Status Competition and Performance in Work Groups

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Abstract

We study the dynamics of a work group whose members value having a high status relative to their peers while being paid a bonus based on group performance. Status is determined both by contributing to group output and by non-productive, social activities that lead to its enhancement. Group members allocate their time between working and non-productive status enhancement, trying to maximize the combined utility from compensation and status rank.

We show that status competition based on merit can push group members to work hard. However, if status can also be achieved through political maneuvering, it can lead to lower overall performance. Moreover, group performance may fluctuate and be unstable over time if the results of effort are either noisy or the group does not share in its ranks. These results clarify the question of whether status competition enhances group performance by pushing group members to work harder, or retards it by causing unproductive behavior. They also suggest ways through which a firm can influence the effects of status competition on overall performance.

Keywords: Status competition, social rank, equilibrium, simulation, team production, collaboration in groups.

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1 Introduction

> *Men do not work to maximize their economic benefits, any more than they try to maximize their physical comfort. What does a billionaire need a second billion for? To be of higher rank than a fellow billionaire who only has a single billion (Jerome Barkow, 1975 and 1989).*

The theory of the firm is in the process of a transformation. First, it is increasingly recognized in economic modeling that firms consist of separate individuals with their own minds and interests (e.g., DeCanio and Watkins 1998). Second, the utility-maximizing framework is being extended from the maximization of consumption and wealth (Becker 1976, 284) to the inclusion of more general social behavior, such as altruism (e.g, Frank 1988, Simon 1990, Bester and Güth 1998), emotionally driven social exchange (Holländer 1990, Kandel and Lazear 1992) and the quest for status (Frank 1984, 1985) and *relative* payoffs (Bolton and Ockenfels 1999).

Work in evolutionary anthropology has convincingly argued that the striving for status has arisen over the five million year history of the human race, in order to facilitate the coordination of simultaneous competition (for mates and resources) and cooperation (against external threats) in groups (e.g., Barkow 1989, Chapais 1991, de Waal 1996). Desire for status operates through emotions (or "inborn tastes", see Frank 1988, 6) and has been largely adaptive in human history (e.g., Frank 1987, 1988, Stevens and Price 1996). However, while status behavior is still with us, it is not clear whether it continues to be adaptive in today's organizations.

In this article, we focus on the problem of team production in work groups. We build a dynamic model of self-interested agents competing for status while simultaneously cooperating to produce a team output. In the context of this model, we examine under which circumstances status competition enhances performance, and under which circumstances it reduces performance.

2 Status and the Social Dilemma of Team Production

Worker performance in teams, where output is produced collaboratively and no member's contribution is separable and recognizable (except through costly monitoring), poses a well-known social dilemma: if the effort of contributing productively to the team is costly to the worker, s/he has to choose between working hard, to the fullest of his/her ability, and "shirking", or cruising at the minimum effort level that does not expose the shirker. If the benefits of the worker's effort are shared among the whole group (which is typical in teams, for example, in the form of team bonuses), they may become so diluted that they are outweighed by the worker's effort cost, so s/he rationally decides to shirk. If, however, every team member shirks, everyone is worse off (e.g., Marschak and Radner 1972, Schelling 1978, 124 - 133, Glance and Huberman 1994).

A number of solutions to this dilemma have been offered. Various social mechanisms such as group norms, peer pressure, and shared values can overcome the social dilemma (e.g., Pfeffer 1994). In economics, it has been proposed to make compensation dependent on a *tournament*: not the contribution itself of a worker, but only a ranking of contributions needs to be monitored, an easier to perform ordinal measurement. This compensation can be constructed in such a way as to give workers the right "incentives" to contribute (Lazear and Rosen 1981). These authors propose that promotion of one person from a group of competing peers to a higher position with a disproportionally higher salary, such as that of a vice president, represents an example of such a tournament scheme. Huberman and Loch (1996) propose another possible solution to the social dilemma. It considers sophisticated collaboration among the workers, where the problem-solving of one individual can be leveraged for others through the sharing of information. If the performance increase of the team from additional effort is sufficiently steep, the social dilemma disappears.

In this article, we propose that an alternative explanation of how social dilemmas in teams can be overcome is offered by *status*. In sociology, *status structures* are defined as "rank-ordered relationships among actors. They describe the interactional inequalities formed from actors' implicit valuations of themselves and one another according to some shared standard of value" (Ridgeway and Walker 1995, 281). A long-standing tradition of the study of status in sociology has examined the seemingly pervasive existence of status hierarchies in group situations. Indeed, at least four theories examine the emergence of status within groups - functionalism (cf. Bales, 1953), exchange theory (cf. Blau, 1964), symbolic interactionism (cf. Stryker and Statham, 1985), and dominance-conflict theories (Ridgeway and Walker, 1995). These theories differ in the extent that status hierarchies are viewed as cooperative, goal-oriented behaviours, or as conflictual behaviors. On the one hand, it is widely agreed that the resolution of status contests allows groups to organize and proceed in pursuit of their joint goal. On the other hand, individual status-seeking behavior imposes a cost in terms of group effectiveness – in and of itself, status seeking is unproductive. For example, recently business literature has begun to discuss the negative aspects of status conflict (e.g., Manager Magazin 1998, Nicholson 1998, The Economist 1998).

Our model is consistent with those conflict-dominance theories that examine the trade-offs between pursuit of self-interest and contribution to a group goal (cf. Ridgeway and Diekema, 1989). We view the desire for status as rooting in *emotional tastes*. In the words of Robert Frank, "feelings and emotions, apparently, are the proximate causes of most behaviors. (...) Rational calculations are an *input* into the [internal] reward mechanism" (Frank 1988, 53). This view is based on work in evolutionary anthropology.

Evolutionary anthropologists have long recognized status competition as an ancient driver in our species (e.g., Barkow 1975, de Waal 1989, Chapais 1991, Stevens and Price 1996). Status behavior has its roots in a general primate tendency toward social hierarchy, where evolution favors competition among group members (for food, mates, nesting sites) to be performed efficiently with as little injury or risk of injury as possible. Determining which of two competing individuals would likely win the encounter, without actual fighting, leads to a status hierarchy in primate groups. Human prestige is more complex than animal status, which is based on pure agonism (strength). Human prestige and status is *symbolic*, and it can rest on a large number of criteria that are, to some extent, choosable by the group (Barkow 1989, Chapter 8). In other words, the *striving* for status is "built into us," but we can shape the manner in which status is rewarded. The possibility of shaping status behavior is emphasized by sociology literature and an important aspect examined in our model.

This work has enabled us to understand what status looks like (e.g., sociology has described how status structures become legitimate in groups and how they stabilize) and what its sources are (the evolutionary explanation from anthropology). However, it has not been settled how status structures influence group performance. In other words, we understand why the preference for status has been adaptive for hunter and gatherer groups of our ancestors, but it is not clear whether it is still adaptive (i.e., performance enhancing) in today's organizations, which emerged over a time frame too short for evolution to follow.

A small literature in economics has begun to adress this issue, notably Frank's (1984, 1985) status theory. Suppose that workers care not only about their absolute wages, but also about how their wages compare with those earned by their co-workers. In other words, relative wages equals status within the local group. If the value of status is taken into account, the relative position in a company comes (partially) under the control of the individual. This can lead to what Frank calls the *positional treadmill*. If, within a given wage scheme, two workers (of similar productivity and thus rank) can influence their productivity with some additional effort, the fact that status depends on the relative productivity introduces a prisoner's dilemma: although both may intrinsically prefer to work only a certain amount, the benefit of gaining the higher rank over the other may cause both to work more than they really desire.

Frank's positional treadmill can be used to offer a solution to the social dilemma of team production: if workers care about *relative* pay compared to that of their peers in addition to absolute pay (because of the skill prestige output and pay confer), the same effect results as if they were paid according to Lazear and Rosen's (1981) tournament compensation scheme. Frank's insightful analysis, thus, offers a possible explanation as to why especially professional employees work so much in some organizations without any discernible compensation incentive to do so. The positional treadmill provides an alternative explanation to culture or values, and it is being elaborated by Bolton and Ockenfels' (1999) "equity, reciprocity and competition" theory.

In Frank's (1985) analysis, status is equated with wages, and his model is static (an equilibrium model). Status is, however, not equal to relative pay (although pay is one component of it, corresponding to the "skill" component of status competition mentioned above). For example, Stevens and Price (1996) generalize the measure of rank in primates to the "resource holding power," and its equivalent in humans self esteem. Barkow (1992) adds achievement, or prestige. Status in this sense can be influenced by a number of different characteristics, such as talent, good looks, a network of friends, favors that one has done others and which are now "debts" that one can call in, knowledge about others, and so on. Building status along such dimensions will require activities that may have nothing to do with productivity on the job, and which, on the contrary, may even detract from productivity.

Second, status is not static, it changes dynamically over time (day by day). The small groups of early humans, from whom we believe to have inherited the striving for status (Tooby and Cosmides 1992, de Waal 1996) lived in the tension between the need for group cohesiveness (to be capable of responding to outside threats from other groups and from predators) and competition among individuals for resources and mates. A complicated pattern of status dominance behaviors and subordinate behaviors resulted, never attaining equilibrium. It sufficed to establish certain bounds of behavior, beyond which the group's survival would be threatened.

The present article extends Frank's model to a dynamic theory of status, treating separately the utility of money and that of status, which is influenced both by the effect of performance (prestige from skills) and by "political means" of enhancing status. We explore the dynamic effect of status behavior on cooperation behavior in the work group and, thus, of group performance over time. Thus, we combine two separate status literatures from sociology and economics, and offer new insights into the drivers of work group performance.

3 A Dynamic Model of Status Competition

3.1 Performance, Compensation and Status

Suppose there are n members in a working group, also referred to as *actors*, who collaborate to produce a group output. Based on Frank's (1985) results, we do not focus on the traditional choice between work and shirking (e.g., Lazear and Rosen 1981). Rather, actors allocate their time between work (contribution to group output) and "social activities" for status enhancement (such as networking, gossiping and influencing others, exchanging favors, etc.).[1] From now on, we refer to such social, non-productive, status enhancement as "politics". Each group member periodically examines his/her status rank as well as group performance (and its resulting bonus), and then makes a decision about working behavior. In the absence of focal external events, each actor will time this evaluation independently from the others, based on a number of unrelated random events (a conversation with an

[1] Note that these activities serve a different purpose than Milgrom and Roberts' (1992, 192 f.) "influence activities," which are concerned with decisions that influence the distribution of wealth among members of an organization.

external colleague, a decision to buy a consumer good of high value, etc.), in which case it is a reasonable approximation to assume that each actor sets his/her behavior according to a Poisson process of rate λ. That is, the time intervals between two consecutive status evaluations by a given actor i are independent exponentially distributed random variables with mean $1/\lambda$. At the time of an evaluation, actor i allocates a fraction $k_i \in [0, 1]$ of his/her total time budget to work and a fraction $(1 - k_i)$ to politics, and this allocation remains stable until the next evaluation.

For the purpose of this article, we assume that all group members are equal, in order to focus our discussion on a symmetric situation. A situation where one actor has more talent, more need for money or a higher ambition would introduce distortions in our exploratory analysis; such a situation will be examined in later work. The actual performance contribution of an actor is determined by his/her work effort, albeit with a random component, stemming from the fact that results are not always fully predictable in professional work.

Consider the τ_ith evaluation by actor i at time[2] $t(\tau_i)$. For the remainder of the model description, we consider what happens at the τ_ith evaluation and suppress the time index t (or, equivalently, the evaluation index τ_i) except where required for clarity. All actors have the same production function, but differing effort levels. Actor i contributes to group output at the rate $\pi_i = 1 - e^{-\theta(k_i + \epsilon_{\pi_i})}$. π_i is a convenient function, which increases concavely from zero (no contribution) to $1 - e^{-\theta}$ (100 % contribution). The parameter θ represents the slope of this performance function as effort increases, and θ also determines the maximum attainable performance. The ϵ_{π_i} are iid. (across actors and evaluation times) random variables with a symmetric distribution around zero. Thus, all actors are subject to uncorrelated random influences of the same nature, which remain stable over time.[3]

[2] $t(\tau_i) = \sum_{j=1}^{\tau_i} \xi_j$, where the ξ_j are the iid. intervals between evaluations.

[3] In this formulation, ϵ_{π_i} represents the *aggregate* performance uncertainty that applies to the whole time interval until the next evaluation, revealed all at once at this evaluation. This aggregation simplifies exposition.

The performance of the work group is determined by the individual performance of all its members, $\Pi = \sum_1^n \pi_i$. The firm faces team production, that is, it cannot monitor the performance of the actors separately, and can only reward the group members depending on total team production.[4] A common compensation scheme is to give every group member a fixed salary w plus a performance bonus of β % of the group's total output, shared among the group members: $w + \beta\Pi/n$. At the τ_ith evaluation, actor i derives a *utility* from this monetary compensation characterized by

$$U_m(i) = \delta_m[w + \frac{\beta\Pi}{n}]. \tag{1}$$

δ_m represents the "value of money", which needs to be compared to the value of status rank in the group (described below).

Based on the cited work in evolutionary anthropology, we assume that group members care not only about salary, but also about their respective status rank within the group. Each group member i holds a certain level of status, or prestige, within the group, which we call S_i. Status is, by definition, public, and group members are ranked along this prestige dimension. Member i's rank is R_i, with rank 1 being the top, and rank n the bottom of the rank order. Assume for now that the predominant convention allows two group members of *equal* status to both enjoy the *higher* of the two ranks, similar to an olympic medal (the two top individuals with equally high prestige are both ranked number one, and the third individual is ranked third). Every individual attaches utility to his/her rank. The parameter δ_r stands for the value of rank, analogous to the value of money. At the τ_ith evaluation, the utility gained from having rank R_i is

$$U_r(i) = \delta_r[1 - \frac{(R_i - 1)^2}{(n-1)^2}]. \tag{2}$$

[4] Π represents the production function of the group. Often, non-separability of the production function is seen as an essential part of team production. In this article, we take a linear function to simplify exposition, while stressing non-observability of the individual contributions to management, but not group peers.

This quadratic function decreases concavely from δ_r for rank 1 to 0 for rank n, and it is normalized in order to be unaffected by group size.

Individual i's status is influenced by two things: first, by his/her contribution π_i. Team members *can* observe contributions, and a strong contribution earns respect in the group. The second influence is "politics," or status enhancing activities $(1-k_i+\epsilon_{p_i})$. The random variable ϵ_{p_i} expresses the fact that an actor cannot perfectly predict the result of his/her politicking; it may work well or backfire, just as the result of work is not fully foreseeable. However, let us assume that the actor's prediction of the outcome of his/her action is *unbiased*, that is, the random variable ϵ_{p_i} has a distribution symmetric around zero (and thus a zero expectation). If this were not the case, the randomness would introduce "drifts" of behavior into our model, or an inherent tendency toward some type of behavior, which we want to avoid in this first effort to understand the basic characteristics of group behavior. We make a simplifiying assumption (for exposition only), namely that the uncertainty affecting politicking ϵ_{p_i} has the same distribution as the uncertainty in work outcome ϵ_{π_i}. However, the two are uncorrelated, that is, work may succeed well, while politicking at the same time may backfire. Because of this randomness, the *realized* work effort and politicking do not always add up to one.

A "meritocracy parameter" γ expresses the group's relative weighing of contribution versus politics, and it may also represent the ability of the organization to measure or observe contribution. If $\gamma = 0$, the organization cares only about politics, and if $\gamma = 1$, the organization is a "meritocracy," where only contribution counts. Finally, each individual builds on a currently available stock of prestige $S_i(\tau_i)$ at the τ_ith evaluation, to which s/he adds by the current activity. However, this stock of status decays over time with a rate of α per time interval from one evaluation to the next. This corresponds to a situation where actors roughly "sense" when their status has decayed by a certain percentage, and then take action to re-evaluate their behavior. If the decay rate α is large, an author basically re-establishes status at every evaluation, and if α is small, the status quo is stable, and the current evaluation has only a small updating influence on the rankings. Thus, the new status level of actor i at the next evaluation $(\tau_i + 1)$ becomes

$$S_i(\tau_i + 1) = \alpha[(1-\gamma)(1 - k_i + \epsilon_{p_i}) + \gamma\pi_i] + (1-\alpha)S_i(\tau_i). \tag{3}$$

The new ranks R_j are determined by ranking the currently assigned status levels $S_i(\tau_i+1)$ from top to bottom after each actor's completed evaluation. If the status levels of two actors are identical, these actors *share* the same rank (analogous to a medal in the olympic games). When performances and new rankings are visible, each individual determines his/her utility by combining wages obtained and rank achieved, $U(i) = U_m(i) + U_r(i)$.[5]

As we have observed above, it is significant that a group may (partly) choose the way by which it awards and updates status rank. For example, status may decay not by a constant percentage of α per evaluation epoch (from evaluation to evaluation), but rather per unit of elapsed time. That is, agents check on their status level after stochastically variable (e.g., externally influenced) intervals and may find that their status has decayed more or less than expected. A third reasonable scenario is a *cumulative* status update, where newly earned status is simply added to an existing prestige "stock," which does not decay at all. As an example, consider a situation where every significant paper written by a researcher is added to his/her reputation, and old papers are remembered along with new work. Finally, we want to consider an alternative way in which status ranks are determined: Instead of adopting the convention that actors of equal status share the higher rank, the organization may not tolerate equal ranks and insist on a strict hierarchy. For example, the organization may resolve status ties randomly, like a "coin toss", or it may perform a "photo finish" analysis which is really arbitrary and *de facto* corresponds to a coin toss. Below, we will examine how such structural changes in status competition influence group behavior.

[5]The additive combination is consistent with experiments in sociology, see Berger et al. 1977.

3.2 Utility Maximization by Boundedly Rational Actors

In determining his/her effort and politicking levels, each individual wants to maximize his/her expected utility for the coming period, taking into account the other group members' efforts. However, a full game-theoretic evaluation of the corresponding Nash equilibrium is computationally very complex, and beyond their capabilities (as is true for most individuals). The actors are boundedly rational (Simon 1955) in the sense that actor i makes the following two simplifications in his/her assessment of the best course of action to take.

First, s/he chooses an effort level to maximize the expectation of $U(i)$ assuming the actions of the other group members stay the same as in the previous period. Second, the individual is not capable of taking the correct expectation over the concave function $\pi_i = 1 - e^{-\theta(k_i + \epsilon_{\pi_i})}$ of the realized effort in evaluating his/her expected performance resulting from the chosen k_i. Instead, the individual overestimates the expected performance by simply substituting k_i into the performance function, pretending no uncertainty is present.[6] In summary, actor i chooses k_i to maximize $U(i)$, holding all $\pi_j, j \neq i$, constant and pretending that $\epsilon_{p_i} = \epsilon_{\pi_i} = 0$. Formally, at the τ_ith evaluation actor i solves

$$
\begin{aligned}
k_i \quad &= \quad \text{argmax } \{U_m(i) + U_r(i)\} && (4) \\
\text{subject to:} \quad & k_j \text{ remains constant at the level of time } t(\tau_i) \quad \forall j \neq i; \\
& \epsilon_{\pi_i} = \epsilon_{p_i} = 0.
\end{aligned}
$$

[6] Formally, the expectation of a concave function of a random variable lies below the function of the expectation of the random variable. The assumption that actors ignore the concavity of π is not critical, it merely simplifies exposition.

4 Existence of Equilibria

To gain an understanding of dynamic behavior in the above-described work group, we first examine when equilibria can exist. We define an equilibrium as follows.

> **Definition.** We call a set of contribution and status levels $(\{k_i\}, \{S_i\}, i = 1, \ldots, n)$ a *static equilibrium* if all k_i fulfill the optimality condition (4) and if $S_i(\tau_i + 1) = S_i(\tau_i)$ in Equation (3) for all i. In other words, in a static equilibrium no actor finds it advantageous to change his/her effort level, and the status levels remain constant.
>
> We call a set of contribution levels $(\{k_i\}, i = 1, \ldots, n)$ a *dynamic equilibrium* if there exists a set of status levels $(\{S_i\}, i = 1, \ldots, n)$ such that all k_i fulfill the optimality condition (4) for the $\{S_i\}$ and for all future status levels that may arise with positive probability.

The static equilibrium requires stricter conditions; every static equilibrium is also a dynamic equilibrium. Before describing equilibria, we can set bounds on the possible behavior in the group. Taking first and second derivatives of actor i's expected status (3) with respect to the effort k_i (and pretending deterministic outcomes as discussed above) tells us that the status outcome as a function of effort is a concave function with its maximum at

$$k^* = -\frac{1}{\theta} \ln(\frac{1-\gamma}{\gamma\theta}). \tag{5}$$

That is, below an effort level of k^*, *both* expected performance (and thus compensation) and expected status (and thus rank) increase with more effort. Thus, no actor will choose an effort level below k^*. A high weight of politics in the work group relative to the marginal performance increase from more effort ($\frac{1-\gamma}{\gamma} > \theta$) implies $k^* < 0$, that is, at all effort levels a trade-off between working and politicking has to be made. On the other hand, a low weight of politics in determining status ($\frac{1-\gamma}{\gamma} < \theta e^{-\theta}$) makes the social dilemma disappear, that is, $k^* > 1$, so full effort allocation to work will be chosen by all actors.

Within these bounds, what level of work versus politicking will constitute possible equilibria? The answer is trivial when the status decay α is zero. In this case, status in Equation (3) is constant, and rank utility cannot be influenced. Thus, maximizum contribution $k_i = 1$ in order to maximize monetary payoff is a static equilibrium. If ranks are externally given and frozen, there is no status competition.

In the cases that interest us, $\alpha > 0$ forces the actors to weigh between monetary and status rank utility. Moreover, any status-differentiated ranking that has been achieved erodes over time, introducing an incentive to politick. Our first result shows that full work effort can be maintained as an equilibrium if the monetary reward is high enough to dominate rank utility.

Proposition 1 *Full work effort $k_i = 1$ by all group members is a dynamic equilibrium if*

$$\frac{\delta_r n}{\delta_m \beta} + e^{-\theta} \leq \ min \ \{1, \frac{1-\gamma}{\gamma\theta}\}. \tag{6}$$

Status levels are random variables $S_i = (1-\gamma)\epsilon_{p_i} + \gamma(1 - e^{-\theta(1+\epsilon_{\pi_i})})$. If $\epsilon_{\pi_i} = \epsilon_{p_i} = 0$, the equilibrium is also static.

The proof of Proposition 1 (as of all following propositions) is shown in the appendix. The intuition is that the increase in monetary utility from choosing full work effort rather than the minimum optimal effort k^* must outweigh the utility loss of falling from first to last status rank. Inspection of condition (6) shows that this is the case for sufficiently small rank utility δ_r and group size n (group size dilutes the compensation benefit of effort), and for sufficiently large monetary utility δ_m, bonus β and production slope θ, all of which enhance the output value of effort. A higher meritocracy parameter γ tightens condition (6), but also pushes upward the minimum effort level k^*; if $k^* \geq 1$, the dilemma between pursuing status and compensation disappears. If no uncertainty is present, this equilibrium is static; otherwise, the status levels and ranks fluctuate.

Our second result shows that *any* effort level equal across actors is sustainable as an equilibrium if uncertainty is absent.

Proposition 2 *If* $\epsilon_{\pi_i} = \epsilon_{p_i} = 0$, $\{k_i = \overline{k}, S_i = \overline{S}\}$ *for all* $i = 1, \ldots, n$ *represent a static equilibrium whenever* $\overline{k} \in [k^*, 1]$ *and* $\overline{S} = (1-\gamma)(1-\overline{k}) + \gamma(1 - e^{\theta \overline{k}})$.

The intuition is that any effort level maintains an associated constant status level (increasing in effort) by Equation (3). If all group members have this status level in common, they all share status rank 1, so no one needs to sacrifice compensation to gain a higher rank. This situation is stable in absence of uncertainty.

It is important to note that Proposition 2 is qualitatively robust to some changes in how the group updates status. First, under the scenario of status decay per unit time (rather than per evaluation epoch), $k_i = \overline{k}$ for all i is again an equilibrium, as the (equal) status levels of *all* actors decay together, so again, rank 1 is shared, and there is no incentive to deviate. Second, under a *cumulative* status update without decay, again any common effort level across all actors can be supported as an equilibrium, where all group members share status rank 1 and have no incentive to deviate.

However, Proposition 2 critically depends on the convention that actors of equal status share the higher rank, similar to medalists in the olympic games. If the organization insists on a strict hierarchy and resolves ties by a "coin toss", the incentive remains to out-politick the rival in order to avoid the risk of being stuck with the lower rank. However, if actors can distinguish status levels and vary behavior with perfect accuracy, an *arbitrarily small* increase in politicking suffices to out-do a rival and gain the higher rank. Consequently, politicking "creeps up" only infinitesimally slowly over time, as the actors do not want to sacrifice compensation. That is, the equilibrium is not perturbed.[7] In many cases, however,

[7]This argument can be made precise by showing that the actor only needs to increase social activities by an amount less than any $\epsilon > 0$.

actors may not be capable of perceiving arbitrarily small status differences. A lower limit on perceivable status differences can be represented in our model as a threshhold. If two status levels are within the threshhold of each other, the actors perceive their status as equal and randomly assign the higher rank, as described above. With such a threshhold, an actor has an incentive to increase politicking by a finite amount, and the equilibrium really breaks down.

Our third result states that the first two Propositions characterize *all possible* equilibria: if uncertainty is present, any status level must fluctuate, and if compensation utility does not dominate rank utility, this fluctuation will prompt group members to vary levels of politicking in order to gain or maintain rank. Therefore, there is no equilibrium. There may be temporarily stable effort levels, but this stability cannot last indefinitely as our definition requires.

Proposition 3 *If status decay $\alpha > 0$ and neither Proposition 1 nor Proposition 2 hold, no equilibrium exists.*

We conclude that in the presence of uncertainty, but also if group members do not share rank and cannot measure status perfectly, status competition will lead the system to *oscillate*, to drift between periods of stability and high performance and periods of status competition and low performance. Stable, high performance is possible temporarily when some group members have intensively politicked and achieved an unassailable status level and rank. Whenever one actor does not need to defend his/her rank, and the rival cannot gain the higher rank, both choose to concentrate on work effort to maximize compensation. However, status decay α compresses status differences over time, forcing the rivals back into status competition.

The model parameters influence transient, off-equilibrium behavior as follows: for any status level profile $\{S_i\}$, the performance slope θ and the meritocracy weight γ increase performance through their influence on the range of effort levels, k^*. A faster status decay

α shortens periods of stability because it compresses status level differences among the actors. Value for money δ_m, wage w and bonus β all boost performance, as they make the comparison of $U_m(i) - U_r(i)$ more favorable. Conversely, the utility for rank δ_r makes this comparison less favorable and, thus, reduces performance. The influence of group size n is summarized in the following Proposition.

Proposition 4 *For any given set of model parameters and any given status profile* $\{S_i\}, i = 1, \ldots, n$*, an increase in group size reduces every group member's chosen effort level.*

The reason for this negative effect is the dilution of the marginal reward of effort: although every new group member adds proportionally to total group output, any given individual makes his/her decision assuming that others hold their contribution levels constant. As output is shared, the monetary return expected by an actor for his/her effort decreases in group size, while the utility difference between being first and last remains the same (δ_r). Therefore, increasing the size of the group effectively decreases the relative weight of money vs. rank, leading to more politicking. Excessive politicking may be counteracted by increasing the monetary utility weight δ_m. In the following section, we illustrate these results using simulation.

5 Simulation Examples

5.1 Basic Model With Two Actors

In this section, we illustrate the dynamic behavior of our model on a numerical example via simulation.[8] For now and for ease of exposition, we stay with an example of $n = 2$ actors. The actors are identical with the exception that actor 1 starts the simulation with a status of 10, while $S_2(t = 0) = 0$. Thus, actor 1 is initially higher ranked, so the group

[8]The simulation is written as a Pascal program within the Delphi environment. One simulation run over 1000 time units takes less than a second on a PC with a 300 MHz Pentium 2 processor.

can start with high work effort and output. This stable state lasts until actor 1's status level has decayed sufficiently close to zero, at which point status competition sets in.

The example has the following parameters: the performance slope is $\theta = 0.8$, that is, performance contribution per actor, π_i, varies between zero (no work effort) and $(1 - e^{-0.8}) = 0.555$, so total group performance can be maximally 1.11. The utility of money is $\delta_m = 1$ per unit of output, and the entire group output is given back to the group members, via a bonus of $\beta = 1$, in addition to a base salary of $w = 1$. The utility elasticity of rank is $\delta_r = 0.33$.

Each actor examines his/her performance and status situation at random time intervals at an average rate of $\lambda = 0.05$; thus, s/he compares compensation and ranks, on average, every twenty time units (in the remainder of the article, we take a time unit to be a day). The simulation has continuous time and discrete events. After every evaluation, the actor's next evaluation time is determined by adding an appropriate exponential random variable to the current time, and the simulation "jumps" to the next evaluation time among all group members.

Existing status decays at a rate of $\alpha = 0.6$ from one evaluation to the next. In determining the change in status during an evaluation, politicking is weighed at $(1 - \gamma) = 0.8$, and contribution is only weighed at $\gamma = 0.2$. Thus, the group is quite "political" and not a meritocracy, although performance does have an influence.

With these parameters, Equation (5) yields the minimum effort level as $k^* = -2.0$. This means that in the situation described in the example, there is a trade-off to be made at every work effort level between pursuing compensation and pursuing rank. We, therefore, observe the full possible range of work effort from zero to one. We tested many combinations of parameters, e.g., with low and high politicking weight, with fast and slow status decay, and with steep and shallow slope θ of the individual performance curve. As expected from the analytical model, high politicking weight, fast status decay, and low performance slope all increase the amount of politicking and reduce work effort and group performance.

First, consider the deterministic case, where the group members can predict with certainty the output from work and from politicking. Figure 1 shows the results of a simulation run over 1,000 days in a graph of the average work effort (averaged over the two actors). On the right-hand side, the parameters of the example are repeated.

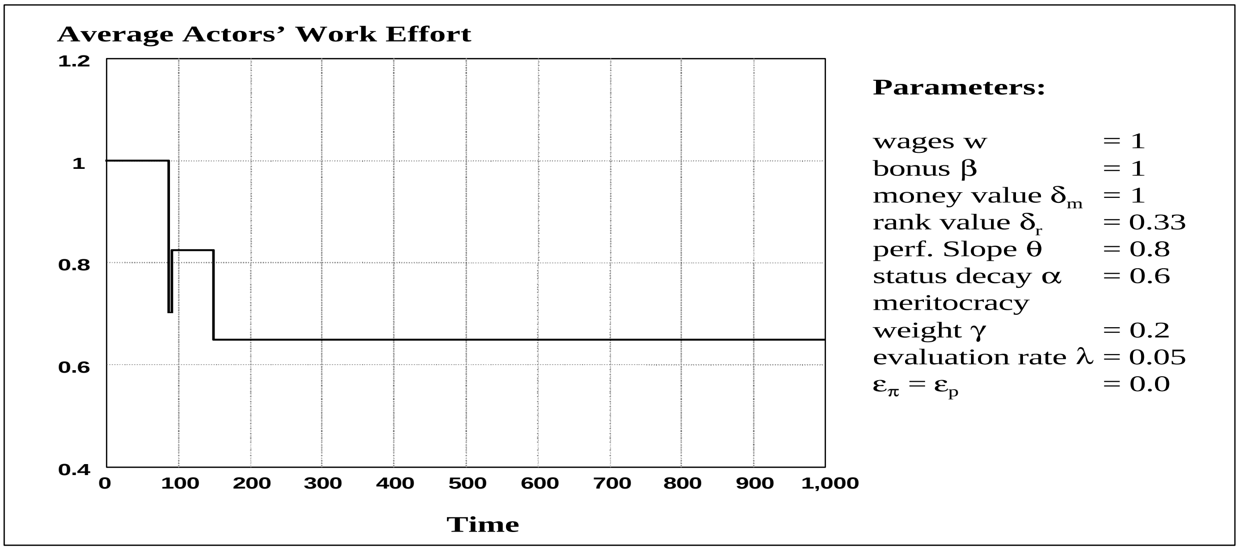

Figure 1: Evolution of work effort without uncertainty

The Figure shows how group performance starts out high, with group output $\Pi = 1.11$ (not shown; the group performance curve is parallel to the average effort curve), and average work effort $k_i = 1$. However, performance deteriorates as the two actors' status levels approach each other. After about 150 days, the group reaches an equilibrium, with both actors spending 65% of their time working, and 35% politicking. After this point in time, there are no more rank changes; both actors share rank 1, with a status level of 0.226.

However, the situation shown in Figure 1 is only one instance of possible group behavior (one sample path). As the actors evaluate their status asynchronously at random points in time, each simulation run reaches a different equilibrium. Over 25 runs of a 1,000 days each, the *average* contribution is 0.74 and the average group output level 0.89. The standard deviation of output over the 25 runs is 0.13, with a minimum of 0.57 and a maximum of 1.07 (as compared with the 1.11 obtainable from full work effort). Thus, the group does settle in a static equilibrium each time, but it cannot be predicted whether the equilibrium is one of high or of low group performance.

Now, we introduce uncertainty into the system. Let us assume that both uncertainties ϵ_{p_i} and ϵ_{π_i} are drawn with probability 1/2 from the random variable ξ, and with probability 1/2 from $-\xi$, where ξ has an exponential distribution with an expected value of 0.05. The exponential distribution has the characteristic that with high probability, the value of the random variable is small (e.g., the value is smaller than the mean with a probability of 63%), and the probability of larger values occurring falls off exponentially. However, very large values can occur, albeit with low frequency. In the context of our example, this is a reasonable probabilistic structure: most of the time, the actors make good guesses about the outcome of their actions, but every once in a while, a prediction is way off the mark. The same work group as in Figure 1 is simulated with this uncertainty introduced. The result is reported in Figure 2.

With uncertainty added, group output does not settle down in a equilibrium. At any point in time, output may go up or down. Moreover, the total range of observed outputs has increased: effective effort levels can rise to above 1, due to randomness which boosts effort some times, and renders it ineffective at other times. As a consequence, group output can increase to above 1.11.[9] In the lower part of Figure 2, each arrow corresponds to one rank exchange. The random variations of performance and politicking effectiveness cause the group members to continuously contest and change status ranks. Whenever status levels are separated sufficiently to decrease the incentive to politick, the work effort level recovers. The behavior of the group fluctuates unpredictably over time.

[9]If one waits sufficiently long, an instance of a *negative* performance will also be observed, due to the infinitely long tail of the exponential distribution.

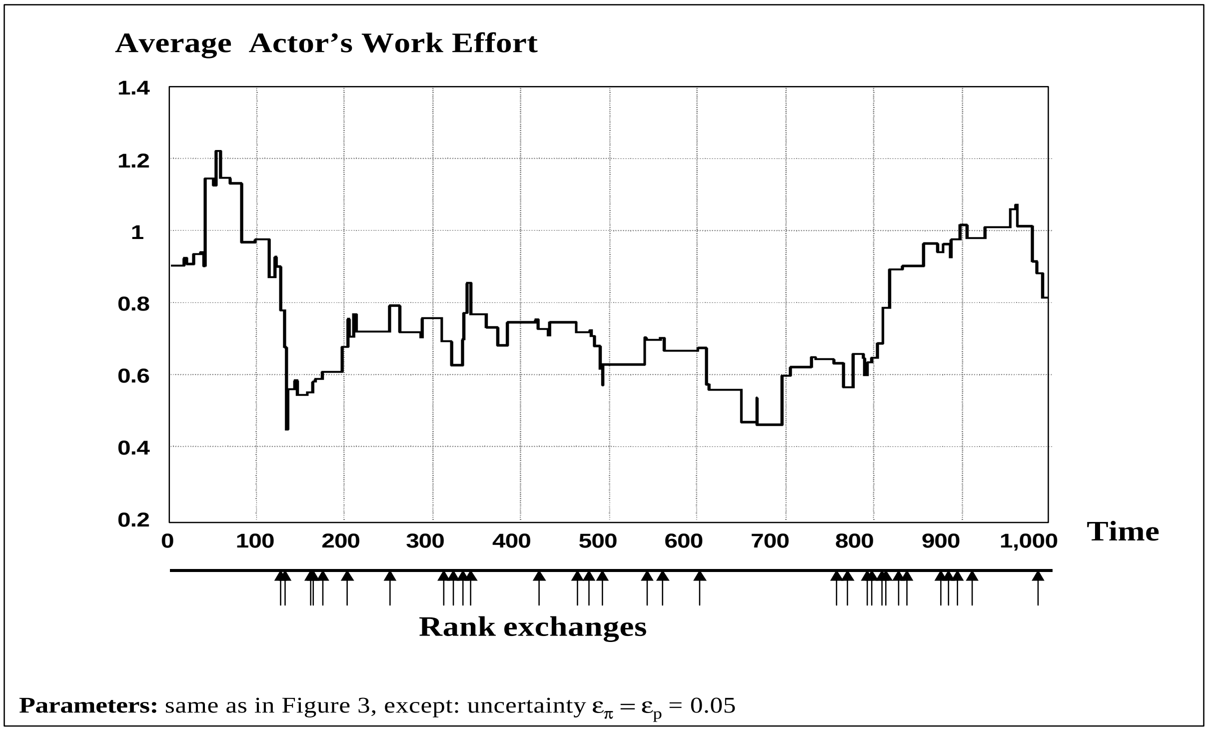

Figure 2: Evolution of effort and ranks, with uncertainty

In spite of this increased unpredictability in one simulation run, or one group history, the *a priori* group performance variability over many runs stays virtually unchanged in comparison to the base case. We performed 25 runs of the group's behavior without uncertainty (Figure 1) and 25 runs with uncertainty (Figure 2). Average performance and standard deviation are statistically indistinguishable for the two sets of runs.[10] The fluctuations may be seen by group management as an "insurance" against the group "getting stuck" in a low-performance equilibrium. The price for this insurance is that the group will not be able to maintain a high-performance equilibrium, either.

We now examine the scenario in which the group does not allow two members to share the same status rank. If two actors share the same status level, a "coin is tossed" to settle the rank. Consistent with the analysis from the previous section, the equilibrium in the simulation stays undisturbed if actors can distinguish status perfectly, because infinitesimal

[10] A t-test could not reject the null-hypothesis of both collections of 25 runs coming from the same distribution, even at the 30% significance level.

politicking suffices to gain rank. However, actors vary their effort levels continuously if a threshhold of perceivable status differences is introduced. Figure 3 shows an example where the threshhold is 0.01. The larger the threshhold, the more does group performance fluctuate. Over 25 runs, the average performance and its standard deviation are again statistically undistinguishable from the base case (Figure 1). Thus, the impossibility of sharing ranks has a similar effect on group performance as (performance and politicking) uncertainty, provided there is a threshhold of perceivable status differences.

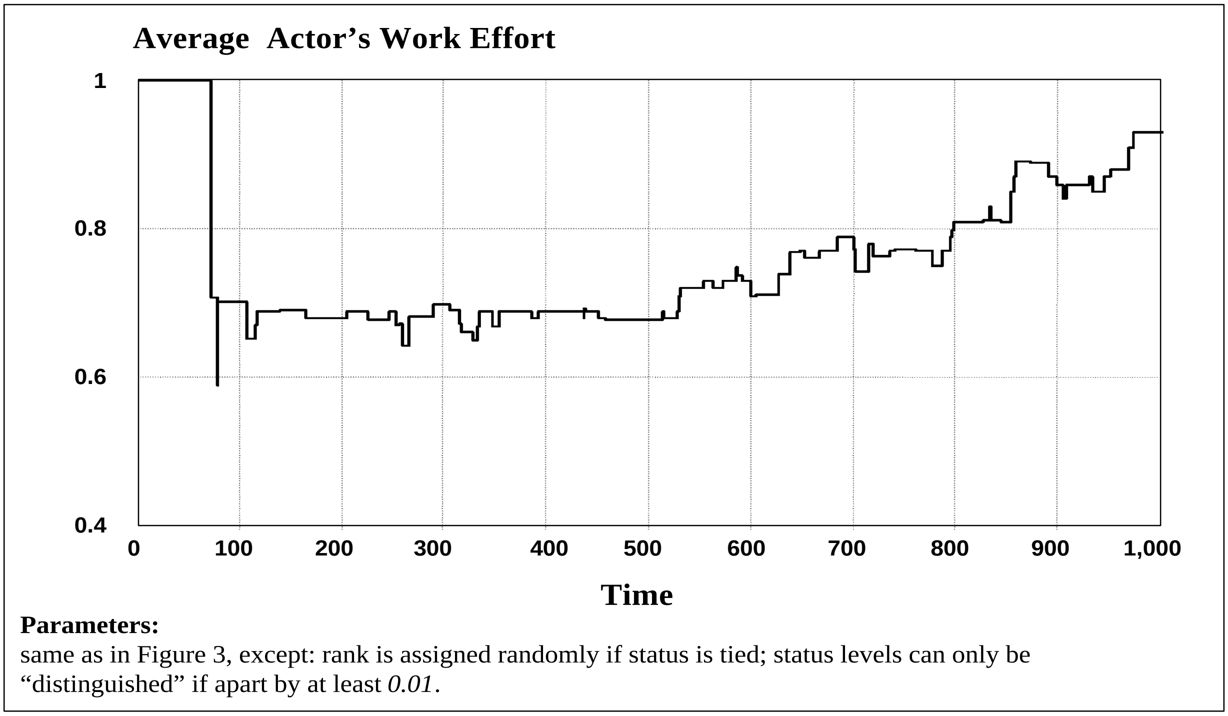

Figure 3: Group work effort without shared status ranks

In the presence of performance uncertainty, the way in which status is updated over time has an important influence on the behavior of the group. The fluctuations in Figures 2 and 3 are driven by the decay of status over time, which eliminates any status separation and forces the group into politicking behavior. If, in contrast, status accumulates over time without decay, an initial status hierarchy can be sustained: no group member has an incentive to politick, as no rank gain is achievable, so status enhancements are determined by contribution only. If the initial status differences are sufficient, the performance variations average out over time and cannot destabilize the existing ranking.

A final observation helps to illuminate the characteristics of our model. When we introduce a threshhold of perceivable status differences into the base case (without uncertainty and with sharing of ranks), the group's equilibrium, whereever it is initially, "creeps up" to full work effort and no politicking. The reason is that actors now can reduce their politicking to the point where their status is lower than their rival's by an amount just below the perception threshhold. As a result, the whole group can, over time, increase work effort. The higher the perception threshhold, the less time needs the group to reach full performance. This illustrates an important result from the model: a group which can choose, or at least influence, the way it updates status, may be able to maintain a high performance equilibrium.

5.2 Larger Group Size

After having illustrated work behavior in groups of two members, we now turn to larger groups. By Proposition 4, effort levels go down because of the dilution of marginal monetary utility. Figure 4 shows the simulated work effort of a group of $n = 7$ actors over $1,000$ days. The upper part shows the evolution of average work effort in the group. The dotted curve corresponds to all parameters being the same as in Figure 1. For the solid curve, monetary utility weight has been increased to $\delta_m = 3.5$ (holding the relative magnitude of δ_m/n and δ_r stable). The lower part of the curve shows the evolution of ranks (each line corresponding to one individual) associated with the dotted curve ($\delta_m = 1$) above.

Average group performance in the dotted curve, compared with Figure 1, increases from 0.90 to 1.19, taken again over 25 simulation runs (performance is not shown in Figure 4, as it decreases quickly from the maximum of 3.8 and then closely parallels the effort level). The group has been increased from one to seven, but output grows only by 30%. This is

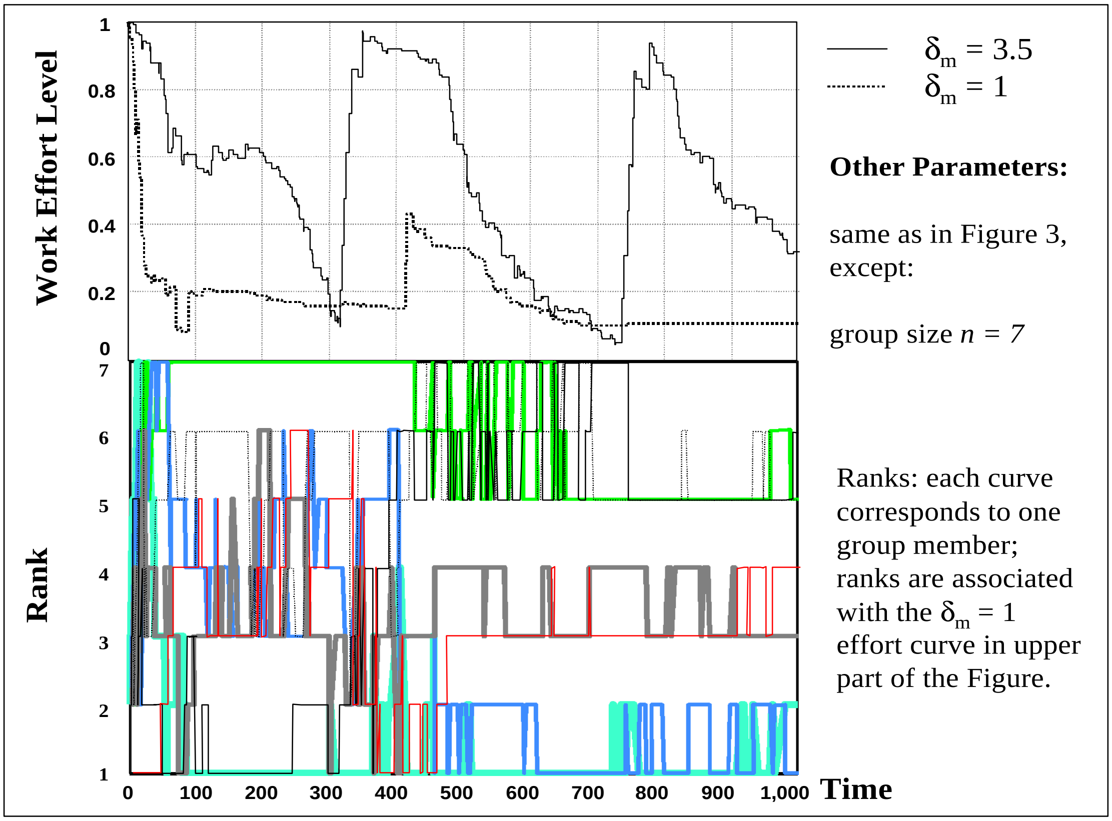

Figure 4: Work effort and ranks in a group of seven actors

due to a much higher level of politicking; simple inspection makes clear that the average level of work effort allocation in the group of seven (0.23) is much lower than in the group of two (0.74). Most of the additional work capacity introduced by the additional group members is dissipated in status competition. This reflects the lower marginal return from an additional unit of effort vs. politicking from Proposition 4. In the solid curve, the weight of monetary contribution has been increased to keep the marginal reward for a unit of effort constant. As a result, the average effort level increases to about 0.5 (measured over 25 runs of 1,000 days each). The solid line shows how effort oscillates with status competition interrupted by recoveries when the group members have separated their status levels. However, even with the comparable marginal reward of effort δ_m/n, average output does not reach the level of the small group.

There is a second contributor to the lower output of the larger group. The rank evolution in the lower part of Figure 4 demonstrates a more complex pattern of encounters among seven rather than two members. After just over 400 days, the group separates into three clusters of 3 individuals vying for status rank 5, and two individuals each competing for ranks 1 and 3, respectively. At this point, average contribution (dotted curve in the upper part of the Figure) jumps upward. Then contribution falls again as competition continues within these clusters. Contribution stabilizes as the status levels of the actors within one cluster approach one another, and only very small changes in politicking are necessary to overtake the closest rival. When δ_m is increased (solid line in Figure 4), such clusters do not form because now the actors are willing to suffer the loss of one or two ranks for the monetary reward. However, as a result, the total number of rank changes dramatically increases (not shown), negating some of the benefit from the added monetary incentive.

Because of clusters, the group needs much more time to reach a stable level. After $1,000$ days, ranks are still being contested and changed (the dotted work effort curve is not perfectly flat), and it takes until almost 2000 days until an equilibrium has been reached. Any average contribution level may correspond to many different constellations of stable clusters. A dynamic equilibrium is reached only when *all* clusters have stabilized, so the total time needed to reach an equilibrium is longer. For the solid curve (with fewer clusters), the equilibrium is reached only after more than $3,000$ days because of the intensified rank exchanges.

Figure 5 shows the effect of uncertainty (of the same type as in Figure 2) in the large group. As before, performance fluctuations within one sample path are increased; the group is capable of coming back to almost full performance once over the $1,000$ days. Over 25 runs, the performance average is again indistinguishable from the deterministic case (Figure 4). However, the standard deviation of performance over the 25 runs is *decreased* significantly, from 50 down to 18.[11] This is because uncertainty makes any clustering impossible, by

[11] An F-test for the difference of the variances is statistically significant at the level of 10^{-6}.

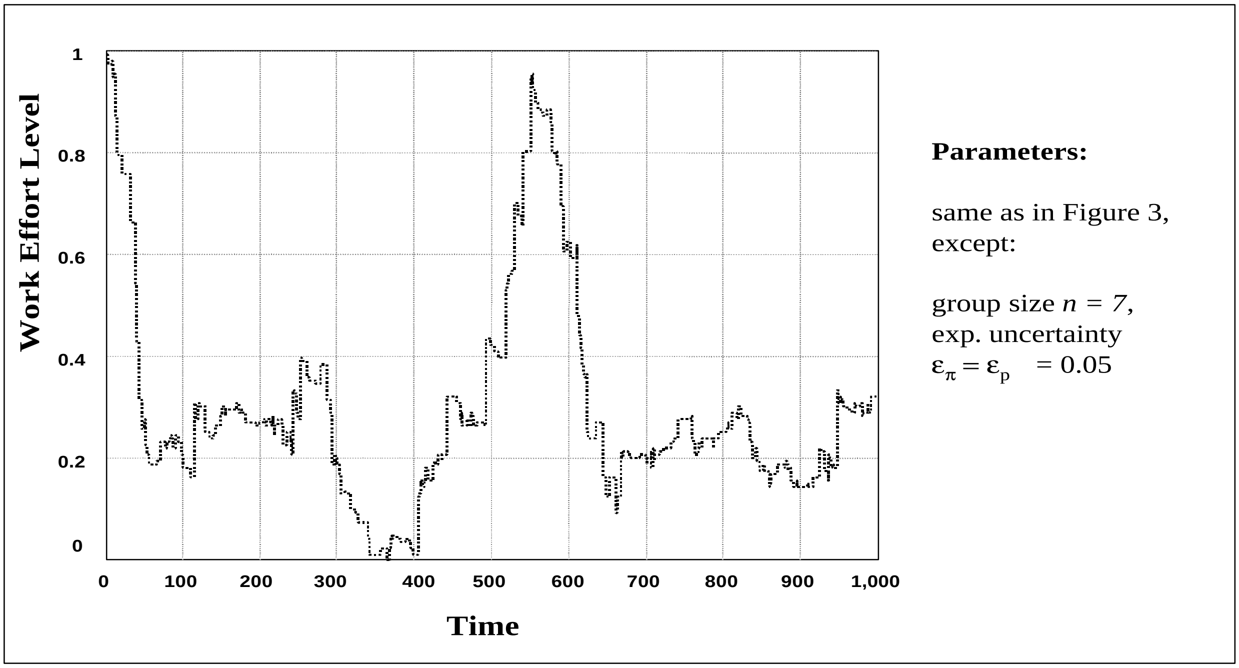

Figure 5: Work effort in a group of seven with uncertainty

sooner or later bridging any status difference.[12] Rather than settling in a wide range of possible equilibria, effort varies more closely around a set of likely values, which reduces the variance in the long run (corresponding to multiple simulation runs). Thus, uncertainty in the effects of work and politicking has a *beneficial* effect for larger groups, by reducing the uncertainty of the firm about where the group's performance level will settle down.

How does this result relate to the performance of large groups in real organizations? An additional factor, not considered so far, may come to the rescue. Large groups tend to separate themselves into subgroups, which are "encapsulated", or characterized by separate status rankings (for example, sports enthusiasts and theater enthusiasts) (Barkow 1989). Our model suggests that separation into subgroups may be helpful in mitigating status competition, keeping *de facto* groups size small and allowing to maintain group performance.

[12]Indeed, with uncertainty present, the standard deviation is the same for $\delta_m = 1$ and $\delta_m = 3.5$.

6 Conclusion

Status is pervasive in human behavior, both in the work environment and in everyday life (Barkow 1989). This article makes a contribution to an ongoing debate whether status competition in work groups pushes employees to perform, or whether it causes wasteful jostling for position and destructive behavior. We formalize status as a relative standing of prestige, determined by both work output and non-productive political activities, such as building status symbols, or spreading gossip. The basic assumption of our model is that employees allocate their total effort "budget" between work and politicking (not between work and leisure, as in traditional economics models). This situation is particularly relevant to professional work groups, such as R&D teams, where the individual's work contribution cannot easily be monitored by management.

The relative importance of work output and politicking in the organization expresses the culture of the group or the ease of measuring contribution, whether it functions as a "meritocracy" or whether people advance via politics. We are, to our knowledge, the first to formally address the question of under which circumstances status competition supports group output, and under which circumstances it reduces output. Frank's (1985) model of a pure meritocracy is a special case of our model where the group's meritocracy focus is so high that workers choose effort rather than politicking. Group incentives (Milgrom and Roberts 1992, 416) work in the special case of our model (Proposition 1) where compensation utility dominates status concerns.

Our model exhibits rich behavior with unexpected dynamic effects, which have not been predicted by previous theory. Under conditions of deterministic performance and olympic sharing of equal rank, the group may settle in an equilibrium of constant work effort, but it is undetermined at what effort level this equilibrium lies. If performance or politicking uncertainty is present, or if there are no shared ranks allowed, status competition drives an organization into oscillations between predominant politicking and predominant work effort. Increasing the group size reduces every individual's marginal reward for effort and, thus, encourages status competition. A key result is that the group may influence status competition by the way status is updated and by allowing shared ranks.

An immediate extension to be explored is interdependence of the group members' performance (for example, via a multiplicative rather than additive group production function Π). Another extension is the actors' ability to control the variance of their performance: does it pay to take performance risks in order to gain status rank? Finally, in interesting phenomenon to be examined is *encapsulation* (Barkow 1989): can status competition be mitigated if individuals can *choose* a status dimension on which to compete, along which they compare themselves only with other individuals who have chosen the same dimension? In other future work, the model parameters should be linked to constructs from practice, and the results of the model tested on real data. However, as a first step, the model parameters have face validity, that is, they seem to correspond to characteristics of real organizations, and the results of the model support some basic intuitions.

Status competition may be detrimental to performance, but an organization that understands what status is based on can use it to foster performance. In either case, it is inevitable that status influences behavior in organizations; the current article makes a contribution to include it in economic models of the firm.

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Appendix

Proof of Proposition 1. Group member i makes his/her decision to maximize the expected utility (pretending that uncertainty is zero):

$$U(i) = \delta_m[w + \frac{\beta}{n}(\sum_{j \neq i} \pi_j + 1 - e^{-\theta k_i})] + \delta_r[1 - \frac{(R_i - 1)^2}{(n-1)^2}].$$

The most pessimistic utility difference between maximum effort $k_i = 1$ and minimum effort $k_i = k^*$ arises if the former implies status rank n and the latter status rank 1. Maximum effort is always chosen if this difference is positive:

$$\frac{\delta_m \beta}{n}(-e^{-\theta} + e^{-\theta k^*}) \geq \delta_r.$$

Substituting k^* from Equation (5) into this condition yields (6). Substituting $k_i = 1$ in Equation (3) yields the fluctuating status levels. □

Proof of Proposition 2. By equation (3), status level $\overline{S}$ stays constant over time for all actors. If all actors have the same status, they all share first rank by the convention in the group. Thus, it is not optimal to increase politicking because no rank improvement can be achieved, and performance (and thus bonus compensation) would decrease. □

Proof of Proposition 3. In the presence of uncertainty, there can be no static equilibrium because the status levels $S_i(\tau_i)$ are random variables drawn at every evaluation. Now assume that $\{k_i, i = 1, \ldots, n\}$ is a dynamic equilibrium. Consider any two actors j and l and assume WLOG that at a given time, $S_j > S_l$ (if $S_j = S_l$, uncertainty will make the assumption true with probability 1 at the next evaluation). If the status difference is large enough to not be overturned by l's current level of politicking, j chooses full contribution. However,when status decay or l's increased politicking reduce the status difference, j must change his/her effort. A similar argument holds from l's point of view.

If the two status levels are close enough that both engage in politicking, the actors set the politicking as to just overtake the status level of the other (l) or to just prevent the other from overtaking (j). But uncertainty changes the difference with probability one at the next evaluation, and thus, the actors must change their effort levels.

Finally, it may be the case that the utility of compensation is high enough to dominate a loss of one rank, although it cannot offset a loss of m ranks, which Proposition 1 would require. In this case, the above comparison of S_j and S_l holds between the actors who are separated by m status ranks. Again, no dynamic equilibrium can be sustained indefinitely.

□

Proof of Proposition 4. The marginal monetary utility of effort is $\frac{\partial U_m}{\partial k_i} = \frac{\delta_m \beta \theta}{n} e^{-\theta k_i}$. This is also the marginal total utility of effort if rank remains stable, but if rank changes, the total utility change from an infinitesimal effort change is $(1/n)\delta_m \beta \theta e^{-\theta k_i} - \delta_r(2R_i - 1)/(n-1)^2$. Thus, the utility loss of *one* rank also shrinks with n. However, in larger groups, several ranks can be gained or lost for a given change in effort level. For any effort change Δk_i, the monetary utility change shrinks with n, while the possible rank utility change stays the same, δ_r, corresponding to going from first to last. Therefore, the solution to optimality (4) is decreasing in n. □