

More or the same? Radical, disruptive, discontinuous, and breakthrough innovation

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This paper addresses the conceptual ambiguity in the literature on *exceptional* innovations, labeled “radical,” “disruptive,” “breakthrough,” or “discontinuous.” A bibliometric analysis of 4407 articles shows that different labels are used by papers with shared theoretical foundations and thematic orientation. An in-depth analysis of 60 seminal contributions shows that definitions are (I) not always provided, (II) inconsistent within labels, and (III) not distinctive across labels. This complicates the exploration of the literature and the comparison of results. Definitions, when provided, agree on the existence of two underlying dimensions—novelty and impact—but disagree on how the labels relate to these dimensions. To advance conceptual clarity, we propose a typology of innovation *trajectories* that treats novelty and impact as distinct concepts and clarifies how and when novelty relates to impact.

JEL classification: O31, O32, O33

1. Introduction

The innovation literature widely acknowledges that not all innovations are alike. The vast majority involve incremental improvements or display modest impacts, while a small minority depart significantly from previous practices or have profound impacts (Schumpeter, 1934; Bower and Christensen, 1995; O’Connor and Rice, 2001; Baumol, 2004). Several labels are in use to denote such innovations, the most prominent of which are *radical* (Ettlie *et al.*, 1984; Dewar and Dutton, 1986; Chandy and Tellis, 1998), *breakthrough* (Mascitelli, 2000; Ahuja and Lampert, 2001; Fleming, 2001), *discontinuous* (Tushman and Anderson, 1986; McKee, 1992; Veryzer, 1998), and *disruptive* (Christensen, 1997; Adner, 2002). The existence of multiple labels for a seemingly similar concept has led some subsequent work to treat these constructs as interchangeable, affording less attention to a precise delineation of the terms and their underlying constituents (Linton, 2009). This has led to concerns about the interpretation of the underlying empirical phenomena, with some scholars asserting that the resulting confusion could well hamper both theory development and the crafting of insights and advice relevant to practitioners (Garcia and Calantone, 2002; Gatignon *et al.*, 2002).

In this paper, we explicitly revisit these concerns—first raised over 20 years ago, most notably in the work of [Garcia and Calantone \(2002\)](#) and [Gatignon *et al.* \(2002\)](#)—by engaging in a systematic, bibliometric analysis of 4407 articles that refer to at least one of the aforementioned labels (i.e., radical, breakthrough, discontinuous, and disruptive). After establishing that conceptual ambiguity has not at all diminished, let alone disappeared over the last two decades, we offer an innovation typology that brings the different labels under one umbrella, highlighting how they are distinct yet related.

In a first step, we use bibliometric techniques, including co-citation analysis and bibliographic coupling, to map the literature's theoretical foundations and thematic orientation. Our analysis of cited articles shows that different labels rely on similar origins. At the same time, labels are scattered over the thematic landscape and papers on similar topics use different labels, signaling no exclusive relationship between theme and label. We then closely examine 60 highly cited publications to assess whether different labels consistently cover different underlying concepts. One-fifth of these highly cited papers lack explicit definitions, and others rely on two underlying dimensions: *novelty* and/or *impact*. At the same time, we observe that definitions within labels vary while similar definitions are used across labels. Based on our combined set of results, it becomes clear that the confusion about the concepts underlying various labels has not vanished since it was first pinpointed over 20 years ago. Labels do not consistently map theoretical foundations, thematic orientation, or conceptualization of exceptional innovations.

We argue that the root cause of the conceptual ambiguity in the literature is that novelty and impact are all too often treated as different sides of the same coin, meaning that “off-diagonal innovations”—those that are novel but not impactful, or impactful but not novel—are overlooked. If indeed novelty implies impact and vice versa, each label essentially addresses the same phenomenon. The inconsistent use of labels, then, is rather harmless, albeit a nuisance for researchers exploring the literature. However, as noted in existing scholarship ([Dahlin and Behrens, 2005](#); [Verhoeven *et al.*, 2016](#)), novelty and impact are distinct concepts and off-diagonals are no exception.

We believe that treating novelty and impact as distinct but intricately related dimensions and conceiving them as such is essential for improving conceptual clarity in the literature. To this end, we develop a typology of innovation trajectories—a series of related inventions that introduce and develop technological novelty and hence impact markets, firms, and industries. Examining any individual invention as part of a trajectory naturally decouples novelty from impact. Novel inventions often initiate a trajectory of follow-on innovation without directly exerting significant impact, while substantial impact may result from minor changes further along in the trajectory.

The concept of a trajectory also allows us to explore how novelty and impact relate to one another. We build on prior work to characterize a trajectory by the type of novelty it introduces: radical or architectural. Radical novelty introduces completely new technological principles ([Arthur, 2007, 2009](#)), while architectural novelty reconfigures existing principles and components into a new value proposition ([Henderson and Clark, 1990](#)). Radical novelty typically requires addressing a long list of problems for which no existing solutions are available, delaying technological performance parity with prior approaches. In contrast, architectural novelty introduces fewer technological problems, especially when its components are well developed in other contexts.

Due to these characteristics, trajectories involving radical and architectural novelty are fundamentally different. Radical trajectories develop slowly, involve high levels of technological uncertainty, and provide limited incentives to private organizations. Conversely, architectural trajectories can diffuse quickly, face limited technological uncertainty, and offer strong private incentives for research and development (R&D). With these distinctions in mind, we conceptualize how both forms of novelty will differ in their impact on value creation and the competitive position of firms.

With this trajectory perspective in mind, it becomes clear how different labels could coexist within the same framework while remaining conceptually distinct. Based on our reading of the literature, consensus could be achieved by using the label “radical” to denote a type of novelty that introduces completely new technological principles. In contrast, “breakthrough” could refer to exceptional impact at the technology level, such as a significant increase in performance

along a relevant dimension. The label “discontinuous” could denote the impact an innovation trajectory has on the knowledge and resources of incumbent firms. When such impacts significantly and simultaneously reduce incumbents’ market share, these innovations could be termed “disruptive.”

Our paper makes two contributions to the innovation literature. First, it directs our attention, once more, to the importance of conceptual clarity in the literature on exceptional innovations. Such attention is warranted because the two landmark contributions that first recognized the issue date back two decades (Garcia and Calantone, 2002; Gatignon *et al.*, 2002). Whereas one might expect that conceptual rigor would have increased with the passage of time, our large-scale assessment—by means of bibliometric techniques—reveals the opposite. Second, we advance a (concise) typology of innovative *trajectories* that has the potential to create conceptual clarity by relating insights from the literature on the origins of technological novelty (Henderson and Clark, 1990; Arthur, 2007, 2009) to the framework of technological trajectories (Dosi, 1982; Van de Ven and Poole, 1990; Freeman, 1991) and the implications these might have on the resource base of (incumbent) firms (Wernerfelt, 1984; Barney, 1991). Doing so provides clear insights into how different types of novelty imply a different pace (in terms of arriving at market readiness), introduce differences in terms of incentives to innovate, and finally can have a differentiated *impact* on the (relevance of) the resource base of the firm.

The remainder of the paper is structured as follows. In the following section, we expand on the concerns about conceptual clarity stemming from the simultaneous use of different terms to denote “exceptional” innovation. In Section 3, we describe how our dataset is constructed and explain the bibliometric methods that we deploy. Subsequently, we present the results of the bibliographic coupling and co-citation analysis, as well as a complementary content analysis of highly-cited papers in Section 4. Section 5 introduces our conceptual framework that clarifies the relationship between novelty and impact. In Section 6, we discuss how our typology compares to previous work, including the conceptualizations proposed by Garcia and Calantone (2002) and Gatignon *et al.* (2002), as well as more recent contributions by Hopp *et al.* (2018a, b), Datta and Srivastava (2023), Frenken and Punt (2023), and Kneupling *et al.* (2022).

2. The ambiguity of innovation terminology

The scope of studies that contribute to our understanding of innovation is broad, delivering a variety of research streams, theoretical perspectives, and concepts (Afuah and Bahram, 1995; Gopalakrishnan and Damanpour, 1997; Hauser *et al.*, 2006; Linton, 2009; Ansari and Krop, 2012; Suroso and Azis, 2015). This becomes clear when inspecting Table 1 which summarizes, for each of the labels (radical, breakthrough, discontinuous, and disruptive), three foundational¹ papers on exceptional innovation. The existence of a plethora of terms to denote the range of related concepts has raised concerns about the comparability and generalizability of results. Most notably, the contributions of Garcia and Calantone (2002) and Gatignon *et al.* (2002) convincingly argue that confusion over the definitions and operationalizations of innovation types can impede academic advancement because it complicates comparing, reconciling, and accumulating the results that empirical studies report. Furthermore, the consequences of inconsistency in denoting different types of innovation are not limited to the realm of academia. As Garcia and Calantone explicitly claim, the empirical findings in new product development scholarship can become confusing and discrepant in terms of their impact on practice to the extent that they are not duly circumscribed.

Likewise, Gatignon *et al.* (2002) signal confusion within the domain: “fundamental concepts and units of analysis are often confused and/or ambiguous. As such, empirical results are often inconsistent or difficult to reconcile” (Gatignon *et al.*, 2002: 1103). They attribute the presence of ambiguity to three distinct, though related, causes: (i) concepts (attributes), such as competence enhancing/destroying or incremental/radical, are not clearly distinguished from the type of innovation (e.g., architectural), (ii) innovation (and its impact) tends to be conceptualized on the product level of analysis, whereas the unit of empirical analysis is often situated on the subsystem

¹ Based on citations.

Table 1. Foundational articles for each label

Label	Article	Topic	Concepts
Radical	Ettlie <i>et al.</i>, 1984 , <i>Management Science</i>	How strategy (technology policy, market-dominated growth strategy, diversification, size) and organization structure (concentration of technical specialists, complexity, formalization, centralization) affect radical versus incremental innovation outcomes.	Innovation is radical when it incorporates technology that is a clear, risky departure from existing practice.
Radical	Dewar and Dutton, 1986 , <i>Management Science</i>	How organizational characteristics relate to the adoption technical process innovations (radical versus incremental)	A (process) innovation is radical when it contains a high degree of new knowledge.
Radical	Chandy and Tellis, 1998 , <i>Journal of Marketing Research</i>	The willingness to cannibalize, rather than firm size, is the main organizational predictor of radical product innovation.	Radical innovations involve substantially new technology and provide substantially greater customer benefits per dollar, relative to existing products.
Breakthrough	Ahuja and Lampert, 2001 , <i>Strategic Management Journal</i>	Firms can achieve breakthrough inventions by experimenting with novel, emerging, and pioneering technologies.	Breakthrough inventions are those foundational inventions that serve as the basis for many subsequent technological developments.
Breakthrough	Mascitelli, 2000 , <i>Journal of Product Innovation Management</i>	Breakthrough innovation results from harnessing tacit knowledge possessed by individuals and project teams.	In breakthrough product innovation, connections between technologies and markets are made that cannot be traced to a seamless lineage of existing knowledge.
Breakthrough	Fleming, 2001 , <i>Management Science</i>	Recombinant search leads to inventions with lower average value but higher variance and thus is conducive to breakthrough invention.	Breakthrough as a positive outlier in the invention's usefulness or importance.
Discontinuous	Tushman and Anderson, 1986 , <i>Administrative Science Quarterly</i>	Studies the effect of technological discontinuities on environmental conditions of the firm. Technology evolves through periods of incremental change punctuated by technological breakthroughs. Whether such discontinuity is competence-enhancing or competence-destroying determines the effect of technological change on (incumbent) firms.	Technological discontinuities (or breakthroughs) offer a sharp price-performance improvement over existing technology so that no increase in scale, efficiency, or design can make old technologies competitive with new technologies.
Discontinuous	McKee, 1992 , <i>Journal of Product Innovation Management</i>	Different organizational learning skills are involved in incremental innovation, discontinuous innovation, and institutionalization of innovation within the organization.	A product-innovation learning curve describes product performance as a function of effort and follows an "S-shape." Movement along the curve represents incremental innovation. Movement <i>between</i> product-innovation learning curves represents discontinuous product innovation.

(continued)

Table 1. (Continued)

Label	Article	Topic	Concepts
Discontinuous	Veryzer, 1998, <i>Journal of Product Innovation Management</i>	Studies how the new product development process along various dimensions differs for incremental as opposed to discontinuous innovation projects.	Discontinuous innovations refer to radically new products that involve dramatic leaps in terms of customer familiarity and use.
Disruptive	Christensen, 1997, <i>The Innovator's Dilemma</i>	Argues that well-managed firms often lose their market leadership because they focus on sustaining innovations catered to existing customers, failing to adopt disruptive innovations that initially target niche markets but eventually overtake established technologies.	A disruptive technology, while initially underperforming, offers new attributes by a small, often overlooked segment of the market but improves and eventually disrupts established players by fulfilling mainstream needs at a lower cost or with greater convenience.
Disruptive	Adner, 2002, <i>Strategic Management Journal</i>	Examines how disruptive dynamics are influenced by demand conditions. It argues that the likelihood of disruption depends on both the degree of overlap and whether segments respond similarly to performance improvements.	A disruptive innovation is a technology that initially underperforms on mainstream performance metrics and is targeted at niche markets. Improvements allow it to displace incumbents by better addressing overlooked consumer preferences.
Disruptive	Markides, 2006, <i>Journal of Product Innovation Management</i>	Disruptive innovations should be subcategorized into business-model innovations and radical product innovations. Each type creates new markets and challenges incumbents but requires different strategies from established firms.	Disruptive innovation is a process where new business models or products reshape market dynamics by appealing to overlooked customer needs and disrupt by introducing new ways of competing.

level, and (iii) innovation research tends to be conducted at a distance from the phenomena of interest.

Renewed attention to this issue seems warranted for two principal reasons. First, the concerns expressed by Garcia and Calantone (2002) and Gatignon *et al.* (2002) were based on a rather small set of (influential) publications.² Both contributions provide examples that describe potential issues arising from scholars' reliance on different terminology to distinguish various types of innovation but do not assess their prevalence in the literature. It is, therefore, appropriate to question whether these concerns apply to the larger body of research in management and economics dealing with exceptional innovations. Second, as both papers date back two decades, rigor and precision in the field may well have increased since—and very possibly because of—the publication of their findings and recommendations. In this paper, we assess whether and to what extent conceptual ambiguity concerning the scholarship on “exceptional” innovation still persists by carefully examining whether different labels rely on different scientific origins, differ in terms of focal topics, and adhere to distinct definitions.

The answer to this question becomes even more relevant as the scholarship on “exceptional innovation” has continued to evolve over the past 20 years. Figure 1 presents this evolution and benchmarks it to the expansion in the number of total publications in the business, management, and economics domains between 2000 and 2021. The scholarship on exceptional innovation

² Garcia and Calantone focus on 21 articles that have been published in one specific journal, the *Journal of Product Innovation Management* up to 2002. Gatignon *et al.* build their argumentation—and provide examples—by reviewing a limited set of (seminal) contributions to the field.

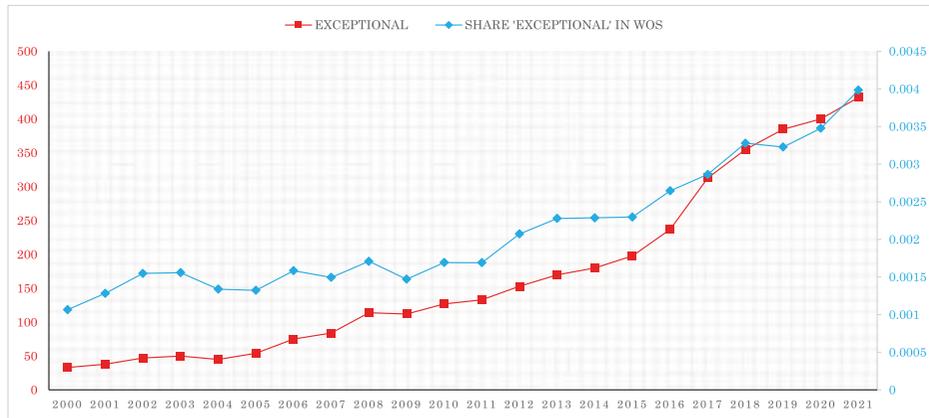


Figure 1. Distribution of WOS publications on “exceptional innovation” versus all business and management publications over time. *Notes:* Trends in the number of publications on exceptional innovation. The red line (squares, left axis) shows the trend of the number of articles on the topic of exceptional innovation (the baseline set of articles used in this paper). The blue line (diamonds, right axis) shows the share of articles on exceptional innovation in the total number of WOS articles published in WOS categories Management, Business, Economics, and Operations Research Management Science.

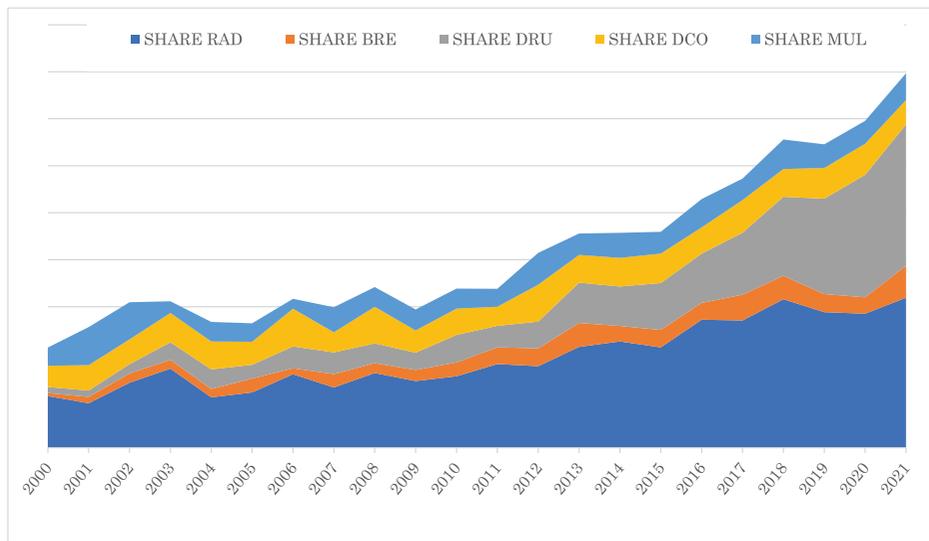


Figure 2. Evolution of the number of publications per label over time. *Note:* Trends in the number of publications on exceptional innovation by label used.

exhibits higher growth rates than those observed in the combined business, managerial, and economics spheres. Between 2000 and 2021, the number of publications on exceptional innovation expanded by a factor of 13.1 (from 33 to 432), whereas the total number of publications in business, management, and economics grew only by a factor of 3.5 (from 30 972 to 108 437). The growth rate of the literature on exceptional innovation has exceeded that of the overall literature mainly during the last decade.

Figure 2 depicts the distribution of publications using the four labels over time. Scholarship on these topics has been growing significantly, with all labels displaying growth since the beginning of the 1990s. Scholarship referring exclusively to the label “radical” has experienced significant growth (relative to other labels) from the mid-2000s, whereas work using the label “disruptive”

has grown starkly since the mid-2010s. In 2020, the number of publications under “radical” and “disruptive” is about five times larger than the number of publications under each of the other labels.

3. Data and methods

3.1 Data

We relied on the “topic search option” in the Web of Science® (WOS) database to retrieve publications that coin the term “innovation” and mention the term³ “radical,” “breakthrough,” “discontinuous,” or “disruptive” in the titles, keywords, or abstract fields of the database.⁴ The search query was refined to include publications in the WOS subject categories⁵: “Management,” “Economics,” “Business,” and “Operations Management and Research Methods” and to encompass only published, original, and peer-reviewed scholarly papers.⁶ All articles published between January 1, 1985 and June 30, 2022 were considered, resulting in a dataset of 5070 publications.

To remove off-topic work (false positives) from our dataset, we relied on WOS bibliographical records, containing standardized information about the authors, journal sources, and—of special importance for this study—the cited references. We drop all articles that do not share at least seven references with other articles in our set. Our assumption here is that publications that share relatively few references with other articles in our set are likely to be irrelevant to the topic of exceptional innovation, and therefore, we can use the number of references in common to eliminate false positives. It is important to note that with any large-scale bibliometric exercise like ours, there is a trade-off between precision—i.e., how many articles are on-topic—and recall—i.e., finding all on-topic articles. Our approach is to allow for a false positives rate of a maximum of 10%.⁷ To implement this decision rule, we categorize all articles based on how many references they share with the rest of the set. We then study the title and abstract of a random sample of 20 papers for each category, starting with lower levels of shared references. For samples that share up to six references, we find the false positive rate to be at least 35%. For papers sharing seven references, this rate drops to 10%. Based on this validation exercise, we decide on a cutoff of seven references in common to ensure an overall false positive rate of less than 10%. Removing all articles that share less than seven references with the rest of the set results in a final dataset consisting of 4407 publications.

3.2 Methods

We applied two bibliometric techniques—bibliographic coupling and co-citation analysis—to analyze the relatedness between publications. The fundamental assumption underlying these techniques is that the degree of overlap between the cited references of a focal pair of publications is representative of their relatedness. The main difference between bibliographic coupling and co-citation analysis lies in the locus of citation patterns. Bibliographic coupling is a technique used to determine the relatedness among a focal set of publications based on an analysis of the references these publications cite, whereas the co-citation analysis technique determines the relatedness among a focal set of publications based on an analysis of citations received. Both techniques have a long-standing tradition in the field of bibliometrics for analyzing the development

³ These terms were chosen based on the authors’ experience with the literature. We explored further terms such as “novel” and “exceptional” but found that adding terms did not add relevant articles to the set.

⁴ Given that the authors may not refer to “radical,” “breakthrough,” “discontinuous,” and “disruptive” directly followed by the term “innovation,” such a requirement was not included in our search key. This means that we captured not only publications that refer, for example, to the combination term “radical innovation” but also publications that contain the terms “radical” and “innovation” separately in the title, abstract, or keywords field of the WOS. In addition, we used stemmed versions of these terms to capture the range of variants used. Both author-provided keywords and keywords given by the WOS database are considered.

⁵ Including additional (related) disciplines increased noise due to fact the search key resulted in many irrelevant articles while adding few relevant ones.

⁶ More specifically, we confined our search to the following document types: “Article,” “Editorial,” “Note,” “Letter,” and “Review.”

⁷ None of our results rely on having zero false-positives. Allowing for some noise in the data ensures that we capture a larger number of relevant articles; as such our approach can be considered “inclusive” by avoiding the occurrence of false negatives (while accepting the presence of a limited number of false positives).

of research fields and communities (see, for instance, Kessler, 1963; Weinberg, 1974; Vladutz and Cook, 1984), and they are often relied on in reviews of managerial and economic research (Chen *et al.*, 2012; Vogel and Güttel, 2013; Kovacs *et al.*, 2015). To determine the relatedness between publications, we applied the Association Strength (AS) measure proposed by Van Eck and Waltman (2009).⁸ AS is a measure of the co-occurrence frequency of citations made (in bibliographic coupling) or citations received (in co-citation analysis) for each pair of focal publications. This is achieved by taking into account the total number of linkages in each focal publication and the total number of linkages in the entire set of focal publications. The AS between a pair of focal publications can therefore be calculated as follows:

$$AS_{ij} = \frac{C_{ij}}{C_i C_j}$$

Whereby C_{ij} denotes the number of linkages (i.e., references/citations) shared by publications i and j , C_i denotes the total number of linkages in publication i , and C_j denotes the total number of linkages in publication j . In bibliographic coupling, the linkages denote the citations given, whereas, in co-citation analysis, they denote the citations received.

To extract topics from our body of literature, we applied Latent Dirichlet Allocation (LDA) to the title and abstract of the articles in our set. LDA is a method that identifies topics in a collection of documents by assuming that each document is made up of a mixture of different topics, and each topic is characterized by certain words. It uses Bayesian techniques to uncover these topics based on the words in the documents. In our implementation, we first preprocessed titles and abstracts (available from WOS data) by merging them, applying stop-word removal, punctuation removal, and lemmatization.⁹ Next, we created a term dictionary and converted the corpus into a document-term matrix. Using the Gensim¹⁰ library, we trained an LDA model on this matrix with 50 topics, iterating 50 times to ensure convergence. Finally, we assigned the most representative topic to each document, providing insights into the primary themes across the dataset.

4. Results

4.1 Origins of the “exceptional” innovation literature

We assess the intellectual origins of the literature on exceptional innovations by assessing the extent to which publications using different labels overlap with respect to the scholarly works they cite. Figure 3 visualizes this co-citation analysis. It maps all papers referenced by our core set of publications, where a referenced paper is colored according to how many of the labels build upon the paper. We classify a paper as contributing to a label when at least 1% of the articles under a label refers to the paper.¹¹ We then count the number of labels for which this is the case for a given referenced article.

The colors in Figure 3 represent how many of our labels build upon the referenced article [gray = less than 1% of the papers refers to this paper; lightest blue = one label (>1% of the papers refers), darkest blue = five labels]. The size of the circles represents the number of citations given by articles in our set to the articles on the map. The relative positions of the papers on the map are determined by how often a pair of papers is cited by the same articles in the set (i.e., they are “co-cited”). Our conclusion that articles on exceptional innovation build on similar intellectual origins is based on two observations. First, no clearly distinct clusters emerge in the

⁸ According to Van Eck and Waltman, this probabilistic measure is more suited to normalizing co-occurrence data (in particular, when co-occurrence data are visualized) than well-known set-theoretic measures, such as Salton’s index and the inclusion index.

⁹ We use the Python library “nltk” to achieve this. See <https://www.nltk.org/>.

¹⁰ See <https://pypi.org/project/gensim/>.

¹¹ This cutoff indicates when an article is considered “used” by the literature under a given label. Without this cutoff, we would assume a label builds on an article even if only one article under this label cites it. A map without the cutoff shows that most papers are built upon by all labels, meaning that introducing the cutoff makes the results more conservative. Increasing the threshold to 2% leads to very few articles being “used” by any label. In this case, labels that are used at all, are used simultaneously by most labels.

Table 2. Overlaps among references cited at least 10 times overall (Jaccard-index scores)

	RAD_ONLY	DRU_ONLY	DCO_ONLY	BRE_ONLY	MULTI
RAD_ONLY	X	0.82	0.76	0.59	0.80
DRU_ONLY		X	0.69	0.54	0.71
DCO_ONLY			X	0.56	0.68
BRE_ONLY				X	0.54
MULTI					X

Jaccard-index scores of overlap between article sets with different labels. For each label, the set of articles cited by articles under the label are collected. Only cited articles that are referred to at least 10 times within the overall body of literature on exceptional innovation are retained. For each combination of labels, the Jaccard index is calculated by dividing the number of articles cited under both labels by the total number of articles cited by any of the two labels.

4.2 Thematic orientation of the “exceptional” innovation literature

Our main method to assess thematic orientation relies on bibliographic coupling, a technique that measures the AS from citation patterns for each pair of publications in our set of 4407. We implement the clustering algorithm described in [Van Eck and Waltman \(2010\)](#) to explore the extent to which thematic clusters of articles can be discovered. The algorithm maximizes within-cluster overlaps and minimizes between-cluster overlaps in references cited. [Figure 4](#) reports the five resulting clusters¹² (colors refer to clusters). Distances between pairs of labels in [Figure 4](#) reflect the extent to which the two articles overlap in terms of references they cite. The size of the label varies with the number of citations the article received.

The obtained bibliographic network is highly connected, indicating that most publications have cited references in common with many other publications. While considerable overlap exists between all the thematic clusters in [Figure 4](#) (reflecting the fact that articles in these clusters cite a very similar set of sources), some of them even cover the same area (e.g., the blue and red clusters). The close proximity of different labels indicates that pairs of focal publications in which different labels are used often have a greater overlap in references cited than pairs of focal publications that refer to the same label. From these results, we can conclude that, in the body of literature examined, similar labels seem to address different topics and, at the same time, different labels are used when studying similar topics. Finally, each of the five (relatively dense) thematic clusters contains publications that represent different labels. This clearly illustrates that none of the identified thematic areas can be associated exclusively with a certain label. Publications making use of the label “radical” are overrepresented in the green cluster and underrepresented in the blue cluster (taking a share of 73.6% and 21.4% of respective clusters while having a share of 44.4% in the overall set). Representing 37.5%, 49.8%, and 45.0% in, respectively, the red, yellow, and purple clusters, the label “radical” is clearly used across the thematic landscape. A similar conclusion emerges for articles using the label “disruptive.” Being responsible for about a quarter of all publications, “disruptive” takes up a share of, respectively, 36.2% and 30.9% in the red and blue clusters, but also appears on 9.0%, 11.6%, and 20.2% of the articles in the green, yellow, and purple clusters. Similar patterns hold for the other labels. These results suggest that labels are not consistently used within topics of study (and any label appears to be used widely across topics). As a result, researchers who want to search for the scholarship on “exceptional” innovation under a given theme should consider each of the labels as a search key (combined with keywords representative of the specific theme they are interested in).

While the method of bibliographic coupling is well established in the literature, it is not without limitations. The set of references cited may reflect, in addition to thematic similarity, disciplinary distinctions, journal affiliations, or even distinct research approaches. This is a concern in that the distance between any two articles in the map based on bibliographic coupling may not fully reflect thematic (dis-)similarity. To address this concern, we adopt two alternative approaches to

¹² The five-cluster solution reported represents the optimal solution. We explored whether imposing a constraint on the number of clusters (demanding that the algorithm delivers different numbers of clusters) alters the fact that, in the optimal solution, overlap between clusters is high. Varying the aforementioned constraint between 2 and 10 clusters does not result in the emergence of clearly distinctive clusters.

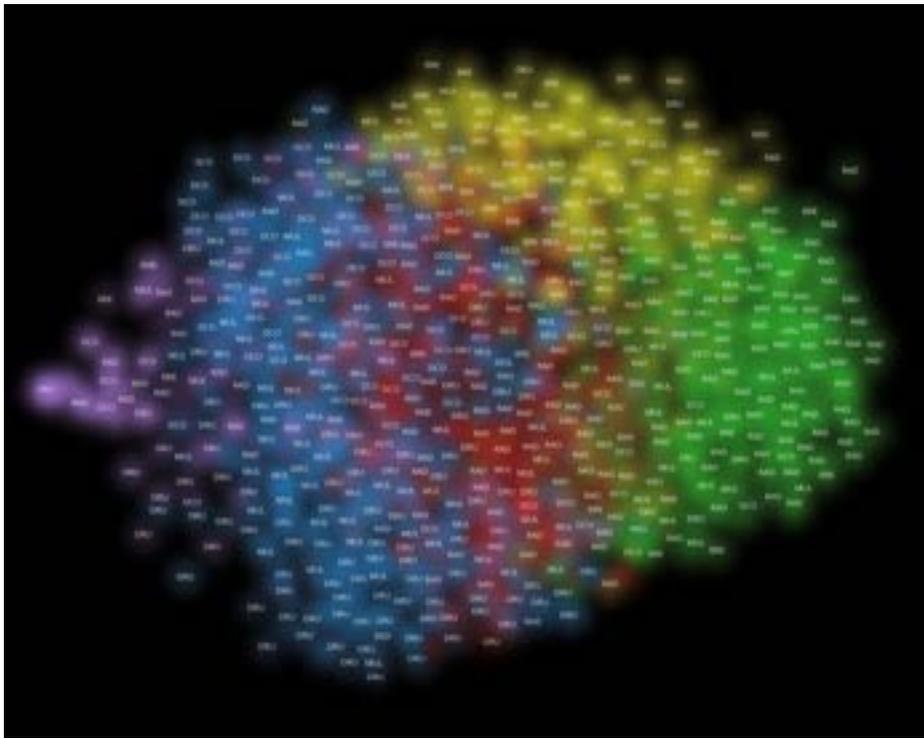


Figure 4. Visualization of clusters of thematically related publications within the network of publications referring to different labels (based on bibliographic coupling). *Notes:* Map of the literature on exceptional innovation based on thematic orientation. Each label represents an article, and the size of the label represents how often the paper is cited within the WOS. Distances reflect the extent to which two papers cite the same papers, an indicator of how thematically related they are. Colors are the result of the assignment of articles to five clusters.

construct the thematic similarity maps. The first approach is to start from the keywords that WOS assigns to articles to measure AS (instead of the references shared). [Figure 5](#) presents the results using the AS measure that signals overlap in WOS keywords. The conclusion from this map is identical to our baseline approach: thematically similar articles (those close to one another in the map) use different labels, and labels appear across the thematic landscape.

Our second approach implies extracting keywords from titles and abstracts. This addresses the concern that the WOS keywords are assigned based on the text of the cited articles, which leaves the concern that shared references reflect more than thematic similarity. To extract keywords, we first merged titles and abstracts, then removed stop words, and applied stemming. We then represented each document as a vector of keywords and a combination of keywords (unigrams and bigrams), ignoring terms that appear in more than 85% of the documents or in fewer than two documents. The Term Frequency–Inverse Document Frequency (TF-IDF) score for each term was calculated as the ratio between the number of times a term appeared in the document and the number of documents it appeared overall. This score is higher for keywords that are specific to a given document. We then postprocessed the result by removing the terms that appeared in at least 20% of the documents to filter our keywords that were too common in our body of literature to represent the specific topic of a given paper. Each of these cutoffs were decided after validating the ability of keywords to represent the topic of the paper for 10 papers that we know in detail. [Figure 6](#) shows the result using the AS measure that uses overlap in TF-IDF-extracted terms and, again, results in the same conclusion as the one from our baseline approach.

To formally compare these three approaches to assess thematic similarity, [Tables 3a–c](#) shows a cross-tabulation of labels and the clusters that are extracted from the map under various definitions of thematic similarity. It displays the actual number of articles under each label that are

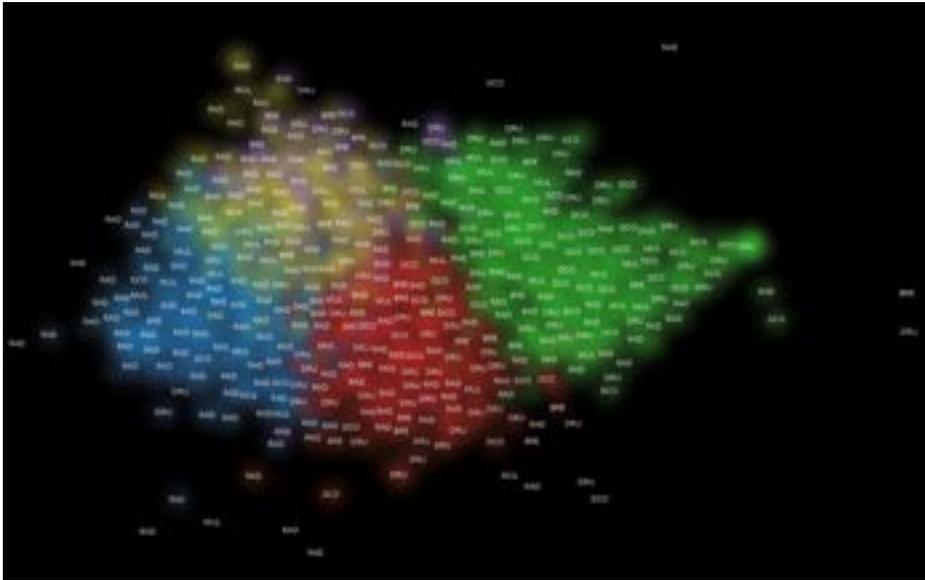


Figure 5. Sensitivity check using WOS keywords to calculate AS. *Notes:* Map of the literature on exceptional innovation based on thematic orientation. Each label represents an article, and the size of the label represents how often the paper is cited within the WOS. Distances reflect the extent to which two papers refer to the same WOS keywords, an alternative indicator of how thematically related they are. Colors are the result of the assignment of articles to four clusters.

assigned to a given cluster, as well as the expected number based on row and column frequencies.¹³ This expected number of articles represents how many co-occurrences we would expect if the labels were distributed among clusters only based on their occurrence in the baseline set. In other words, if all clusters use labels at the same rate as the overall body of literature, we expect this to be the co-occurrence. The table reveals that the actual distribution is very close to such a situation for each of the methods we employed to quantify AS. Combined, the conclusion we draw from our analysis seems robust.

4.3 Analyzing definitions

The bibliometric analyses suggest a considerable overlap between the labels in use, both in terms of intellectual origins and thematic orientation. Despite their clear contribution in terms of rigor, bibliometric methods do not provide a detailed view on the concepts and definitions underlying the different labels in use. Indeed, the results presented so far—in theory—do not exclude the possibility that, for each label, underlying concepts are consistently delineated. To examine whether this is the case, we conduct a content analysis of 60 highly cited papers to extract and analyze definitions used under each label. To address the issue of truncation in citation counts (i.e., older publications have had more time to be cited), the number of citations received by each article is divided by the average number of citations received by all articles with the same publication year. To construct a sample of highly cited publications that cover the different labels, we first define five groups, one for each of the four labels and one for articles covering multiple labels. For each group, we initially restrict ourselves to papers published from 1985 until 2016. We impose this time restriction because citation counts for more recent articles are increasingly noisy (i.e., allowing for a minimum time window should better identify truly impactful articles). For each group, we rank all articles in our set by normalized citation count and analyze the definition of the 10 most highly cited, relevant articles. Articles that appear to be less relevant—because

¹³ Tables 3b and 3c does not include our full set of articles because of missing keyword information in the WOS database.

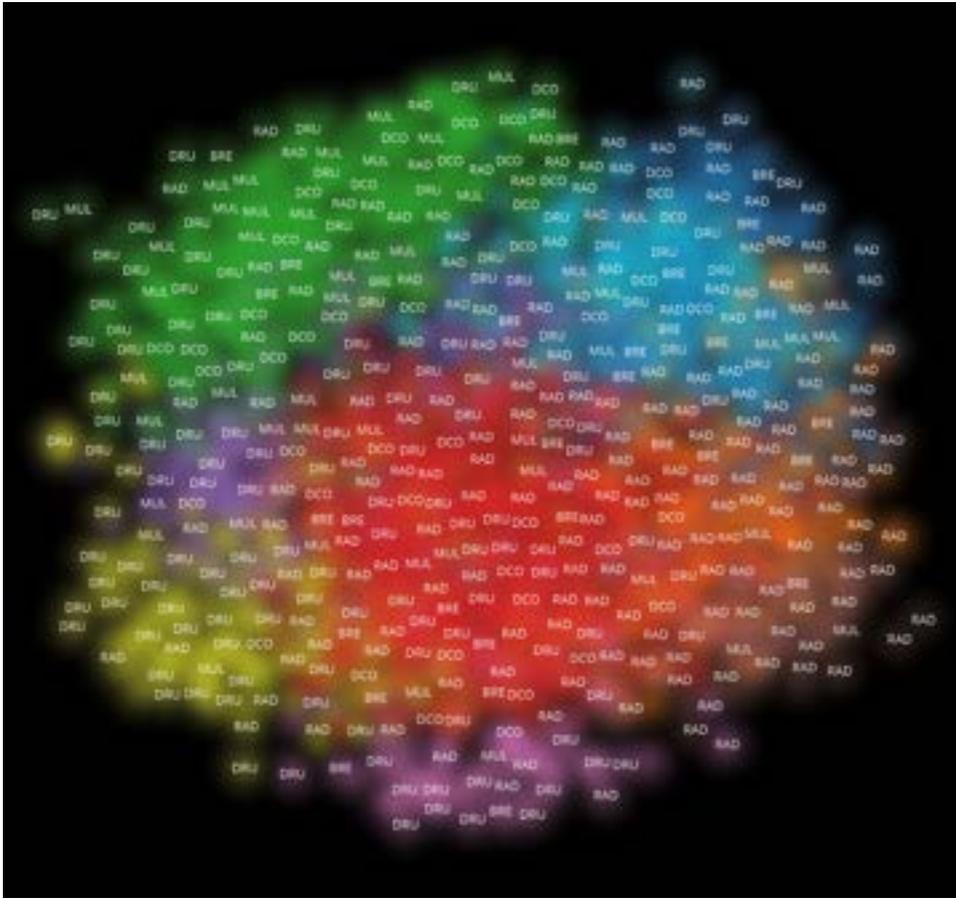


Figure 6. Sensitivity check using TF-IDF keywords to calculate AS. *Notes:* Map of the literature on exceptional innovation based on thematic orientation. Each label represents an article, and the size of the label represents how often the paper is cited within the WOS. Distances reflect the extent to which two papers refer to the same TF-IDF-extracted keywords, an alternative indicator of how thematically related they are. Colors are the result of the assignment of articles to five clusters.

“exceptional” innovation is not a central concept in the analysis—are excluded from this set. Articles covering multiple labels are assigned to the label that is most emphasized within the paper. To cover highly cited articles stemming from the last 5 years in our sample, we also include the 10 most highly cited articles (again, normalizing by year) from 2017 onward. These articles are added to label groups as discussed before. This results in a total sample of 60 highly-cited articles across four labels.

Table 4 summarizes the results of this content analysis, and Table 5 lists the 60 articles analyzed. Three observations stand out. First, 12 out of 60 articles do not explicitly define what exactly is meant by the label used, nor do they explicitly justify or discuss the choice of the label used. The omission of explicit definitions is most pronounced for articles covered by the label “disruptive,” with 7 out of 21 not providing a definition. Second, all papers that explicitly define the type of innovation under study do so by relying on the concepts of (i) novelty and/or (ii) impact. Novelty is typically defined as a characteristic that can be observed *ex ante*—that is, when the innovation appears—and is based on the extent to which the knowledge and components embodied in an invention depart from existing practices. Impact is defined as an *ex post* characteristic that can only be observed in hindsight. Various types of impact are considered to define the exceptional nature of an innovation. The most common ones are the impacts on the

Table 3. Cross-tabulation of labels and thematic clusters using different methods to calculate AS

		(a) Bibliographic coupling					
		Label					
		BRE	DCO	DRU	RAD	MUL	Total
Cluster 1	Nr. Art.	188	208	681	705	98	1880
	Expected	143.4	237.3	481.4	833.9	183.9	1880
Cluster 2	Nr. Art.	49	49	89	732	75	994
	Expected	75.8	125.5	254.5	440.9	97.3	994
Cluster 3	Nr. Art.	23	175	253	175	193	819
	Expected	62.5	103.4	209.7	363.3	80.1	819
Cluster 4	Nr. Art.	58	78	52	224	38	450
	Expected	34.3	56.8	115.2	199.6	44	450
Cluster 5	Nr. Art.	18	46	53	118	27	262
	Expected	20	33.1	67.1	116.2	25.6	262
Total		336	556	1128	1954	431	4405
		336	556	1128.0	1954.0	431	4405

		(b) Web of Science keywords					
		Label					
		BRE	DCO	DRU	RAD	MUL	Total
Cluster 1	Nr. Art.	104	164	467	478	124	1337
	Expected	99.1	175.2	332.9	594.8	135	1337.0
Cluster 2	Nr. Art.	119	235	367	301	111	1133
	Expected	84	148.5	282.1	504.1	114.4	1133.0
Cluster 3	Nr. Art.	34	63	66	620	98	881
	Expected	65.3	115.4	219.3	392	89	881
Cluster 4	Nr. Art.	24	49	70	286	54	483
	Expected	35.8	63.3	120.3	214.9	48.8	483
Cluster 5	Nr. Art.	25	30	58	152	30	295
	Expected	21.9	38.7	73.4	131.2	29.8	295
Total		306	541	1028	1837	417	4129
		306	541	1028.0	1837.0	417	4129.0

		(c) TF-IDF keywords					
		Label					
		BRE	DCO	DRU	RAD	MUL	Total
Cluster 1	Nr. Art.	204	308	534	1312	189	2547
	Expected	194.2	321.3	651.9	1129.9	249.7	2547.0
Cluster 2	Nr. Art.	60	92	105	364	69	690
	Expected	52.6	87.1	176.6	306.1	67.6	690
Cluster 3	Nr. Art.	61	128	142	166	99	596
	Expected	45.4	75.2	152.6	264.4	58.4	596
Cluster 4	Nr. Art.	8	23	269	82	72	454
	Expected	34.6	57.3	116.2	201.4	44.5	454
Cluster 5	Nr. Art.	3	5	78	31	3	120
	Expected	21.9	38.7	73.4	131.2	29.8	295
Total		336	556	1128	1955	432	4407
		336	556	1128.0	1955.0	432	4407.0

Table 4. Conceptualization of “exceptional innovation” in 60 highly-cited publications on “exceptional innovation”

	Novelty	Impact	Novelty and impact	Undefined	Total
Radical	7	2	4	2	15
Disruptive	3	11	0	7	21
Discontinuous	6	2	1	2	11
Breakthrough	0	9	3	1	13
Total	16	24	8	12	60

Results of the analysis of definitions in a group of highly cited articles on exceptional innovation. The sample of highly cited articles contains the 10 most highly cited papers within each label (including “multi”—the articles using multiple labels—which are added to other labels based on which label is emphasized most). The sample of 50 articles only contains those published between 1985 and 2016, allowing all articles at least 5 years to collect citations. In addition, the 10 most highly cited articles published after 2016 are added to the sample (without distinguishing by label). To select highly cited papers, citation counts are normalized by year to reduce the influence of variation in how much time an article has had to be cited. Papers in which the concept of exceptional innovation does not play a prominent role are not retained for the analysis.

technological performance of a product, on the competitive position of firms, and on the knowledge foundations of industries as a whole. While the ubiquitous use of novelty and impact as underlying dimensions might signal consistency, Table 4 demonstrates that there is no consensus on whether any of the focal labels relate specifically to one or the other dimension. Third, a considerable number of papers (eight) provide a definition that combines novelty and impact. This observation is concerning because it feeds the notion that each dimension implies the other: more (less) novelty will result in more (less) impact. However, this is not always the case. Continuous improvements of an incremental nature can have a considerable impact, while a considerable share of novel inventions may not beget any impact.

4.4 Insights literature analysis

Taken together, these results suggest that concerns about conceptual vagueness—raised 20 years ago (Garcia and Calantone, 2002; Gatignon *et al.*, 2002)—are still warranted and pertain to the entire body of literature on exceptional innovations. Different labels to denote exceptional innovations are used widely. They rely on similar sources of inspiration and address highly similar topics, but they are not consistently defined. This situation introduces at least three problems that may stifle progress in the field.

A first problem concerns the interchangeable use of different labels to denote relatively homogenous topics within the literature. This situation unnecessarily creates confusion with respect to the state of the art in the field and adds to the risk of duplication of research efforts. The solution to this problem, however, is rather straightforward. Scholars should be aware of the fact that various—partly complementary, partly substitutable—labels are in use, and they should, therefore, adapt their study of the literature to it.

A second issue is that different studies conceptualize the “exceptional nature” of an innovation differently while using the same label (e.g., see Table 4 for the body of literature on “radical” innovations). For some studies, an innovation qualifies as “exceptional” when it is novel. Others require (high) impact along some dimension, and yet others include both or even conflate novelty and impact into one dimension. This situation is cumbersome because it hampers comparability and hence complementarity or even cross-fertilization between studies. For this reason, it is important that future work clearly defines the underlying concepts when using a label. In addition, it may be necessary to revisit some previous findings through a lens that clearly distinguishes novelty from impact.¹⁴

A third issue concerns the choice of the most useful conceptualization when studying exceptional innovation. As argued previously, conflating novelty and impact into one dimension overlooks “off-diagonal” cases and is likely to result in misleading conclusions. A more rigorous approach would be to study phenomena related to novelty and impact per se—that is, conceptualize both novelty and impact independently and assess potential relationships only in a

¹⁴ For instance, studies of novelty-targeting firm strategies—such as broad technological search—may have drawn overly optimistic conclusions about the effectiveness of such strategies by not explicitly acknowledging novel inventions with little or no technological impact.

Table 5. List of articles used for content analysis of definitions

Label	Authors	Journal	Year	Title
BRE	Ramirez, R	<i>Strategic Management Journal</i>	1999	Value co-production: intellectual origins and implications for practice and research
BRE	Ahuja, G	<i>Strategic Management Journal</i>	2000	The duality of collaboration: inducements and opportunities in the formation of interfirm linkages
BRE	Fleming, L	<i>Management Science</i>	2001	Recombinant uncertainty in technological search
BRE	Zhou, KZ; Yim, CK; Tse, DK	<i>Journal of Marketing</i>	2005	The effects of strategic orientations on technology- and market-based breakthrough innovations
BRE	Geels, FW	<i>Technological Forecasting and Social Change</i>	2005	Processes and patterns in transitions and system innovations: refining the co-evolutionary multi-level perspective
BRE	Phene, A; Fladmoe-Lindquist, K; Marsh, L	<i>Strategic Management Journal</i>	2006	Breakthrough innovations in the US biotechnology industry: the effects of technological space and geographic origin
BRE	Sorescu, AB; Spanjol, J	<i>Journal of Marketing</i>	2008	Innovation's effect on firm value and risk: insights from consumer packaged goods
BRE	Singh, J; Fleming, L	<i>Management Science</i>	2010	Lone inventors as sources of breakthroughs: myth or reality?
BRE	Srivastava, MK; Gnyawali, DR	<i>Academy of Management Journal</i>	2011	When do relational resources matter? Leveraging portfolio technological resources for breakthrough innovation
BRE	Schilling, MA; Green, E	<i>Research Policy</i>	2011	Recombinant search and breakthrough idea generation: an analysis of high impact papers in the social sciences
BRE	Kleis, L; Chwelos, P; Ramirez, RV; Cockburn, I	<i>Information Systems Research</i>	2012	Information technology and intangible output: the impact of IT investment on innovation productivity
BRE	Kaplan, S; Vakili, K	<i>Strategic Management Journal</i>	2015	The double-edged sword of recombination in breakthrough innovation
BRE	Castaldi, C; Frenken, K; Los, B	<i>Regional Studies</i>	2015	Related variety, unrelated variety and technological breakthroughs: an analysis of US state-level patenting
DCO	Tushman, ML; O'Reilly, CA	<i>California Management Review</i>	1996	Ambidextrous organizations: managing evolutionary and revolutionary change
DCO	Benner, MJ; Tushman, ML	<i>Academy of Management Review</i>	2003	Exploitation, exploration, and process management: the productivity dilemma revisited
DCO	Reid, SE; de Brentani, U	<i>Journal of Product Innovation Management</i>	2004	The fuzzy front end of new product development for discontinuous innovations: a theoretical model
DCO	Gilbert, CG	<i>Academy of Management Journal</i>	2005	Unbundling the structure of inertia: resource versus routine rigidity
DCO	Kaplan, S; Tripsas, M	<i>Research Policy</i>	2008	Thinking about technology: applying a cognitive lens to technical change
DCO	Makri, M; Hitt, MA; Lane, PJ	<i>Strategic Management Journal</i>	2010	Complementary technologies, knowledge relatedness, and invention outcomes in high technology mergers and acquisitions
DCO	Vasudeva, G; Anand, J	<i>Academy of Management Journal</i>	2011	Unpacking absorptive capacity: a study of knowledge utilization from alliance portfolios
DCO	Coviello, NE; Joseph, RM	<i>Journal of Marketing</i>	2012	Creating major innovations with customers: insights from small and young technology firms

(continued)

Table 5. (Continued)

Label	Authors	Journal	Year	Title
DCO	Berggren, C; Magnusson, T; Sushandoyo, D	<i>Research Policy</i>	2015	Transition pathways revisited: established firms as multi-level actors in the heavy vehicle industry
DCO	Huenteler, J; Schmidt, TS; Ossenbrink, J; Hoffmann, VH	<i>Technological Forecasting and Social Change</i>	2016	Technology life-cycles in the energy sector—technological characteristics and the role of deployment for innovation
DCO	Adner, R; Kapoor, R	<i>Strategic Management Journal</i>	2016	Innovation ecosystems and the pace of substitution: re-examining technology S-curves
DRU	Christensen, CM; Rosenbloom, RS	<i>Research Policy</i>	1995	Explaining the attackers advantage—technological paradigms, organizational dynamics, and the value network
DRU	Matos, S; Hall, J	<i>Journal of Operations Management</i>	2007	Integrating sustainable development in the supply chain: the case of life cycle assessment in oil and gas and agricultural biotechnology
DRU	Zeschky, M; Widenmayer, B; Gassmann, O	<i>Research-Technology Management</i>	2011	Frugal innovation in emerging markets: the case of mettler toledo
DRU	Pagani, M	<i>MIS Quarterly</i>	2013	Digital business strategy and value creation: framing the dynamic cycle of control points
DRU	Carvalho, MM; Fleury, A; Lopes, AP	<i>Technological Forecasting and Social Change</i>	2013	An overview of the literature on technology roadmapping (TRM): contributions and trends
DRU	Akamavi, RK; Mohamed, E; Pellmann,K; Xu, Y	<i>Tourism Management</i>	2015	Key determinants of passenger loyalty in the low-cost airline business
DRU	Vargo, SL; Wieland, H; Akaka, MA	<i>Industrial Marketing Management</i>	2015	Innovation through institutionalization: a service ecosystems perspective
DRU	Osiyevskyy, O; Dewald, J	<i>Strategic Entrepreneurship Journal</i>	2015	Explorative versus exploitative business model change: the cognitive antecedents of firm-level responses to disruptive innovation
DRU	Karimi, J; Walter, Z	<i>Journal of Management Information Systems</i>	2015	The role of dynamic capabilities in responding to digital disruption: a factor-based study of the newspaper industry
DRU	Kim, SK; Min, S	<i>Strategic Entrepreneurship Journal</i>	2015	Business model innovation performance: when does adding a new business model benefit an incumbent?
DRU	Kamalahmadi, M; Parast, MM	<i>International Journal of Production Economics</i>	2016	A review of the literature on the principles of enterprise and supply chain resilience: major findings and directions for future research
DRU	Rayna, T; Striukova, L	<i>Technological Forecasting and Social Change</i>	2016	From rapid prototyping to home fabrication: how 3D printing is changing business model innovation
DRU	Santoro, G; Vrontis, D; Thrassou, A; Dezi, L	<i>Technological Forecasting and Social Change</i>	2018	The Internet of Things: building a knowledge management system for open innovation and knowledge management capacity
DRU	Lee, I; Shin, YJ	<i>Business Horizons</i>	2018	Fintech: ecosystem, business models, investment decisions, and challenges
DRU	Hinings, B; Gegenhuber, T; Greenwood, R	<i>Information and Organization</i>	2018	Digital innovation and transformation: an institutional perspective

(continued)

Table 5. (Continued)

Label	Authors	Journal	Year	Title
DRU	Gomber, P; Kauffman, RJ; Parker, C; Weber, BW	<i>Journal of Management Information Systems</i>	2018	On the fintech revolution: interpreting the forces of innovation, disruption, and transformation in financial services
DRU	Buhalis, D; Harwood, T; Bogicevic, V; Viglia, G; Beldona, S; Hofacker, C	<i>Journal of Service Management</i>	2019	Technological disruptions in services: lessons from tourism and hospitality
DRU	Bai, CG; Dal-lasega, P; Orzes, G; Sarkis, J	<i>International Journal of Production Economics</i>	2020	Industry 4.0 technologies assessment: a sustainability perspective
DRU	Verhoef, PC; Broekhuizen, T; Bart, Y; Bhattacharya, A; Dong, JQ; Fabian, N; Haenlein, M	<i>Journal of Business Research</i>	2021	Digital transformation: a multidisciplinary reflection and research agenda
DRU	Khanagha, S; Ansari, S; Paroutis, S; Oviedo, L	<i>Strategic Management Journal</i>	2022	Mutualism and the dynamics of new platform creation: a study of Cisco and Fog computing
DRU	Wamba, SF; Queiroz, MM	<i>Production Planning & Control</i>	2022	Industry 4.0 and the supply chain digitalisation: a blockchain diffusion perspective
RAD	Tripsas, M; Gavetti, G	<i>Strategic management journal</i>	2000	Capabilities, cognition, and inertia: evidence from digital imaging
RAD	Subramaniam, M; Youndt, MA	<i>Academy of Management Journal</i>	2005	The influence of intellectual capital on the types of innovative capabilities
RAD	Laursen, K; Salter, A	<i>Strategic Management Journal</i>	2006	Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms
RAD	Markard, J; Truffer, B	<i>Research Policy</i>	2008	Technological innovation systems and the multi-level perspective: towards an integrated framework
RAD	Verganti, R	<i>Journal of Product Innovation Management</i>	2008	Design, meanings, and radical innovation: a metamodel and a research agenda
RAD	Eggers, JP; Kaplan, S	<i>Organization Science</i>	2009	Cognition and renewal: comparing CEO and organizational effects on incumbent adaptation to technical change
RAD	Tripsas, M	<i>Organization Science</i>	2009	Technology, identity, and inertia through the lens of “the digital photography company”
RAD	Andriopoulos, C; Lewis, MW	<i>Organization Science</i>	2009	Exploitation-exploration tensions and organizational ambidexterity: managing paradoxes of innovation
RAD	Ordanini, A; Parasuraman, A	<i>Journal of Service Research</i>	2011	Service innovation viewed through a service-dominant logic lens: a conceptual framework and empirical analysis
RAD	Parida, V; West-erberg, M; Frishammar, J	<i>Journal of Small Business Management</i>	2012	Inbound open innovation activities in high-tech SMEs: the impact on innovation performance

(continued)

Table 5. (Continued)

Label	Authors	Journal	Year	Title
RAD	Zhou, KZ; Li, CB	<i>Strategic Management Journal</i>	2012	How knowledge affects radical innovation: knowledge base, market knowledge acquisition, and internal knowledge sharing
RAD	Ritala, P; Hurmelinna-Laukkanen, P	<i>Journal of Product Innovation Management</i>	2013	Incremental and radical innovation in cooptation—the role of absorptive capacity and appropriability
RAD	Rotolo, D; Hicks, D; Martin, BR	<i>Research Policy</i>	2015	What is an emerging technology?
RAD	Erevelles, S; Fukawa, N; Swayne, L	<i>Journal of Business Research</i>	2016	Big Data consumer analytics and the transformation of marketing
RAD	Mikalef, P; Boura, M; Lekakos, G; Krogstie, J	<i>British Journal of Management</i>	2019	Big Data analytics capabilities and innovation: the mediating role of dynamic capabilities and moderating effect of the environment

subsequent step. In the discussion section of the paper, we explore how (different types of) novelty and impact could be conceived and then, at a later stage, consistently brought together. In doing so, we hope to provide the foundations of a useful conceptualization of “exceptional” innovation as trajectories, which relate novelty to impact in an insightful, pragmatic, and actionable manner.

5. Towards a (useful) typology of innovative trajectories?

5.1 From innovations to innovation trajectories

In this section, we advance a stylized typology of innovative *trajectories* that allows us to relate the nature of novelty to its potential impact. Inspired by evolutionary theories of innovation (Dosi, 1982; Van de Ven and Poole, 1990; Freeman, 1991), we adopt a longitudinal perspective in studying the creation of novelty and the resulting impact as they unfold over time. We define a trajectory as the set of inventions that develops a certain technological approach over time (Dosi, 1982). Combining the insights of Henderson and Clark¹⁵ (1990) and Arthur¹⁶ (2007, 2009), we distinguish between two types of trajectory: *radical*¹⁷ and *architectural*.¹⁸ Radical trajectories imply the introduction of a completely new technological principle. Architectural trajectories introduce a new configuration of (existing) technologies, resulting in at least partially novel functionality. Both trajectories differ fundamentally from each other in terms of time to market, uncertainty, and hence the incentives to become involved.¹⁹

We then explore how these characteristics can be used to relate novelty to impact. First, we consider impact in terms of value creation—that is to say, the market share of the technologies

¹⁵ Henderson and Clark (1990) describe the most well-known—and widely accepted—typology of (individual) innovations. By introducing a distinction between components and architecture, they differentiate between incremental, architectural, modular, and radical innovations. The latter mean that both the architecture and the core components are overturned. Incremental innovations improve the functionality of core components—without fundamentally changing them—while leaving the overall architecture intact. Innovations of a modular and architectural nature replace key components and alter the linkages between components.

¹⁶ Arthur (2007, 2009) extensively discusses the processes behind the creation of radical innovations, which entails the introduction of a new core “principle” of a technology. A principle applies a natural phenomenon to serve a certain purpose. For instance, the principle of a turbojet engine is to use Newton’s second law of motion (a natural phenomenon) for the purpose of accelerating an airplane. In Arthur’s framework, radical “invention” corresponds to introducing a new technological principle. The notion of “standard engineering” captures the continuous improvement of an invention until it reaches satisfactory performance.

¹⁷ Note that modular innovations, as outlined by Henderson and Clark, are considered here as similar to a radical innovation (on the level of a subsystem).

¹⁸ Thus, a resemblance can be noted with the distinction between disruptive and architectural innovation elaborated by Gans (2016). Contrary to Gans and for obvious reasons, we refrain from using the label “disruptive” to refer to the novelty of an innovation.

¹⁹ The reader will note that we have not included “incremental” innovations as a specific trajectory. In this paper, we treat incremental innovations as typical for the latter stages of either radical or architectural trajectories (see *infra*).

stemming from a trajectory. We argue that both trajectory types have the potential to reach market dominance but with considerable differences in terms of time horizons required. Second, we assess how technological novelty might impact the competitive position of the firm. Building on the resource-based view of the firm (Wernerfelt, 1984; Barney, 1991), it is clear that different trajectories entail different processes vis-à-vis existing resource configurations. Radical trajectories involve the replacement of previously critical resources, while architectural trajectories entail reconfiguration processes. Consequently, the impact of both types of trajectory on incumbents can differ substantially.

5.2 Novelty: radical versus architectural trajectories

5.2.1 Radical trajectories: introducing a new principle

Radical trajectories involve the introduction of a completely new technological principle. For instance, the first digital camera introduced the principle of using electronic photodetectors to capture images. At the time of their introduction, such radically novel inventions were often ill-conceived prototypes that did not perform at levels equal to existing technologies. If they came to fruition—that is, by outperforming existing technology—this usually only happened after solving a host of technological problems associated with the principle it introduced (Arthur, 2007). In the case of the digital camera, the first working, portable prototype—with a resolution of 0.01 megapixels and a shutter speed of 23 s—was no competition for existing analog devices when introduced in the second half of the 1970s. It was only through the solution of many intermediate problems—and hence, the introduction of follow-on innovations on the trajectory—that the novel principle was able to achieve its profound impact (i.e., gaining a dominant market share after 2000).

As outlined by Arthur (2007), radical trajectories involve *extended timelines* before performance (potentially) matches that of existing technologies. This time is needed to painstakingly translate a “principle of working” into a “working principle.”²⁰ For most products based on radically novel technologies, the technological principle was introduced decades before. A large number of (incremental) inventions are often necessary to arrive at market entry. Recent COVID-19 vaccines are the first innovations that successfully use messenger-RNA techniques to achieve reliable virus protection. The technological principle—injecting transcribed mRNA molecules to produce a targeted protein—was shown to be viable in animals in 1990 (Wolff *et al.*, 1990). From that point, it took three decades of innovation to solve a host of challenges²¹ specific to the novel principle (Veugelers, 2021).

In essence, radical trajectories are characterized by high levels of *technological uncertainty*. At inception, and often for many years to follow, it is difficult to assess the likelihood that the technology will deliver on its promise. While the potential of a new principle—conditional on success—is usually agreed upon early on, the realization of this potential fundamentally depends on finding previously unknown solutions that may or may not be found by searching and expanding the knowledge space. Consequently, radical trajectories face “Knightian” uncertainty (Knight, 1921).

The combination of long time horizons and high uncertainty shapes the *incentive structure* guiding the development of radical trajectories. Even at modest discount factors, the—often decades—long paths to fruition make investing in radically novel technologies unattractive to profit-oriented actors. In addition, incumbents face high opportunity costs because they are faced with more lucrative short-term opportunities stemming from exploiting existing technologies.

²⁰ “...translating this base principle into physical reality requires the creation of suitable working parts and supporting technologies. These raise their own challenges or problems, the solution to which may raise further challenges. As a result, invention is a recursive process. It repeats until each challenge or problem (and sub-problem, and sub-sub-problem) resolves itself into one that can be physically dealt with. It is challenging, usually lengthy, part-conceptual, and part-experimental.” (Arthur, 2007: 274).

²¹ Most critical problems to be solved came from the immune system destroying the targeted protein and from the fact that first approaches resulted in serious side effects. One critical solution was to replace “uridine”—the molecule appearing in mRNA that provoked the human immune system—with “pseudouridine” (another such molecule) to avoid triggering the immune system after injection (Franzoni, *et al.*, 2022).

Therefore, radical trajectories are often subject to market failures and rely on public investments in their preliminary stages of development (Nelson, 1959; Arrow, 1962; Mazzucato, 2011).

5.2.2 Architectural trajectories: introducing new functionality based on novel configurations

Architectural novelty reconfigures existing component technologies—and their underlying principles—in a new value configuration. Thus, architectural trajectories do not introduce a novel technological principle, but their novelty resides in advancing a new architecture. By using components that are often well developed and have proven their functionality elsewhere, these innovations generally face relatively few technological problems that need to be solved before performance reaches a par with existing technologies. For instance, smartphones did not introduce new technological principles but rather combined existing small but powerful processors and components (including lithium-ion batteries) allowing wireless connectivity into a multifunctional handheld device.

Architectural trajectories typically reach performance *much faster* than radical ones because they do not introduce entirely new principles but rather focus on a new configuration. They reuse existing principles—often embodied in well-developed components—to serve a new purpose. For this reason, the time windows needed to reach important performance increases over existing alternatives can be much smaller than in the case of radical trajectories. A case in point is the introduction of ride-hailing applications for (urban) mobility. These apps combine and reconfigure several existing component technologies, such as mobile internet, GPS, and cars. The fact that each of these component technologies was well developed allowed for fast development and market adoption. The “on-line booking” segment of the US taxi market²² accounted for 58% of its sales in 2017, barely a decade after the inception of ride-hailing companies, such as Uber and Zimride (now Lyft).

Given their reliance on well-established components and technological solutions, architectural trajectories do not face high levels of *technological uncertainty*. While clearly not all architectural trajectories will be successful, their success depends much less on technological factors than on consumer preferences and related adoption behavior.

The (private) *incentives* provided by architectural trajectories are much more favorable than those for radical trajectories. Rapid testing and iterating might result in an appealing market introduction within a relatively short time period. Given this potentially large commercial impact, architectural trajectories easily attract large private investments targeted at the fast development and scaling of products, services, and/or platforms.

5.2.3 And what about incremental (sustaining) innovation?

It is important to note that, even after a trajectory reaches the stage of market acceptance, a long line of sustaining or incremental improvements might still drive the trajectory forward. They refine and optimize previously introduced novelties and further shape both radical and architectural trajectories. Idiosyncratic contributions to performance by incremental innovations are often small but their cumulative impact can be large (Abernathy and Utterback, 1978; Baumol, 2004). A well-known example of such cumulative impact is the continuous miniaturization of semiconductors leading to ever-increasing computational power (in smaller devices). Similar observations can be made with respect to operating systems (both for computers and handheld devices). Given our focus on trajectories, it is clear that sustaining innovations do not constitute a trajectory per se. Rather, they are typical for the later stage of both radical and architectural trajectories.

²² Ride-hailing & Taxi—United States. (n.d.). Retrieved January 4, 2022, from www.statista.com/outlook/mmo/mobility-services/ride-hailing-taxi/united-states.

5.3 Novelty and impact

5.3.1 Impact on value creation

We argue that our typology of exceptional innovation may be useful when assessing the link between novelty and impact. A classic approach in the literature is to define the impact of innovation by assessing actual value creation—namely, to what extent are innovative trajectories able to convince customers and to conquer the market?²³

The answer to this question in the light of our typology is nuanced. Both trajectory types provide potential—but no assurance—to spawn products and processes with superior performance and, therefore, widespread adoption.²⁴ Our longitudinal perspective detaches novelty from impact on value creation. Indeed, the novelty introduced during the early stages of the trajectories may be well-established technological knowledge at the time it exerts an impact on markets. Consequently, it is clear that conflating novelty and impact may fail to account for the complexity inherent in the inventive process.

While the novelty–impact disconnect is common to both types of trajectory, they differ significantly in terms of the time required to achieve the technology-readiness levels needed to acquire meaningful market shares. Radical trajectories typically take decades before they create value in the marketplace (e.g., mRNA, digital imaging, and quantum computing),²⁵ while architectural trajectories can create a significant footprint in the market within a few years (e.g., urban mobility platforms and smartphones). This difference in swiftness of impact—in terms of value creation—is an important factor to take into account for the competitive responses on the level of firms. This is further explored in the remainder of this section.

5.3.2 Disrupting firms (and industries)?

Dating back to the work of Schumpeter, innovation scholars have been interested in the impact of exceptional innovation on the competitive dynamics between firms. In particular, the literature has widely discussed the role of firm characteristics conducive to creating exceptional innovations and firm strategies that may help to avoid becoming exposed to “creative destruction.”

Over recent decades, it has largely been the work of [Bower and Christensen \(1995\)](#), [Christensen and Bower \(1996\)](#), and [Christensen \(1997\)](#) that have directed our attention to the potential disruptive impact of innovation on the competitiveness of the firm. Here, the distinction between radical and architectural innovation seems informative, especially when one takes into account the insights advanced by scholars adopting a resource-based perspective. According to the resource-based view, a competitive advantage can be created and *sustained* to the extent that value propositions are built on (a bundle of) unique and valuable resources. Acknowledging the critical role of resources for the competitive position of firms (within markets) allows us to connect the nature of novelty with the potential firm-level impact. Indeed, as argued by [Tushman and Anderson \(1986\)](#), and more recently by [Gans \(2016\)](#), radical and architectural trajectories involve fundamentally different processes in terms of future relevant resource bundles: *replacement versus reconfiguration*.²⁶

Thus, the type of trajectory may play an important role when addressing the question of which firm is “best placed” to pursue exceptional innovations. Radical trajectories attract fewer private actors in the early stages due to long time horizons and the presence of “Knightian” uncertainty ([Knight, 1921](#)). As the trajectory evolves, however, uncertainty decreases, and the expected profits become quantifiable and lie within acceptable time horizons. The success of “entering the trajectory” will depend on the effectiveness with which the firm is capable of solving technological challenges. Consequently, knowledge in the area of the technological principle can be a key advantage. It is important to note that this knowledge does not necessarily reside within firms

²³ This market-adoption focus is a central theme in the field and can be equally found in the works of Schumpeter, the writings of [Bass \(1969\)](#), and the work on regime shifts ([Dosi, 1982](#); [Geels, 2002](#)).

²⁴ As discussed in the previous section, the individual invention allowing for a leap in performance may be an incremental step in the trajectory rather than a truly novel invention.

²⁵ To the extent that “premature” versions (of a radical trajectory) already enter the market, the overall diffusion path of the new technology tends to be longer than is the case with architectural trajectories.

²⁶ Note that, during the latter sustaining stages of both trajectories, the core process becomes one of refinement/reinforcement.

Table 6. Innovation trajectories

Radical trajectories	Architectural trajectories
Bringing new principles to the market	Bringing new configurations to the market
<p><i>Novelty:</i> working on novel principles (or combinations thereof) means extended time frames and profound levels of technical uncertainty before the implied functionality becomes a competitive reality.</p> <p><i>Impact:</i> if successful, novel principles (technologies) will <i>replace</i> significant parts of the relevant knowledge base of the firm.</p> <p><i>Examples:</i> digital imagery, CRT/LED (screens), quantum computing, nuclear fusion, and fuel cells (hydrogen)</p> <p>“Slow but Devastating”</p>	<p><i>Novelty:</i> creating novel value configurations—based on new combinations of existing technologies—allows to create functional “breakthroughs” in a relatively short time period. Uncertainty resides mainly in the extent to which customers/market segments will embrace the new value proposition.</p> <p><i>Impact:</i> if successful, novel configurations will <i>redefine</i> significant parts of the relevant knowledge base of firms.</p> <p><i>Examples:</i> digital platforms for mobility, e-commerce, social media platforms, and business model innovations (e.g., servitization)</p> <p>“Fast and Furious”</p>
Incremental trajectories	
Optimizing/improving radical and architectural trajectories previously introduced (exploitation)	
<p><i>Novelty:</i> Over time, radical and architectural trajectories might achieve a “dominant” design status within their industries. At that moment, innovations become incremental.</p> <p><i>Impact:</i> will further <i>reinforce</i> the relevant knowledge base of the firm, potentially resulting in superior competitive positions. Levels of uncertainty are limited, and new generations are introduced steadily.</p> <p><i>Examples:</i> processors/memory chips, sensors (silicon based), and fuel-efficient gasoline.</p> <p>“Festina Lente”</p>	

that traditionally serve the target market of the trajectory. Incumbents (in markets potentially affected) may not be able to compete in efficiently solving some of the key problems imposed by the trajectory when they lack sufficient relevant technological resources (e.g., current taxi companies that face the challenge of complementing their current services with a digital platform). Their resources and capabilities—that are to a large extent geared to older, established technological principles—lose their relevance and, in a number of instances, may become completely obsolete in the face of radical trajectories. If this is the case, engagement in the radical trajectory means that incumbents are faced with the challenge of simultaneously developing new (technical) capabilities and disposing of resources (know-how, machinery/installation, and R&D personnel) that were a core element in their success in a previous era. Therefore, new entrants, consisting of either existing firms with a set of more relevant (technological) set of resources or entrepreneurs backed by venture capital, may be the prime beneficiaries of radical trajectories.

Combining the extended time frames required for these trajectories to unfold with their “creative destruction” potential on the relevant resources of firms, radical trajectories can be labeled as “slow but devastating” (Table 6).²⁷

Innovation in the early stages of architectural trajectories is more lucrative in the short term. Since existing—and proven—component technologies are directly relied on, technical uncertainties reside mainly in the creation of a novel architecture (integration). Success depends on the speed with which solutions to initial problems in the trajectory are addressed, and uncertainty mainly comes from whether markets quickly adopt the new functionality based on novel architectures. Fast prototyping is instrumental in reducing uncertainty related to customer preferences and, hence, market acceptance. To the extent that economies of scale or network externalities

²⁷ Note that this type of trajectory resembles the disruptive paths described (and theorized) by Christensen. The time frames required to arrive at “mature” functionality also explain why, in a number of cases, entry is situated outside the mainstream market and/or pursued by new entrants rather than incumbents.

arise, growth curves may become very steep for entrepreneurs and incumbents alike. Technological sophistication or superiority in terms of further improving technology is less critical than in the case of radical trajectories. Capabilities pertaining to branding, scaling, and/or business model innovation are often more critical. Given the architectural nature of the innovation, its impact on relevant resource bases is often less devastating because particular components (resources) remain an integral part of the new technology. Therefore, architectural configurations entail processes of complementing rather than replacing. Whether, and to what extent, the introduction of novel architectures will pose a serious threat to incumbents will critically depend on how easily new and relevant resources can be developed (or acquired), to what extent existing, complementary assets will continue to be relevant,²⁸ and how easily both can become integrated (in this respect, see, among others, the work of Tripsas (2009), Tripsas and Gavetti (2000), Teece (1986), Van Looy *et al.* (2005), and Danneels (2007, 2011)). A good example are companies that currently offer mobility services using digital platforms (e.g., Uber, Lyft, and Lime). While they do compete using a different value proposition, core constituents of the service offer (including driver, car, and bicycle/scooter) have existed in the marketplace previously. Digital platforms are being added to facilitate and optimize the different steps in the service journey. If these new value configurations become the preferred option for larger segments of customers, incumbents (e.g., traditional taxi companies) may well be forced to add similar functionality [and invest in the development of relevant (Information Technology) capabilities]. However, previous assets (including physical equipment and human capital) will remain relevant. Adaptation processes revolve around complementing and integrating, and not replacing.

As architectural innovations combine speed with the potential for considerable impact—especially if economies of scale (or network externalities) are crucial—they can be labeled as “fast and furious” (Table 6).

As both trajectories evolve, further incremental improvements will prevail, resulting in incentives that are similar for both radical and architectural trajectories (during the later stages). With these sustaining innovations occurring in the later stages of both radical and architectural trajectories, it should be noted that the immediate impact will be modest. At the same time, their cumulative impact will be considerable over time. Thus, the label “festina lente” seems appropriate to describe market dynamics during such phases (Table 6). Firms that are consistent in further investing in refinements and optimization might benefit over time in terms of market share/dominance—for example, operating systems for computers/handheld devices (Windows and Android) or processors (Intel).

Finally, it follows that both types of trajectory also differ significantly in terms of impact of a more aggregated nature—namely, at the level of the technological regime of industries. Only radical trajectories have the potential to replace existing technological regimes, which—by definition—coincide with the relevant knowledge base of firms operating in these industries. Architectural innovations involve a reconfiguration of relevant resources, which might eventually blur the boundaries between industries (is Uber a taxi company or an IT firm?), while incremental innovations only reinforce and refine existing regimes and their knowledge constituents.

6. Discussion and conclusion

This paper revisits concerns about the lack of clarity in the literature on “exceptional” innovation by conducting a bibliometric analysis of 4407 articles that use the labels radical, disruptive, breakthrough, or discontinuous innovation. Our analysis shows that the body of literature on exceptional innovation shares similar intellectual foundations and thematic areas, but definitions within labels are inconsistent and similar definitions are used across labels. In order to provide conceptual clarity, we advance a typology of innovative trajectories that treats novelty and impact as distinct but related concepts.

²⁸ Similar considerations apply to the case of “modular” innovation, and the fourth type of innovation included in the framework of Henderson and Clark. Here, a new principle is being introduced on the level of a subsystem (or component). Whether or not incumbents are able to follow a “plug and play” strategy (by replacing one component with the novel technology) will depend on the complexity of integration and the competitive relevance of complementary resources.

By building on the consensus within the existing literature that novelty and impact are the underlying constituents of exceptional innovation, we advance a nomological network²⁹ (Cronbach and Meehl, 1955) that relates these two distinct concepts. We propose using the idea of trajectories to incorporate the fact that the development of technologies and, consequently, the realization of impact imply a temporal dimension.

Our contribution differs from previous work in several ways. Whereas Garcia and Calantone (2002) proposed a new classification³⁰ without always providing a clear delineation of different types of novelty or impact,³¹ our typology explicitly distinguishes between these dimensions and relates them within a coherent framework. Gatignon *et al.* (2002) characterize innovations in terms of “its locus in a product’s hierarchy (core/peripheral), its type (architectural or generational), and its characteristics (competence-enhancing/destroying, and incremental/radical)” (Gatignon *et al.*, 2002: 1105). As such, no explicit distinction between novelty and impact is proposed. At the same time, it can be noticed that, within our typology, impact on existing competencies (replacing, redefining, and reinforcing) is equally inspired by the work of Tushman and Anderson (1986) and Anderson and Tushman (1990), which is also central in the framework of Gatignon *et al.* (2002).

More recently, several papers have raised similar issues with respect to the notions of radical, disruptive, and breakthrough innovations.

Hopp *et al.* (2018a, b) focus on disruption³² by analyzing 1078 relevant publications. They rely on natural language processing techniques to develop a thematic map (consisting of 84 distinct topics). In the next step, two subnetworks emerge focusing on disruptive and radical innovation, respectively, and depicted as “two sides of the same coin.” In Hopp *et al.* (2018b), the distinction between radical and disruptive innovation is further substantiated by relying on the themes identified. For disruption, the definition stays close to Christensen’s definition, whereas radical is defined as pertaining to creating and commercializing novelty. However, adherence to the related topics does not result in a clear distinction between novelty and impact.³³ The implications are surprisingly far-reaching as they result in diametrically opposing (conceptual) conclusions.³⁴

Datta and Srivastava (2022) focus on breakthrough innovation by analyzing a set of publications ($n = 86$) pertaining to the theme. While also advancing a nomological network (by means of a configuration–application–performance framework), they do not comprehensively relate different types of innovation to impact.³⁵ Notice that we concord with their conclusions on breakthroughs as reflecting impact whereby different types of novelty can indeed produce this effect.³⁶ At the same time, within our typology, incremental innovation might result in (product) functionality improvements (of an exceptional nature) but will not disrupt existing resource configurations of firms (or industries).

Frenken and Punt (2023) adopt a neo-institutional sociological perspective, viewing novelty as becoming apparent during the diffusion process. Radical innovations introduce new categories

²⁹ A nomological network represents the system of relationships between theoretical constructs and observable variables. It encompasses the empirical laws linking these constructs to each other and to their observable manifestations. This network is essential for establishing construct validity, as it integrates theoretical propositions, empirical findings, and the operational definitions of the constructs.

³⁰ Distinguishing between radical, really new, discontinuous, incremental, and imitative innovations.

³¹ For example, when delineating the notion of “really new inventions.” This type of innovation coincides with either a market discontinuity or a technological discontinuity but not both: “If both do occur, it should be classified as a radical innovation, if no discontinuity occurs ... it should be classified as an incremental innovation.” (p. 123)

³² Notice that the search key also includes radical, discontinuous, architectural, and breakthrough innovations. Data have been extracted in 2016 explaining the difference in terms of number of publications vis-à-vis our selection.

³³ Which actually should not come as a surprise given the conceptual “nonchalance” characterizing the field as documented earlier.

³⁴ For example, John Deere’s creation of a (digital) platform described in Hopp *et al.* (2018b) as radical, would be classified in our typology as architectural.

³⁵ At the same time, a lot of relevant contingencies are introduced (e.g., the impact of past experiences and risk averseness), and different managerial decision options (e.g., make or buy) are presented.

³⁶ “We define breakthrough innovation as high-impact technological inventions that may originate from a prior radical/incremental or architectural/modular innovation trajectory, could be competence enhancing or destroying, take the form of a product, process, or business model, and are measured through its performance outcomes.” (Datta and Srivastava, 2022: 10)

in the minds of relevant actors, disruptive innovations stretch existing categories, and breakthroughs provide leaps in performance withing existing categories. This approach differs from ours, as we consider both *ex ante* novelty and impact as distinct constructs. Novelty, in our framework, can be assessed shortly after the innovation is conceived, while impact is realized *ex post*. We acknowledge that a neo-institutional sociology perspective is useful by highlighting that the nature and impact of innovations are socially constructed, but we maintain that a formal distinction between novelty and impact is instrumental and valuable for our understanding of how innovation trajectories are launched, evolve, and realize impact.

Knuepling *et al.* (2022) review 532 prominent articles to provide a detailed analysis of how the terms “radical,” “discontinuous,” “disruptive,” “breakthrough,” “continuous,” and “incremental” are defined. They identify three key dimensions—requirements, features, and effects—and examine the frequency with which these dimensions appear under each label, finding significant overlap across definitions. Their work produces a descriptive framework that captures the variety of definitions in the literature. Similarly, our large-scale bibliometric study and analysis of definitions reach a comparable conclusion. However, our approach is more normative, as we propose a typology aimed at resolving some of this ambiguity.

Our framework also provides practical implications for understanding the impact of different innovation trajectories on market dynamics (Christensen, 1997). While we agree with Christensen that market “turmoil” can result from all types of innovation (radical, architectural, and incremental), we further argue that the nature of the innovative trajectory has differentiated implications for firms’ competitive positions. Our typology, based on core premises of technology and innovation management, explains the appropriateness of responses, which, according to our typology, critically depends on the impact on a firm’s resource base—a view inspired by earlier work of Tushman and Anderson (1986), Barney (1991) and shared by Gans (2016). Thus, our framework might inspire managers to develop scenarios in which alternative configurations—either radical or architectural—become industry standards. This will allow to assess the implications for future resource configurations and the swiftness of these changes, inspiring strategic decision-making. As such, understanding the nature of innovation trajectories enables to better anticipate the potential impact of different types of innovation and make informed strategic decisions about resource allocation and development. Stated otherwise, our typology allows for a nuanced analysis of how innovations can reshape markets and influence the future relevance of firms’ resource configurations.

In summary, our work enhances the understanding of exceptional innovation by providing a robust framework that distinguishes between novelty and impact, offering clearer guidance for both theoretical development and practical application in innovation management. One direction for future research is to strengthen our framework by linking its core constructs to measurable outcomes (Cronbach and Meehl, 1955). Another direction is to use these measures to test how radical versus architectural novelty affects different types of resources and to assess its impact as well as the feasibility and effectiveness of incumbent firms’ strategic responses. We hope our study encourages further theoretical refinement and empirical work alike.

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