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Rethinking scientific progress in the social sciences: disruptive or cumulative?

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ABSTRACT

This paper offers a critical reassessment of claims that scientific progress is best understood through the disruptiveness of new research. Park, Leahey and Funk in *Nature* (2023) have re-opened the debate by presenting results using the citation-based 'CD index' to assess the extent to which individual academic publications are consolidating or disruptive. Analyzing Park et al. as a focal point of these claims, we challenge the adequacy of this approach to capture both genuine scientific disruption and scientific progress, particularly within the social sciences. Drawing on philosophy and sociology of science, we show that scientific progress is predominantly cumulative rather than disruptive, and that papers' high disruptiveness scores may often reflect phenomena such as pseudo-novelty or fragmentation rather than true epistemic breakthroughs. Our analysis demonstrates that in fields marked by intellectual pluralism and weak paradigmatic consensus, apparent disruptiveness may be an artifact of scholarly practices rather than an indication of substantive innovation. Hence, measures of disruptiveness appear ill-suited as a marker of scientific progress – as used in individual and collective research evaluations. Instead, we advance a constructive agenda by proposing that scientific progress is best conceptualized not as a dichotomy between cumulation and disruptiveness, but as a multi-dimensional process embracing elements of both disruption and consolidation within an overarching cumulative trajectory, whereby established knowledge is iteratively refined, rejected, or recombined in the light of new evidence or insight. By rethinking how scientific advancement is measured and cultivated, and suggesting ways to foster cumulative scientific progress, this article contributes to the theory and practice of research evaluation.

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1. Introduction

Why study scientific progress? Science has had a monumental influence on contemporary societies (Hallonsten, 2021), for better (Laudan, 1978) or worse (Sassower, 2021). Modern societies are knowledge societies, and science is widely recognized as "the premier knowledge institution worldwide" (Knorr-Cetina, 1999: 1). Today and in the future, scientific progress is indispensable in tackling the unprecedented challenges of global unsustainability. Alongside natural sciences and technology, social sciences will be essential in providing evidence, for example, to inform the governance of transformations to sustainability (Creutzig et al., 2022; Martin-Ortega, 2023). Through advancing understanding of natural and social phenomena and various means of cross-fertilization among scientific fields, scientific progress will ultimately benefit society, irrespective of intentions of any immediate 'use' (Stokes, 1997; Hallonsten, 2021).

Philosophers and sociologists of science generally assume progress in scientific fields to be of a cumulative nature: as empirical knowledge cumulates, and scientific concepts and theories are refined over time, they allow for better and more general explanations and facilitate new discoveries (Bird, 2007; Niiniluoto, 2024). Debates have been revolving around whether research in a field also cumulates across major shifts of scientific paradigms or competing research programs; whether progress occurs through the cumulation of knowledge, understanding or truthlikeness; and whether progress occurs at all (in some scientific fields) (Shan, 2023b).

Largely unnoticed by philosophy and sociology of science, the notion of 'disruptiveness' of individual publications has recently been introduced as a measure of scientific progress (Funk and Owen-Smith, 2017; Wu et al., 2019; Park et al., 2023; Leahey et al., 2023). Based on quantitative citation patterns, this literature defines 'disruptiveness' as the extent to which papers destabilize (disrupt) existing knowledge, thereby rendering it 'obsolete'. One spectacular conclusion of this work is that scientific progress appears to be slowing across a broad range of disciplines (Park et al., 2023), which has sparked considerable public debate (Bornmann et al., 2024). So far, these works have resonated mainly in scientometrics as well as in medical and technical areas of science. However, they give rise to questions about the nature, measurement, and future trajectory of scientific advancements in general that reach far beyond technical testing of quantitative measures of disruptiveness. Their focus on disruptiveness as a measure of scientific progress is both remarkable and daring, given that – as elaborated below – scientific progress is predominantly viewed as cumulative.

From these works, three major questions arise that we will address in this article: First, does the scientometric definition of 'disruptiveness', which forms the basis for the empirical findings cited above, actually capture scientific advances that render existing knowledge obsolete? We hypothesize that several types of papers, notably from the social sciences, may distort such measurements. Second, beyond issues of measurement, how does the notion of disruptive publications inform our understanding of scientific progress? Contrary to recent works on disruptiveness that have mostly resonated within life sciences and technology, we will focus in particular on the implications for the social sciences. Third, how can notions of 'cumulation' and 'disruptiveness' be conceptualized and applied in a more meaningful way? Our starting assumption is that the answers to these questions may have implications in the social sciences that differ from those in other fields of research with less epistemological diversity and less fluid research objects. Hence, the aim of this paper is fourfold: (1) To critique the usefulness of the CD index to appropriately identify genuine disruption; (2) to interrogate the epistemological assumptions behind using disruptiveness as a proxy for scientific progress; (3) to develop an understanding of scientific progress that positions disruption as an integral component of a broader cumulative trajectory; (4) to indicate ways that cumulative scientific progress in the social sciences can be facilitated.

In Section 2, we briefly review how philosophy and sociology of science, and also individual fields of science, conceive of scientific progress and its predominantly cumulative nature. In Section 3, we introduce the recently developed measure of disruptiveness and the emerging discussion around it. In Section 4, we discuss and critique the disruptiveness index by presenting types of academic papers – focusing on the social sciences – that are likely to be assessed as technically 'disruptive' even though they are not disruptive in a substantive sense. In Section 5, again drawing on the social sciences, we examine how disruption, cumulation and falsification relate to one another. In Section 6, we develop a multi-dimensional notion of scientific progress in which both cumulation and disruption have their place. In Section 7, we propose ideas for strengthening the cumulation of social science knowledge. Section 8 concludes by discussing the broader issues of the role of disruptiveness for defining and assessing scientific progress and presenting thoughts on moving forward with the discussion on disruptiveness and knowledge cumulation, regarding both research practice and research policy.

2. Reviewing scientific progress and its relation to cumulation and disruptiveness

In order to be able to discuss the role of disruptiveness for scientific progress, let us first briefly review how scientific progress has been conceived in the scholarly literature.

Traditionally, scientific progress has been viewed as cumulative, reflecting the spirit expressed in Isaac Newton's famous 17th-century proverb: "If I have seen further, it is by standing on the shoulders of giants." This perspective aligns with Francis Bacon's emphasis on empirical cumulation and John Locke's view of knowledge as expanding progressively through observation and reason. George Sarton (1936) famously argued that science is the only truly cumulative intellectual endeavor. He maintained that scientific progress is both continuous and cumulative: Even if individual theories or discoveries are later modified, they still contribute to an ever-growing body of knowledge, with each new discovery building upon previous ones.

One of the earliest modern challenges to purely cumulative models of scientific progress was Karl Popper's falsificationism (Popper, 1959 [1934]), arguing that science advances through the elimination of falsified hypotheses rather than their mere accumulation. Fundamentally challenging views of continuous and cumulative progress, Thomas Kuhn (1962) introduced the concept of paradigm shifts, arguing that scientific progress – while cumulative in periods of 'normal' science – also occurs through scientific revolutions. Largely based on observations of early modern physics and astronomy, he conceived of science to operate within paradigms – frameworks of assumptions, methods, and practices shared in a scientific field. Normal science progresses incrementally within a paradigm until the dominant paradigm is unable to explain major developments or new events, leading to a crisis. When a new paradigm emerges in a field (once in decades or even centuries), the previous one is often rendered obsolete (even though Kuhn acknowledges that new paradigms often retain significant elements of the previous dominant paradigm). This model suggests that scientific progress is episodic and discontinuous, with major disruptions occurring at the level of entire scientific fields.

Kuhn's ideas, while still influential in the philosophy of science, faced criticisms on several levels. One criticism is that his notion of a single dominant paradigm at any given time oversimplifies the reality of scientific practice, where multiple paradigms often coexist and compete within different subfields (Toulmin, 1970; Laudan, 1978). Another challenge to Kuhn's model is that it suggests that new paradigms render existing theories entirely obsolete, overlooking the ways in which older theories can persist in modified forms or continue to provide useful explanations within certain domains (Lakatos, 1970a, 1970b; Hacking, 1981). His concept of incommensurability, which implies that paradigms are so fundamentally different that they cannot be compared or translated into each other's terms, has been criticized as overly rigid, as

scientific transitions often involve significant continuity in methods and language (Shapere, 1984). Relatedly, the idea of discontinuity in scientific progress has also been challenged, with scholars arguing that even paradigm shifts retain and refine prior knowledge rather than completely overthrowing it (Toulmin, 1970; Doppelt, 1978). Finally, Kuhn's emphasis on paradigm shifts has been accused of leading to relativism, as it suggests that scientific truth is contingent on the prevailing paradigm (Doppelt, 1978). A fortiori, the yet more relativist position of Feyerabend (1975)[1] has largely been rejected or tempered by more nuanced perspectives (Hacking, 1981; Laudan, 1978) – even though some of his ideas have been absorbed into contemporary discussions on the plurality of scientific methods (Jasanoff, 2012).

In the light of these developments, recent discussions have slightly shifted away from the *dynamics* of scientific progress, emphasizing the question of what *constitutes* progress. The epistemic approach, rooted in Francis Bacon's empirical cumulation and John Locke's expansion of knowledge through observation, sees progress as the steady accumulation of justified true beliefs, even when theories change (Bird, 2007, 2023). Inspired by Karl Popper, the semantic approach argues that progress lies in increasing truthlikeness (verisimilitude), with science producing theories that approximate reality more closely over time, even if they remain imperfect (Rowbottom, 2010; Niiniluoto, 2023). Moving away from truth and knowledge as benchmarks, Dellsén's (2023) noetic approach, influenced by Wilfrid Sellars and Catherine Elgin, identifies progress as changes in publicly available scientific information that enable relevant members of society to increase their understanding of relevant phenomena. Similarly, Shan's (2023a) functional approach, drawing on Larry Laudan and Thomas Kuhn, shifts focus from theoretical correctness to the usefulness of scientific practices, arguing that progress occurs when methodologies, tools, or investigative frameworks enhance problem-solving across domains. Many of these ideas are reflected in the pragmatist school of thought developed by Peirce and Dewey, which highlights the tentative nature of truth as well as the practical use of theory (Johnson and Onwuegbuzie, 2004).

Although there are varying understandings of what exactly constitutes scientific progress in the first place, the accounts on scientific progress in a range of different disciplines mostly suggest an overall cumulative as opposed to disruptive nature of progress, such as in chemistry (Hendry, 2023; Needham, 2023), economics (Walliser, 2009; Angrist and Pischke, 2010; Boumans and Herfeld, 2023), seismology (Miyake, 2023), psychology (Feest, 2023), or medicine (Cook, 2023). For physics, Darrigol (2023) identified both cumulative and disruptive progress, where older theories are often transformed, refined or embedded in newer frameworks. Some major paradigm shifts (e.g. quantum mechanics) represent genuine Kuhnian theoretical revolutions, but even these maintain some continuity with past knowledge. Similarly, Jablonka (2023) observes a generally cumulative progress in biology, while some developments could be regarded as partial ruptures, e.g. the recent advances in epigenetic inheritance shifting away from the gene-centered view of inheritance. For the social sciences, matters appear more complicated. While the question of whether scientific progress occurs at all in different fields of social sciences has been a persistent topic of debate (Turner, 2023), observers assume a generally non-disruptive development, as evidenced by a continuous engagement with the disciplines' early foundational works (Burawoy, 2021). In fact, specifics of social science research warrant further inspection of disruption and cumulation, which we will elaborate in Section 5.

These considerations suggest that scientific progress is generally cumulative, with rare occasional disruptions that render previous knowledge obsolete, such as the Copernican Revolution, which shifted astronomy from a geocentric to a heliocentric model. However, most major scientific shifts tend to preserve prior knowledge (Zucker et al., 2007: 851), as exemplified by relativistic mechanics, where Newtonian mechanics remains valid as a special case (Niiniluoto, 2023). In fact, a recent analysis of 761 major scientific breakthroughs (Nobel prize and awards of similar reputation) finds that virtually all developed in a cumulative as opposed to disruptive manner, supporting the view of the generally cumulative nature of scientific progress (Krauss, 2024). Similarly, Wuestman et al. (2020), studying 335 breakthrough scientific articles, found the vast majority of breakthroughs to be characterized as "normal science" in the sense of Kuhn and not as paradigm-shifting discoveries.

In summary, while scientific progress is predominantly cumulative, building upon prior discoveries and retaining useful elements of past theories, it can in rare cases involve episodic disruptions that lead to paradigm shifts, fundamentally altering scientific frameworks. These shifts, however, rarely result in a complete rejection of previous knowledge; instead, they often incorporate, modify, or recontextualize older theories within a broader or more accurate explanatory framework.

3. PLF's model of disruptiveness (CD index) as a measure of scientific progress

Researchers from the quantitative 'science of science' – which integrates scientometrics with the economics and sociology of science (Fortunato et al., 2018) – have proposed to study the disruptiveness of individual publications as a measure of scientific progress (Funk and Owen-Smith, 2017; Wu et al., 2019; Park et al., 2023; Leahey et al., 2023). Below, we will refer to the main paper by Park et al. (2023) as PLF. In this thought-provoking contribution, the authors argue that disruptive papers "break with the past" and "disrupt existing knowledge, rendering it obsolete, and propelling science and technology in new directions" (PLF: 138–9). The core methodological proposition – the 'CD index' – is applied to individual publications, where C stands for 'consolidating' and D for 'destabilizing' (Funk and Owen-Smith, 2017) or, in the more recent article (PLF), for 'disruptive'. Based on citation patterns (to be explained below in detail), every publication studied can be attached a CD value between −1 (fully consolidating) and +1 (fully disruptive), with 0 being neither consolidating nor disruptive. While PLF do not deny the value of papers that consolidate the status quo for improving existing streams of knowledge, they clearly associate scientific progress with disruptiveness ("major advances").[2] From their finding that disruptiveness has historically been declining in all areas of sciences, they conclude that progress is slowing.

Park et al. (2023) (PLF) base their method on previous studies of technology change (Funk and Owen-Smith, 2017), especially patents, and, following Wu et al. (2019: 93), apply it to publications in major fields of science more generally. Their "intuition is that citations of predecessors should decrease after a destabilizing [i.e., disruptive] invention is introduced because the technology entails a break with past ways of thinking. By contrast, consolidating inventions should be cited together with their predecessors and therefore increase citations of technologies on which they build". In other words, and transferred to academic publications, PLF assume – and define –

[1] Paul Feyerabend argued that science has no reliable or consistent rules for progress, and that in practice, "anything goes" – meaning that even irrational or contradictory methods can play a valid role in scientific advancement.

[2] So far underappreciated by the literature on the CD index is its potential function to identify truly novel ideas that can easily be overlooked in a vast and growing sea of publications. Because the CD index is independent of citation counts, it could help identify overlooked research with transformative promise. History suggests such work continues to exist – despite broader access. The development of mRNA technology, for instance, was long marginalized before gaining recognition during the COVID-19 pandemic, ultimately earning Katalin Karikó a Nobel Prize.

- a *disruptive* focal paper as one where subsequent papers (i.e., those citing the focal paper) cite few, if any, of the references originally cited in the focal paper;
- a *consolidating* focal paper as one where subsequent papers cite many or all of the references from the focal paper.

The CD index quantifies this effect: The fewer references from the focal paper are cited by subsequent papers, the closer the focal paper's CD index approaches 1 (indicating disruption). The more references from the focal paper are cited by subsequent papers, the closer the focal paper's CD index approaches −1 (indicating consolidation). PLF track citations for up to five years after the focal paper's publication (CD_5), though the method can be adapted to different time spans (CD_t). In addition to the CD index, PLF measure disruptiveness (or consolidation) of papers through linguistic metrics, measuring the diversity of language (based on the share of unique words of total words in paper titles) and through the novelty of word combinations (that have not previously been used in paper titles).

It is not our main interest to discuss the empirical *findings* of PLF, namely the declining disruptiveness of papers in major scientific areas over decades of time. However, it is interesting how the social sciences compare against other major research areas. Using both the CD index and the two linguistic measures, PLF find papers across four major scientific fields – life sciences and biomedicine, physical sciences, social sciences, and technology, according to Web of Science research areas – to decline in their disruptiveness from 1945 to 2010. Average CD values decline from 0.20 (life sciences) to 0.00, and from 0.54 (social sciences) to 0.04, with social sciences constantly showing the highest average values and life sciences and physical sciences ranging at the lower end of disruptiveness, as measured by the CD index.

Similarly, for linguistic disruptiveness, PLF find a continuous decrease over time. For share of unique words, social science papers declined from 0.22 in 1945 to 0.05 in 2010.[3] Since the late 1960s, social sciences have continuously scored relatively highest among all four fields, while they had medium scores before then. For novel word combinations in the title, social science papers decline from 0.50 in 1945 to 0.35 in 2010.[4] Here, the pattern for social sciences is less clear, but while scoring lowest in 1945, they scored highest in the last few years analyzed, suggesting an increase in 'disruptiveness'.

The CD index (and related variants) has been applied and been subject to methodological testing and critique in a number of studies. Leibel and Bornmann (2024) provide a systematic literature review on methodological issues, variants of the index, and their validity. *First*, general flaws of citation-based measures concern the coverage of publications in major databases and different citation practices across scientific fields and time. Different citation practices and availability of publications in the early periods of PLF's study have been suggested to account for the high CD values of publications before the advent of electronic databases (Leibel and Bornmann, 2024: 2018–19). For example, social science papers often cite books not covered in citation databases (such as Web of Science) and hence are likely to receive an artificially inflated CD index because subsequent papers' references to these books are not recognized as such. *Second*, the CD index of a focal paper is sensitive to the number of cited references and their number of citations (Leibel and Bornmann, 2024: 617–8): Focal papers that cite only few and little-cited references bear higher chances that subsequent papers cite only the focal paper but not its references (and hence receive high disruptiveness scores). On the other hand, papers with long reference lists including highly-cited references are more likely to receive lower disruptiveness scores. Petersen et al. (2024) find that the historical increase in length of reference lists explains the decline in disruptiveness observed by PLF – rendering this observation a mere artifact.[5] *Third*, the fact that papers citing the focal paper's references *but not the focal paper itself* are included in the CD index tends to draw the index closer to 0. Alternative indices are proposed that exclude such citing papers. *Fourth*, a number of studies have sought to validate the CD index. Several of the reviewed studies associate low CD values with 'normal science' in Kuhn's framework, and high CD values with drastic breakthroughs or even paradigm shifts (Leibel and Bornmann, 2024: 606). However, the results of the reviewed studies are inconclusive on whether Nobel-prize winning publications receive higher or lower CD values (Leibel and Bornmann, 2024: 622).

More fundamentally, Leibel and Bornmann (2024) also criticize that the concept of disruption – at present "loosely associated with the idea of scientific breakthrough or paradigm shift" (634) – still lacks a precise definition, which would be needed "before the indices can be used in the research evaluation practice" (601). Specifically, they raise the issue that the CD index is constructed as a zero-sum game between disruption and consolidation, arguing that much speaks in favor of disentangling both concepts, as papers could be both disruptive and consolidating (and not only either) (Leibel and Bornmann, 2024: 604–5, 611).

4. Why the CD index may not actually measure disruption

In the following, we argue that the way the CD index is designed will often not capture 'disruptiveness' in the sense of papers that "disrupt existing knowledge, rendering it obsolete, and propelling science and technology in new directions" (PLF). We distinguish four types of papers whose citation pattern – so we hypothesize – erroneously produce high CD values, i.e. high degrees of disruptiveness, especially considering papers from the social sciences. Table 1 summarizes these four types of papers that may lead to an overestimation of disruptiveness values.

4.1. Pseudo-novelty

We hypothesize that a key reason for a paper's CD index to score high is what might be broadly labeled 'pseudo-novelty'. In several scientific domains – notably within the social sciences – there exists a strong desire for novelty, even when such novelty lacks genuine originality, utility or truthlikeness (Sovacool et al., 2018). Scholars have long critiqued the tendency to relabel existing phenomena with new terminology – "old wine in new bottles" – without substantive innovation (e.g. Spell, 2001).

Moreover, observers have found social science research to follow epistemic fashions and attention cycles (Sunstein, 2001; Bentley et al., 2023). Theories and concepts are often replaced by seemingly new ones, not because the old ones were falsified or exhausted, but due to intellectual trend shifts. As a result, purportedly 'novel' concepts may lack greater explanatory power or usefulness compared to their predecessors (Gans, 1992; Gerring et al., 2020; Mancilla García and Bodin, 2025).

This appetite for (ostensible) novelty is also reflected in the academic language of titles and abstracts. For instance, our recent Scopus search[6] reveals over 4900 papers containing the phrase "fresh look" in title, abstract or keywords, 27% of which within the social sciences and 21% in arts & humanities (for comparison, Scopus contains only 8% social science papers and 4% arts & humanities).

Papers like these – driven by symbolic novelty rather than substantive innovation – are unlikely to be truly disruptive in the PLF sense. Nonetheless, they may appear disruptive under the CD index. This is because subsequent papers are likely to cite the ostensibly 'new' framing introduced by the focal paper while omitting references to the older

[3] Life sciences and biomedicine declined from 0.18 to 0.04; physical sciences from 0.30 to 0.05; technology from 0.34 to 0.04.

[4] Life sciences and biomedicine declined from 0.59 to 0.31; physical sciences from 0.67 to 0.34; technology from 0.82 to 0.33.

[5] Similarly, Macher et al. (2024) find that the explicit omission of references to older patents in PLF's dataset explains the largest share of the apparent decline in patents' disruptiveness.

[6] Own search performed on 26 March 2025.

Table 1
Overview of hypothesized mechanisms/paper types that are likely to yield inflated values of disruptiveness as measured through the CD index (CDI).

Hypothesis/ type of paper	Definition	Examples	Supporting evidence and avenues
Pseudo-novelty	"Relabeling existing phenomena with new terminology"	Epistemic fashions, attention cycles without substantive innovation	Bornmann et al. (2020) show a direct measure of novelty is little correlated with CDI and that CDI is negatively correlated with criteria such as original hypothesis, new finding, and novel drug target. Sample: papers from biological and medical research. Possible test: regressing CDI on papers including "fresh look" alike words
Symbolic citation	"Rhetorical rather than substantive citation"	Blockbuster papers and canonical papers, signal of affiliation	Balietti et al. (2025) shows social interactions and peer disagreement explain field fragmentation around "church" papers, and that this fragmentation critically limits scientific progress. Possible test: Qualitative text analysis (e.g. following Erikson and Erlandson, 2014)
Citation gap	References omission	Ignorance of others disciplinary contributions, predatory journal approach of self-citations	Holst et al. (2024) found that papers with no reference are less frequent over time, which contributes to explaining the decline in disruptive metrics. It stresses the importance of cumulation as a driver of scientific progress, and that citation gaps exist.
Purely cumulative papers	Synthesis of previous work	Meta-analysis, synthesis review	Possible test: Comparing CDI of articles with systematic reviews and meta-analyses to average CDI.

literature it has relabeled. A similar issue arises with PLF's linguistic change metric, which may misinterpret stylistic novelty or terminological shifts as indicators of conceptual innovation.

4.2. Blockbuster papers and canonical authors

A second reason why the CD index may fail to capture true disruptiveness lies in its vulnerability to blockbuster papers and trendy citations, which may reflect symbolic capital rather than substantive innovation. Such papers – whether genuinely foundational or simply fashionable – often attain canonical status within a field. Once entrenched, they are cited not necessarily for their content but as a form of disciplinary ritual or identity work – in short, more for rhetorical than substantive reasons (Erikson and Erlandson, 2014; Teplitskiy et al., 2022; Bornmann et al., 2024). This can occur even when a paper was initially disruptive in the PLF sense; over time, its citations may become increasingly trivial or performative, serving purposes such as name-dropping, delimitation, or boundary-marking rather than substantive engagement (Teplitskiy et al., 2022).

Erikson and Erlandson (2014: 630) describe such practices as "passive support" – a mere "acknowledgment that certain scientists are important and worth pointing out." Canonical authors are regularly invoked as part of a scientific tradition, regardless of whether their work is directly relevant to the citing text. In such cases, references function more as signals of affiliation or "respectability" than carriers of knowledge. Gilbert (1977), cited in Erikson and Erlandson (2014: 631), argues that respected papers may be cited "to shine in their reflected glory," a phenomenon that supports an author's self-image but says little about the intellectual dependence of their work on the cited material.

The CD index, however, is not equipped to distinguish between citations of symbolic allegiance and those of substantive disruption. As a result, highly cited papers – especially those regarded as touchstones within a field – may be wrongly identified as disruptive, when, in reality, their role is more ceremonial than substantial.

4.3. Citation gaps

A third type of paper that the CD index may falsely capture as 'disruptive' arises from its inability to account for citation omissions, including – but not limited to – those stemming from sloppy or selective citation practices. In many fields, researchers have noted a growing tendency to cite incompletely, strategically, or carelessly, omitting relevant prior work (Horbach et al., 2022). Ironically, such omissions can make a paper appear more disruptive in the PLF sense, as subsequent citations may bypass older foundational literature and instead anchor themselves in the focal paper, falsely amplifying its perceived novelty.

This dynamic creates a citation vacuum, in which papers that sidestep or ignore earlier, relevant contributions seem to initiate a fresh line of inquiry – even when their ideas are neither unprecedented nor conceptually independent. By failing to engage with the existing literature, these papers break citation continuity required to follow-up scientific progress (Horbach et al., 2022), giving the impression of having displaced prior work. Yet this displacement may not reflect genuine intellectual rupture but rather a flaw in scholarly diligence. As a result, such papers may score highly on disruption metrics not because they overturn previous knowledge, but because they fail to acknowledge it.

The CD index, relying solely on citation structures, lacks the granularity to differentiate between intentional innovation and accidental neglect. In fields where citation norms are inconsistent or where authors increasingly cite only a narrow subset of accessible or well-known works, the risk of false positives for disruptiveness increases. True disruptiveness, however, should rest on intellectual confrontation with the status quo – not merely its absence in the reference list.

4.4. Purely cumulative papers

Finally, the CD index labels papers as 'disruptive' that are in fact prime examples of cumulative research. As Gerring (2020) suggests, in an idealized model of cumulative science, new publications build upon – and ideally synthesize – all relevant prior work on the topic at hand, making it efficient for subsequent authors to cite only the most recent contribution.[7] This practice – ideally embodied in systematic reviews or meta-analyses whose very function it is to synthesize existing research – could yield citation patterns indistinguishable from those PLF associate with disruptiveness: Older sources receive fewer citations while the focal paper is preferentially cited. However, in such a case, this obsolescence is not due to theoretical rupture but due to methodological

[7] Even though the 2012 San Francisco Declaration on research assessment recommends otherwise.

refinement or conceptual extension – hallmarks of cumulative and typically also consolidating science. In this light, papers that enhance or update existing knowledge may be misclassified as "disruptive" merely because they have rendered prior work less citable, when in fact they exemplify scholarly continuity. While Wu et al. (2019) report "review articles" to be more consolidating than original research, their analysis actually focuses narrowly on journals with "annual" and "review" in their titles, thus ignoring the widespread prevalence of meta-analyses and systematic reviews in regular journals.

4.5. Interim conclusion

To sum up, there are numerous situations in which we hypothesize that PLF's CD index assigns high disruptiveness scores to papers that do not genuinely embody disruptiveness as it is conceptually intended. While each of such cases may apply to a subset of papers, these may add up to a relevant share of papers with artificially inflated CD values. Below, we will argue that this issue is particularly pertinent in the social sciences – perhaps more so than in other scientific domains – where such paper types are more likely to occur. Consequently, it is not unexpected that the social sciences consistently register the highest levels of disruptiveness compared to all other fields of science.

5. Implications for progress in the social sciences

5.1. Why disruption per se does not indicate progress in the social sciences

From the above considerations, we can note that the social sciences in particular are prone to various issues of pseudo-disruption, in which citation patterns seemingly reflect some degree of "breaking with the past" instead of a more continuous flow of knowledge. As we will elaborate below, such appearances of discontinuity are, for many fields of social science research, less likely to indicate genuine disruptions of established research but more likely due to an overall fragmented, heterogeneous and individualistic research practice.

Many fields of social science are regularly witnessing so-called 'turns', in which new perspectives are introduced, gaining substantial traction within the field, such as linguistic or cultural turns in sociology (Campbell, 2019) or the argumentative turn in policy analysis (Fischer and Forester, 1993). These shifts, however, are not typically disruptive in the sense of rendering prior knowledge obsolete. While proponents of such turns may critique earlier research and highlight its limitations – sometimes even dismissing aspects of it as outdated – their primary contribution is often to open up new avenues of inquiry. For example, the argumentative turn redirects attention from questions of policy effectiveness to issues such as which voices are excluded from policy debates. Moreover, full disruptiveness would imply that basically all scholars in a field buy into the respective turn, so that the line of past research is largely discontinued. However, we do not observe this. While proponents of these turns may sometimes critically distance themselves from the past, these turns rarely encompass the entire field. After all, some scholars continue the "disrupted" line of research, thereby ignoring or actively opposing the turn. Many of these turns originate in developments outside the respective discipline, such as philosophy or linguistics, reflect societal developments outside academia, or emerge from simple novelty (Campbell, 2019). None of these trends obliterate previous achievements to a degree that they could be interpreted as Kuhnian paradigm shifts (Campbell, 2019). However, they do – in the words of PLF – propel science to new directions. This occurs either through replacing earlier trends in the sense of academic fashions (Gans, 1992; Sunstein, 2001; Gerring et al., 2020), or novel streams of research develop in parallel that neither replace one another (sensu Kuhn) nor compete with each other (sensu Laudan). Abbott (2006: 61) concludes that "sociology is littered with research programs that are exciting for a couple of decades, then peter out into routinism and time-serving." Bills (2013) points to the downsides of such "pluralism" or "multiple paradigmaticity", namely to hinder "the cumulative possibilities of theoretical and empirical work, and causes uncertainty over what kinds of research questions are even worth asking" (ibid., 271).

More generally, and perhaps apart from economics, research in many areas of the social sciences has been characterized as what Whitley (2006) had aptly termed 'fragmented adhocracy'. Referring to social sciences such as sociology, political science, and management studies, "fragmented adhocracies" denote fields in which "research is rather personal, idiosyncratic, and only weakly coordinated across research sites", where "scientists do not have to produce specific contributions which fit into those of others in a clear and relatively unambiguous manner. Rather, they tend to make relatively diffuse contributions to broad and fluid goals which are highly contingent upon local exigencies and environmental pressures" (Newig and Rose, 2025: 159). In fact, fragmentation of scientific disciplines has been found to "critically limit scientific progress" (Balietti et al., 2025).

One important driver of such fragmentation lies in the institutional and incentive structures of academic research. As Watts (2017) observes, social scientists are often rewarded for publishing in peer-reviewed journals and conference proceedings that prioritize novelty, counterintuitive findings, or otherwise "interesting" results over cumulative, incremental contributions. This incentive structure – potentially aggravated by the increasing marketization of academic research (Bauwens et al., 2023) – discourages the kind of coordinated programmatic research necessary for building a coherent body of knowledge. Instead, it encourages intellectual individualism and the constant pursuit of new angles or framings, often at the expense of engaging with existing work in a sustained manner. In such a context, as Watts puts it, "facts and theories pile up in an incoherent heap" (ibid., 2), reinforcing the tendency toward fragmentation rather than integration.

A related critique comes from J. H. Turner (1991), who identifies postmodernist tendencies in sociology – such as relativism, solipsism, and nihilism – as challenges to theory building and the pursuit of universality. These tendencies, he argues, are structurally supported by the proliferation of subfields, allowing researchers to "do their own thing" without engagement with shared disciplinary frameworks. In such a context, each study often investigates "a unique problem with a unique set of variables" (Davis, 1994: 179–80), posing severe obstacles to scientific progress.

The critique that the social sciences are insufficiently progressive is not new, but it remains pressing. Scholars such as Turner (2023) and Bouvier (2009) have argued that the lack of intellectual integration and sustained theoretical development hampers sociology's ability to evolve in a structured and cumulative way. Similarly, Newig and Rose (2020, 2025) observe for the field of environmental governance a lack of coherent research programs as a key obstacle to synthesis, cumulation, and ultimately impact.

Taken together, these observations suggest that genuine scientific disruption – understood as a radical break from an established body of knowledge – is unlikely in much of the social sciences. For disruption to occur in the Kuhnian sense, there must first be a paradigm to disrupt: a shared consensus, a coherent research tradition, and a history of cumulative development. Where these are absent, what appears to be disruption is often better understood as pseudo-disruption – shifts that reflect intellectual fragmentation, academic fashion, or external influences, rather than fundamental theoretical breakthroughs.

5.2. Falsification as a mode of genuine disruption?

While cumulative knowledge-building remains a foundational ideal in the social sciences, it is important to recognize that scientific progress is not solely driven by linear cumulation. As Popper (1959 [1934]) and later Lakatos (1970a) argued, falsification, where theories are rigorously tested to prove them wrong, is a critical mechanism through which theories are systematically challenged resulting in their improved robustness, modification or invalidation.

In the social sciences, however, falsification has proven to be a double-edged sword. On the one hand, the openness, dynamics, and variability of social phenomena make bold theories inherently vulnerable to refutation – especially since these are not governed by fixed natural laws.[8] On the other hand, the very absence of such laws makes strong falsifiability difficult to establish. Many frameworks remain intact not because they are repeatedly confirmed or successfully tested, but because they are not subjected to systematic challenges at all. This situation is exacerbated by a scientific culture that often favors novelty over scrutiny, where null results are harder to publish, and, as reviewed above, by fragmentation – a proliferation of disconnected theoretical 'silos' that rarely engage with one another (Kozlov, 2024; Mancilla García and Bodin, 2025).

In this context, we should consider the role of replication. The recent replication crisis, especially visible in psychology, has increasingly become resonant in sociology and political science (Engzell and Rohrer, 2021; Freese and Peterson, 2017; Janz and Freese, 2021; Larsson, 2009; Sudmant et al., 2025). It has underscored both the importance of replication and the vulnerability of many established findings. Replication, while often framed as a conservative force in scientific practice, may of course lead to the rejection of established claims (Picho et al., 2016). Within a cumulative framework, failed replications are not setbacks but indicate which theoretical structures and empirical evidence are robust and which are not. The field must recognize that critical reassessment and even obsolescence are not signs of failure, but vital signs of intellectual vitality. In some rare cases, this process may culminate in genuine epistemic breaks, where long-held assumptions are abandoned and previously accepted paradigms rendered obsolete. In this way, replication and falsification enable a mode of disruption that is intellectually rigorous rather than merely rhetorical.

Hence, progress in the social sciences will depend not only on building knowledge step-by-step, but also on the willingness to confront, falsify, and sometimes discard what no longer holds. At the same time, social science scholars who want to advance scientific progress should not limit themselves to either falsification or incremental forms of knowledge cumulation. As Simmons and Smith (2025) recently pointed out, especially qualitative researchers conducting case studies may struggle with these modes of knowledge cumulation. Instead of retreating to idiosyncratic, non-cumulative approaches and results, the authors encourage qualitative social scientists to engage in what the authors call "translation", i.e., an abductive, recursive way of reshaping or extending existing theories through creatively working the tensions and mismatches between rather general theories and rather specific empirical cases. While this requires a deep engagement with the literature and relevant theories and advances the cumulation of knowledge, it does not involve replication, testing, falsification or the addition of further scope conditions, but the creative use of component pieces of theories that may behave and combine differently in specific empirical contexts, and hence may help to explain surprising empirical phenomena, and with it, contribute to theory development (Simmons and Smith, 2025).

What is urgently needed, then, is a culture of deep engagement with existing theories – not only to build upon them but also to question them, translate them in new contexts, and, if necessary, reject them. Such engagement must go beyond the individualistic ethos of "do-your-own-thingism" that characterizes large parts of the social sciences. Rejection of flawed frameworks, when undertaken through robust testing, constitutes a powerful mode of disruption that advances cumulative science rather than undermining it. A case in point is the recent intervention by Dannemann et al. (2024), who systematically challenge the widespread academic confidence in the transformative potential of civil society-led eco-political experimentation. Conducting a conjunctural and comparative analysis of past and present waves of such experimentation, they conclude that the current trust in grassroots experimentation is empirically and theoretically unfounded, casting serious doubts on what they see as "hopeful attributions" that may in fact stabilize the unsustainable status quo.

6. Disruption and cumulation combined: a multi-dimensional model of scientific progress

Reflecting on the above considerations, we propose that disruption and cumulation should not be viewed as mutually exclusive. Rather, certain forms of disruptive research – particularly those involving falsification or systematic refutation – can contribute meaningfully to cumulative progress. As highlighted by PLF and others, the antipode of disruption is consolidation; and from our discussion, it becomes clear that the antipode of cumulation is fragmentation. These relationships form the basis for our proposed multi-dimensional model of scientific progress, which is depicted in Fig. 1. In this model the disruption-consolidation axis represents the research outcome spectrum we understand PLF is *aiming* to measure and not the *actual* CD index reported by PLF, which as discussed may have significant anomalies.

Viewing both the disruptive-consolidating and the fragmented-cumulative axes as essentially continuous characteristics, four quadrants emerge. Much of scientific research, arguably, falls into the cumulative and consolidating quadrant, which aligns with Kuhn's notion of "*normal science*" as incremental, steady knowledge-building. This is in line with recent works that found the majority of breakthroughs to be characterized as "normal science" and not as paradigm-shifting discoveries (Wuestman et al., 2020). Most approaches listed above in 5.2 – such as replication or theory refinement – fall under this category, as do meta-analysis and synthesis.

Conversely, as laid out above, much of social science is non-cumulative in the sense of largely disconnected theoretical 'silos' that rarely engage with one another—fragmented, heterogeneous, and individualistic research, marked by "do-your-own-thingism" (Turner, 1991). Insofar as such research leads to consolidation within narrow subfields, it may warrant the broad label of "*Isolationism*". Potentially, highly individualized, case-based research may draw on methods such as translation (Simmons and Smith, 2025) to achieve more generalized,

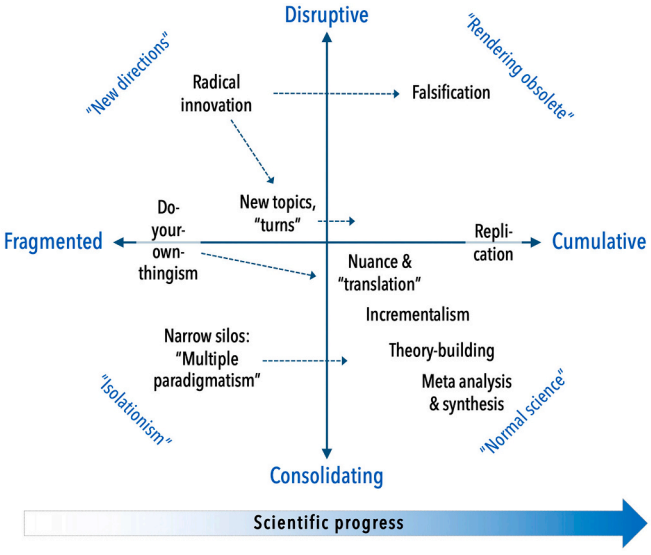

Fig. 1. Forms of knowledge contribution as a function of the *disruptive* vs. *consolidating* and the *cumulative* vs. *fragmented* nature of research. Dashed arrows indicate exemplary pathways toward more cumulative research.

[8] Giddens (1993) has famously introduced the notion of 'double hermeneutics' to argue that the social sciences shape the very social world they are studying, hence fundamentally questioning time-invariant and law-like generalizations in social inquiry.

cumulative knowledge (indicated by dashed arrow in Fig. 1) as discussed in Section 5.

Disruption – again following PLF – plays out in two different ways: by *rendering existing knowledge obsolete*, and by *propelling science into new directions*. The first type – rendering obsolete – corresponds to genuine progress, particularly when achieved through rigorous falsification, as discussed above. A classic example, cited by PLF, is Watson and Crick's model of DNA, which refuted Pauling's triple helix. Similarly, failed replications can result in the obsolescence of once-accepted findings, and thus contribute positively to knowledge cumulation. However, propelling science into new directions does not constitute progress per se (Campbell, 2019), as shown by our above discussion of scientific 'turns'. "There is a fine line here between progress and changing the subject, or extending the problem in a novel direction" (Turner, 2023: 219). Yet, turns can support progress if they lead to systematic theory-building, one example being the constructivist critique of established international relation theories that has inspired profound theorizing on the role of ideas and norms (Checkel, 1998). Radical innovations that "break with the past" (PLF) will only advance science if they serve to falsify existing research – and hence contribute to cumulative knowledge. If they remain isolated or only contribute to mere 'turns', they will end up building fragmented knowledge of little value to progress.

7. How knowledge can cumulate in the social sciences

Given the above accounts on how little progressive and cumulative the social sciences appear – how is knowledge cumulation to be achieved? Knowledge cumulation in the social sciences can be understood as the gradual development of a deeper, more nuanced, and more robust understanding of social phenomena and causal mechanisms (Mahoney, 2003; Campbell, 2019; Elman et al., 2020). While novel ideas and emerging research directions certainly push the boundaries of a field, they rarely operate in a vacuum. Instead, they tend to build upon, revise, or extend existing theoretical and empirical insights. Even in research domains characterized by conceptual ambiguity and institutional fragmentation, cumulative knowledge can be realized – if scholars engage explicitly with prior work, clarify conceptual boundaries, and strive to compare and integrate empirical findings across studies (e.g. Ostrom, 2006; Campbell, 2019; Newig and Rose, 2020). Scientific advancement, therefore, is not a process of discarding the past but of organizing, synthesizing, and contextualizing existing and new knowledge in transparent and comparative ways. This is not to discount the importance of creativity, innovation, or conceptual novelty. However, their transformative impact is contingent on the foundations upon which they are built – a fact that is acknowledged by PLF ("previous accumulated knowledge enables future progress", p. 138) at the outset of their article.

The cumulability of social science research is, of course, not without limits. Social phenomena and their systemic interactions with their environments are complex, dynamic, socially constructed and specific to time and place, and research results are usually contingent not only on this specificity, but also on the research lenses employed (Rose et al., 2025; Sudmant et al., 2025). As Ostrom (2006) has argued from a political science perspective, it is nonetheless possible – even in the face of social complexity – to achieve cumulative understanding by identifying common building blocks and analyzing how configurations of institutional and contextual elements shape outcomes. This involves developing shared concepts and frameworks, embracing comparative and meta-analytical methods, and institutionalizing knowledge coordination (e.g. Gerring, 2020; Newig and Rose, 2020).

To operationalize cumulative progress in the social sciences, specific structural and methodological investments are essential. Better data infrastructure is a foundational requirement. The accessibility of high-quality, longitudinal, and interoperable data enables cross-study comparisons, robust meta-analyses, and replication efforts – key components of cumulative inquiry. Platforms that support open data sharing and standardized metadata practices enhance transparency and promote collaborative reuse (Alexander et al., 2020; Engzell and Rohrer, 2021; Pauliuk, 2020).

Equally important is the proliferation of meta-studies and evidence synthesis efforts. These approaches distill and synthesize findings across a wide array of individual studies, allowing researchers to detect overarching patterns, inconsistencies, and knowledge gaps. Systematic reviews, meta-analyses, and realist syntheses (e.g. Pawson, 2002) serve not only to summarize but also to elevate empirical knowledge into more generalizable theoretical propositions (Jensen and Rodgers, 2001; Newig and Rose, 2020; Ford et al., 2025). Knowledge synthesized within academia or at interfaces with other societal actors should ultimately inform policy-making and practice (Hofmann et al., 2025; Hoffmann et al., 2017; Creutzig et al., 2025).

Furthermore, the use of commonly used variables – or at least clearly defined and conceptually coherent operationalizations of key constructs – can dramatically enhance the comparability of findings across research contexts. Shared measurement conventions reduce ambiguity and enable researchers to build upon one another's work without constant redefinition or reinvention of core concepts (Mears and Stafford, 2002; Newig and Rose, 2025). Practices of open science, such as the systematic sharing of code-book and meta-data are also likely to enable cumulation, and should therefore be encouraged (Chakravorty et al., 2022).

The adoption of common theoretical frameworks and research protocols can provide the scaffolding necessary for more cumulative research practices. By aligning research designs, theoretical models, and methodological tools, scholars create pathways for research efforts that speak to one another, avoiding fragmentation. Such standardization does not imply rigidity but facilitates structured diversity, where different approaches can still contribute to a coherent body of knowledge (Mahoney, 2003; Newig and Rose, 2020; Richardson, 2018). Moreover, cumulation may occur by synthesizing different but complementary theoretical approaches (Partelow et al., 2020).

With a view to assessing the effects of social interventions, Pawson and colleagues' work on realist evaluation complements this agenda by offering a framework explicitly designed to uncover underlying causal mechanisms. According to Pawson and colleagues (Pawson and Tilley, 1997; Pawson, 2013), social interventions are best understood as context-mechanism-outcome configurations. Rather than seeking universal laws, realist evaluation seeks to generate transferable explanatory insights that can be refined and tested across different settings. This approach values replication not in terms of rigid standardization but as a way of refining and cumulating knowledge about how and why interventions succeed or fail under varying conditions. Realist approaches provide a pathway to cumulate knowledge through mechanism-based theorizing, supporting a form of generalization that remains sensitive to complexity and diversity in real-world contexts.

Other scholars, such as Gerring (2007) and George & Bennett (2005), have similarly emphasized the value of comparative case study logic and process tracing in building cumulative causal understanding. These approaches support the creation of middle-range theories that are sufficiently abstract to be widely applicable, yet grounded enough to be meaningful in empirical contexts. Ultimately, a pluralistic and theory-driven research culture – open to methodological diversity and collaborative knowledge building – is essential for achieving sustained knowledge cumulation in complex social domains.

Another avenue through which cumulative knowledge can be supported is the strategic application of triangulation. By drawing on multiple methods, data sources, or theoretical frameworks, triangulation enables researchers to explore a common phenomenon or research question from diverse angles, thereby increasing the robustness and transferability of findings. While triangulation has long been established (see, e.g. Denzin, 1970; Jick, 1979), it appears only seldom to be systematically applied, such that recent calls for stronger triangulation (as well in the natural sciences) have been published (Munafò and Smith, 2018). While nurturing diversity in approaches, triangulation presupposes common research objects and research questions. Hence,

common research questions and research objects appear as a key precondition for knowledge to effectively cumulate (Newig and Rose, 2025).

Importantly, facilitating the cumulation of knowledge, as outlined above, is not a straightforward or purely technical endeavor – it must be approached as a self-critical and reflexive process. While there are valid calls for greater coherence in frameworks, concepts, and research questions, scientific progress often thrives on the coexistence of diverse approaches, methods, and perspectives (Newig and Rose, 2025). Decisions about which bodies of knowledge to cumulate inevitably involve normative and pragmatic considerations. Prioritizing results that appear more readily cumulable – such as those from quantitative studies – may inadvertently marginalize more contextualized and interpretive forms of knowledge, including insights generated through ethnographic and transdisciplinary research (Gosselin and Gauquelin, 2025).

This leads us to acknowledge that measures to assess knowledge cumulation will need to cover the above dimensions and pathways of cumulation. For example, Newig and Rose (2025) have developed metrics that cover aspects of cumulation preconditions, facilitators and actual knowledge cumulation, and applied them to a particular community of environmental governance research. In contrast to citation indices, this direct engagement with the preconditions and substance of knowledge cumulation is more likely to provide insights on overall scientific progress.

8. Conclusions: rethinking disruption, cumulation and progress in the social sciences

This article has argued that while the notion of disruptiveness, as introduced by Park et al. (2023), offers an intuitively appealing and formally tractable measure of scientific progress, its operationalization through citation metrics (particularly the CD index) presents significant limitations – especially in the context of the social sciences. Here, what appears as disruption is often not the consequence of rigorous refutation or theoretical innovation, but possibly the result of stylistic rebranding, citation omissions, or broader patterns of intellectual fragmentation. Importantly, it also risks neglecting important processes of knowledge cumulation and (being based solely on researchers' citation behavior) any assessment of societal understanding and problem solving (the noetic and functional views of progress discussed in Section 2).

Rather than viewing disruption and cumulation as mutually exclusive, we have proposed a more nuanced, multi-dimensional understanding of scientific progress: one that recognizes selective disruption as part of cumulative development. Especially in fields with multiple, coexisting paradigms, disruption is meaningful only when embedded in a context of theoretical engagement and systematic testing. Progress, then, is best conceptualized not as a dichotomy between preservation and rupture, but as a process of refining, rejecting, or recombing established knowledge in the light of new evidence and cumulative insight.

Our analysis suggests conclusions for scientific practice and research policy: High disruptiveness scores, as measured by citation-based indices like the CD index, should not be equated with scientific progress – particularly not in fields like the social sciences, where citation practices, epistemic diversity, and institutional fragmentation complicate such inferences. First, policy-makers, notably in research evaluation, should exercise caution in interpreting apparent high disruptiveness as inherently valuable, or low disruptiveness as indicative of stagnation. Second, given the biases identified – ranging from pseudo-novelty and citation omissions to measurement distortions – the conclusion drawn by PLF that scientific disruptiveness is in decline should be interpreted with care. This decline may reflect changes in citation practices, reference list lengths, or database coverage rather than genuine epistemic slowdown. Third, paradoxically, actual substantive disruptiveness – understood as knowledge that truly renders prior findings obsolete – may be even rarer than these metrics suggest. Finally, and most importantly, there is a real risk that such disruption-based research evaluations divert research policy attention away from more fundamental processes of scientific advancement: the (co-)production, refinement, and synthesis of cumulative knowledge.

The above reframing calls for a research culture that moves beyond the individualistic pursuit of novelty and toward more collective, theory-driven engagement. To this end, the social sciences would benefit from policy and practice supporting investment in shared methodological frameworks, sustained comparative inquiry, triangulation of results across theories and methods as well as stronger incentives for replication and evidence synthesis. Where such conditions are met, even certain discontinuities in knowledge production can be understood as part of a broader cumulative trajectory.

To promote meaningful progress, research policy ought to shift its focus from rewarding symbolic novelty to actively facilitating cumulative knowledge-building. This is a responsibility not just for funders and policymakers, but for all actors in the research ecosystem – researchers, supervisors, journal editors, reviewers, and interface institutions alike (Rose et al., 2025). Structural barriers – like reward systems favoring individual novelty, disciplinary silos, short funding cycles, and little support for replication – must be openly addressed. Institutions should promote collaboration, knowledge integration and synthesis, replication, and theory-building, not just novelty. This requires funding for long-term, comparative work, recognition of joint and integrative efforts, and publication formats that value conceptual depth (Rose et al., 2025). To move beyond repackaging old ideas, research policy is well-advised to invest in the infrastructures, norms, and shared systems that sustain cumulative knowledge over time.

Looking ahead, several avenues for further inquiry emerge. Theoretically, there is a need to develop more integrated models of scientific progress that can account for both continuity and disruption without reducing either to a citation pattern. Such models would benefit from closer dialogue between philosophy of science, (quantitative) science studies including scientometrics, and field-specific epistemologies. Conceptually, the term "disruption" itself deserves greater analytical precision. What kinds of theoretical change qualify as disruptive? Must disruption imply obsolescence, or can it take subtler forms, such as reframing or integration?

Empirically, more qualitative and mixed-method studies are needed to unpack the dynamics behind high-CD-index papers: What kinds of knowledge claims do they make? How are they received and built upon? Are their effects lasting or transient? Complementing large-scale citation analysis with in-depth case studies could help clarify when citation patterns truly reflect epistemic change – and when they do not. Cross-disciplinary comparisons, especially between natural, life, and social sciences, could further illuminate the varying meanings and mechanisms of knowledge continuity and change across different cultures.

In sum, scientific progress – particularly in the social sciences – is not well captured by formal disruptiveness metrics. What is required is a stronger conceptual toolkit for distinguishing between epistemically generative disruption and apparent novelty. We invite fellow researchers to use and empirically test our hypotheses on how papers' CD index may erroneously yield high values of disruptiveness. We call for a research infrastructure that enables theories to be not just created, but seriously tested, synthesized, extended, and if necessary, left behind. Recognizing disruption as part of a broader and cumulative epistemic ecology – rather than a standalone indicator of progress – offers a more realistic and constructive path for advancing the social sciences.

CRediT authorship contribution statement

Jens Newig: Writing – review & editing, Writing – original draft, Conceptualization. **Michael Rose:** Writing – review & editing, Writing – original draft, Conceptualization. **Zühre Aksoy:** Writing – review & editing, Writing – original draft. **Simon Beaudoin:** Writing – review & editing, Writing – original draft. **Thomas Bolognesi:** Writing – review &

editing, Writing – original draft. **Oliver Fritsch:** Writing – review & editing, Writing – original draft. **Dries Hegger:** Writing – review & editing, Writing – original draft. **Benjamin Hofmann:** Writing – review & editing, Writing – original draft. **Nicolas W. Jager:** Writing – review & editing, Writing – original draft. **Elke Kellner:** Writing – review & editing, Writing – original draft. **Sina Leipold:** Writing – review & editing, Writing – original draft. **Åsa Persson:** Writing – review & editing, Writing – original draft. **Hens Runhaar:** Writing – review & editing, Writing – original draft. **Robert Webb:** Writing – review & editing, Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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