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# Circular economy and resilience: A research agenda

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## Abstract

The circular economy is argued to be a way of organising industrial systems that support resilience through decoupling economic growth from material consumption. Yet, extant research exploring the impacts of circular economy business practices on resilience is nascent, with few studies detailing if and how these practices enable firms, industries and social-ecological systems to adapt and transform in the face of shocks and disturbances. In this article, we seek to advance research on the circular economy by proposing a research agenda that connects the circular economy to resilience at multiple levels. Based on insights from resilience theory and findings from the limited literature on the circular economy that has considered resilience to date, our research agenda focuses scholarly attention on key areas of congruence and contestation. We posit that pursuit of answers in these areas has the potential for advancing circular economy business practices capable of supporting resilience at multiple levels.

**KEYWORDS**
adaptation, circularity, research agenda, resilience, resource loops, transformation

## 1 | INTRODUCTION

The declining state of the natural environment raises substantial concerns about how current industrial systems are eroding the resilience of social-ecological systems—that is, the ability of ecosystems and human society to cope with shocks and disturbances that may lead to non-linear and transformative change (Folke et al., 2010). Resource extraction, land-use changes and unfettered waste and emissions are pushing social-ecological systems towards exceeding adaptation limits and entering new regimes of functioning that are far less favourable for human existence and economic activity (Steffen et al., 2015, 2018). The circular economy has emerged as an alternate way of organising industrial systems, seeking to ensure that social-ecological systems stay within limits favourable to human life by reducing the exploitation of raw materials and decreasing industrial emissions and waste.

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The aim of the circular economy is to create industrial systems 'that are restorative or regenerative by intention and design' (Ellen MacArthur Foundation, 2013, p. 7). Managers are guided to maximise value from extracted materials by *narrowing resource loops* (e.g., improving resource efficiencies), *slowing resource loops* (e.g., increasing resource longevity) and *closing resource loops* (e.g., eliminating waste through recycling) (Bocken et al., 2016). Through these practices, the circular economy seeks to keep ecosystems and biodiversity intact by consuming renewables at or below regenerative rates and slowing the extraction of non-renewables (Goodland, 1995). This, in turn, reduces land-use pressures and enables ecosystems degraded by economic activity to be restored (Ellen MacArthur Foundation, 2021). By reducing and removing waste and emissions from industrial processes, the circular economy aims to keep waste within the assimilative capacity of ecosystems. For instance, implementing circular economy practices such as resource-efficient construction, sustainable food production, avoiding planned obsolescence for consumables (including electronics and textiles) and optimised transportation planning can lead to substantial decreases in greenhouse gas emissions (Circle Economy, 2021).

However, management studies bridging the circular economy and resilience are sparse, leaving critical questions unanswered, including how pursing the circular economy may influence firm, industry and social-ecological resilience and how principles of resilience may be integrated into circular business practices. While management research on the circular economy shares some foundations with management research on resilience (e.g., both research streams seek to develop managerial solutions to address complex environmental challenges), they have developed largely independently and have substantial differences in focus and key managerial practices. Circular economy business practices are implicitly assumed to build social-ecological system resilience, that is, the resilience of interacting, nested systems at multiple levels. Yet, the conceptual or empirical research that supports this assumption through explicitly studying the areas of compatibility and contestation of the two domains is lacking. By not engaging with the discourse on resilience more deeply, we posit that circular economy research is in danger of advocating business practices that may lead to suboptimal outcomes for resilience and may even increase the vulnerability of firms, industries and social-ecological systems to collapse. For instance, practices that seek to increase resource efficiencies in the circular economy may remove the buffers, diversity and slack resources needed to withstand and adapt to shocks and disturbances.

To advance the circular economy, we propose a new research agenda that connects it to resilience at multiple levels. Our research agenda firstly contributes by providing an explicit foundation for management scholars on which to engage with the circular economy from a resilience perspective. We discern the two fields of the circular economy and resilience and draw distinctions between their principles and business practices. Furthermore, we offer an examination of the limited body of literature that has sought to connect the two fields to date. Secondly, our research agenda helps to focus the attention of management scholars to the critical intersections between the circular economy and resilience by identifying and explaining the key areas of congruence and contestation. We argue that advancing circular economy research in these directions offers the potential to inform circular economy business practices that account for how they impact the adaptive and transformative capacities of firms and industries.

This article is organised as follows. We begin our investigation by offering background about the two domains and key principles and practices of business management (Section 2). Then, we review the limited body of existing work in management studies that links these two domains (Section 3). We then build a research agenda linking the circular economy and resilience by examining the three main circular economy business practices (Section 4) before offering some concluding remarks.

## 2 | BACKGROUND

In the following section, we explore the key principles and business practices from both the circular economy and resilience literatures. We summarise key insights from the different sections in Table 1 below.

**TABLE 1** Summary of insights from the circular economy and resilience literature

| Dimension | Circular economy | Resilience |
|---|---|---|
| Seminal works | Boulding (1966); McDonough and Braungart (2008); Pauli (2010) | Natural sciences: Holling (1973); Gunderson and Holling (2002)<br>Management sciences: Meyer (1982)—environmental jolts; Weick and Roberts (1993)—collective mindfulness; Weick et al. (1999)—high reliability organizing |
| Definition | 'Industrial systems that are restorative or regenerative by intention and design' (Ellen MacArthur Foundation, 2013, p. 7). | Natural sciences: 'The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks' (Walker et al., 2004, para. 7)<br>Management sciences: 'Organizations that are able to respond more quickly, recover faster or develop more unusual ways of doing business under duress than others' (Linnenluecke, 2017, p. 4) |
| Key principles | Material health (e.g., non-toxic products)<br>Material recirculation<br>Eliminate waste<br>Renewable energy | Adaptability<br>Transformability |
| Business practices | Narrowing loops<br>Slowing loops<br>Closing loops | Slack and buffer capacities diversification<br>Redundancy |

## 2.1 | The circular economy

The circular economy is an approach to decouple economic activity from negative environmental impacts of production and consumption (Ellen MacArthur Foundation, 2013), in contrast to the prevailing linear economy wherein raw materials are extracted to make products that become waste after consumer use (Murray et al., 2017). The idea is for companies and industries to maximise value by introducing a high level of interconnectedness and resource dependency amongst various actors (suppliers, customers, etc.). As such, circular economy strategies seek to reconfigure businesses and industries to become industrial systems of closed material loops with the goal of eliminating waste and pollution, enabling multiple product life cycles, and maximising the use and embedded value of products and materials, as well as capacity for resource use (Lacy & Rutqvist, 2016).

### 2.1.1 | Key principles

Central to the circular economy are concerns regarding which materials should circulate within industrial systems and how. While there is no prevailing list of managerial recommendations (Merli et al., 2018), several principles appear consistently in extant literature. First, firms must consider the health implications of products, including packaging and production processes. Materials should be non-toxic (or at least cause no harm to humans and the biosphere) and preferably offer positive impacts (Braungart et al., 2007). Second, materials need to return to either the biological cycle or the technical cycle (McDonough & Braungart, 2008). Consumables such as food, detergents and shampoos are part of the biological cycle and should return to the biosphere through decomposition. Durables such as televisions, computers and automobiles are part of the technical cycle and should maximise services to users through sequential loops (McDonough & Braungart, 2008). Third, products, production processes and industrial symbioses should be intentionally designed to eliminate leakage of energy and materials (Ellen MacArthur Foundation, 2013; Murray et al., 2017). The circular economy reconceptualises waste as 'food' that can be continuously fed back into the two cycles via interconnecting industrial processes. Fourth, industrial processes should be powered by renewable energies (Ellen MacArthur Foundation, 2013) to reduce resource dependency and carbon emissions.

### 2.1.2 | Business practices

Business practices for the circular economy centre on improving the efficient use of resources and prolonging their use (Blomsma & Brennan, 2017; Lüdeke-Freund et al., 2019). A popular conceptualisation presents the three core strategies of narrowing, slowing and closing resource loops (Bocken et al., 2016; Braungart et al., 2007) mentioned in the Introduction. Narrowing resource loops involves reducing the resources required per product and minimising the number of products required to meet customer needs and is already a common component of firm strategies within the linear economy (Bocken et al., 2016). Narrowing may be achieved by finding more efficient ways to produce products and by redesigning products to use fewer materials (Lüdeke-Freund et al., 2019). Furthermore, firms may consider how to dematerialise offerings to replace physical resources with digital offerings or services (Geissdoerfer et al., 2020).

Slowing resource loops refers to maximising the amount of time materials spend within the economic system and intensifying their usage (Bocken et al., 2016). Slowing resource loops requires firms to find ways to maximise the number of consecutive life cycles by maintaining materials in a product state for as long as possible (reusing) before moving to cycles requiring disassembly of components and parts (remanufacturing) and eventually breaking down materials to elements to provide a fresh supply of raw materials (recycling) (Blomsma & Tennant, 2020; Sirkin & Houten, 1994). Firms are encouraged to circulate materials in the tightest loops possible, for as long as possible. Business practices include designing products to extend their useful lives (e.g., long-life design, repair, and upgrading) or facilitating transitions to new lifecycles (e.g., design for disassembly) (Bocken et al., 2016). Innovative business models can support looping to enable multiple product use phases while maintaining resource value. For instance, instead of buying and then discarding products, rent, lease or pay-per-use arrangements facilitate the return of products to firms and maximises their use by serving multiple customers over short periods of time (Lüdeke-Freund et al., 2019; Tukker, 2004).

Closing resource loops involves actions to prevent the leakage of materials from industrial systems. Internally, firms collect material waste and by-products of production processes to use within their own operations or offer them to other firms as inputs for industrial processes, known as industrial symbiosis (Chertow, 2000). Such inter-firm resource exchanges may take advantage of geographic proximities to connect firms from different industries and form eco-industrial parks (Chertow, 2000). Firms may consider product designs and how easily products may return to biological and technical cycles through strategies such as design for disassembly (Bocken et al., 2016). Externally, managers are required to close post-consumer loops to return resources to the industrial system after their first lifecycles through product collection systems and reverse logistics. Firms may also consider how to close post-society resource loops (Wells & Seitz, 2005) that have already leaked from the industrial system, such as plastic in the ocean.

## 2.2 | Resilience

The concept of resilience can be defined as the capacity of social-ecological systems (and entities therein, such as firms) 'to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks' (Walker et al., 2004, para 7). Resilience is thereby generally understood as a multi-scale concept to assess interacting, nested entities (e.g., firms) and systems (e.g., supply chains, industrial systems and social-ecological systems) (Holling et al., 2002). Resilience research has focused on studying resilience *at* different levels of analysis (e.g., Berkes & Ross, 2016; Linnenluecke, 2017). For instance, researchers who study firm-level (or organisational) resilience are commonly interested in identifying 'the inherent characteristics of those organizations that are able to respond more quickly, recover faster or develop more unusual ways of doing business under duress than others' (Linnenluecke, 2017, p. 4). Yet, due to growing concerns about issues such as climate change, biodiversity loss and sustainable development more broadly, interdisciplinary work is increasingly examining resilience *across* different levels to study how changes in resilience at one level can impact resilience at other levels. This work includes studies of how firms, industries and communities can maintain resilience (often narrowly defined as economic prosperity) while preventing destruction of the life-supporting foundations provided by ecosystem resilience (Dentoni et al., 2021; Williams et al., 2021).

### 2.2.1 | Key principles

While various literatures on resilience have evolved separately, several key principles underpin resilience thinking. First, managing for resilience requires embracing a continually changing world and building adaptive and transformative capacities to understand, anticipate and respond to various types of disruptions and change (Walker et al., 2004; Walker & Salt, 2006). Adaptability concerns actors' ability to build resilience by adjusting in the face of change (Walker et al., 2004). Managers must be sensitive to feedback signals from the systems in which they are embedded and take action to avoid adverse outcomes at the firm, industry or social-ecological system level (Williams et al., 2021). However, sudden changes to internal processes or external shocks and disturbances can cause critical adaptation limits to be exceeded (i.e., an organisation or system cannot adapt fast enough to continue with business-as-usual), forcing organisations and broader systems to either decline or transform (Dow et al., 2013). For instance, a forestry company may cease operations when the land on which it operates can no longer sustain a healthy forest, or it can transform (e.g., into a livestock agribusiness) and continue operating. Transformability refers to actors' capacities to deal with transformative change (Walker et al., 2004) by thinking about value creation in profoundly new ways; by reconfiguring structures, processes and interactions to conform with completely new ways of thinking; and by establishing new governance arrangements in social-economic systems (Folke et al., 2010).

### 2.2.2 | Business practices

Practices for building resilience vary depending on the level (firm, industry, social-ecological systems) at which resilience is meant to be achieved. At the organisational level, management scholars have devoted significant attention to how organisations can build *internal resilience* by organising for high reliability (i.e., improving their abilities to discover and correct failures before they escalate). Organising for high reliability requires collective mindfulness (e.g., Weick & Roberts, 1993) as well as 'a preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and underspecified structuring' (Weick et al., 1999, p. 84). The principles are particularly relevant for organisations that need to operate with high levels of reliability, such as hospitals, air traffic controllers or nuclear power plants (Roberts, 1990). Other work has focused on how organisational resilience can build *resilience to exogenous change* through adaptable business models, rapid responses (e.g., rapid innovation) and the establishment of resilient supply chains (e.g., Davis et al., 2021; Hamel & Valikangas, 2003; Linnenluecke, 2017; Rusinko, 2020).

A commonly mentioned principle for both internal resilience and resilience to exogenous shocks is the implementation of slack and buffer capacities within a firm and across its supply chain to avoid tight coupling and high levels of interconnectedness that can lead to cascading or escalating failures within or across firms. Such capacities can be achieved through diversification (e.g., across supplier/buyer networks, markets and manufacturing sites) and redundancy (e.g., of structures, relationships and personnel), which enable functions to continue in times of adversity. Companies can also invest in insurance, accumulate financial resources or choose alternative locations (Hillmann & Guenther, 2021; Linnenluecke, 2017). Other research has highlighted the importance of social networks, as well as access to financial and human resources in order to react quickly (e.g., Gittell et al., 2006).

Researchers are increasingly looking beyond the firm's boundaries to understand the intersection between firms and the resilience of larger systems within which the firm is embedded. An industry-wide lens reveals how firms are interdependent and provides opportunities for business practices that aim to strengthen entire economic sectors. Business practices have focused on determining the optimal configuration of entire industry networks through principles such as diversification, flexible design and the reduction of possible bottlenecks (e.g., Mackay et al., 2020), as well as careful management of interdependencies.

Researchers are also beginning to consider how managers can simultaneously build organisational resilience and resilience of social-ecological systems as many business practices that have created (financially and economically) resilient firms come at the expense of social-ecological system resilience. For instance, in the face of climate change, ski resorts may choose adaptation practices such as the expansion of ski slope terrain and the production of artificial snow that further deplete natural resources (Tashman & Rivera, 2016). Business practices that support social-ecological system resilience include building sensitivity and a deeper understanding of complex social-ecological dynamics (Williams et al., 2021), establishing cross-sector partnerships to understand interconnections between issues and actors and strengthen collective learning (Dentoni et al., 2021) and proactively transforming firms to avoid surpassing the adaptation limits of the biosphere (Clément & Rivera, 2017). There is also evidence that, through agency, organisations can restore social-ecological system resilience, for instance by restoring protected areas to improve flood control and cultural and recreational value (Olsson et al., 2004).

## 3 | THE CIRCULAR ECONOMY AND RESILIENCE IN MANAGEMENT STUDIES

In this section, we interrogate the circular economy from a resilience perspective by drawing upon the limited body of existing work in which scholars have sought to connect the two conceptual domains. To date, the two literatures have evolved separately for the most part. A search on the Web of Science reveals approximately 100 articles that refer to both resilience and the circular economy, but a closer examination reveals that few provide an investigation of how these concepts intersect and whether they instruct competing or complementary practices. Consequently, although authors have written about the need to connect the circular economy with resilience, few theoretical, empirical and practical insights have accrued on potential synergies and trade-offs between them. Nevertheless, we summarise these below in this section based on level of focus: firm and industry-level resilience, economic resilience and social-ecological resilience.

### 3.1 | The circular economy and firm and industry resilience

Some scholars have examined implications of the circular economy for firm- and industry-level resilience, arguing that adopting dynamic capabilities, reducing dependence on raw materials and increasing access to exchange partners within a circular economy can promote resilience. For instance, Bag et al. (2019) identified the moderating effect of *flexible* versus *control orientation* on the relationship between dynamic remanufacturing capability (i.e., 'the ability to produce remanufactured parts as per market demand using existing resources and current capacity of the plant', p. 865) and supply chain resilience within a circular economy. The authors concluded that, overall, dynamic remanufacturing capability increases *adaptability and flexibility*, which, in turn, increases resilience. However, research on the use of dynamic remanufacturing capabilities to promote organisational and supply chain resilience remains limited; as such, theoretical and empirical evidence supporting the adoption of dynamic remanufacturing as a resilience strategy requires further exploration.

Other researchers have focused on *supply diversity*, arguing that reduced dependence on raw materials can promote organisational resilience in a circular economy. Baars et al. (2021) examined the effectiveness of this strategy for the process of manufacturing electric vehicle batteries, which is highly dependent on sourcing cobalt (a by-product of mining nickel and copper). The authors concluded that circular economy strategies can increase supply diversity through battery reuse and recycling and, subsequently, supply chain resilience. Fisher et al. (2020, p. 97) agreed: 'recovering, reusing, recycling and valorising waste resources … will further increase the resilience of manufacturing systems from disruptions in the supply chain'. Walls and Paquin (2015) added that diversity is an important mechanism to create resilience within such systems, as a more diverse range of actors (e.g., suppliers) can fill any gaps created when an actor leaves the system. However, and as we further examine below, researchers have not examined possible new dependencies that are created (e.g., between a firm and the actors required to implement reuse or recycling strategies) and their impacts on organisational resilience.

Scholars have also examined implications of the circular economy for the resilience of organisational networks. Fraccascia et al. (2020) discussed the relationship between *redundancy* and *resilience* within a circular economy network. Specifically, the authors discussed the resilience of so-called industrial symbiosis networks, which engage 'traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and/or by-products' (Chertow, 2000, p. 313, as cited in Fraccascia et al., 2020). Their agent-based models reveal that high redundancy in the form of many exchange partners within a circular economy network can increase network resilience. However, the authors also voiced some reservations about the implementation of redundancy strategies, including difficulties balancing economic and environmental performance within the network.

### 3.2 | The circular economy and economic resilience

To support economic resilience, some commentators have argued for a shift towards resilient, circular and low-carbon economic systems, particularly in light of the COVID-19 pandemic. In an opinion piece, Blériot (2020) provided two examples of how a circular economy can benefit overall economic resilience. The first example focuses on the early stages of the COVID-19 crisis, which exposed disruptions and brittleness in many global supply systems that limited access to medical equipment and many other essential goods and services. Blériot (2020) argued that circular principles such as improvements in the design and reusability of products could have helped create resilience (defined as the availability of stock). The second example focuses on increasing flexibility by designing products that can be repurposed and potentially enhance value creation in the future.

Similarly, Ishii and van Houten (2020, para. 1) argued that 'the best way to build resilience against future pandemics and the impact of climate change is to move to a circular economy'. They recommended (a) implementing economic stimulus packages focused on green and circular investment, (b) developing policy frameworks to support the formation of a circular economy (e.g., phasing out single-used plastics), (c) adopting circular business models and (d) promoting innovation to stimulate creativity and future solutions. Fokeer and Domenech (2020, section 6) likewise argued that 'green, circular, scalable, customizable technologies' and increased interconnectivity are needed for greater resilience and response capacity within circular economy systems. Although these articles offer many important points, they offer few details regarding specific principles or practices that would support both resilience and the circular economy, especially at the firm and industry levels.

### 3.3 | The circular economy and social-ecological resilience

In addition, scholars have claimed that a circular economy supports social-ecological resilience and sustainable development more broadly (see Geissdoerfer et al., 2017). This outcome is often an implicit assumption rather than the central focus of analyses. Many scholars have argued (and we agree) that the transformation of current linear systems of production and consumption is essential to avoid societal decline and ecosystem collapse at a global scale (Esposito et al., 2018; Pla-Julián & Guevara, 2019; Stahel, 2016; Webster, 2017). A circular economy is generally viewed as an intentionally designed, restorative and regenerative economy (Pla-Julián & Guevara, 2019). However, the exact channels through which the circular economy contributes to social-ecological system resilience are typically not further conceptualised. Aguiñaga et al. (2018) presented a visualisation of a circular value ecosystem (CVES) to show how minimising resource use and waste can help restore ecological resilience, but few others have made such attempts.

Moreover, few have considered the potential for unintended consequences. Korhonen, Honkasalo, and Seppälä (2018) and Korhonen, Nuur, et al. (2018) argued that many ideas related to the circular economy are based on increasing efficiencies of material use and thus are subject to rebound effects (e.g., Berkhout et al., 2000) and 'Jevon's paradox' (see Alcott, 2005). As production efficiency increases, production costs and prices decrease, thereby driving consumption. The resulting economic growth might offset environmental gains created by increased efficiency and not actually support social-ecological system resilience. Based on this reasoning, Desing et al. (2020) argued for the explicit integration of bio-physical limits into studies on the circular economy and opened discussions on how a sustainable resource base may be identified and apportioned.

## 4 | A RESEARCH AGENDA FOR THE CIRCULAR ECONOMY AND RESILIENCE

In the circular economy, material usage is reduced through narrowing, slowing and closing resource loops (see Section 2.1). However, from a resilience perspective, such strategies are seen as problematic as they may reduce the slack resources, diversity, and buffers required for adaptation and change (Biggs et al., 2012; Walker & Salt, 2006). Consequently, there appears to be a need to examine how circular economy business practices impact resilience at the social-ecological, firm and industry levels.

Based on theory and findings from the few extant intersecting studies, we therefore propose a new research agenda to examine the circular economy from a nested, social-ecological resilience perspective. This agenda aims to advance understanding of circular business practices that can help firms, industries and social-ecological systems adapt and transform in the face of shocks and disturbances. We organise the new research agenda by focusing on the three core business practices of narrowing, closing and slowing resource loops (Bocken et al., 2016; Braungart et al., 2007). We examine implications of these three core practices for resilience at the firm, industry and social-ecological system levels to reveal the main areas of congruence and contestation that provide opportunities to advance circular economy research. We summarise our findings in Table 2.

### 4.1 | Increasing resource efficiency by narrowing resource loops

At the social-ecological level, resource efficiency strategies may improve social-ecological system resilience by reducing demand for virgin materials, decreasing exploitation and enabling habitats to remain intact and biodiversity to be restored. For instance, in a circular economy with more efficient wood production practices, deforestation could move closer to regenerative rates and create spaces for nature preservation. However, there is a lack of empirical evidence that a circular economy will lead to these desired outcomes and that an optimisation approach is effective for building social-ecological resilience. It is unclear whether resource efficiencies lead to reduced virgin material demand because cost savings per unit may lead to rebound effects of consumption and increased production. Firms across the circular economy may capitalise on efficiency gains to increase production instead (Korhonen, Honkasalo, & Seppälä, 2018). Moreover, pursuing resource efficiencies is contrary to building the diversity and redundancy needed for resilient social-ecological systems. Building on the above example, more efficient wood production practices promote the uniformity and apparent stability of monocropping over the introduction of different types of flora and fauna and varying spatial configurations.

At the industry level, the collective pursuit of resource efficiency strategies may improve industry resilience by helping to reduce an industry's dependence on virgin natural resources and preventing material supply shortages. Yet, pursuing resource efficiencies could also create industry level vulnerabilities by lowering an industry's response diversity if firms converge on efficient, yet narrowly defined production systems; that is, an industry becomes 'locked in' to a singular resource-efficient way of delivering value to customers. Lean production methods, such as just-in-time supply chains, have become common practices across many industries to minimise both costs and resource use. However, while such methods improve efficiencies, they are highly susceptible to disturbances. The impacts of the COVID-19 pandemic illustrate this point: The simultaneous closure of many partners across supply chains caused significant global disruptions that were felt in many sectors, from shipping to logistics to the availability of goods and services to end consumers (Bryce et al., 2020).

At the firm level, resource efficiencies are generally expected to decrease dependence on virgin material resources for value creation (subject to rebound effects, discussed above) and thus improve firm

**TABLE 2** The circular economy and resilience: Congruence and contestation

| Circular economy business practice | Social-ecological resilience | | Industry resilience | | Firm resilience | |
|---|---|---|---|---|---|---|
| | Congruence | Contestation | Congruence | Contestation | Congruence | Contestation |
| Narrowing resource loops | • Reducing use of renewable materials to within regenerative rates.<br>• Reducing land use pressures to enable restoration of ecosystems.<br>• Reducing use of non-renewable materials to rates at which renewable substitutes may be found.<br>• Reducing waste and emissions within the assimilative capacity of ecosystems.<br>• Restoring the health of social-ecological systems by retrieving resources leaked from industrial systems. | • Optimisation approaches may be ineffective at building ecosystem resilience.<br>• Resource efficiencies may induce rebound effects, increasing consumption.<br>• Resource extraction, waste and emissions may not reduce at rates required to prevent thresholds from being exceeded. | • Reduces an industry's dependency on virgin natural resources for value creation.<br>• Reduces the risk of scarcity of materials and supply shortages. | • Convergence upon optimal practices may result in industries with low response diversity.<br>• Lean production methods, such as just-in-time supply chains are susceptible to operational stresses and disturbances. | • Reduces a firm's dependency on virgin natural resources for value creation. | • Reduces functional and response diversity in search of optimal resource use.<br>• Firms may experience trade-offs between redundancy and the drive for efficiency. |
| Slowing resource loops | | | • Reduces an industry's dependency on virgin natural resources for value creation.<br>• Reduces the risk of scarcity of materials.<br>• Improved diversity of manufacturing capabilities. | • Sequential looping may lock industries into suboptimal ways of operating, reducing their ability to transform. | • Reduces a firm's dependency on virgin natural resources for value creation.<br>• Stimulates improved functional and response diversity of product offerings and customer segments. | • Business models within sequential loops can be highly vulnerable to shocks such as changes in technology or fashion. |
| Closing resource loops | | | • High interconnectivity may enable collective action within and across industries to respond to shocks.<br>• Greater number of firms with exchanges increases potential redundancies. | • Tight coupling within industries reduces slack in the system and increases the speed and distance of disturbances propagating through the system.<br>• High interconnectivity across industries may result in shocks and disturbances of one industry impacting another. | • Types of supply may become more diverse.<br>• By increasing partners for exchange, firms may improve the availability of material substitutes.<br>• High interconnectivity may mean a faster and stronger response to shocks as resources can be quickly moved where they are needed. | • Number of suppliers may become more limited.<br>• Firms may become exposed to a wider scope of shocks and disturbances. |

resilience against supply shortages and price volatility (Ellen MacArthur Foundation, 2013). Yet, maximising resource efficiencies could increase brittleness and vulnerability by decreasing functional diversity (i.e., the range of current and future products and services that can be offered) and response diversity (i.e., the ability of a firm to switch to different products or services when a shock occurs). For instance, a firm may choose to optimise its production capabilities and sell only one product that requires the least materials. While such a strategy achieves resource savings, it might leave the firm susceptible to rapid changes in technology, sudden changes in fashion or product controversies. Relatedly, the drive for efficiency may lead a firm to remove redundancies that can protect against disruption (Skene, 2018). For instance, a delivery company pursing a narrowing strategy based on average conditions may seek to minimise the number of vehicles in its fleet, only to be highly impacted by unexpected vehicle breakdowns and accidents (Azadeh et al., 2014).

Examining these tensions leads to several questions for future research: Does the creation of narrow resource loops through circular economy strategies increase vulnerabilities at the firm and industry levels by reducing functional and response diversity? Do 'optimisation' strategies that seek to maximise resource efficiencies lead to increasing brittleness and vulnerability by potentially removing resources and capabilities that could provide a buffer against disruption? The resilience literature already proposes that efficiency should be balanced with redundancy (Biggs et al., 2012). Yet, redundancies can create additional costs for firms and yield limited benefits if no disruptions occur (Sheffi & Rice, 2005) and can lead to greater risk taking, shirking and increased system complexity (Sagan, 2004). The creation of redundancies also necessitates additional resources and capabilities to create buffering capacity (e.g., emergency stocks, larger back-up fleets and additional production capabilities), which is at odds with circular economy strategies attempting to avoid 'excess' resource use. Firms may find balance by establishing partnerships that allow for resource exchanges or creating a common pool of resources to be used in times of adversity (e.g., fleet sharing arrangements). Yet, such approaches have their limitations when partners experience the same stress, suggesting heterogeneity in partners would be preferred.

## 4.2 | Increasing resource longevity through slowing resource loops

At the social-ecological level, the circular economy practice of slowing resource loops can clearly reduce pressures on social-ecological systems by reducing resource extraction, waste and emissions. Yet, such business practices may not be substantive enough to prevent social-ecological systems from exceeding thresholds or help them recover from those already surpassed (Desing et al., 2020; Steffen et al., 2015). For instance, slowing loops may reduce rates of deforestation but not to within regenerative rates. Likewise, slowing resource loops may reduce carbon emissions but not at the pace required to avoid significant climate impacts.

At the industry level, sequential looping may strengthen resilience by reducing supply chain dependence on virgin materials (and thus avoiding supply disruptions) and by adding remanufacturing and refurbishment capabilities alongside production (Bag et al., 2019). However, sequential looping creates new interdependencies and possibly also undesirable path dependencies that prevent fundamental transformations (Korhonen, Honkasalo, & Seppälä, 2018). For instance, firms may become dependent upon a waste stream for product inputs, which, in turn, might reduce an industry's willingness to explore how the system could be redesigned to eliminate the waste stream altogether (Walker et al., 2004). Industries may also face fewer external pressures to undergo transformative change, as the less substantive changes adopted help maintain their legitimacy and social licence to operate. Similarly, product take-back schemes and remanufacturing practices might lead to modifications of the current production system but without tackling the root causes of material use (Hobson & Lynch, 2016). The resulting sequential loops may slow the exhausting of resources but do not remove the need for more radical industrial transformations for the industry to flourish in the long term.

At the firm level, the introduction of sequential loops stimulates firms to diversify their product offerings (e.g., new, remanufactured and refurbished) to serve diverse customer segments. This strategy provides greater functional diversity and response diversity if there are disruptions to products or customer types. Yet, such firms may become liable to shocks and disturbances that impact the sequential nature of this practice and require the firm to make transformative changes. For instance, re-manufacturing firms specialising in product repair or restoration may be highly vulnerable to changes in technologies and customer preferences. Effective circular economy practices may also pose threats. For instance, successful long-life designs may decrease the availability of products for remanufacturing and their consumer demand, or marketplace competition for recycled materials may cause shortages and large price increases, as observed for recycled PET flakes in 2021 (Financial Times, 2021).

In future research, scholars may focus on how firms may become skilled in ambidexterity to adapt existing processes to sequential loops while maintaining the capacity to transform to new ways of working (O'Reilly & Tushman, 2004). Important questions include: How do firms and industries maintain their potential for transformative change when industrial systems become highly optimised and interlocked within sequential loops? How do firms sense when a transformative alternative may be available? Circular economy studies have begun to shed light on the importance of experimentation when building new models of circular value propositions, creation and capture (Bocken et al., 2018), for instance, by conducting small scale field experiments following how users experience a new circular business model design (Bocken et al., 2018). This work can be extended to consider what types of experiments firms can perform to test the adaptive limits of current sequential loops and to learn what transformative options may be available and feasible.

### 4.3 | Increasing interconnectivity of industrial systems through closing resource loops

At the social-ecological level, the practice of closing resource loops can enhance social-ecological resilience by reducing pressure for virgin materials and decreasing the waste and emissions of industrial systems below the assimilative capacity of ecosystems. It also restores ecosystems by retrieving materials leaked from industrial systems that compromise social-ecological system functioning. For instance, collecting discarded fishing nets may restore the functioning of coral reefs, which, in turn, impacts tourism and fisheries (Net-Works, 2021). Again, it is unclear whether resource loops can be closed quickly enough to prevent social-ecological system thresholds from being exceeded.

At the industry level, closing resources loops establishes inter-firm resource exchanges through high levels of interconnectedness between firms. Studies of resilience recognise the value of connectivity within industries—it enables firms to respond quickly and effectively because resources and information can move to areas of need, thus facilitating collective action through support networks (Biggs et al., 2012). Connectivity may also improve information sharing and governance of shared material resources (Bodin & Prell, 2011) and creates inherent redundancy in exchanges involving many partners (Fraccascia et al., 2020). However, resilience studies also warn that, under conditions of high interconnectedness and tight coupling between firms and across industrial systems, any disruptions or shocks may spread quickly and lead to cascading or escalating failures amongst organisational systems, supply chains and infrastructure systems. Thus, firms may become exposed to a wider scope of shocks and disturbances, and an increased number of firms may be impacted by a single shock. Consequently, product faults, production delays or physical disruptions (e.g., extreme weather impacts) may have widespread impacts within an industrial symbiosis.

At the firm level, closing resource loops involves recirculating material waste back into the sequential loops of the primary product use. For instance, unused materials from the original production process may be useful for repair or remanufacturing processes. This may benefit organisational resilience by offering an inherently diverse supply of materials, as virgin sources are supplemented by used materials (Fisher et al., 2020). Supply diversity can strengthen firms and industrial systems by providing options when faced with disturbances (Biggs et al., 2012; McDonough & Braungart, 2008). However, closing loops may also create a high reliance on a small number of suppliers offering materials and products designed for circularity. Thus, while types of supply may increase (virgin, used, recycled) the number of potential suppliers may become more restricted. Researchers may consider: Does closing resource loops increase a firm's supply diversity? Do the principles of closing resource loops create critical bottlenecks for supply? Future research might be able to draw upon insights from supply chain research focused on how firms select resource suppliers and build resilient supply chains to answer these questions (e.g., Sheffi & Rice, 2005).

Closing resource loops also requires firms to consider secondary purposes of products, components and waste in other industries (Sirkin & Houten, 1994) which might bring benefits such as new customers and new information (Bodin & Prell, 2011) but also the drawbacks of exposure to increased complexity and the possibility of unforeseen shocks. Tensions of high interconnectivity are also pertinent at the firm level posing important questions such as: How can managers close resource loops while maintaining the capacity to contain local shocks? How can barriers be created to stop shocks from being transmitted while maintaining cost-effectiveness and efficiency? Do managers consider how new connections may enable firms to better adapt to shocks or leave them more vulnerable? When establishing connections to other industries, firms need to balance the benefits of new information (Bodin & Prell, 2011) with the drawbacks of exposure to new shocks. This raises an interesting question: How do firms currently consider this tension and in what ways may it be managed?

Industrial ecology scholars posit that much value can be extracted from taking a network perspective that permits mapping and modelling of firms and their interconnectivity within industrial systems (Genc et al., 2019). Resilience studies have shown that modular structures with high internal connectivity but low connectivity with one another may provide the greatest stability (Biggs et al., 2012). Modular systems may best protect industries from shock transference, yet raise intriguing questions, such as: Would firms want to pursue building modularity? How would managers assess the relative benefits and costs of modularity? Moreover, how would firms pursue building modular network configurations while seeking to close resource loops?

## 5 | CONCLUDING REMARKS

The circular economy continues to attract attention as a primary solution to keep social-ecological systems within limits favourable for humankind. Yet, circular economy studies exploring the interconnections of the circular economy and social-ecological resilience are sparse as the two have evolved as management fields in relative separation. By overlooking resilience, circular economy research is currently at danger of advocating business practices that are ineffective at strengthening the ability of firms, industries and social-ecological systems to manage for shocks and disturbances. Moreover, business practices pursued in the name of circularity without consideration of resilience may even be harming the capacity of actors to ably adapt and transform.

Our research agenda offers an abundance of research opportunities for advancing the circular economy by incorporating insights from resilience. Specifically, our research agenda focuses on connecting resilience to the main circular economy business practices of narrowing, slowing and closing loops. We offer that there are substantial areas of congruence whereby circular economy practices may strengthen firm, industry and social-ecological system resilience. Yet, we also see several important areas of contestation that firms will need to navigate. We posit that these areas warrant close examination to ensure building a circular economy that is fit for a world of ongoing and shocks and disturbances of increasing magnitude and frequency.

Our work encourages managers to find synergistic approaches to what may sometimes appear as contradictory recommendations of managing for future change from the two fields. We call on managers to build understandings of how their circular economy practices influence resilience across multiple levels to unearth unintended consequences and enhance their positive impact. We invite management scholars to work closely with managers to explore and examine the main areas of intersection presented in this paper and develop studies that may address the research questions that we outline. We call for these to be pursued with both multi-level studies to capture multi-level outcomes of resilience and micro-level studies that may provide a clearer understanding of how firms consider resilience when formulating and executing business strategies for circularity and how the potential trade-offs and tensions are managed.

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