Exploring the Impact of Tenure on US Professors' Research Practices

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Extended Abstract

Tenure is the bedrock upon which modern US higher education is built. Granting tenure is a milestone in a professor's career, signifying that one's academic contributions have undergone the most rigorous evaluations. Tenure encourages open inquiry, critical discourse, and the exploration of innovative ideas, which are fundamental for advancing knowledge and fostering intellectual growth within academic institutions. With the incentives of granting tenure, professors are likely to foster high academic standards and practices, laying a foundation of scholarly excellence throughout their careers [1]. However, the past few decades have witnessed a dramatic increase in the critics of the tenure system, including weakening research efficiency, discouraging efforts and motivations to do research, and suppressing labor market competition [2, 3]. While existing studies considered tenured professors' research productivity, which is suggested to decline after tenure [4–6], the research impact and innovation of their research are underexamined, although they are also part of the tenure criteria and are supposed to grow with tenure's incentive [7–9].

To fill in the research blank, we investigated tenure-track professors' research practices, including perspectives on research performance, innovation, and team collaboration after tenure. The analysis is supported by data from Academic Analytics of 41,869 tenure-track professors who obtained tenure from 2011 to 2019 in 10,031 departments of 368 US PhD degree-granting institutions. These professors engage in research across extensive fields of four broad domains: Applied Sciences, Natural Sciences, Health Sciences, and Humanities, Arts, and Social Sciences (HASS). These professors' research practices were traced by analyzing their 1,047,745 research papers published from 2006 to 2020 across various disciplines.

Our analysis starts with tenure's role in research productivity. Consistent with previous studies [3, 4, 6], we observed that across all four domains, professors' average productivity increases by 61.1% (Natural Sciences) to 106% (HASS) up to tenure, peaking in the last year before tenure and then stabilizes in the post-tenure career stages.

Next, we investigated how tenure might affect professors' research impact. We use a paper's five-year citation percentile and venue's impact factor (IF) percentile to assess its citation impact relative to its same-year and subfield papers. **Figure 1a** shows that in most domains, the likelihood of a paper being in the top 10% of citations demonstrated a downward trend over the observed period. The average citation percentile of professors' papers also continued to decrease by 2.59 to 8.47 pp from the initial year of observation to the final year (see **Figure 1b**). While the citation percentile displays a linear decline, the IF percentile shows general stability followed by a decline post-tenure. **Figure 1c** and **d** tested the slope differences using fixed-effect segmented regression and found IF has different trends before and after tenure across domains and most fields. It is possible that because tenure evaluation centers more on the venue prestige, not individual papers' impact, professors are more motivated to sustain the venue impact than citation impact [8, 9].

However, checking the overall performance may not be able to capture the dynamic range of professors' research contributions. To address this nuance, from each professor's publications in one year, we selected the key papers (the top 20% papers) and minor papers (the bottom 20%

papers) by each measure to represent their most significant and minimal academic achievements in that year. **Figure 1b** illustrates that both key and minor papers display non-linear trends in citation impact, with a notable change occurring at the tenure year. For all domains, the average citation and IF percentile for professors' key and minor papers generally reach their highest levels during the pre-tenure phase, followed by a gradual decline post-tenure. Notably, tenure appears to decelerate the rate of decrease in the impact of their minor papers. **Figures 1c** and **d** indicate a marked difference in the post-tenure declining slopes for key papers compared to their pre-tenure counterparts, and the decline in citation percentiles for minor papers is more gradual post-tenure than pre-tenure.

For innovation, we use a novelty measure, the atypicality of reference pair combination, to represent this innovation [10–12]. Overall, unlike citation impact, professors' innovation kept increasing. The average of innovation percentiles and the annual changes with covariates controlled both show a rise over the observation period, irrespective of their tenure status (see **Figure 2a**). When examining the key and minor papers, the trend for novelty paralleled that of citation and venue impact: the key papers continued to show an upward trend pre-tenure, while the minor papers showed a downward trend (see **Figure 2a**). In most domains and fields, post-tenure, unlike the downward trends observed in citation impact and IF, novelty either stabilized or exhibited a slight increase from the tenure year onwards, as indicated by the positive slopes post-tenure (see **Figure 2b** and **c**). While the rate of increase for key papers post-tenure was not as pronounced as pre-tenure, the downward trend for the minor papers halted around the tenure year. We also used the disruptiveness index (CD index) with different time windows as an alternative innovation measure and found similar results.

To quantify the tendency to generate and accept changes and novel ideas, we employ a paper-level metric, topic dissimilarity. The metrics gauge the extent to which a professor's current paper topic deviates from their past five years of research papers in terms of topics. Overall, its pattern across most domains closely mirrors those observed in field innovation (see **Figure 2**). While key papers show a deceleration in their innovation pace post-tenure, the minor papers display a reverse trend with higher increasing speed of innovation propensity.

Finally, we explored collaboration by focusing on five key characteristics within a paper's author team: team size, disciplinary diversity, new collaborator share, early-career researcher (ECR) share, and international diversity. **Figure 3** presents the results of tenure's impact on the collaboration patterns among professors. In the sample we studied, the team size and disciplinary diversity of professor teams increased over time (**see Figure 3a**). As reflected by **Figure 3b**, the rate of increase in team size post-tenure was faster than pre-tenure in all domains and most fields. Regarding new collaborators, there was a unique pattern: the proportion peaked about three years prior to tenure, declined until the tenure year, and then stabilized post-tenure around 46% (Applied Sciences) to 60% (HASS). International diversity showed a declining trend pre-tenure but increased consistently post-tenure in most domains. The ECR representation in teams peaked at around 42% (Natural Sciences) -49% (Applied Sciences) in the tenure year, subsequently declining post-tenure at a low speed. Nevertheless, including collaboration features in regression analysis does not significantly alter the research performance trend patterns, adding evidence to the robustness of our results.

Overall, the above results provide insights into changes in research practices post-tenure from a wide range of aspects and contribute to more informed decisions regarding tenure policies and a better public understanding of the tenure system's value and relevance.

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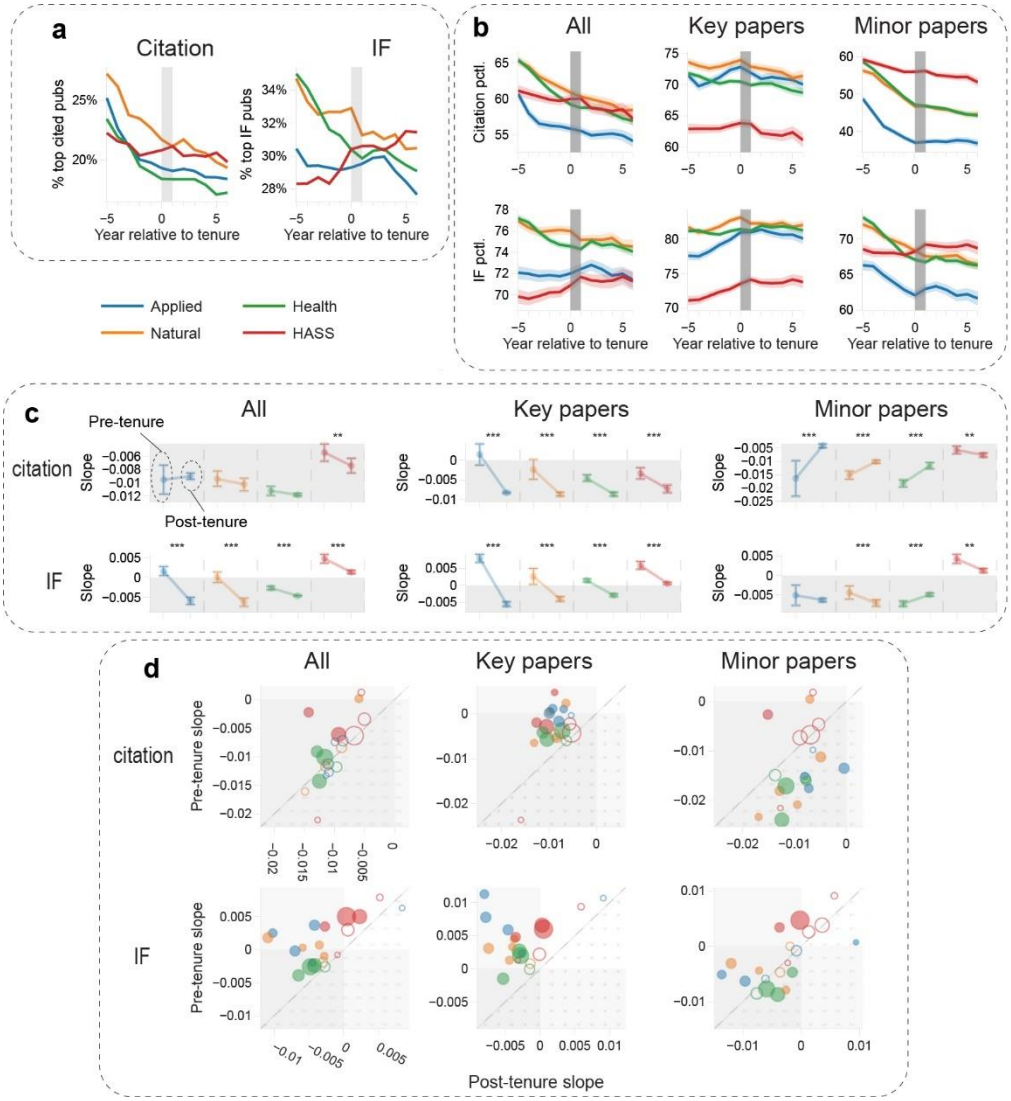

Figure 1. Pre- and post-tenure citation impact trends. a) Proportion of papers that are ranked in the top 10% among same field and same year papers. **b)** Average citation and IF percentile through career years by research domain. Key and minor papers are the top 20% and bottom 20% papers published by each professor in each year, respectively. **c)** Slope comparison of pre- and post-tenure productivity by research domain. Effects are estimated by segmented OLS regression including individual fixed effects, controlling for a series of covariates. **d)** Slope comparison of pre- and post-tenure citation impact by 20 research fields. Fields are represented as circles sized by the number of professors. Circles are solid if for that field, the difference between pre- and post-tenure productivity slopes are significant ($p < 0.05$). Otherwise, they are empty. A circle below the diagonal (dotted area) indicates that the pre-tenure slope is lower than the post-tenure slope.

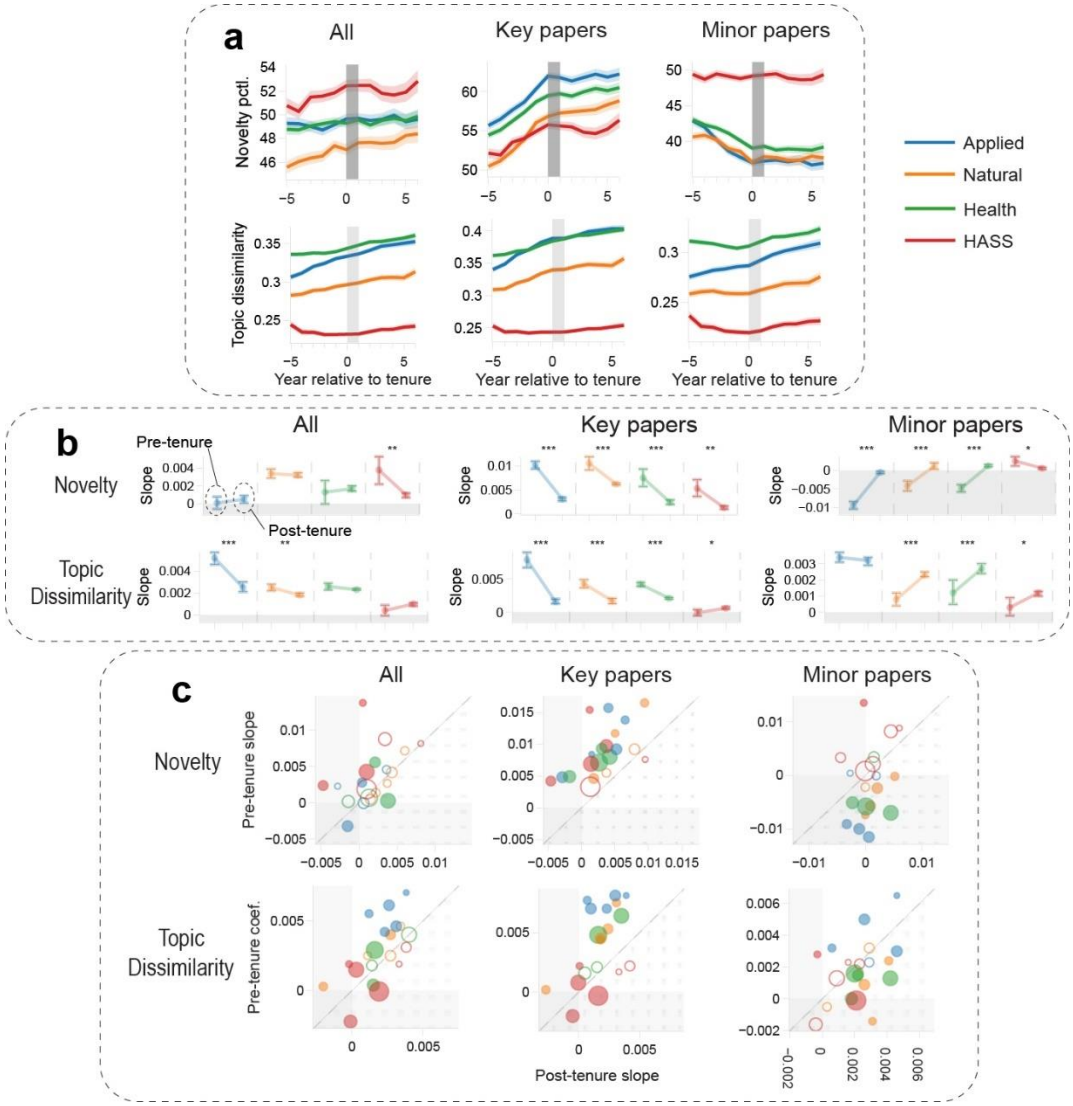

Figure 2 Pre- and post-tenure innovation trends. a) Average novelty percentile and topic dissimilarity through career years by research domain. b) Slope comparison of pre- and post-tenure productivity by research domain. Effects are estimated by segmented OLS regression including individual fixed effects. d) Slope comparison of pre- and post-tenure innovation by 20 research fields. Fields are represented as circles sized by the number of professors. Circles are solid if for that field, the difference between pre- and post-tenure productivity slopes are significant ($p < 0.05$). Otherwise, they are empty. A circle below the diagonal (dotted area) indicates that the pre-tenure slope is lower than the post-tenure slope.

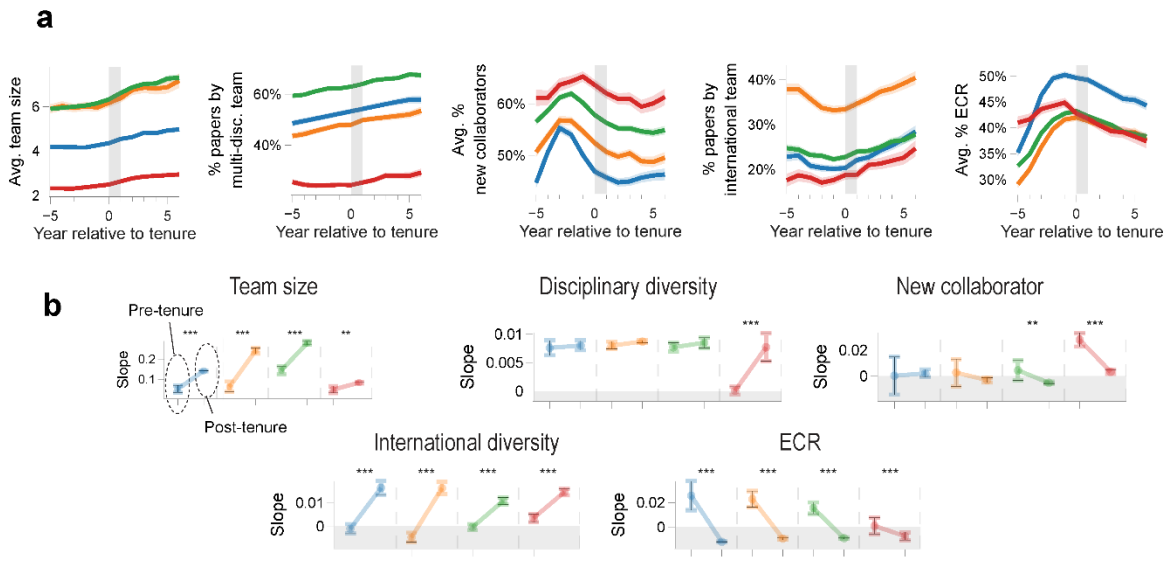

Figure 3 Pre- and post-tenure collaboration feature trends. a) Average team size, share of papers by multi-disciplinary team, average share of new collaborators, share of papers by international teams, and average share of ECRs through career years by research domain. **b)** Slope comparison of pre- and post-tenure collaboration features by research domain. Effects are estimated by segmented OLS regression including individual fixed effects.