



The dual impact of generative AI on research: structural stability and attention reallocation

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Abstract

Introduction. We present an exploratory analysis of the short-term effects of generative AI (GenAI) on the research landscape. As GenAI becomes more deeply embedded across multiple stages of scientific work, there is an increasing need to examine its broader impact on all forms of research.

Method. We retrieved 24,309,359 publications (2020–2024) from OpenAlex across 26 disciplines after excluding records with missing references or unspecified research fields. Distinct research topics were identified via graph clustering algorithms for subsequent analysis.

Analysis. Using a multidimensional framework, we calculated topic diversity indices to examine temporal evolution, constructed topic networks to measure structural changes via clustering coefficients, and assessed GenAI publication proportions among hot topics.

Results. The available evidence detected no significant changes in overall topic variety or network structural properties from 2020 to 2024. However, within the most prominent topics, GenAI-related publications increased significantly, indicating internal reallocation of research attention.

Conclusion. Initial evidence suggests no detectable macro-structural changes coexist with micro-level attention shifts toward GenAI within established domains. This dual pattern suggests that GenAI is less a disruptive force than a catalyst that amplifies research attention within established domains.

Introduction

The rapid advancement of artificial intelligence (AI) is fundamentally reshaping the landscape of research enterprise (Gans, 2025; Gao & Wang, 2024). A notable recent breakthrough is generative AI, represented by ChatGPT, which has demonstrated a remarkable capacity to generate coherent and contextually relevant human-like text (Demirci et al., 2025; Dwivedi et al., 2023). Following its launch on November 30, 2022, it quickly achieved widespread adoption and is now used extensively by diverse users, including researchers (Dwivedi et al., 2023). Generative AI (GenAI) is being increasingly integrated throughout the entire scientific workflow, encompassing: (a) problem formulation and research design, (b) data collection and analytical processing, (c) interpretation and theoretical development, and (d) scholarly composition and communication (Erduran & Levirini, 2024; Susarla et al., 2023). Throughout these stages, GenAI acts as a powerful tool for knowledge synthesis and recombination, supporting scientific decision-making by offering data-driven and more precise solutions (Gans, 2025).

The integration of AI into scientific practice has stimulated considerable debates regarding its broader implications. A central concern lies in its impact on diversity within research (van Dis et al., 2023). Empirical evidence indicates that although AI assistance enhances individual scientific productivity, it also tends to narrow scientific diversity and discourage broad scholarly engagement—revealing a tension between individual productivity and collective scientific progress (Hao et al., 2024). This paradox echoes findings in creative domains: for instance, AI-assisted short story generation improves individual output yet reduces collective novelty (Doshi & Hauser, 2024). Specifically, as shown by Hao et al. (2024), AI-assisted research is associated with a contraction in the scope of scientific topics. While existing research has highlighted the effect of AI usage on the contraction of science's focus, it has focused specifically on AI-oriented publications—using research papers on AI-related topics as datasets and defined AI technology as advanced before GenAI (with deep learning being the prominent example) (Hao et al., 2024). This raises a question: Does the penetration of GenAI affect the research landscape?

As GenAI becomes increasingly embedded across various stages of scientific practice, there is a growing need to investigate its impact on the research enterprise. Using the OpenAlex dataset across multiple disciplines, this study employs graph clustering algorithms to identify research topics and analyses the dynamics in research topic structure and attention allocation as the rise of GenAI. Our results reveal a dual pattern in GenAI's initial impact: macro-structural stability coexists with micro-level attention reallocation. It can be inferred that neither topic diversity nor network cohesion is likely to undergo significant changes in the short term, underscoring the structural resilience of existing knowledge architectures. At the same time, within already prominent research topics, GenAI-related publications have increased significantly, indicating a substantive reallocation of scholarly attention toward GenAI within established research domains. These findings offer valuable insights for science and innovation policy as well as AI education strategies.

Data and methods

We conducted a large-scale analysis to examine the short-term impacts of GenAI on research topic variety and concentration. All papers published between 2020 and 2024 were extracted from the OpenAlex dataset. After excluding records with missing reference lists or unspecified research fields, a total of 24,309,359 valid entries were retained for analysis. The OpenAlex platform utilises the All Science Journal Classification Codes (ASJC) (Scopus, 2024) for disciplinary categorisation, which includes four major subject areas and 26 specific disciplinary classifications (as presented in Table 1). It should be noted that although the original ASJC system contains 30 subject classifications, the 'Multidisciplinary' category—which is duplicated across the four major areas—was excluded from the dataset, resulting in a final set of 26 distinct fields.

The number of research topics within each field was calculated following Zeng et al. (2019), using a static network clustering approach. For each field, a bibliographic coupling network was constructed based on all its scientific publications in a given year. The network is undirected and unweighted, with edges created between two publications that share at least one common reference. We employed the fast-unfolding algorithm (Blondel et al., 2008) to detect the network's community structure. This heuristic method operates by optimising the modularity metric. The quality of the community structure was evaluated using modularity Q , which quantifies the extent to which connections within communities exceed random expectations. Modularity Q is defined by the following formula (1):

$$Q = \frac{1}{2m} \sum_{i,j} \left[A_{ij} - \frac{k_i k_j}{2m} \right] \delta(c_i, c_j) \quad (1)$$

Here, A_{ij} represents the adjacency matrix of the network. If there is an edge between node i and node j , then $A_{ij} = 1$; otherwise, $A_{ij} = 0$. k_i and k_j are the degrees of nodes i and j (i.e., the number of edges connected to each node). m is the total number of edges in the graph. c_i and c_j are the community assignments of nodes i and j . $\delta(\cdot)$ is an indicator function that equals 1 when $c_i = c_j$, and 0 otherwise. Then, it uses a computational method to solve the following optimisation problem, as shown in formula (2), and obtain the community of each node and the optimal number of communities.

$$c^{optimal} = \operatorname{argmax}_c Q \quad (2)$$

The final optimal number of communities was adopted as a direct measure of the number of research topics within each field. Based on this, we then calculated the average number of topics per paper (i.e., topic diversity) for each field by dividing the total number of topics by the total number of publications.

Results

Temporal changes in topic variety from 2020 to 2024

This study aims to investigate whether the emergence of GenAI has had a structural impact on the variety of research topics across different fields. We measured topic variety by calculating the average number of topics per paper for each discipline from 2020 to 2024, and specifically compared topic diversity before and after the release of GenAI. Since the first publicly accepted GenAI application was launched at the end of 2022, and there is a delay period from conducting research to publication, we chose the years 2022 and 2024 to represent publications before and after GenAI release.

We first visualised the individual trajectories of topic variety for all 26 fields from 2020 to 2024, organised by their four major disciplinary categories (Figure 2). The results show that between 2022 and 2024, none of the four major discipline categories exhibited a unified pattern of change. Within each major category, the trajectories of individual disciplines diverged into multiple types (such as continuous rise, initial decline followed by rise, continuous decline, fluctuating equilibrium), and the dominant patterns of change were inconsistent across categories.

To assess whether these diverse discipline-specific trajectories collectively resulted in a statistically significant net effect at the aggregate level, we conducted a paired-sample t-test. Prior to the test, the normality assumption was verified using the Shapiro-Wilk test. The results indicated that the topic variety distributions for both 2022 ($W=0.829$, $p=0.101$) and 2024 ($W=0.814$, $p=0.097$) did not significantly deviate from normality, thereby satisfying the parametric test assumption. We then employed a paired-sample t-test to compare the topic variety of 26 fields between 2022 and 2024. The statistical analysis revealed no statistically significant difference between the two years (see Table 2). The combined evidence points to a cancellation effect as one

plausible interpretation. The absence of an aggregate-level statistical signal (Table 2), alongside observed micro-level heterogeneity (Figure 2), is most consistent with a scenario in which opposing disciplinary shifts counterbalanced one another.

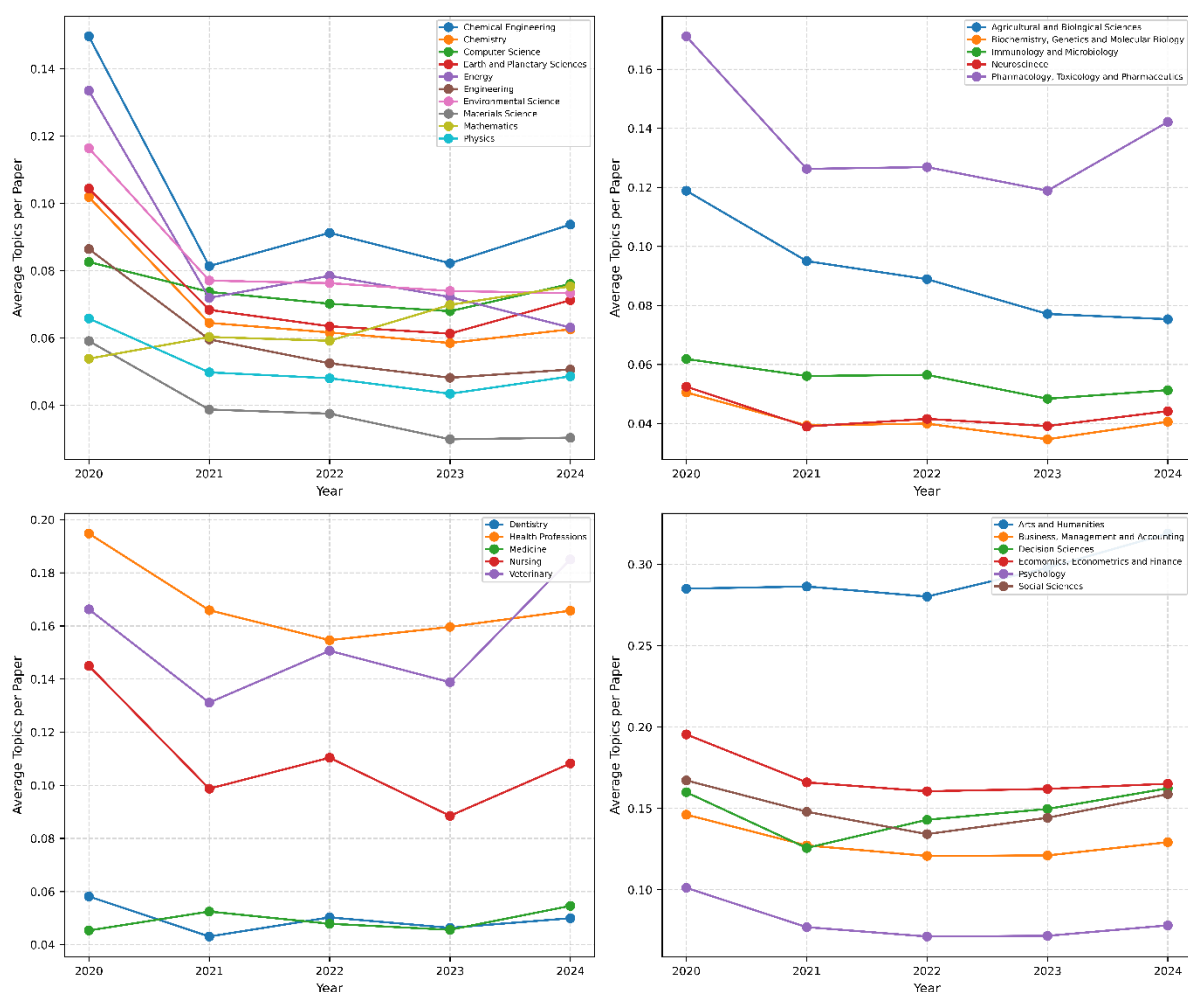


Figure 1. Temporal changes of topic variety across 26 disciplines (2020–2024).

	2022	2024	t-value	p-value
<i>Average Topics per Paper</i>	0.093 ± 0.055	0.099 ± 0.064	0.368	0.714

Table 2. Statistical comparison of topic variety for 2022 and 2024.

Comparison of research topic network structures between 2022 and 2024

To further investigate the impact of GenAI on the structure of disciplinary research, we constructed a research topic network based on citation relationships and conducted a comparative analysis of the network topological properties between 2022 and 2024 using both quantitative and visual methods. This section examines the issue from two dimensions: the inter-topic association patterns and the overall network cohesion.

We began by constructing and comparing the research topic network layouts of 2022 and 2024 (as shown in Figure 2) to identify shifts in thematic structure across the 26 disciplines. In these layouts, nodes represent research topics, with their size corresponding to the number of publications. The distance between nodes reflects the similarity between topics, and the outer nodes form the disciplinary boundaries. A comparative visualisation of the 2022 and 2024 thematic networks revealed a notable divergent pattern across disciplines: thematic boundaries expanded in some

fields while contracting in others. These visual observations set the stage for our subsequent quantitative analysis, which examines whether such divergent thematic shifts translated into measurable changes at the aggregate level.

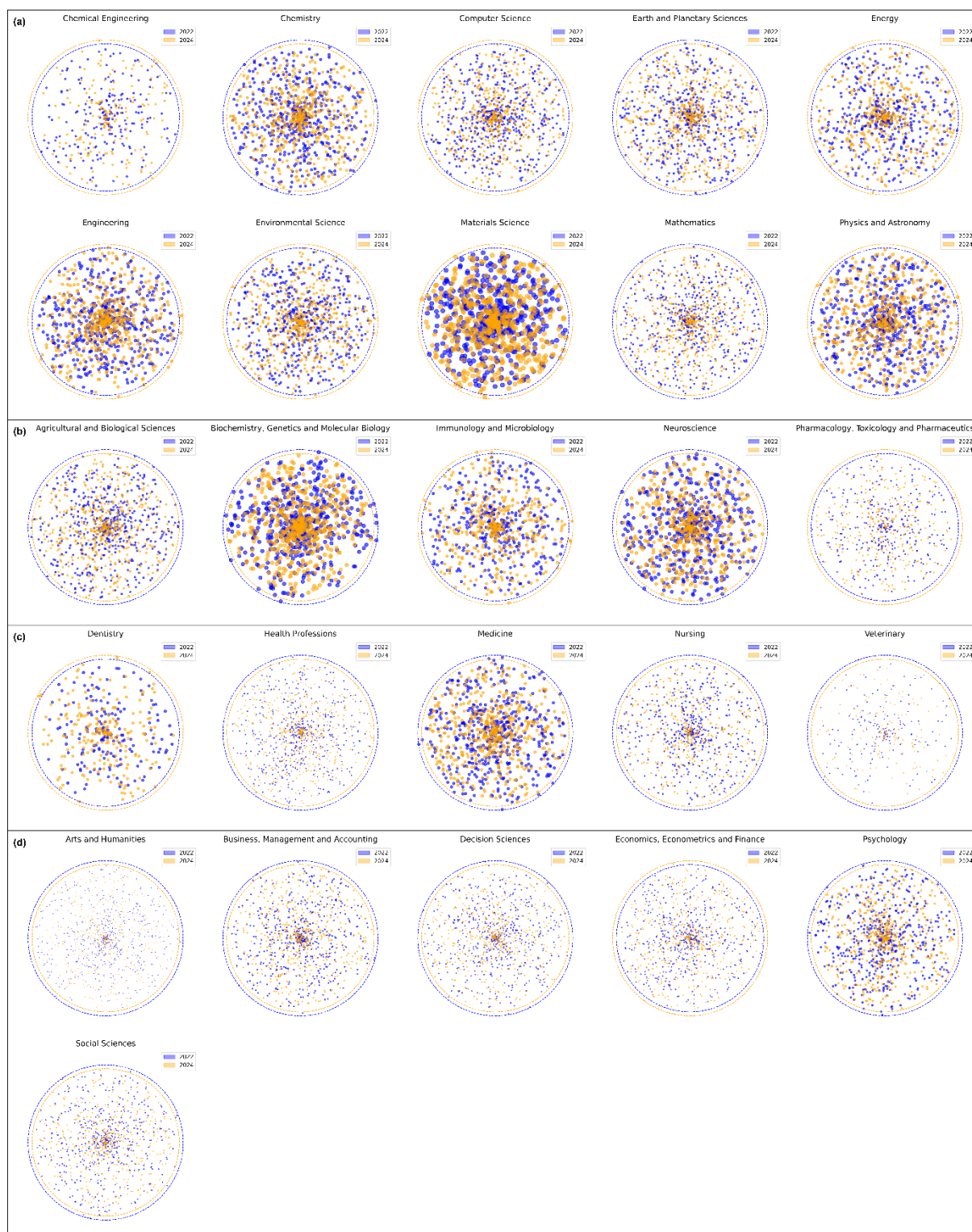


Figure 2. Comparison of research topic networks in 2022 and 2024.

To assess whether these field-specific shifts resulted in a statistically significant net effect, we conducted a paired-sample t-test comparing the global clustering coefficients between 2022 and 2024. A high clustering coefficient signifies tightly bound thematic clusters, whereas a low value corresponds to a sparsely connected or fragmented network structure. The Shapiro-Wilk test showed no evidence to reject the assumption of normality for the clustering coefficient data in 2022 ($W=0.952$, $p=0.264$) and 2024 ($W=0.900$, $p=0.216$), thus meeting the fundamental assumption for employing parametric statistical tests. The paired-sample t-test (see Table 2) revealed no statistically significant difference in mean clustering coefficients between 2022 and 2024. Therefore, despite the field-specific thematic shifts observed visually, we found no evidence that the overall cohesion of the disciplinary knowledge networks changed significantly during this period.

	2022	2024	t-value	p-value
<i>Clustering Coefficient</i>	0.208 ± 0.065	0.151 ± 0.090	1.961	0.055

Table 2. Statistical comparison of clustering coefficients for 2022 and 2024.

Internal reallocation of research attention within hot topics

To investigate how the rise of GenAI has influenced the allocation of research attention, we calculated the proportion of publications accounted for by the top 10% most popular topics (in terms of publication volume) in each field and performed a paired-samples t-test comparing data from 2022 and 2024. The analysis covered 26 disciplinary domains.

The first test found no statistically significant difference in the proportion of publications within hot topics between 2022 and 2024 (Table 3). However, a finer-grained analysis of the internal composition of these topics can infer a notable reorientation of research focus. To quantify this shift, GenAI-related publications were identified through a keyword-based retrieval method, which targeted occurrences of terms such as ‘*generative artificial intelligence*’, ‘*large language model*’, ‘*LLM*’, ‘*foundation model*’, ‘*generative pre-trained transformer*’, ‘*GPT*’, and ‘*chatbot model*’ in titles, abstracts, and keywords. Subsequent calculation showed that the proportion of GenAI-related publications within these prominent topics increased significantly from 2022 to 2024 (Table 3). Taken together, these two findings indicate that within the stable framework of overall attention to dominant topics, a marked shift in research focus has occurred, characterised by a pronounced convergence on GenAI-related subjects.

	2022	2024	t-value	p-value
<i>Paper Proportion</i>	0.804 ± 0.056	0.825 ± 0.054	1.395	0.169
<i>GenAI-Paper Proportion</i>	0.005 ± 0.004	0.025 ± 0.041	2.516	0.019

Table 3: Statistical comparison of the proportion of publications and GenAI-related publications in hot topics (2022 vs. 2024).

Discussion and conclusion

This study employs a multidimensional analysis to comprehensively assess the initial impact of GenAI on the landscape of disciplinary research. The results suggest a dual pattern of influence: macro-level knowledge structures appear largely stable, while indications of a reallocation of research attention are observed at the micro level. These findings tentatively imply that GenAI may be beginning to reshape certain aspects of research focus, though further evidence is required to establish a definitive relationship.

The duality of GenAI's initial influence

On one hand, the available evidence did not detect statistically significant changes in research topic variety or in the structural properties of topic networks—including clustering coefficients—following the release of GenAI. This could suggest a degree of resilience in the macro-level

knowledge architecture. Such an interpretation appears consistent with the concept of new inventions that consolidate the status quo (Funk & Owen-Smith, 2017). The new technologies are initially absorbed and reconfigured within established knowledge structures rather than triggering immediate paradigm displacement. In addition, due to mechanisms such as peer review, theoretical traditions, and disciplinary norms, academic systems generally exhibit a certain inertia toward change, which helps maintain structural continuity. As noted by DiMaggio & Powell (1983), rational actors who try to change their organisational fields often unintentionally promote homogeneity through three isomorphic processes: coercive, mimetic, and normative. Stability at the macro level is also related to the characteristics of GenAI as a general-purpose technology. Its initial effect is not to change existing structures, but to diffuse widely within them, enhancing productivity and opening new pathways within established paradigms, thereby generating 'innovational complementarities' (Bresnahan & Trajtenberg, 1995).

On the other hand, although the proportion of publications on hot topics did not change significantly following the emergence of GenAI, its internal composition underwent a notable shift. The significant increase in the proportion of GenAI-related publications within these hot topics reveals an internal shift in research attention. This suggests that a transformation is occurring at the micro level of scholarly resource distribution. Such concentration on emerging trends aligns with widely observed patterns in the sociology of science and corresponds to the 'Matthew Effect' (Merton, 1968), wherein scientific resources increasingly accumulate within topics that have shown signs of success (Merton, 1968).

Limitations and future research

This study has several limitations. First, the time lag in academic publishing means that we are capturing only the very early stages of GenAI's impact. Second, our analysis relies primarily on quantitative indicators and does not reveal qualitative investigation on how GenAI is used in the scientific research cycle. Future research should: (1) extend the observation window to examine whether the current findings represent short-term fluctuations or long-term trends; (2) employ qualitative methods such as interviews and ethnography to delve deeper into changes in research practices; and (3) incorporate more diverse metrics, such as funding flows and changes in collaboration networks, to more comprehensively depict the transformation brought about by GenAI.

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