

Productivity, Collaboration, and Citizenship in Academic Departments

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ABSTRACT

Background: Junior faculty in academic departments must make two critical decisions. One is how to allocate their time and resources between departmental citizenship tasks and their research pursuits. Another is whether to pursue their research alone or in a group. Little is known how faculty make these decisions, or how departmental policies influence productivity, collaboration between faculty, departmental citizenship, and tenure outcomes.

Methods: Two models of faculty behavior in an academic department were constructed. Model A (agent-based) focuses on the choice between citizenship tasks and research productivity. Model B (cellular automata) emphasizes the choice between solo and group research. The two models examine how faculty choices influence success in competing for resources, publishing articles, and achieving tenure, and how departmental norms and policies influence faculty behavior by doling out resource allocation and tenure.

Results: In Model A, three different department strategies for the allocation of excess resources were used: in all three cases, the primary determinant of a faculty member achieving tenure was their scientific/research ability. Even when significant department resources were allocated to those who were contributing to ‘citizenship’ tasks, citizenship contribution had little if any affect on achieving tenure. In a model in which substantial financial incentives were created for citizenship, however, more faculty were tenured overall. This was because the increased citizenship activity resulted in a smoother running, more profitable department.

In Model B, group size trended towards 4-5 members; and groups were reasonably unstable over more than 2-3 years. Publication quantity depended primarily on length of service; the influence of scientific ability, collaborative skill and group size was minimal. In model B, when the collaborative desire of department members waned over time, the departmental publication output dropped off tremendously and success at achieving tenure also fell dramatically. Under conditions of poor cooperation the performance of a few “stars” stood out much more dramatically from the rest of the department. Thus, while low cooperation reduced department output and the number of faculty achieving tenure, it actually created a condition of better discrimination for inherent scientific quality. Under these conditions, the department ultimately was populated by only two or three “superstars” and tended to coalesce into one giant group.

Conclusions: Agent-based and cellular automata models may have some promise in modeling critical career choices in academic departments. The department policies that would lead to improved cooperation are not obvious on the basis of these preliminary models, which exhibit some emergent effects, and where it appears difficult to accrue faculty with desired behaviors with simple reward-benefit rules.

INTRODUCTION

Junior faculty in academic departments must allocate their time and resources between departmental citizenship tasks and research activity. They must also decide whether to pursue their research alone or in a group. These decisions are critical not only for the individual faculty member, but also for the department, the discipline, and academia as a whole, since institutional policies that reward one behavior over another may profoundly affect faculty productivity, citizenship, and selection. In the extreme case, systematic biases favoring one type of faculty have the potential to influence the type and quality of research produced across an entire discipline. (Fairweather, 2002; Moussa, 2001; Change, 2000; McPherson, et al, 1999)

This paper distinguishes two decisions faced by junior faculty. The first decision concerns the allocation of time and resources between departmental citizenship tasks and research activities. Citizenship includes teaching required courses, advising students who are not working on the faculty member's own research, performing departmental administrative functions, serving on departmental committees, and other tasks that do nothing for the faculty member's research productivity. This decision will be labeled "citizenship versus self."

The second decision is whether to conduct research alone or in a research group. Here, the conflict is not between self interest and the good of the department. Rather, the faculty member must choose between two different methods of conducting research in order to (selfishly) maximize his or her productivity, acquisition of departmental resources, and chance of getting promoted. This decision will be referred to as "solo versus group."

Boiling down faculty decisions to these two dichotomous choices is highly artificial. In the real world, faculty choices are extremely complex and surely less than fully rational or fully informed. We feel justified in making simplifying assumptions to facilitate modeling and analysis. We will need to keep the limitations of our assumptions in mind when we interpret our results. (Richardson, 1999; Trower, 1999; Ehrenberg, et al, 1998; Magner, 1998; Leslie, 1998).

We did not ask the question of "should tenure exist?" There is an extensive literature that argues tenure is dated and not effective in the current world (Brock and Butts, 1998; Wiener, 1998; Bess, 1998; Lenz, 1997; Pilant and Ellison, 1997; Yarmolinsky, 1996, Shulevitz, 1995; O'Toole,). Additional arguments are made on the economic basis that the cost of tenure is too high, such that market forces or contracts should be the norm (Whicker, 1997, Finkin, 1996; Reiland and Burgan, 1996;). While these arguments are important when considering the whole question of tenure and tenure rule reformation, they are not relevant to understanding the current situation as described by the models below.

Our models have the potential to shed light on the following questions:

- a. How the two faculty decisions, "citizenship versus self" and "solo versus group," influence faculty success in competing for resources and achieving tenure.
- b. How departmental policies concerning the allocation of resources and the awarding of tenure influence faculty decisions and the type of individuals who achieve tenure.

METHODS

Model A: Citizenship versus Self

Methods

Potential factors that might influence an individual's decision on this axis were identified by a review of the literature and informal discussions with a convenience sample of academic faculty. Factors we considered including in the "citizenship vs. self" model were the faculty member's enjoyment of citizenship tasks, their skill at performing these tasks, their sense of department loyalty and desire to improve the department, pressure from (or frank mandate by) department administration, peer pressure, and their perception as to whether citizenship tasks are rewarded by resource allocation and promotion within their department (Leslie, 1998; Plater, 1998; Arden 1997; Magette, et al, 1990; Grassmuck, 1990).

An agent-based model was constructed to evaluate the effect of rewarding different behaviors. In this model, all faculty were considered to be independent researchers. A baseline amount of research resources were provided to each faculty member based on academic rank. During each time interval, each faculty member had to choose either to focus on his/her research, or to focus on citizenship contributions. Their research output, if they chose research for a given iteration, was considered to be a function of their resources times their inherent "quality" (i.e. ability to perform high quality research). If they chose citizenship tasks, their contribution to the department was likewise estimated as the product of their administrative skill times their resources.

We made the assumption that the department runs most effectively, and hence can acquire and distribute the most research resources, when the correct amount of citizenship tasks is performed by the faculty as a whole. If no citizenship tasks are performed, the department grinds to a halt. However, if everyone chooses citizenship, the marginal contribution of each becomes small and the lack of publication output hinders the competition for outside dollars. Thus, at each iteration, we summed the entire departmental "citizenship" contribution and awarded an additional sum of research dollars to the department, with this "bonus" contribution at a maximum when the total citizenship contribution was in the middle range of possible values.

Three conditions were tested. In condition 1 ("communism") the total department bonus was distributed equally to all faculty, regardless of their behavior in the last period. In condition 2 ("publish or perish," or "Pravda" for short), the total department bonus was distributed only to those who published in the last period, in proportion to their publication output. In condition 3 (citizenship, or "Party membership"), the total department bonus was distributed only to those who chose citizenship in the last period, in proportion to the size of their citizenship contribution. In all three conditions, criteria for promotion were unchanged, and were based solely on lifetime publication output.

Results

Under all three conditions, the primary determinant of faculty promotion was scientific quality. Citizenship ability did not influence promotion in any of the models. This was true even in the model in which the bonus was distributed entirely to those choosing citizenship in a given cycle. Although the "bonus" was sometime substantially larger than an assistant professor's base research resources, this method of resource distribution did not lead to preferential promotion of individuals with high citizenship abilities.

However, an important difference between the three models was that in the Party membership model, more research was done and more faculty were ultimately promoted. Approximately 75% of new faculty members ultimately became tenured professors in this model, compared to about 35% in the Communism and Pravda models. The reason for this appeared to be that the citizenship incentive led to the department functioning at a higher level, which in turn made more resources available for all faculty, and thus more research output and a greater chance of promotion. Nonetheless, there was no clear linkage between an **individual's** choice of citizenship tasks, and his/her likelihood of promotion.

Model B: Solo versus Group

Methods

Potential factors that might influence an individual's decision on this axis were identified by a review of the literature and informal discussions with a convenience sample of academic faculty. Factors we considered including in the "solo vs. group" model were the faculty member's "collegiality," their enjoyment of group work vs. individual work, their group skills, peer pressure, their research interests and the availability of other department members with similar interests, their resources and the resources of potential collaborators, perceived quality of potential collaborators, whether the nature of their research interest lends itself to solo or group research, and whether pooling resources and intellectual skills has a synergistic effect on academic output (or is perceived to) (Wiener, 1998; Lenz, 1997; Grassmuck, 1990).

An cellular automaton model was constructed as follows. A 10 x 10 fully populated matrix was considered to represent a department faculty, with each matrix element a faculty member. At time zero, an inherent desire to collaborate and an inherent research ability were assigned to all faculty using a gaussian distribution. Also at time zero, the department was constructed randomly of approximately equal numbers of assistant, associate and full professors, and resources were distributed preferentially (but not exclusively) to the higher ranks.

At each time interval, all faculty chose whether to collaborate with each of their four closest neighbors (excluding diagonal neighbors), based on the neighbor's research ability, resources, and collaborative ability. Faculty members with an inherently high desire to collaborate had a lower threshold to offer collaboration to neighbors after evaluating their "value." It was assumed that group productivity was in excess of individual productivity by a chi squared distribution in which the optimal group size was approximately 5 individuals, and when an individual's productivity was on the order of 35% higher when they were in an optimally sized group (relative to productivity in a group of self). After the optimal size, productivity fell as a function of size until it was equal to solo productivity at higher n.

At each iteration, faculty were then allowed to produce research output, and their departmental resources were re-allocated based on their output at that iteration. After 8 years, an individual with a substandard publication output was terminated; his/her cell was repopulated with a new assistant professor, whose slate was wiped clean and who was, initially, not in a group. An individual with a satisfactory research output at 8 years was promoted to associate professor and to full professor at 16 years. After 25 years, individuals "retired" and these cells were also repopulated with a new assistant professor with a "clean slate."

We systematically varied the individual faculty's desire to collaborate according to two rules. In one, collaborative impulse remained constant over time. In the other, collaborative

impulse was initially drawn from the same Gaussian distribution but then decayed by 50% each year. We questioned if a model of psychosocial “burnout” would lead to increased solo research in the department.

Results

In the model in which collaborative skill/impulse was allocated on a Gaussian distribution and held constant over time, faculty groups tended to a size of about 4-6 individuals. This was not surprising in light of the fact that our group function rewarded output to a maximum size of about 5 individuals. Groups tended to migrate or morph over 2-5 “years.” After a large number (> 25) years, about half the faculty were tenured at any given moment.

We questioned whether causing the collaborative impulse/skill to decay over time would lead to increased solo research. Interestingly, in this model groups would coalesce into a single large group at about 30 years. Examination of the individual arrays showed that this was likely due to increased turnover in the department. When collaborative impulse decays, groups are initially smaller and department research output decreases. Very few junior faculty are tenured. New individuals in the department tend to be rapidly absorbed into a group. Therefore, an increased turnover in junior faculty led to progressive growth in group size and, ultimately, to a single group. Paradoxically, a decay in the collaborative impulse leads to a much larger group size and, therefore, a smaller departmental research output.

Four representative scatter plots of the two simulation conditions are shown. In each case the points are a “slice” of the entire faculty after 50 “years.” (The lines between the points should be ignored.)

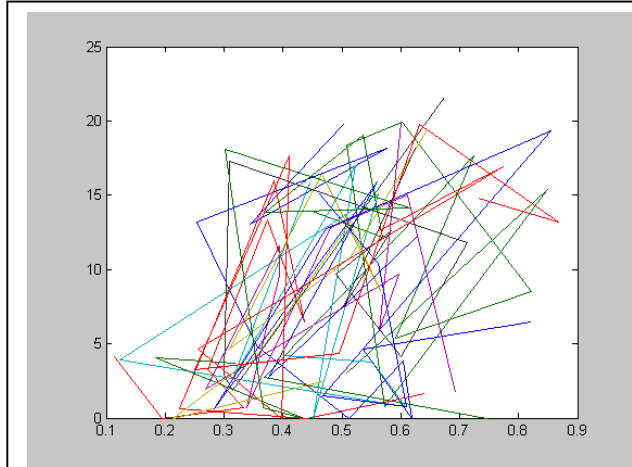


Figure 1a. Publication output vs. scientific ability in a model where collaborative impulse is normally distributed and remains stable over time. The x-axis is scientific ability, y-axis is publication output. Points are a scatter plot of all faculty after 50 years. There is a weak dependence of publication on ability.

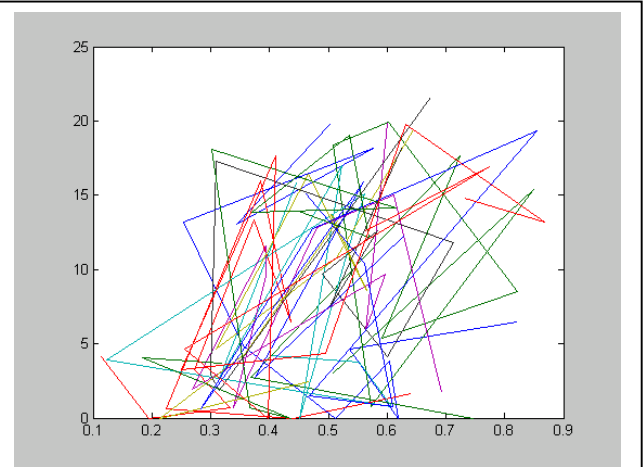


Figure 1b. Publication output vs. collaborative impulse in the same model, at the same time. There is little if any dependence of publication on collaborative impulse/ability.

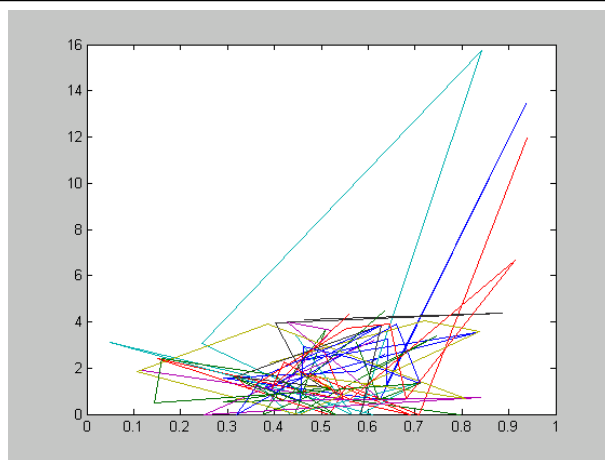


Figure 2a. Publication output vs. scientific ability in a model where collaborative impulse is initially normally distributed and decays over time (“burnout”). Although few faculty are promoted, this model is very good at promoting only the very best scientists (upper right points). The large numbers of faculty at the bottom are assistant professors, few of any of which will be promoted in this model.

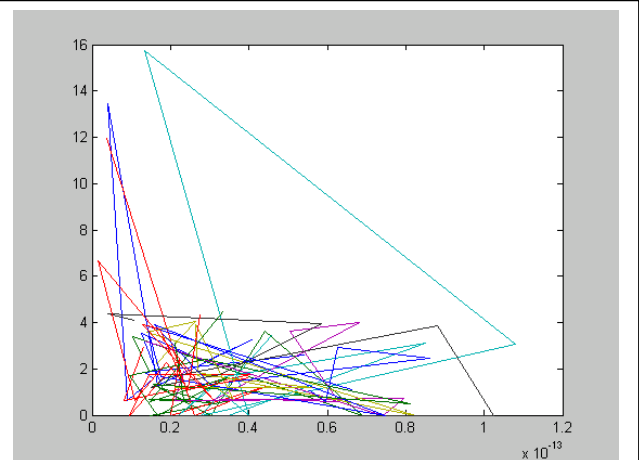


Figure 2b. Publication output vs. collaborative impulse/ability in the “burnout” model. Since all faculty decay, the few faculty who are promoted (upper left corner) decay to very low collaboration skills. This model paradoxically leads to a small number of senior faculty with low collaborative interest leading a very large group of junior faculty, few of which are ever promoted.

CONCLUSIONS

Agent-based and cellular automata models may have some promise in modeling critical career choices in academic departments. In a model of citizenship vs. collaboration, rewarding citizenship on a year-by-year basis led to improved overall departmental productivity and an increased number of faculty achieving tenure, but there was no individual correlation between the individuals with high citizenship skills and their chance of promotion. In effect, rewarding citizenship on a year-by-year basis, by increasing departmental resources overall, “lowers the quality bar” for promotion without selecting for individuals with higher citizenship.

In a model of solo vs. group research, we showed that “burnout” (decay in collaborative impulse) paradoxically led the department to coalesce into one giant research group, even though the overall department research output fell. This was because a decrease in cooperation led to a department-wide decrease in research output, which led to an order of magnitude decrease in faculty reaching tenure. The rapid turnover led to formation of a “super-group”—not seen in the stable collaboration model—because new junior faculty are particularly prone to be drawn into pre-existing groups.

This burnout model is particularly interesting in that it led to a department that was extremely successful in promoting only the best scientist, and that had the appearance of high cooperation (since there is one “supergroup”). Hidden in this “supergroup” is the fact that almost all junior faculty who join are never promoted, and also the fact that total department research output is reduced. This is in comparison to a department in which cooperation is maintained, where many small groups persist, a substantial number of faculty achieve tenure and overall research output is higher.

These models emphasize that department policies that would lead to improved cooperation, and to preferential promotion of collaborative individuals, are not readily identified. An obvious disconnect is that both models rewarded collaboration on a year-by-year basis, but based tenure solely on academic output. A reasonable preliminary hypothesis would be that, in order to selectively promote citizenship-prone, cooperative individuals, departments must include these qualities in tenure decisions as well as in year-to-year financial rewards. The link between year-to-year financial rewards, increased publication output, and ultimate success in promotion may well be too remote and tenuous to drive successful promotion unless these qualities are considered formally in the tenure process.

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