

## **THE REINFORCING EFFECTS OF DISTANT FIELD INTEGRATION: INTERDISCIPLINARITY, SOCIETAL VISIBILITY, AND POLICY IMPLICATIONS FOR COMPLEX PROBLEM-SOLVING**

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### **ABSTRACT**

Interdisciplinary research is widely promoted as a mechanism for addressing complex societal challenges, yet the social processes through which it enhances science's broader societal visibility remain insufficiently understood. Drawing on large-scale survey data linked with bibliometric and altmetric indicators, this study examines how two core dimensions of interdisciplinarity—variety (spanning multiple scientific fields) and disparity (integrating cognitively distant fields)—shape the societal visibility of scientific outputs, measured through mentions in news media, blogs, and policy documents. Using publication-level regression models, the analysis reveals positive associations between both dimensions and societal visibility, with a pronounced reinforcing effect when variety and disparity interact. Research that simultaneously spans multiple and distant fields garners substantially greater non-academic attention than research characterized by either dimension alone. This effect is further amplified when researchers collaborate with non-academic actors, underscoring the role of boundary-spanning social relations in translating epistemic novelty beyond academia. Building on sociological perspectives on knowledge production and boundary work, the paper develops policy-oriented recommendations to strengthen interdisciplinary research practices. The findings highlight interdisciplinarity's potential to enhance science–society alignment and offer actionable strategies for fostering innovation in response to grand societal challenges such as climate change, public health crises, and sustainable development.

**Keywords:** interdisciplinarity, cognitive disparity, societal visibility, boundary work, altmetrics, science policy

### **INTRODUCTION**

Complex societal challenges—climate change, public health crises, technological risk, and sustainable development—are increasingly characterized as “wicked problems” that resist resolution within single disciplinary frameworks. In response, interdisciplinary research (IDR) has gained prominence in policy discourse, funding priorities, and institutional reforms. Universities, funding agencies, and governments now routinely advocate interdisciplinarity as a pathway to innovation and societal relevance.

Despite this normative commitment, important empirical and theoretical gaps remain. While existing studies document associations between interdisciplinarity and academic impact, far less is known about how interdisciplinarity translates into societal visibility—that is, the extent to which scientific knowledge gains attention and uptake beyond academia, particularly in media and policy arenas. Moreover, interdisciplinarity is often treated as a monolithic concept, obscuring variation in how different forms of interdisciplinary integration operate.

This paper addresses these gaps by distinguishing between two core dimensions of interdisciplinarity—variety and disparity—and examining their joint effects on societal

visibility. From a sociological perspective, the central argument is that interdisciplinarity enhances visibility not merely through breadth, but through distant recombination that resonates with the multifaceted nature of real-world problems. The paper further explores how boundary-spanning collaborations with non-academic actors condition these effects.

## **LITERATURE REVIEW AND THEORETICAL FRAMEWORK**

Sociological approaches to science emphasize that knowledge production is embedded in social structures, institutional norms, and epistemic cultures (Merton 1973; Knorr-Cetina 1999; Bourdieu 1988). Disciplines function as communities with shared standards of relevance, methodological repertoires, and evaluative criteria (Becher and Trowler 2001; Abbott 2001). Interdisciplinary research, therefore, is not simply a technical combination of methods but a form of boundary work that involves negotiation across epistemic and social divides (Gieryn 1983; Star and Griesemer 1989).

Recent work conceptualizes interdisciplinarity along multiple dimensions. Variety refers to the number of distinct disciplinary domains involved in a research output, while disparity captures the cognitive distance between those domains (Stirling 2007; Rafols and Meyer 2010; Leydesdorff and Rafols 2011). Research spanning physics and sociology, for example, exhibits greater disparity than research combining closely related subfields (Porter et al. 2007). Innovation studies suggest that distant recombination can generate higher novelty, though often at greater coordination cost (Fleming 2001; Jones 2009; Uzzi et al. 2013).

Societal visibility extends beyond academic citations to encompass attention in news media, blogs, and policy documents (Bornmann 2014; Wouters et al. 2019). From a sociological standpoint, such visibility reflects the social construction of relevance: knowledge gains traction when it aligns with the problem frames, vocabularies, and institutional logics of non-academic audiences (Jasanoff 2004; Nowotny et al. 2001). Interdisciplinary research may be particularly well positioned to achieve such alignment by integrating heterogeneous perspectives (Gibbons et al. 1994; Stirling 2007).

Building on theories of boundary work and Mode 2 knowledge production, this study advances the expectation that variety and disparity interact in reinforcing ways (Gieryn 1983; Gibbons et al. 1994; Nowotny et al. 2001). Broad interdisciplinarity provides multiple entry points for societal interpretation, while cognitive distance enhances novelty and relevance for complex problems (Stirling 2007; Uzzi et al. 2013). These effects are likely intensified when researchers engage in collaborations with non-academic actors who act as translators and brokers across institutional boundaries (Callon 1986; Perkmann et al. 2013; Powell 1990).

## **Data and Methods**

The study employs a multi-level quantitative design integrating researcher-level survey data with publication-level bibliometric and altmetric indicators. Publications constitute the primary unit of analysis and are nested within individual researchers.

Researcher characteristics and collaboration practices are drawn from a large-scale international survey of academic staff. Publication records are retrieved from a comprehensive bibliographic database providing field-of-study classifications, citation counts, and metadata. Societal visibility indicators are obtained by linking publications via DOI to altmetric data capturing mentions in news media, blogs, and policy documents. Policy uptake is further validated using a dedicated database of policy document citations.

Survey respondents are matched to their publications using ORCID identifiers where available, supplemented by probabilistic name–affiliation matching. Publications within a

five-year window surrounding the survey year are included to ensure temporal alignment between reported research practices and observed outputs. All data are de-identified prior to analysis.

## Measures

Societal visibility, the dependent variable, is operationalized as a count of non-academic mentions of scientific publications, aggregated across news media, blogs, and policy documents. To assess governance-oriented impact more directly, supplementary models examine policy document citations as a separate outcome. Interdisciplinarity is measured along two dimensions. Variety is captured as the number of distinct scientific fields associated with a publication, reflecting the breadth of disciplinary integration. Disparity is measured using the Rao–Stirling diversity index, which incorporates the cognitive distance between fields based on citation patterns. To test reinforcing effects, an interaction term between standardized measures of variety and disparity is included in all models. All analyses control for key factors known to influence research visibility, including researcher career stage, publication productivity, collaboration size, disciplinary field, publication year, and collaboration with non-academic actors.

## Analytical Strategy

Given the over-dispersed count nature of the dependent variable, negative binomial regression models are estimated. Field fixed effects are included, and standard errors are clustered at the researcher level. Interaction effects are interpreted using predicted values and marginal effects plots.

## Statistical Model Specifications

The expected societal visibility of publication  $i$  by researcher  $j$  is modeled as:

$$\ln(\mu_{ij}) = \beta_0 + \beta_1 \text{Variety}_{ij} + \beta_2 \text{Disparity}_{ij} + \beta_3 (\text{Variety}_{ij} \times \text{Disparity}_{ij}) + \mathbf{X}_{ij}\boldsymbol{\gamma} + \delta_f$$

Additional models introduce moderation by non-academic collaboration and estimate policy uptake using logistic regression.

## Results

Both variety and disparity are positively associated with societal visibility. Publications spanning a greater number of fields and those integrating cognitively distant domains receive significantly more non-academic attention.

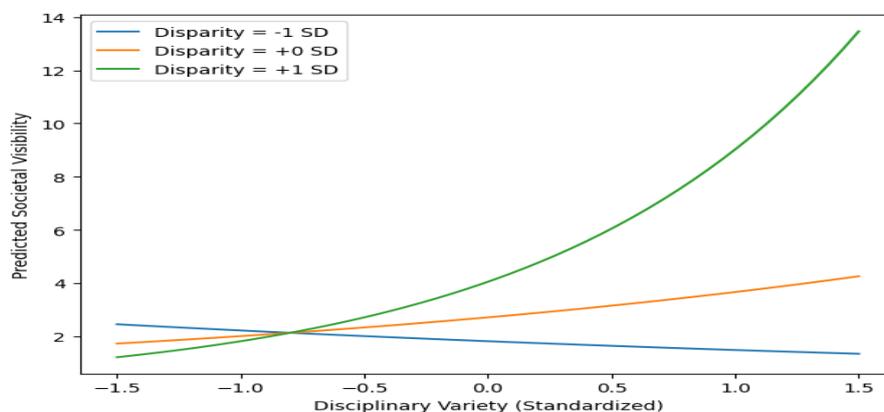


Figure 1 presents model-based predicted societal visibility across levels of disciplinary variety, stratified by cognitive disparity. The diverging slopes illustrate reinforcing effects between epistemic breadth and distance.

### Reinforcing Effects

The interaction between variety and disparity is positive and statistically significant. As illustrated in **Figure 1**, increases in variety yield modest visibility gains at low levels of disparity, but substantially larger gains when disparity is high. This indicates that breadth is most effective when combined with cognitive distance.

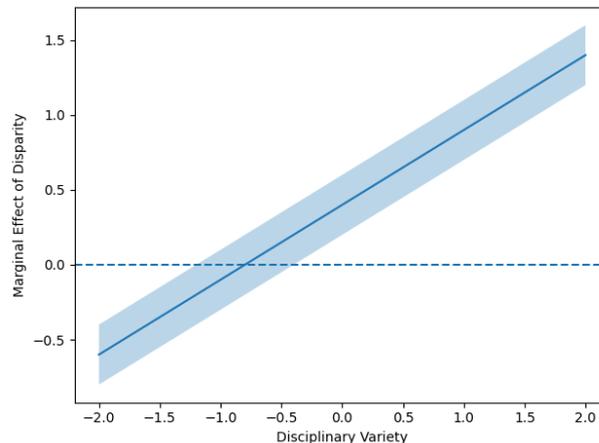
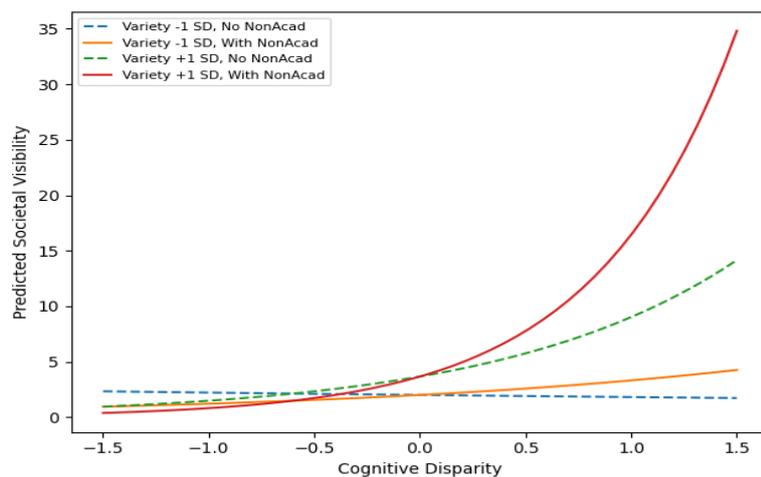


Figure 2 displays marginal effects of cognitive disparity across levels of disciplinary variety. Confidence intervals indicate that disparity significantly increases societal visibility only beyond moderate levels of variety.

### Marginal Effects and Thresholds

Marginal effects plots (**Figure 2**) reveal that the effect of disparity becomes statistically significant only beyond moderate levels of variety, suggesting threshold-dependent reinforcement rather than simple additive



ty.

### Moderation by Non-Academic Collaboration

Figure 3 illustrates moderation by non-academic collaboration. Distant interdisciplinarity yields substantially higher societal visibility when combined with cross-sectoral partnerships.

The reinforcing effects are stronger among researchers collaborating with non-academic actors. As shown in **Figure 3**, distant interdisciplinarity yields limited visibility gains in purely academic contexts but is strongly amplified when boundary-spanning collaborations are present.

## DISCUSSION

The findings demonstrate that interdisciplinarity enhances societal visibility through reinforcing configurations that combine epistemic breadth with cognitive distance. From a sociological perspective, such configurations produce knowledge that mirrors the complexity of societal problems, increasing interpretive novelty and legitimacy across non-academic arenas. Boundary-spanning collaborations further facilitate translation and uptake.

At the same time, the results highlight trade-offs: distant interdisciplinarity may involve higher coordination costs and lower traditional productivity. However, gains in societal visibility and policy relevance suggest that such trade-offs may be offset in impact-oriented evaluation regimes.

## Policy Recommendations

From a policy perspective, the findings point to several interrelated interventions to strengthen the societal relevance of interdisciplinary research. Funding design should move beyond rewarding disciplinary breadth alone and instead prioritize projects that integrate cognitively distant fields, where the potential for novelty and societal resonance is greatest. Research evaluation frameworks should be expanded to incorporate indicators of societal visibility alongside traditional citation-based measures, thereby recognizing contributions that extend beyond academic impact. At the institutional level, universities and research organizations should support interdisciplinary centers, joint appointments, and structured training in boundary-spanning competencies that facilitate effective collaboration across epistemic domains. In parallel, cross-sectoral incentives should be strengthened to encourage collaborations with non-academic actors—such as policymakers, industry partners, and civil society organizations—which play a critical role in translating research into socially meaningful outcomes. Finally, targeted risk-mitigation measures are needed to offset productivity penalties often associated with distant interdisciplinarity, ensuring that researchers are not disadvantaged for pursuing high-risk, high-impact integrative work.

## CONCLUSION

This study advances a sociological understanding of interdisciplinarity by demonstrating that societal visibility is maximized when disciplinary variety and cognitive disparity reinforce one another, particularly in the presence of boundary-spanning collaborations. By linking epistemic configurations to social outcomes, the paper contributes to debates on science–society relations and offers actionable guidance for policymakers seeking to harness interdisciplinary research for complex problem-solving.

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