat{F}H}$.

As an alternative to the rather stylized modeling of competition via (6), we could assume a competition model that explicitly considers the quantities produced by the firms and the inverse demand function of the market (e.g., Cournot competition). Such modeling would not change the analysis of the recruitment contest between the workers at stage 4 of the game. However, the derivation of the firm's optimal wage policy may become more complicated without altering the qualitative result, which is that creating incentives for its rival's workforce makes external recruiting less attractive for a firm.[17]

6. Conclusion

We have addressed two kinds of externalities that arise if a firm chooses external recruiting. First, opening up the career system can lead to both negative and positive externalities for worker competition. Negative externalities always arise since, for a given vacancy, the enlarged pool of applicants leads to worker discouragement. Positive externalities are generated if external recruiting induces a homogenization of active players which boosts the incentives of a firm's high-ability workers. The firm prefers external recruiting, if the positive externalities from homogenization dominate the negative ones from worker discouragement. Second, there are externalities in case of product market competition. Suppose there are two firms competing in the same market. If one firm opens its career system to the workers of the other firm, the latter will profit from the incentives its workers receive without paying for them. Thus, the second firm becomes a stronger competitor, which harms the first firm. Consequently, strong product market competition makes opening up of the career system less attractive for a firm.

[17] For example, when considering Cournot competition we could assume that a firm's unit costs are a decreasing function of total effort spent by the firm's workforce. In that case, a recruiting firm will only open its career system to external applicants if this leads to a more homogeneous contest and if the firm profits more from this effect than the rival firm.

Appendix.

Proof of Proposition 1:

If $e_{L1}, \ldots, e_{Lm_L}$ denote the efforts of the L-type workers, $e_{H1}, \ldots, e_{Hm_H}$ those of the H-type workers and M_L and M_H the respective sets of workers, then L-type worker α will maximize

$$EU_{L\alpha}(e_{L\alpha}) = \frac{e_{L\alpha}}{e_{L\alpha} + \sum_{i \in M_L \setminus \{\alpha\}} e_{Li} + \sum_{j \in M_H} e_{Hj}} w - \frac{e_{L\alpha}}{t_L},$$

whereas H-type worker β chooses effort $e_{H\beta}$ to maximize

$$EU_{H\beta}(e_{H\beta}) = \frac{e_{H\beta}}{e_{H\beta} + \sum_{i \in M_L} e_{Li} + \sum_{j \in M_H \setminus \{\beta\}} e_{Hj}} w - \frac{e_{H\beta}}{t_H}.$$

If $w > 0$, there cannot be an equilibrium with each worker exerting zero effort because in that case one of the workers can switch to a marginal amount of positive effort and wins w for sure. Since each worker has a strictly concave objective function, worker α either optimally chooses $e^*_{L\alpha} = 0$ if $EU'_{L\alpha}(0) \le 0$, or $e^*_{L\alpha} > 0$ with $EU'_{L\alpha}\left(e^*_{L\alpha}\right) = 0$ if $EU'_{L\alpha}(0) > 0$. In analogy, we obtain

$$e^*_{H\beta} \begin{cases} = 0 & \text{if} \quad EU'_{H\beta}(0) \le 0 \\ > 0 \text{ with } EU'_{H\beta}(e^*_{H\beta}) = 0 & \text{if} \quad EU'_{H\beta}(0) > 0. \end{cases}$$

Hence, a corner solution $e^*_{L\alpha} = 0$ satisfies

$$\begin{aligned} \frac{\sum_{i \in M_L \setminus \{\alpha\}} e_{Li} + \sum_{j \in M_H} e_{Hj}}{\left(e^*_{L\alpha} + \sum_{i \in M_L \setminus \{\alpha\}} e_{Li} + \sum_{j \in M_H} e_{Hj}\right)^2} w &\le \frac{1}{t_L} \Leftrightarrow \\ \frac{1}{\sum_{i \in M_L \setminus \{\alpha\}} e_{Li} + \sum_{j \in M_H} e_{Hj}} w &\le \frac{1}{t_L}, \end{aligned}$$

and an interior solution $e^*_{L\alpha} > 0$

$$\frac{1}{\sum_{i \in M_L \setminus \{\alpha\}} e_{Li} + \sum_{j \in M_H} e_{Hj}} w > \frac{1}{t_L},$$

with $e^*_{L\alpha}$ being described by the first-order condition

$$\frac{\sum_{i \in M_L \setminus \{\alpha\}} e_{Li} + \sum_{j \in M_H} e_{Hj}}{\left(e^*_{L\alpha} + \sum_{i \in M_L \setminus \{\alpha\}} e_{Li} + \sum_{j \in M_H} e_{Hj}\right)^2} w = \frac{1}{t_L}. \tag{8}$$

Next, we show that there is a unique equilibrium, with all workers of the same type choosing identical effort levels. To show uniqueness of the Nash equilibrium, we follow an approach put forward by Cornes and Hartley (2005). Let $E \equiv \sum_{i \in M_L} e_{Li} + \sum_{j \in M_H} e_{Hj}$. From (8) we know that for $e^*_{L\alpha} > 0$ we must have $\frac{E - e^*_{L\alpha}}{E^2} w = \frac{1}{t_L}$ or

$$e^*_{L\alpha} = E\left(1 - \frac{E}{wt_L}\right).$$

Let $e^*_{L\alpha}(E) \equiv \max\left\{E\left(1 - \frac{E}{wt_L}\right), 0\right\}$, which is the unique possible equilibrium value of $e_{L\alpha}$, given that the sum of all effort levels is equal to E. Similarly, define $e^*_{H\beta}(E) \equiv \max\left\{E\left(1 - \frac{E}{wt_H}\right), 0\right\}$. Therefore, a necessary condition for $(e_{L1}, \ldots, e_{Lm_L}, e_{H1}, \ldots, e_{Hm_H})$ being an equilibrium is that the sum of these effort levels E is equal to the sum of the equilibrium effort levels of $e^*_{L\alpha}(E)$ and $e^*_{H\beta}(E)$. Formally, we must have:

$$\begin{aligned} E &= \sum_{i \in M_L} e^*_{Li}(E) + \sum_{j \in M_H} e^*_{Hj}(E) \Leftrightarrow \\ 1 &= \sum_{i \in M_L} \max\left\{1 - \frac{E}{wt_L}, 0\right\} + \sum_{j \in M_H} \max\left\{1 - \frac{E}{wt_H}, 0\right\}. \end{aligned} \tag{9}$$

The RHS of (9) is decreasing in E, has value $m > 1$ for $E = 0$, and tends to 0 for $E \to \infty$. Hence, a unique value E^* exists satisfying (9). Since $e^*_{L\alpha}(E)$ and $e^*_{H\beta}(E)$ constitute the unique equilibrium candidate for a given value E, the unique equilibrium is given by $e^*_{L\alpha}(E^*)$ and $e^*_{H\beta}(E^*)$. Thus, there exists a unique equilibrium that has the property that all workers of the same type choose identical effort levels.

Therefore, we have symmetric solutions in the sense of $e^*_{L\alpha} = e^*_L$ ($\alpha = 1, \ldots, m_L$) and $e^*_{H\beta} = e^*_H$ ($\beta = 1, \ldots, m_H$). The condition for the corner solution $e^*_{L\alpha} = e^*_L = 0$ boils down to

$$\frac{1}{m_H e^*_H} w \leq \frac{1}{t_L}, \tag{10}$$

and the conditions for an interior solution $e^*_{L\alpha} = e^*_L > 0$ can be simplified to

$$\frac{1}{m_H e^*_H} w > \frac{1}{t_L} \text{ and} \tag{11}$$

$$\frac{(m_L - 1) e^*_L + m_H e^*_H}{\left(m_L e^*_L + m_H e^*_H\right)^2} w = \frac{1}{t_L}. \tag{12}$$

Analogously, we obtain

$$\frac{1}{m_L e^*_L} w \leq \frac{1}{t_H} \tag{13}$$

for $e^*_{H\beta} = e^*_H = 0$, and

$$\frac{1}{m_L e^*_L} w > \frac{1}{t_H} \text{ and} \tag{14}$$

$$\frac{m_L e^*_L + (m_H - 1) e^*_H}{\left(m_L e^*_L + m_H e^*_H\right)^2} w = \frac{1}{t_H} \tag{15}$$

for $e^*_{H\beta} = e^*_H > 0$.

First, we can show by contradiction that a solution $e^*_L > 0$ and $e^*_H = 0$ is not possible. For this solution (12) and (13) must hold at the same time. Inserting $e^*_H = 0$ into (12) yields $e^*_L = [t_L (m_L - 1) w] / m_L^2$. Plugging into (13) and rewriting gives $t_H m_L \leq t_L (m_L - 1)$, a contradiction.

However, a corner solution with $e^*_L = 0$ and $e^*_H > 0$ is possible. Combining (10) with (15) and $e^*_L = 0$ leads to

$$e^*_H = \frac{(m_H - 1) t_H}{m_H^2} w \quad \text{and} \quad t_H \geq \frac{m_H}{m_H - 1} t_L \quad (m_H > 1),$$

where the last inequality is clearly satisfied for $m_H \to \infty$.

Finally, an interior solution with $e^*_L > 0$ and $e^*_H > 0$ is described by the two first-order conditions (12) and (15). Straightforward computations yield (2) and (3).

Proof of Proposition 2:

If $n_L = 0$ or $n_H = 0$, competing workers are homogeneous irrespective of whether firm F allows external applicants or not. In this situation, F strictly benefits from excluding external hires since a worker's individual equilibrium effort decreases in the number of contestants.

The other possible situations can be divided into three cases. Case (1) deals with $t_L \leq t_H \frac{n_{FH}-1}{n_{FH}}$. Then L-type workers drop out with and without external recruiting (see Proposition 1). F solves

$$\max_w \; v\left(n_{FH} \frac{n_{FH} - 1}{n_{FH}^2} t_H w\right) - w$$

when excluding external workers, and

$$\max_w \; v\left(n_{FH} \frac{n_H - 1}{n_H^2} t_H w\right) - w$$

if it allows external workers to apply. Note that we have an immediate result without solving for the optimal wages: Since $(n_{FH} - 1)/n_{FH}^2 \geq (n_H - 1)/n_H^2$, the first objective function always lies above the second one so that firm F prefers to exclude external candidates. Because the firm's objective function is strictly concave, the optimal wage is described by the first-order condition

$$v'\left(\frac{n_{FH} - 1}{n_{FH}} t_H w^*\right) \frac{n_{FH} - 1}{n_{FH}} t_H = 1,$$

given that $v'(0) \frac{n_{FH}-1}{n_{FH}} t_H > 1$ guarantees an interior solution. The first-order condition can be rewritten to

$$w^* = \frac{n_{FH}}{(n_{FH} - 1) t_H} V\left(\frac{n_{FH}}{(n_{FH} - 1) t_H}\right),$$

with V denoting the inverse of the marginal value function v'.

Case (2) is characterized by $t_H \frac{n_{FH}-1}{n_{FH}} < t_L \leq t_H \frac{n_H-1}{n_H}$. Now L-type workers drop out with external recruiting but do not drop out without external hires. Using (2) and (3), under pure internal career competition, firm F maximizes

$$v(n_{FH} \cdot e_H^* + n_{FL} \cdot e_L^*) - w = v\left(\frac{t_H t_L (n_F - 1)}{n_{FH} t_L + n_{FL} t_H} w\right) - w. \tag{16}$$

If F additionally includes external candidates, its L-type workers will drop out and F maximizes

$$v\left(n_{FH} \frac{n_H - 1}{n_H^2} t_H w\right) - w. \tag{17}$$

Firm F will prefer external recruiting, if

$$n_{FH} \frac{n_H - 1}{n_H^2} t_H > \frac{t_H t_L (n_F - 1)}{n_{FH} t_L + n_{FL} t_H},$$

which can be rewritten to (5). If F prefers to allow external job candidates, it will maximize (17), leading to $w^* = \Phi_1 V(\Phi_1)$ with $\Phi_1 = n_H^2/(n_{FH}(n_H - 1)t_H)$, given $v'(0) n_{FH} \frac{n_H-1}{n_H^2} t_H > 1$. Otherwise, F maximizes (16), yielding $w^* = \Phi_2 V(\Phi_2)$ with $\Phi_2 = (n_{FH} t_L + n_{FL} t_H)/(t_H t_L (n_F - 1))$, given $v'(0) \frac{t_H t_L (n_F-1)}{n_{FH} t_L + n_{FL} t_H} > 1$.

Case (3) deals with $t_H \frac{n_H-1}{n_H} < t_L$. Now L-type workers will not drop out irrespective of whether firm F allows external applicants or not. Thus, the only effect of opening up the career system is an increase in the number of L-type and H-type contestants without influencing the number of effort-spending internal workers. We can show that such an opening does not pay off for the firm since the negative incentive effect of an increased number of contestants always dominates a possibly positive incentive effect of a less heterogeneous pool of contestants.

Proof of Proposition 3:

Let conditions (4) and (5) be fulfilled. As before, L-type workers drop out with external recruiting but not without external hires. Using (2) and (3), under pure internal career competition, firm F maximizes in analogy to (16):

$$\pi(n_{FH} \cdot e_H^* + n_{FL} \cdot e_L^*) - w = \pi\left(\frac{t_H t_L (n_F - 1)}{n_{FH} t_L + n_{FL} t_H} w\right) - w.$$

If F additionally invites external job applicants, all L-type workers will drop out and F maximizes

$$\pi(n_{FH} \cdot e_H^* - n_{\hat{F}H} \cdot e_H^*) - w = \pi\left((n_{FH} - n_{\hat{F}H}) \frac{n_H - 1}{n_H^2} t_H w\right) - w. \tag{18}$$

Thus, F will prefer external recruiting iff

$$(n_{FH} - n_{\hat{F}H}) \frac{n_H - 1}{n_H^2} t_H > \frac{t_H t_L (n_F - 1)}{n_{FH} t_L + n_{FL} t_H}.$$

This condition can only be satisfied for $n_{FH} > n_{\hat{F}H}$. In that case, it can be rewritten to (7).

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