Research papers on the Circular Economy

A holistic perspective with insights on business models, ecosystems, and policy-firm interactions

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Preface

I created this cumulative thesis during an intense journey of doctoral studies. Inspired by my last Master Thesis' that also focused on the circular economy, I wanted to dive deeper into the topic of the circular economy to build new insights and make novel contributions to this dynamic field of research. On a more personal level, I chose this topic, as working on it can contribute to the fight against climate change and the loss of biodiversity, as well as our livelihoods. I wanted to understand how companies in the private sector can implement the circular economy and what role the various levels, i.e., working within and outside of company boundaries, can play in this endeavor. Hence, I started to analyze the various factors of circular value creation in the three peer-reviewed and published papers of this thesis (Pietrulla, 2022a, 2022b; Pietrulla & Frankenberger, 2022).

Researching and writing this dissertation gave me a fantastic learning experience: I learned the various aspects of researching and writing a dissertation, such as rigorous research methods, recurring self-organization and -motivation as well as extended resilience when I faced challenges. More important though, while I learned that we already know a lot about the circular economy from the technical and theoretical perspectives, as researchers have contributed significantly to this debate in recent years, we have seen slow uptake in practice. Why is that? It is resistance to change itself that holds people back from transforming. As Barack Obama observed, "Change will not come if we wait for some other person or some other time. We are the ones we've been waiting for. We are the change that we seek" (New York Times, 2008, p.1). Following this wisdom, I hope that my humble contribution to this highly complex endeavor of change can spark useful discussions and inspire action. I personally now feel well equipped with theoretical knowledge and ideas for practice as I move into the next stage of my career.

That being said, I hope that this dissertation can support managers who seek to advance the circular economy and that it offers an intriguing and motivating read for those who are curious about circular approaches in the private sector.

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I wrote this dissertation during my doctoral studies at the Institute of Strategy and Management at the University of St. Gallen. I am grateful for this opportunity to have been able to work with inspiring peers in a driven, collaborative, and motivating environment. The completion of this dissertation would not have been possible without my doctoral advisor, Prof. Dr. Karolin Frankenberger, who accepted me into the program and mentored me during the journey. I am grateful for her insights into the world of academia and business model innovation, for her guiding comments in moments of challenge, and for her flexibility and trust in my work, incl. the opportunities to freely experiment with new ideas. Working and learning from her gave me advantages for which I remain very thankful.

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I also acknowledge the invaluable help of other academics who agreed to review and comment on my work and to discuss further ideas, including Fabian Takacz, Johannes Wiedemann, Anni Sternisko, Sebastian Kahlert, and more. My thanks also go to my peers, whom I got to know during the recent foundation of the HSG Impact Scholar Community. This authentic and smart community helped shape my ideas into tangible research output.

Finally, I send a special thanks to all my cheerleaders and constructive critics: First, a big "thank you" goes to my parents, Lucia and Bodo, who provided the right nudge for reflection to put things into perspective. I would also like to thank my big sister, Jessica, for starting her Ph.D. just a few months earlier and being a source of sharp insights. Another big thank you goes to my friends: The "homies" from my hometown, the "mampfis" from old Konstanz times, friends from around the globe and nearby: Maria, Lucy, Fabi, Enrico, Caro, Tobias, Inka, Theresa, Daniel, and so many more. And, of course, the biggest thank you goes to my partner, Thilo, for being the best partner I could ever imagine!

Munich, December 2021 Felicitas Pietrulla

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Summary

In the current linear economy, most growth is based on exploiting limited resources, on carbon-intensive production and consumption. In the context of this take-make-dispose logic and increasing demand for often scarce materials, we produce massive amounts of waste that cannot always be reused to create additional value. This linear economic system has led us to cross planetary boundaries that are vital to our well-being on this planet. Hence, we must radically change how we create value to avoid negative environmental impacts. In addition to classic approaches like decarbonization techniques, the circular economy concept is a promising avenue for balancing economic growth with environmental sustainability by eliminating waste, emissions, and other toxic pollution while maintaining the value of the required materials through, for example, technical innovations and innovative business models. As firms are central to the transformation to such a circular economy, this thesis investigates their role by connecting management theory to the massive amount of literature on the circular economy. The thesis discusses how companies can think about circular business models in an integrated and holistic framework (Chapter 2) and, given that circular business models often require collaboration, it presents a thorough revision of the concept of circular ecosystems and how companies can master them (Chapter 3). To complete the analysis of firms' role in the circular economy, the thesis investigates what factors drive firm support for circular economy regulation and under which conditions firms are likely to favor or oppose circular economy regulation (Chapter 4). All three papers of this thesis have been published in peer-reviewed journals.

Zusammenfassung

Das Wachstum im heutigen linearen Wirtschaftsmodell basiert zu großen Teilen auf der Ausbeutung begrenzter Ressourcen, kohlenstoffintensiver Produktion und kohlenstoffintensivem Konsum. Wir leben nach einer "Take-Make-Dispose" (engl. Entnehmen-Produzieren-Wegwerfen) Logik: Aufgrund der stetig wachsenden Nachfrage produzieren wir Unmengen an Abfall, die nur schwerlich recycelt werden können oder nur selten für eine alternative Wertschöpfung in Frage kommen. Dieses lineare Wirtschaftssystem hat dazu geführt, dass wir kritische planetarische Grenzen überschreiten, die für unser langfristiges Wohlergehen auf diesem Planeten elementar sind. Daher ist es besonders wichtig, die Art und Weise, wie wir Wert schaffen, radikal zu verändern, um negative Umweltauswirkungen in Zukunft zu vermeiden. Neben eher klassischen Ansätzen wie Dekarbonisierungstechniken stellt das Konzept der Kreislaufwirtschaft einen vielversprechenden Weg dar, um Wirtschaftswachstum und ökologische Nachhaltigkeit in Einklang zu bringen. Die Kreislaufwirtschaft zielt darauf ab, Abfälle, Emissionen und andere toxische Nebenprodukte zu vermeiden und gleichzeitig den Wert der benötigten Materialien auf Dauer zu erhalten – zum Beispiel durch technische Innovationen oder innovative Geschäftsmodelle. Da Unternehmen bei der ökonomischen Transformation hin zu einer Kreislaufwirtschaft besonders relevant sind, wird ihre Rolle in dieser Thesis näher beleuchtet. Dafür verknüpft diese Thesis Managementtheorie mit der stark gewachsenen Literatur zur Kreislaufwirtschaft: Zunächst wird erörtert, wie Unternehmen in einem integrierten und ganzheitlichen Rahmen über zirkuläre Geschäftsmodelle nachdenken können (Kapitel 2). Da zirkuläre Geschäftsmodelle häufig auf der Zusammenarbeit zwischen verschiedenen Akteuren basieren, wird in der Thesis auch das Konzept des zirkulären Ökosystems gründlich untersucht, und es wird aufgezeigt, wie Unternehmen diese Konstellationen meistern können (Kapitel 3). Um die Analyse zur Rolle von Unternehmen in der Kreislaufwirtschaft zu vervollständigen, untersucht diese Thesis welche Faktoren die Einstellung von Unternehmen hinsichtlich Regulierung für eine Kreislaufwirtschaft beeinflussen und unter welchen Bedingungen sie eher eine Position pro oder contra die Regulierung für eine Kreislaufwirtschaft einnehmen (Kapitel 4). Alle drei Artikel dieser Thesis wurden von unabhängigen Fachkollegen geprüft und sind in Fachzeitschriften veröffentlicht.

List of publications

In this thesis

Pietrulla, F., & Frankenberger, K. (2022). A Research Model for Circular Business Models–Antecedents, Moderators, and Outcomes. *Sustainable Futures*, 100084.

Pietrulla, F. (2022). Circular ecosystems: A review. *Cleaner and Circular Bioeconomy*, 100031.

Pietrulla, F. (2022). Private firm support for circular economy regulation in the EU policy context. *Sustainability*, *14*(14), 8427.

Other publications & relevant contributions

Bocken, N., Stahel, W.R., Dobrauz, G., Koumbarakis, A., Obst, M., & Matzdorf, P. (2020). Circularity as the new normal. Future fitting Swiss businesses.

Frankenberger, K., & Pietrulla, F. (2020). How the Circular Economy increases the degrees of freedom – From Resource dependency to circular material flows. In *St. Gallen Business Review, Spring publication,* 68-71.

Geisendorf, S., & Pietrulla, F. (2018). The circular economy and circular economic concepts—a literature analysis and redefinition. *Thunderbird International Business Review*, *60*(5), 771-782.

Pietrulla, F., & Frankenberger, K. (2021). Circular business models: Antecedents, Moderators and Outcomes. In *Academy of Management Proceedings* (Vol. 2021, No. 1, p. 16217). Briarcliff Manor, NY 10510: Academy of Management.

Stern, A. D., Pietrulla, F., Herr, A., Kesselheim, A. S., & Sarpatwari, A. (2019). The impact of price regulation on the availability of new drugs in Germany. *Health Affairs*, *38*(7), 1182-1187.

1 Introduction

1.1 Background and relevance

Our current linear economic system, which is based on an ever-increasing extraction of resources, has destructive environmental effects such as pollution, carbon emissions, climate change, and loss of biodiversity (Bellard, Bertelsmeier, Leadley, Thuiller, & Courchamp, 2012). By 2050, our annual waste is expected to increase by 70 percent from 2.01 billion tons in 2016 to 3.4 billion tons (Kaza, Yao, Bhada-Tata, & Woerden, 2018). While our economic system has brought growth, welfare, and many other societal improvements, it is not always healthy or sustainable. The long-term effects of climate change have forced many people to leave their homes because of such dramatic changes in weather conditions as intensified storms, floods, and wildfires (Woetzel, Pinner, & Samandari, 2020). In addition to these migration pressures, this climate risk causes real financial damage. For example, the United Nations Environment Program estimates that the cost of adapting to these climate impacts will rise to at least $140-300 billion per year by 2030 and to $280-500 billion per year by 2050 (UNEP, 2016). With the current rate of deforestation, climate change, and other extraction of resources, it is estimated that about a quarter of all species are on the brink of extinction (Díaz et al., 2019).

If we cannot contain global warming to two degrees Celsius, researchers predict that we will reach an irreversible *hothouse* (Lenton et al., 2019; Steffen et al., 2018). Given this urgency, developing solutions to these increasing negative environmental impacts should be our highest priority. As valuable approaches to these issues, the circular economy and circular business models are the focus of this discussion.

1.2 The circular economy and circular business model strategies

The circular economy is a promising alternative to the linear economy that leads to large amounts of waste and emissions. Several papers discuss the various definitions of a circular economy (e.g., Kirchherr, Reike, & Hekkert, 2017). One of the most widely accepted definitions describes the circular economy as "an industrial system that is restorative or regenerative by intention and design" (Ellen MacArthur Foundation, 2015, p.19). While the focus of the circular economy concept is on the industrial system, this definition takes a holistic perspective on the whole economy and its societies. The circular economy aims at inclusive growth (e.g., Schröder,

Lemille, & Desmond, 2020) through job creation where these jobs enable circular value creation. It reduces or eliminates the negative environmental impact of economic activities by enabling the circularity of materials and components and other value-retention strategies (Geissdoerfer, Savaget, Bocken, & Hultink, 2017; Tukker, 2015). Circular economy scholars have developed several circular strategies (Bocken, de Pauw, Bakker, & van der Grinten, 2016a), including narrowing the loop, slowing the loop, closing the loop, regenerating the loop's materials while using renewable energies, and using non-toxic materials to support a sustainable loop. These advances have opened room for a much broader discussion on circular business models, circular ecosystems, and non-market strategic responses of firms to the circular economy.

1.3 A holistic three-level lens on firms' circular economy implementation

This thesis is based on the major proposition that the circular economy cannot be meaningfully implemented if we look at only one level, small units, or single actors in isolation. For instance, while a product design lens is essential to establish fundamental circularity on a product level through, for example, improved recyclability (Hollander, Bakker, & Hultink, 2017; Moreno, De los Rios, Rowe, & Charnley, 2016) or modular design (Minunno, O'Grady, Morrison, & Gruner, 2020), it is insufficient for a fully circular economy. Looking only at one such limited unit of interest does not address our convoluted and complex sourcing, production, and consumption system. This thesis takes a stance that implementing the circular economy requires an integrated and well-orchestrated set of activities that involves various actors, units, contexts, boundaries, and levels. Therefore, the thesis provides a multi-level perspective on firms' implementation of a circular economy by investigating those levels separately as well as their interfaces (Parida, Burström, Visnjic, & Wincent, 2019; Tate, Bals, Bals, & Foerstl, 2019). The first paper of the dissertation starts on the firm and circular business models level, the second paper moves one level higher towards circular ecosystem research, and the third paper concludes with an investigation of firms' interactions with policy-makers in the European Union policy context. The next section outlines the need for research on this holistic, three-level perspective.

First, publications that address circular business models have increased significantly in recent years (Atasu, Dumas, & Van Wassenhove, 2021). Circular business models describe "how a company creates, captures, and delivers value with the value creation logic designed to improve resource efficiency through contributing to extending useful life of products and parts (e.g., through long-life design, repair and

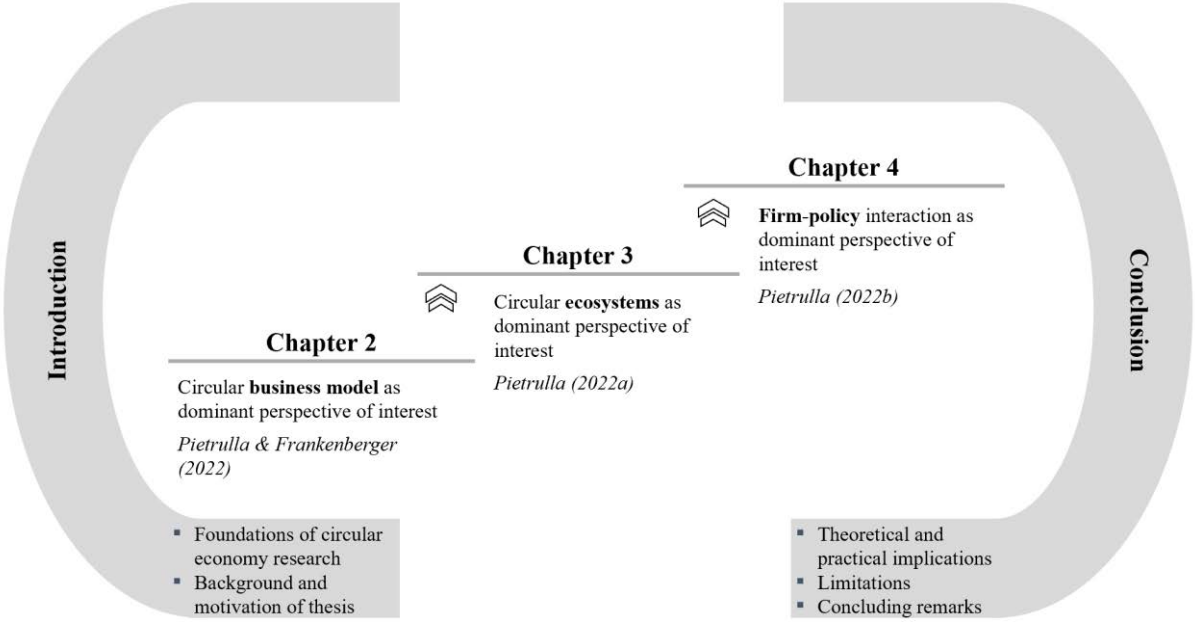
remanufacturing) and closing material loops" (Nußholz, 2017, p. 12). Therefore, circular business models are considered the micro-level implementation of a circular economy that enable firms to establish organizational environmental sustainability (Geissdoerfer, Pieroni, Pigosso, & Soufani, 2020). However, the rapid growth of literature on circular business models has focused on detailed research, while a study that summarizes the field and presents an integrative framework of the concept is missing. This thesis aims to close this gap.

Second, the thesis investigates the circular ecosystem level because to implement circular business models fully, coordination often takes place across firm boundaries. In many cases, circular business models or other broad sustainability activities rely on the involvement of many stakeholders (Adams, Jeanrenaud, Bessant, Denyer, & Overy, 2016) and the complementarity of their inputs (Jacobides, Cennamo, & Gawer, 2018). These stakeholders may operate in different industries, on different continents, in different cultures, and at different hierarchical levels (Ceschin & Gaziulusoy, 2016). This perspective allows us to think in terms of networks and to consider the interrelationships among the actors that collectively create and innovate in pursuit of circularity (Konietzko, Bocken, & Hultink, 2020; Talmar, Walrave, Podoynitsyna, Holmström, & Romme, 2020). Scholars have not investigated this level in such depth as the business model level. Questions that remain to be answered range, for example, from definitions and typologies to the circular ecosystem's most effective management and coordination mechanisms. Because this level is central to the implementation of the circular economy implementation, it is surely the next frontier in circular economy research. To contribute to closing this gap, this thesis investigates the circular ecosystem concept in a detailed review.

Third, the thesis addresses the interactions between firms and policy-makers. While research has widely studied the macro-level circular economy, for example from an industrial ecology perspective (Fellner, Lederer, Scharff, & Laner, 2017; Merli, Preziosi, & Acampora, 2018) and a policy perspective (Kirchherr et al., 2018), research on the interaction between firms and policy-makers is missing. Consequently, we know very little about firms' non-market strategies or corporate political activities in the circular economy context (Mellahi, Frynas, Sun, & Siegel, 2016). However, understanding what drives firms to support instead of oppose circular economy regulation can help policy-makers to design and communicate their policies effectively and managers to understand how their firms' characteristics may influence their corporate political activities in the field of the circular economy. Figure 1 shows the structure of the thesis, where the introduction (Chapter 1) and conclusion (Chapter 5)

frame the heart of the thesis, i.e., the three peer-reviewed and published papers on circular business models, circular ecosystems, and the firm-policy context.

Figure 1 Graphic display of the thesis' structure



1.4 Theoretical perspectives: the circular economy and the resource-based view

Marques & Manzanares (2022) conclude in their analysis of the research field of the circular economy that it is vastly atheoretical. Given that the circular economy is a phenomenon and not a theory, this is, per se, not necessarily surprising. Similarly, the much larger field of CSR or social impact research is sometimes accused of not being driven by theory (Barnett, Henriques, & Husted, 2020). Systematically identifying and analyzing the reasons for this kind of atheoretical development in CE research is quite interesting. One main reason is that the CE was invented to solve a very real problem in practice: climate change, resource scarcity, and the decline of our natural environment. With the reasonably practical goal of increasing resource circularity, scholars were looking for practical impact, as was also dictated by various public grants for CE research (Su, Heshmati, Geng, & Yu, 2013). As a logical consequence, CE research must have grown into a more practice-than-theory-driven field (Suárez-Eiroa, Fernández, Méndez-Martínez, & Soto-Oñate, 2019). Besides, the reasons might be manifold, but a complete analysis of this topic goes beyond the scope of this introduction.

This thesis connects the often similarly considered atheoretical fields of business model innovation (Chesbrough, 2010; Foss & Saebi, 2018) and ecosystems research (Spigel & Harrison, 2018; Theodoraki, Dana, & Caputo, 2022) with the circular economy research. Therefore, the purpose of the following paragraphs is to share how this thesis approaches the circular economy field from a theoretical angle and introduces the resource-based view (RBV) as an influential lens taken in the respective papers of the thesis. For this purpose, I first introduce the RBV and two related fields (dynamic capabilities and natural-RBV) that are particularly important for the RBV and this thesis. Afterwards, I comment on how the RBV is relevant for the respective papers of the thesis.

1.4.1 Introduction to the resource-based view and related fields

The resource-based view (RBV) of the firm is a prevalent and established management theory in strategic management research (Kraaijenbrink, Spender, & Groen, 2010; Lockett, Thompson, & Morgenstern, 2009; Newbert, 2007; Rouse & Daellenbach, 2002). It relates to mainstream strategy research and organizational economics literature and is "complementary to industrial organization research" (Mahoney & Pandian, 1992, p. 363). According to the RBV, a firm's resources play an essential role in the competitive position of the firm. While Wernerfelt (1984) is considered the formal inventor of the RBV with his paper "A resource-based view of the firm" in the Strategic Management Journal, earlier scholars have advocated similar ideas. For example, Penrose (1959) suggested in her book "A theory of the growth of the firm" that a firm's growth, be it driven internally or through external activities like mergers and acquisitions, is defined by how a firm deploys its resources. Thus, her contributions are significant and relevant to resource-based thinking (Kor & Mahoney, 2004), even though an interesting discourse was raised around her contributions (Jacobsen, 2013; Kor & Mahoney, 2004; Lockett, 2005; Rugman & Verbeke, 2002). Similarly, Rubin (1973) interpreted firms as resource bundles and argued that mere resources might not benefit a firm unless they are processed correctly. Wernerfelt, in his paper, then stated that "resources and products are two sides of the same coin" for the firm (Wernerfelt, 1984, p. 171), i.e., the firm's products define firm performance. However, lastly, the performance depends on the resources used for the production (see also Barney, 1986). Based on this reasoning, firms can improve their performance by acquiring resources that enable them to develop high-demand products (Wernerfelt, 1984).

However, "widespread appreciation for the RBV did not begin to accumulate until several years later" (Newbert, 2007, p. 123), when both a practice-oriented paper in the Harvard Business Review (Prahalad & Hamel, 1990) and an influential theoretical publication in the Journal of Management (Barney, 1991) were published. Prahalad and Hamel (1990) suggested that managers think of a firm as core competencies instead of just separate business units or departments to enable better management of resources across organizational boundaries. These resources thus encompass tangible and intangible assets like knowledge, skills, and technologies, which help to leverage the former. Barney (1991), based on the two assumptions that "strategic resources are heterogeneously distributed across firms and that these differences are stable over time" (Barney, 1991, p. 99), suggests in his theoretical framework that sustained competitive advantage can be achieved through valuable, rare, inimitable, and non-substitutable resources (VRIN). While valuable and rare resources give a firm a competitive advantage in the short term, the additional inimitability and non-substitutability of these resources may promise a sustained competitive advantage (Barney, 1991; Dierickx & Cool, 1989). All of Jay Barney's work (Barney, 1991, 1995, 2001a) on the RBV was central to forming the RBV. In his 1995 work, he also shed light on the importance of complementarity, saying that resources "have limited ability to generate competitive advantage in isolation" (Barney, 1995, p. 56). He, for example, highlighted the importance of not only value creation but also value capture as complementary activities (instead of one single activity as best practice, which can be more easily imitated). The idea of complementarity of resources was also taken up in the research stream of business ecosystems (Adner, 2017; Adner & Kapoor, 2010a). While the RBV takes the internal perspective on resources and how they lead to sustained competitive advantage of one firm, in ecosystems research, the complementarity of the resources or capabilities of different ecosystem participants (e.g., firms) strongly influences the success of the consortium of firms, i.e., business ecosystem.

One of the main criticism of the RBV was the relatively static understanding of resources, in other words, not answering the "'how' questions" (Priem & Butler, 2001, p. 22) explaining how exploitation of these resources allows sustaining competitive advantage. As Barney assumed that "implementation [of the resources] follows, almost automatically" and were somehow considered "self-evident" (Barney, 2001a, p. 53), scholars dedicated more time to understanding the mysterious inner workings of these processes: Analyzing the "role of heterogeneous organizational 'competence' for competition" (Henderson & Cockburn, 1994, p. 63) was promising: For example,

Mahoney and Pandian summarize that not the resources per se cause competitive advantage, but also the "distinctive competence (…) [of the firm to make] better use of its resources" (Mahoney & Pandian, 1992, p. 365) by, for example, effectively allocating financial capital to highest return projects or by matching the right people in the best fitting roles (Mahoney & Pandian, 1992). These authors also shed light on the different kinds of processes needed to leverage the resources (Peteraf, 1993), for example, core capabilities (Leonard-Barton, 1992) and organizational capabilities (Russo & Fouts, 1997). Christmann (2000) summarizes in her empirical work on the effects of *best practices* of environmental management that "capabilities for process innovation and implementation are complementary assets that moderate the relationship between "best practices" and cost advantage, a significant factor in determining firm performance" (Christmann, 2000, p. 663).

Based on these kinds of feedback and increased interest in processes to achieve higher returns, the RBV was further refined. Barney published the VRIO framework, which added the "organized" criteria to the previous framework and summarized the characteristic of non-substitutability under the "I" of the inimitability (Barney, 1997). In other words, not just owning valuable, rare, inimitable (and non-substitutable) resources is vital for sustained competitive advantage but also processing them distinctively within the organization (Barney, 1997; Barney & Wright, 1998). Resources can be implemented and processed most effectively through the proper organizational context, i.e., structures, control systems, routines, and compensation policies (Barney & Mackey, 2005; Newbert, 2007). However, the need for a process lens and understanding of how resources and their deployment develop over time gave room for a new theory that evolved within the RBV: Dynamic Capabilities. This theoretical approach incorporated ideas from organizational routines (Winter, 1995, 2003) and more clearly defined the types of processes that allow a firm to realize the full potential of its resources. It explains "how combinations of competences and resources can be developed, deployed, and protected" (Teece et al., 1997, p. 510) in order to respond to dynamic and competitive environments (Barreto, 2010; Gassmann, Frankenberger, & Sauer, 2016; Wang & Ahmed, 2007; Winter, 2003). Dynamic capabilities are often idiosyncratic and path-dependent (Eisenhardt & Martin, 2000). They have been defined as "the ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece et al., 1997, p. 516) and as "a set of specific and identifiable processes such as product development, strategic decision making, and alliancing" (Eisenhardt & Martin, 2000, p. 1105).

The high-level dynamic capabilities for superior performance in a dynamic environment, as proposed by Teece (2007), differentiate between sensing, seizing, and transforming capabilities. These capabilities are especially relevant for firms to innovate, create, refine or transform their business model (Harreid, O'Reilly, & Tushman, 2007; Teece, 2018a). Very entrepreneurially thinking management should thus have the "ability to sense and then seize opportunities, navigate threats, and (…) reconfigure" (Teece, 2007, p. 1344). However, the latter, i.e., the transforming capability, does not mean that firms always need to reinvent themselves, but this rather "depends on events, anticipated or otherwise" (Teece, 2007, p. 1343). Dynamic capabilities have also strongly inspired recent sustainability literature, such as Bocken and Geradts' (2020) study on multinational incumbents, highlighting the importance of organization design for the required dynamic capabilities for sustainable business innovation. Concerning the circular economy, first publications show how dynamic capabilities in the firm support a firm's implementation of circular activities (Khan, Daddi, & Iraldo, 2020a).

Besides the dynamic capabilities literature, the RBV has also received a further extension – the natural RBV (NRBV) of the firm (Hart, 1995). This theory complements the internal perspective of the classical RBV with an external perspective. According to this theory, superior firm performance is also strongly influenced by the firm's interaction with the natural environment. Hence, this kind of thinking, focusing on the natural environment, is very relevant for circular economy thinking. It can be achieved by following "three key strategic capabilities: *pollution prevention, product stewardship,* and *sustainable development"* (Hart & Dowell, 2011, p. 1466). Implementing pollution prevention activities is associated with the competitive advantage of lower costs. This proactive behavior reduces environmental damage by, for example, reducing the materials used by deploying more energy-efficient production solutions or using less CO2-heavy manufacturing processes. Doing so avoids the need to clean up adverse environmental effects afterwards, which usually comes with a cost. Product stewardship is associated with "strategic preemption" (Hart & Dowell, 2011, p. 1466), as firms now consider the entire life-cycle of the product (i.e., not only the pollution lens as in the first strategy). With this more holistic value chain understanding, firms engage stakeholders and listen to "the "voice of the environment" (…) [which] can be effectively integrated into the product design and development process" (Hart & Dowell, 2011, p. 1466). The strategy of *sustainable development* promises positive effects for a company as production can be completed "indefinitely into the future" (Hart & Dowell, 2011, p. 1466), i.e., the firm

should not have any risks that are, for example, associated with scarce resources as inputs. Furthermore, the *sustainable development* strategy extends the perspective of the previous two as it considers not only environmental but also social and economic issues at the heart of the question of sustainable development (Brundtland, 1988; Hart, 1995). Hence, the effect on less developed countries must be considered when pursuing economic activities in developed countries. Environmental, social, and economic benefits should also reach emerging and developing countries and increased poverty or environmental damage should be avoided (Hart, 1995).

Of all these strategies, *pollution prevention* received the most attention in empirical research, focusing on whether and in what context it pays to be *green* for an organization (Dowell & Muthulingam, 2017; Hart & Dowell, 2011). Indeed, research shows that following these proactive corporate environmental strategies may positively influence firm performance (Sharma & Vredenburg, 1998) – a promise that also seems to hold for emerging countries (Chan, 2005). Specific research on product stewardship and sustainable development was relatively scarce, given that the competitive cost advantage and pay-off may not be linked as obviously to these two strategies. While product stewardship is considered an extremely promising strategy for environmental impact (Lane & Watson, 2012), the concept did not fully take off. Sustainable development, which by definition comprises a broader field of activities, has been researched from many perspectives and hence has various interpretations, as scholars have summarized elsewhere (Lélé, 1991). In particular, the definition of sustainable development goals has led to various publications (Griggs et al., 2013; Sachs et al., 2019).

Concerning the circular economy, publications may deploy the NRBV to explain how it can support the fulfillment of the circular economy paradigm with regard to supplier selection (Münch, Benz, & Hartmann, 2022), how food-tech companies can upscale their circular impact (Sehnem et al., 2022), and how collaboration enables the advancement of circular economy in developing countries (Mishra, Chiwenga, & Ali, 2021).

The theories of the dynamic capabilities and the NRBV of the firm have been combined to explicate the advances of sustainable firm activities (Maleki Minbashrazgah & Shabani, 2019; Miemczyk, Howard, & Johnsen, 2016). Indeed, to understand corporate environmental strategy, scholars often combine the perspectives offered by the classical RBV, the NRBV, dynamic capabilities, and other complementing theories. Aragón-Correa & Sharma (2003), for example, additionally included contingency theory and showed that the firm's context in the business

environment, namely "uncertainty, complexity, and munificence moderate the relationship between the dynamic capability of a proactive environmental strategy and competitive advantage" (Aragón-Correa & Sharma, 2003,p. 71). Other more recent discussions on the RBV focus on its overlap with other management fields, such as human resources (Gerhart & Feng, 2021), operations management (Chahal, Gupta, Bhan, & Cheng, 2020), and business ecosystems (Gueler & Schneider, 2021), but also on the refinement of the theory itself. For example, Freeman et al. (2021) show how stakeholder theory can complement the RBV, as the role of stakeholders is classically absent in RBV theory. To conclude, the RBV is a very insightful and widely cited theory in the field of strategy (Lockett et al., 2009), which has strongly influenced management scholarship and still does so today – despite the various critiques (Kraaijenbrink et al., 2010).

1.4.2 The resource-based view in this thesis

The previous section introduced the RBV and its related fields as they are insightful perspectives for the circular economy, and thus also in this thesis. These theories can guide the phenomenon-driven and mostly practice-oriented research of circular business models (Ghisellini, Cialani, & Ulgiati, 2016; Liu, Feng, Zhu, & Sarkis, 2018) and provide it with a theoretical lens (Marques & Manzanares, 2022). The following section explains how the papers of this thesis engage with the theoretical lenses discussed above.

The first publication in this thesis (Pietrulla & Frankenberger, 2022) proposes a research framework for circular business models and does not directly deal with the RBV of the firm. Instead, it deploys more recent research streams, which stem from or whose thinking is strongly influenced by the RBV. By doing so, the paper follows the suggestion by Newbert (2007), who proposed that scholars should deploy "more contemporary theoretical extensions" (p. 121) of the RBV. Hence, the first paper uses, among others, the dynamic capabilities and business model innovation lens. As described in the previous section, the theory of dynamic capabilities directly evolved from the RBV, and the business model innovation literature is even more recent. However, it indirectly links to the RBV through the dynamic capabilities as "BMI [business model innovation] can be seen as a dynamic capability itself" (Gassmann et al., 2016, p. 56).

While the idea of the paper is to create a research framework around circular business models that inspires further research and practitioners in the implementation

of circular business models, it contributes to the dynamic capabilities and business model innovation literature by extending them to the circular business model context. The paper thereby also builds on Bocken and Geradts's (2020) paper which showed the value of dynamic capabilities to sustainable business models. Dynamic capabilities may also be considered antecedents of circular business models: First, the opportunity for a circular business model must be properly identified, and then both the right amount and kind of resources need to get allocated to create and later capture value (Khan, Daddi, & Iraldo, 2020b; Khan et al., 2020a). In fact, identifying or seizing this opportunity for a circular business model may strongly be related to the (more general) business model innovation capability.

The second publication (Pietrulla, 2022a) in this thesis on circular ecosystems is a more practice-oriented paper. It builds on the circular economy and ecosystems literature for a literature review on the just emerging works on circular ecosystems. Hence, similar to the first paper, this article does not directly rely on the RBV but focuses on the more recent literature stream of ecosystems (Adner, 2006, 2017; Adner & Kapoor, 2010a; Jacobides et al., 2018; Kapoor & Lee, 2013; Tsujimoto, Kajikawa, Tomita, & Matsumoto, 2018). Nevertheless, the RBV also has an indirect footprint in this paper due to the overlap of the two literature streams of ecosystems and RBV, as shown elsewhere (Gueler & Schneider, 2021). Especially one key idea is central to the ecosystems theory that, on a more abstract level, has already emerged in the RBV literature: the concept of complementarity (Jacobides et al., 2018). When in business ecosystems the complementary inputs, contributions, and know-how of ecosystem players are critical for a successful outcome of a business ecosystem (Jacobides et al., 2018; Lin, Yang, & Arya, 2009), the RBV states that complementary resources and capabilities within a firm lead to sustained competitive advantage (Barney, 1995; Gerhart & Feng, 2021). Hence, while the abstract idea of complementarity stays the same, the perspective, level, and unit of analysis change from the internal company level (in RBV) to the external, inter-company level (in ecosystem literature). Within the business ecosystem and industrial ecology ecosystem types (Tsujimoto et al., 2018), circular ecosystems may be considered a specific sub-category for sustainable development. The paper in the thesis extends the ecosystems' knowledge towards the circular economy context.

The third publication in this thesis (Pietrulla, 2022b) analyzes the firm characteristics that may determine a firm's support for circular economy regulation. The paper builds on Christmann's finding "that competitive effects of environmental strategies differ across firms with certain characteristics" (Christmann, 2000, p. 694).

So following this logic, stating that different firm characteristics influence the environmental strategies (and competitive effects), this paper focuses on the aspect of the corporate political activity of a firm (Lawton, McGuire, & Rajwani, 2013; Mellahi et al., 2016), which represents an essential part of environmental strategy. The paper does so with a particular focus on the circular economy context in the EU. The paper deploys the RBV to develop the hypotheses on the firm characteristics, which may determine whether a firm will support circular economy regulation. While the idea is not to analyze the specific political resources of a firm (Bonardi, 2011), the paper focuses on the rather classical RBV resources, which are, for example, firm size (Armas-Cruz, Gil-Soto, & Oreja-Rodríguez, 2017; Hamdoun, 2020). The RBV, which looks at internal resources in terms of tangible and intangible assets, provides insightful ideas which help formulate the hypotheses.

To conclude, this thesis extends the RBV to the circular economy and circular business model context. It thereby contributes a theoretical approach to the vivid development of the literature on circular business models. For this thesis as a whole, the perspective of the RBV has been quite enriching and influential. Thereby, this thesis shows the value of more frequently connecting the rather phenomenon-driven field of circular economy research with more established theories. By doing so, scholars may generate and integrate practical insights into the circular economy roll-out faster and simultaneously contribute to established management theory by applying their lenses to a new context.

1.5 The three papers in brief and their contribution

Written as a cumulative dissertation project, this thesis consists of five chapters. The first chapter presents the general introduction and the fifth chapter the conclusion. The second, third, and fourth chapters are independent studies that investigate unanswered research questions in the field of circular economy research. Chapters 2, 3, and 4 each clarify the conceptual and theoretical background to the topic, explain the research gap they seek to fill, and present their contributions to academics and practitioners. Given that all three publications deal with the circular economy, the reader might observe a certain level of repetition in the introductory elements when key concepts are explained. This repetition also allows the reader to read these publications in isolation from each other, as the concepts used for each paper are always described in full. Table 1 summarizes the most critical information on each publication.

Table 1 The three papers summarized

Title; Author(s)	**Research Question(s)**	**Method**	**Contributions**	**Publications; Journal**
"A Research Model for Circular Business Models – Antecedents, Moderators, and Outcomes"; Felicitas Pietrulla, Karolin Frankenberger	What factors play a role in the research framework of CBMs? What is the paradigmatic status of the CBM concept?	Literature review	**To theory**: Shows that the CBM concept has not reached paradigmatic status yet; highlights how several theoretical lenses must be combined to understand CBMs better **To practice**: Helps practitioners understand the influencing factors that can play a role when implementing a CBM	(Pietrulla & Frankenberger, 2022) Sustainable Futures
"Circular Ecosystems: A review"; Felicitas Pietrulla	What are circular ecosystems, and what types exist?	Literature review	**To theory**: Analyzes the evolution of the circular ecosystem concept as well as reviews and categorizes existing knowledge on circular ecosystems; provides a typology of circular ecosystems **To practice**: Presents a novel way for practitioners to approach circular ecosystems and discusses success factors for implementation	(Pietrulla, 2022a) Cleaner and Circular Bioeconomy
"Private firm support for circular economy regulation in the EU policy context";	What drives firm support for circular economy regulation?	Empirical, quanti-tative analysis	**To theory**: Contributes insights on corporate political activities in the circular economy and EU context, hypothesizing that firm size and slack resources influence support of circular economy regulation,	(Pietrulla, 2022b) Sustainability

Title; Author(s)	Research Question(s)	Method	Contributions	Publications; Journal
Felicitas Pietrulla			especially in the case of public listing **To practice**: Helps policy-makers understand firms' potential reactions so they can tailor policies accordingly; helps managers understand how their firm's characteristics may influence their stand on circular economy regulations	

Chapter 2 reviews the circular business model literature and links it to related concepts and explanatory theories. Besides the circular economy, business model innovation, and ecosystems research streams, institutional theory, managerial cognition theory, and dynamic capabilities theory are assessed for their value in creating a comprehensive research model for circular business models. In addition to providing a framework that highlights the antecedents, moderators, and outcomes of circular business models, the paper critically reflects on the paradigmatic status of the circular business model concept to reveal weaknesses to be addressed in future research. This paper can help management academics locate useful topics of study within the broader research framework of circular business models and provide inspiration for future research. Furthermore, practitioners find insights in this paper from its holistic overview of factors that should be considered when implementing circular business models. Given the broad benefits of this paper, it was considered among the top 10% of papers at the Academy of Management Conference in 2021 and was published in the conference proceedings. In addition, this version has received interest from publishers who requested a more extended book version. The final version of this paper has been published in the journal *Sustainable Futures*.

Chapter 3 reviews the literature on circular ecosystems, presents the evolution of the circular ecosystem term, provides a classification framework, and discusses success factors. The classification equips practitioners with the language and a less complex approach to think of their own envisioned circular ecosystem. In addition, the discussion of success factors can be applied directly during the set-up of circular ecosystems. For academics, this review offers a clear-cut picture of the concept of circular ecosystems by means of a thorough review of the two literature streams of circular economy and ecosystems research. The paper also helps circular economy and management scholars to be more explicit about the type of circular ecosystem they refer to or investigate. Finally, the classification framework can inspire future research to investigate how a specific circular ecosystem subtype functions in different contexts. The final version of this paper has been published in the journal *Cleaner and Circular Bioeconomy,* a companion journal of the *Journal of Cleaner Production*.

Chapter 4 then takes a look at the firm-policy-maker interactions by identifying drivers of firms' support for circular economy regulation. The chapter explores which firm characteristics may influence their attitude toward environmetal regulation, so it adds to the corporate political activity literature by providing empirical evidence from the EU context. It hypothesizes that firm endowments like assets, employees, and slack resources influence firms' support for circular economy regulations and expects

that the public listing of firms has a moderating effect on those relationships. So far, circular economy research has focused on the policy level or micro (i.e., product or firm) level, leaving a gap in what we know about the interaction of these two levels. This paper provides a starting point for further multi-level analyses. For practitioners, the paper offers insights into how to understand one's own company and how its characteristics may influence its stance on circular economy regulations. At the same time, the paper gives policy-makers insights into how specific companies may react to circular economy regulation. The final version of this paper has been published in the journal *Sustainability.*

2 A Research Model for Circular Business Models – Antecedents, Moderators, and Outcomes

Abstract: The concept of circular business models, defined as firm activities to create and capture value in a circular manner by, for example, extending or continuously reusing product materials, has received increasing attention in management research. The emerging literature, however, lacks theoretical underpinning and empirical findings are not cumulative. Therefore, this article analyzes existing and related research in much detail and presents a comprehensive research model on antecedents, moderators, and outcomes of circular business models. The theories and related research streams considered for the research framework include Institutional Theory, Managerial Cognition, Dynamic Capabilities, Corporate Social Responsibility, Business Model Innovation, and Ecosystems. Gaps within and across the respective research streams concerning circular business models are revealed, and relevant avenues for future research are suggested.

Keywords: Circular business models, Corporate social responsibility, Dynamic capabilities, Institutional theory, Review

Comment*:* The final version of this paper has been published in 2022, as open access in the peer-reviewed journal of *Sustainable Futures*. It can be retrieved via this link:

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Pietrulla, F., & Frankenberger, K. (2022). A Research Model for Circular Business Models – Antecedents, Moderators, and Outcomes. *Sustainable Futures*, 100084.

An earlier version of this paper was selected as top 10% of papers submitted to the 2021 Academy of Management (AOM) Conference and has been published in the Proceedings of the AOM. As we received a book request from a publisher, an extended version might be forthcoming.

2.1 Introduction

The alternative to the rather unsustainable linear economy that fuels climate change through high emissions, waste, and resource depletion is the circular economy concept (CE hereafter). Interest in the concept has increased significantly in policymaking, industry, and academia (Bocken, Strupeit, Whalen, & Nußholz, 2019b; Mishra et al., 2021; Morone & Yilan, 2020). Accordingly, the field of Circular Business Models (CBM hereafter) is entering the management literature with a growing number of publications (e.g., Atasu, Dumas, & Van Wassenhove, 2021). CBMs are considered a crucial enabler on the micro-level for organizational and environmental sustainability (Geissdoerfer et al., 2017) and describe "how a company creates, captures, and delivers value with the value creation logic designed to improve resource efficiency through contributing to extending useful life of products and parts (e.g., through long-life design, repair and remanufacturing) and closing material loops" (Nußholz, 2017, p. 12). Thus far, the concept has been mainly researched from an industrial ecology perspective (De Angelis, 2021; Lahti, Wincent, & Parida, 2018; Merli et al., 2018), but less so from an integrated management perspective (Urbinati, Chiaroni, & Toletti, 2019). Applying management theory to the concept of CBM can reveal promising pathways to transform a linear towards a CBM more effectively. Doing so also answers the call of many researchers asking for a more integrated view on CE to make it a reality (Gregorio, Pié, & Terceño, 2018; Hussain & Malik, 2020; Jabbour et al., 2019).

Besides, we see the need to synthesize CBM related research streams for two academic reasons. Firstly, the still relatively young CBM concept has never been summarized in one holistic CBM-framework entailing antecedents, moderators, and outcomes and has never been assessed for its paradigmatic status. While sustainable BM research has advanced significantly and contributed extremely valuable archetypes (e.g., Bocken, Short, Rana, & Evans, 2014), this research focuses on typologies and a mostly "internal" view of sustainable business models. Thereby, this research only lightly touches upon influencing factors external to the actual CBM. We, therefore, want to contribute to the field by providing this holistic (external) perspective on CBMs in particular – to account for both the risen interest in the sustainable business model subfield of CBMs and to account for the elements that are specific to circular, but not necessarily sustainable business models. Secondly, previously unlinked legacy domains contributing to the CBM concept like Institutional Theory (IT), Managerial Cognition (MC), and Dynamic Capabilities (DC) as theoretic

lenses, and Corporate Social Responsibility (CSR), Business Model Innovation (BMI), and Ecosystems (ES) as literature streams have not meaningfully been combined yet to move the CBM research field forward. As those streams primarily developed in isolation, the use of terms is often imprecise, and concept boundaries have become blurry (Ranta, Aarikka-Stenroos, & Mäkinen, 2018a; Salvador, Barros, Luz, Piekarski, & de Francisco, 2020). Like this, we reveal gaps within and across research streams and propose promising avenues for future research. With this integrative and generative approach for concept advancement (for a similar approach, see Raisch & Birkinshaw (2008)), we firstly systematically organize the dynamic research field of CBM by elaborating on the evolution of the concept; and secondly, show how other management fields can contribute to the field moving forward.

2.1.1 Evolution of circular business model research

Schwager and Moser first mentioned the core idea of CBMs CBMs, i.e., circular value creation, in 2006 (see also, Geissdoerfer et al., 2020). Along with other practitioner-oriented publications on CE (e.g., Ellen Macarthur Foundation (2013)), studies on CBMs recently grew exponentially finding inspiration from firstly, the sustainable BM literature (e.g., Joyce & Paquin, 2016), and secondly, the CE literature (Geissdoerfer et al., 2017). The sustainable BM literature promises a competitive advantage through sustainability-inspired innovation (Nidumolu, Prahalad, & Rangaswami, 2015). These sustainable BM address social and environmental challenges (Dentchev et al., 2018; Morioka, Bolis, Evans, & Carvalho, 2017) and thereby create shared value (Porter & Kramer, 2011), inclusive growth (Adams et al., 2016) and a larger value pie through stakeholder synergies (Tantalo & Priem, 2016). Within this research stream, researchers showed that it pays to be sustainable (Ambec & Lanoie, 2008; Burke & Logsdon, 1996; Stoian & Gilman, 2017), they developed various practical tools (e.g., Joyce & Paquin, 2016) and classifications of sustainable BMs (Bocken et al., 2014; Lüdeke-Freund, Carroux, Joyce, Massa, & Breuer, 2018; Schaltegger, Hansen, & Lüdeke-Freund, 2016a), and they investigated the sustainable BM sub-stream of social BMs and social BMI (Gasparin et al., 2020; Michelini & Fiorentino, 2012; Mongelli & Rullani, 2017; Rispal & Servantie, 2017; Yunus, Moingeon, & Lehmann-Ortega, 2010). Besides those significant advances, authors of the field still search for practical approaches to transform organizations towards truly sustainable ones (Bocken & Geradts, 2020; Cosenz, Rodrigues, & Rosati, 2020). For example, while the sustainable BM archetypes by Bocken et al. (2014) provide comprehensive insights into the different types of BM that are also relevant for CBMs,

such as "Create value from waste," we want to contribute to this stream of literature by adding two elements: First, we provide a complementary external perspective on CBM analyzing external factors, such as antecedents, moderators, and outcomes that may influence such archetypes of CBMs, which in return represent a focused and "internal" view of CBMs. Second, we want to create a holistic framework for CBM using a CE lens. While our CBM framework can learn from these sustainable BM archetypes, the practice revealed that social and CBMs can be pretty different. Therefore, we hope that the specific focus on CBM and the external perspective brings more clarity to the field and brings our research community closer to finding meaningful ways to enable effective organizational transformations towards CBMs.

The second inspiring literature stream of CE is central to the CBM concept: CE is defined as "an industrial system that is restorative or regenerative by intention and design" (Ellen MacArthur Foundation, 2015, p. 19) and is inspired by earlier concepts, such as closed-loop systems (Boulding, 1966), or industrial economy loops (Stahel & Reday, 1981) as described in more detail by Geisendorf and Pietrulla (2018). Connecting the CE field with business model research was essential to leaving the CE "niche" (Kirchherr et al., 2018).

As the review of Geissdoerfer et al. (2020) reveals, current CBM research primarily deals with typologies of CBMs, such as reuse, repair, and maintenance models (Bocken, de Pauw, Bakker, & van der Grinten, 2016a; Bocken, Short, Rana, & Evans, 2014; Bocken et al., 2016b; Evans et al., 2017; Lewandowski, 2016; Lüdeke-Freund et al., 2019; Manninen et al., 2018; Rizos et al., 2016). While some studies discussed CBMs' effectiveness in terms of (primarily environmental) performance outcomes (e.g., Bocken et al., 2016b; Geissdoerfer, Morioka, de Carvalho, & Evans, 2018a) and propose first relevant antecedents (e.g., Del Giudice, Chierici, Mazzucchelli, & Fiano, 2020) or other factors impacting CBM implementation (Salvador et al., 2020), fewer scholars have empirically investigated more intricate associations of moderators (Ranta, Aarikka-Stenroos, & Väisänen, 2021). Overall, CBM publications tend to focus on a specific context with limited generalizability and just one particular area of a typical research framework, i.e., antecedents, outcomes, moderators, or the concept of CBMs itself. An integrative research framework synthesizing accrued knowledge from adjacent domains into one framework of antecedents, moderators, and outcomes of CBMs is missing. We list dominant reviews and conceptualizations in Table 2.

Table 2 Reviews and selected conceptual studies on circular business models

Publication	**Focus**
Geissdoerfer et al. (2020)	Systematic review of CBMs concerning history, definitions, and conceptualization of new frameworks
Bocken et al. (2019)	Presentation of CBM innovation techniques
Lüdeke-Freund et al. (2019)	Analysis of current (29) CBMs and synthesis of major BM design options and BM patterns
Pieroni et al. (2019a)	Review and comparison of approaches for sustainability and CBM innovation through a dynamic capability view
Lewandowski (2016)	Analysis of CBM typologies, introduction of triple-fit-challenge as enabler for CE transition
Reim, Parida, & Sjödin (2019)	Review of CBM literature concerning bio-economy barriers and in the forestry context
De Pádua Pieroni, Pigosso, & McAloone (2018)	Review of CBMs and identification of sustainability qualifying criteria per BM type
Antikainen & Valkokari (2016)	Conceptualization of CBM innovation framework including barriers and ES ideas based on case study approach
Rosa et al. (2019)	Review of CBM approaches and classification of most prominent archetypes, challenges, and decision criteria
Nußholz (2017)	Review of CBM literature based on a resource efficiency lens
Salvador et al. (2020)	Literature review summarizing CBM implementation aspects and identification of research gaps

2.1.2 Literature streams related to circular business models

Domains that are closely related to the field of CBMs (Geissdoerfer et al., 2017; Nußholz, 2017) can further inform the discussion of CBMs. Due to space constraints in this paper, we focus on the most relevant theoretical lenses and management concepts and explain what they can contribute to CBM concept research. We identified IT, MC, and DC as the most relevant theoretical lenses by screening the twenty most relevant management theories of BM research (Gassmann et al., 2016). We identified those theories as most relevant for our study for the following criteria:

Firstly, the theory at hand has strongly influenced the debate on other sustainability phenomena (e.g., CSR (Aguinis & Glavas, 2012)). Secondly, the theoretical perspective has already been applied to the CE or CBM concept – even when not in much detail. However, as third criteria, we dismissed those theories whose value for CBM has already been assessed in much detail elsewhere (e.g., for stakeholder theory and resource-based-view applications to CE, see (Jabbour et al., 2019). Regarding other phenomena and management concepts, we decided to focus on CSR, BMI, and ES research for the following reasons: CSR is somewhat similar to CBM as part of its goals is corporate environmental sustainability (besides the social and long-term profit goal). At the same time, CSR is much more advanced than CBM research, thereby providing an excellent opportunity for CBM research to learn from this phenomenon's state of knowledge. We chose BMI as a relevant phenomenon as it provides the relevant process and activity perspective on the transformational aspect required to make CBM a reality. At the same time, this research field is also far more advanced than the relatively small subfield of CBM and promises a great learning opportunity. Lastly, we chose ecosystems as a highly relevant phenomenon due to the nature and required structure of CBMs. Indeed most scholars argue that an ecosystem set-up for CBM is required as various partners need to collaborate to circulate materials fully.

Hence, this section first reviews IT, MC, and DC as the most relevant theoretical lenses. Secondly, we review the value of CSR, BMI, and ES as adjacent literature streams of CBM research. This analysis allows us to identify the relevant factors for the integrated research model of CBMs consisting of antecedents, moderators, and outcomes.

2.1.2.1 *Institutional theory*

IT is a well-established theory in management research that has also informed various work on other sustainability-related corporate phenomena such as corporate social responsibility (McWilliams & Siegel, 2001; McWilliams, Siegel, & Wright, 2006). IT explains how institutions affect the characteristics of organizational structures (Scott, 1987) through, e.g., authoritative guidelines and how institutional processes (e.g., DiMaggio & Powell, 1983) relate to organizational change and strategic response (Oliver, 1991). Institutions that represent specific rules, norms, and routines contribute to an accepted standard within an industry. Therefore, it is often difficult for organizations to break out of this usual operating model. As the switch from a linear to a CBM typically requires institutional change, CBM authors used IT to explain the institutional challenges and path dependencies from a systemic

perspective. The IT lens proves especially helpful to explain when firms struggle to achieve their social mission, environmental stewardship, and economic goals (Fehrer & Wieland, 2021; Weerawardena, Salunke, Haigh, & Sullivan Mort, 2021) or when facing institutional barriers to CE as a whole (Ranta, Aarikka-Stenroos, Ritala, & Mäkinen, 2018b). Some papers also review specific contexts, such as the fashion industry (Stål & Corvellec, 2018) or battery recycling (Levänen, Lyytinen, & Gatica, 2018), to present institutional drivers. However, the theoretical lens of IT has not been applied in much depth yet. The comparably older research field of CSR (which we will also present in more detail below) benefited substantially from applying the institutional theory lens (e.g., Aguinis & Glavas, 2012).

2.1.2.2 *Managerial cognition*

The 'cognitive view' implies that managerial cognition, e.g., managers' beliefs, sensemaking processes, and interpretations, drives strategic action in organizations (Daft & Weick, 1984; Nadkarni & Barr, 2008). This view thereby complements the rational 'economic view,' that implies that industry structure defines strategic outcomes, such as strategy formulation and implementation (Narayanan, Zane, & Kemmerer, 2011). MC theory deploys several concepts such as sense giving (Maitlis & Lawrence, 2007), sensemaking (Balogun & Johnson, 2004), and attention (Ocasio, 2011) and several themes such as schemata (Schwenk, 1988) and dominant logics (Prahalad & Bettis, 1986), i.e., cognitive structures to navigate challenges, as well as boundary objects (Levina & Vaast, 2005; Star, 2010) that ensure common comprehension in different contexts. Scholars identified cognitive barriers towards CBMs in the EV batteries industry context, such as managerial disbelief in the value behind second-life BMs or a lack of interest in such solutions that are in direct competition with co-existing (linear) BMs (Olsson, Fallahi, Schnurr, Diener, & van Loon, 2018). These barriers more broadly represent a relevant factor in the transformation of the BM towards a circular one (Frishammar & Parida, 2019; Martins, Rindova, & Greenbaum, 2015). To summarize, only very few papers take a detailed view of cognitive managerial factors influencing CBMs.

2.1.2.3 *Dynamic capabilities*

Some scholars argue that the DC view of the firm is a more dynamic version of the resource-based view of the firm (Barney, 2001a), as it explains how resources or capabilities are developed or renewed (Barreto, 2010; Wang & Ahmed, 2007; Winter,

2003). Hence, dynamic capabilities are the "ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece, Pisano, & Shuen, 1997, p. 1018). The DC view has already been broadly applied in corporate sustainability studies (Kabongo & Boiral, 2017), in business model studies (Amit & Zott, 2016; Teece, 2018a) and more recently with a focus on sustainable business models (Bocken & Geradts, 2020). Overall, the DC view has been scarcely applied in environmental sustainability (Daddi, Todaro, De Giacomo, & Frey, 2018). However, a few studies on the role of DC for CBM specifically exist: Developing CBMs as DC represents the organizational strategic flexibility to respond to the changing environmental demand that asks for more sustainability in BMs (e.g., Bag, Gupta, & Foropon, 2019). Scholars find that sensing, seizing, and reconfiguring dynamic capabilities (Khan et al., 2020b, 2020a), collaborating with partners/suppliers to innovate products (Annunziata, Pucci, Frey, & Zanni, 2018), managing the environmental systems (Scarpellini, Valero-Gil, Moneva, & Andreaus, 2020), as well as establishing basic competences, standards and information (Fernandez de Arroyabe, Arranz, Schumann, & Arroyabe, 2021) are critical micro-foundations of the needed DCs. Furthermore, Bocken et al. (2020) explain how the right organizational design for sustainability largely nurtures the development of the needed DC.

2.1.2.4 *Corporate social responsibility*

CSR occurs when firms engage in social good activities beyond their interests and legal requirements (McWilliams & Siegel, 2001; McWilliams et al., 2006). The debate on CSR definitions (Jones, 1980) led to the widely cited publication of the "triple bottom line" framework (Elkington, 1998; Slaper, 2011) that differentiated the three Ps, namely People, Planet, and Profit of a sustainability strategy. While CBMs are mainly associated with the planet dimension (Del Baldo & D'Anghela, 2020), followed by the economic and, lastly, social dimensions (Merli et al., 2018), the CSR debate historically focused on the economic pay-offs (Ambec & Lanoie, 2008; Burke & Logsdon, 1996; Cochran & Wood, 1984; McGuire, Sundgren, & Schneeweis, 1988).

Ingulfsvann (2020) identifies sustainable production information as a circular element of CSR brand communication in an outdoor industry case study. Besides, deeper investigations between CSR and CBMs are scarce. While CSR often takes a firm perspective and often addresses the perception of the firm (e.g., del Mar García-De Los Salmones and Perez, 2018), the CBM concept is broader: It takes a complete product value chain perspective (Ingulfsvann, 2020), i.e., investigating a unit of

analysis that may span across firm boundaries (Geissdoerfer et al., 2020). Nevertheless, the two concepts are similar in their goals: Contributing to financial stability while making a positive environmental contribution. Given the advanced level of CSR research compared to the CBM field, understanding the factors influencing the success of (environmental) CSR initiatives can inform the CBM research field to expand its hypothesized relationships.

2.1.2.5 *Business model innovation*

Research on BMI has increased significantly over the last years (see for a recent review: Massa, Tucci, and Afuah, 2017) and attracted scholars' interest from strategic management (e.g., Casadesus-Masanell and Ricart, 2010), entrepreneurship (e.g., Amit and Zott, 2001), technology management (e.g., Chesbrough, 2010; Baden-Fuller and Haefliger, 2013) and most recently, sustainability (Evans et al., 2017a; Geissdoerfer et al., 2018a; Lopez, Bastein, & Tukker, 2019; Schaltegger, Freund, & Hansen, 2012). A BM refers to the firm architecture of value creation, delivery, and capture (e.g., Amit & Zott, 2001; Chesbrough, 2010; Gassmann, Frankenberger, & Csik, 2020; Osterwalder, Pigneur, & Tucci, 2005; Teece, 2010; Zott & Amit, 2007, 2008). BMI explains how firms can develop an architecture that "complements the traditional subjects of process, product, and organizational innovation" (Zott, Amit, and Massa, 2011, p. 1032). BMI scholars have shown increasing interest in how BMI can help companies achieve triple-bottom-line results (e.g., Bocken et al., 2014; Brehmer, Podoynitsyna, & Langerak, 2018; Schaltegger, Lüdeke-Freund, & Hansen, 2016). BMI for circularity means that BMs will create economic and environmental value for various stakeholders (Bocken, Schuit, & Kraaijenhagen, 2018; Lüdeke-Freund et al., 2019). However, BMs for sustainability differ from traditional BMs and require re-thinking the nature of the value proposition towards economic, environmental, and social value for various stakeholders (Bocken et al., 2018; Lüdeke-Freund et al., 2019). The literature also discusses managing multiple BMs in a portfolio to, e.g., avoid cannibalization (Velu & Stiles, 2013) or other trade-offs. Active portfolio management of different BMs is exceptionally informative for the success of a CBM when a firm complements its product portfolio with a circular offering addressing the same market as the traditional (linear) product.

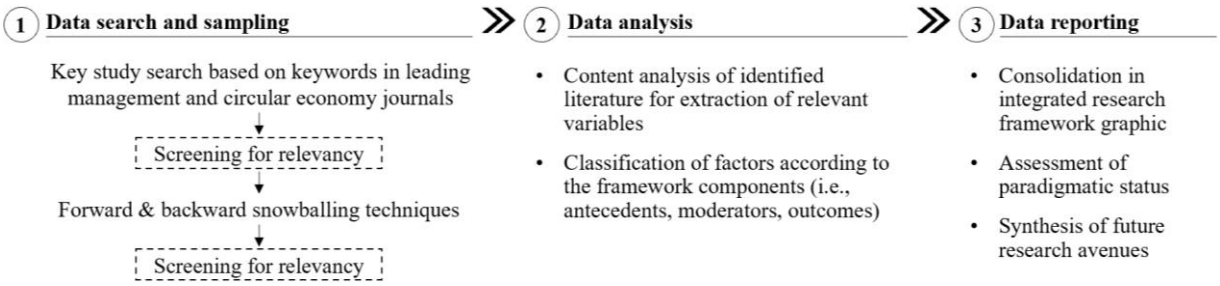
2.1.2.6 *Ecosystems*

Defined as "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (Adner, 2017, p. 40), an ES view on strategy adds value by effectively managing multilateral dependencies (Jacobides et al., 2018). ES actors are typically complementary and dependent on each other to create value in a systems-level architecture (Adner & Kapoor, 2010b; Kapoor, 2018; Kapoor & Lee, 2013) – an understanding that is also typical for CBMs. Indeed for CBM research, ESs are deemed quite relevant (Geissdoerfer et al., 2020): ES approaches promise a solution to manage the CBM inherent coordination challenge along the supply circle (Bocken, Short, Rana, & Evans, 2013; Mentink, 2014) by, e.g., optimizing transaction cost, revenue sharing contracts among ES actors, and joint innovation (Gomes, Facin, Salerno, & Ikenami, 2018; Granstrand & Holgersson, 2020) for competitive advantage (Barnett, 2006; Clarysse, Wright, Bruneel, & Mahajan, 2014). Scholars agree on the importance of ES for CE and sustainability research (Barnett, 2006; Clarysse, Wright, Bruneel, & Mahajan, 2014; Mishra et al., 2019; Pieroni, McAloon, & Picasso, 2019b). However, except for the specific studies on eco-industrial parks (e.g., Shi, Chertow, & Song, 2010; Zeng, Chen, Xiao, & Zhou, 2017), we know relatively little about how a circular ES works. Hence, the CBM concept learns from the two perspectives of ES research: Firstly, the actor-centric view of "ecosystems as affiliation," i.e., all stakeholders along the material flow chain, must be considered to make circularity a reality. Secondly, the activity-centric interdependencies or "ecosystem as structure" view, i.e., each stakeholder's interdependent activities (Adner, 2017), such as the recollection of materials at the end of a product's lifecycle, must be coordinated effectively.

2.2 Methodology

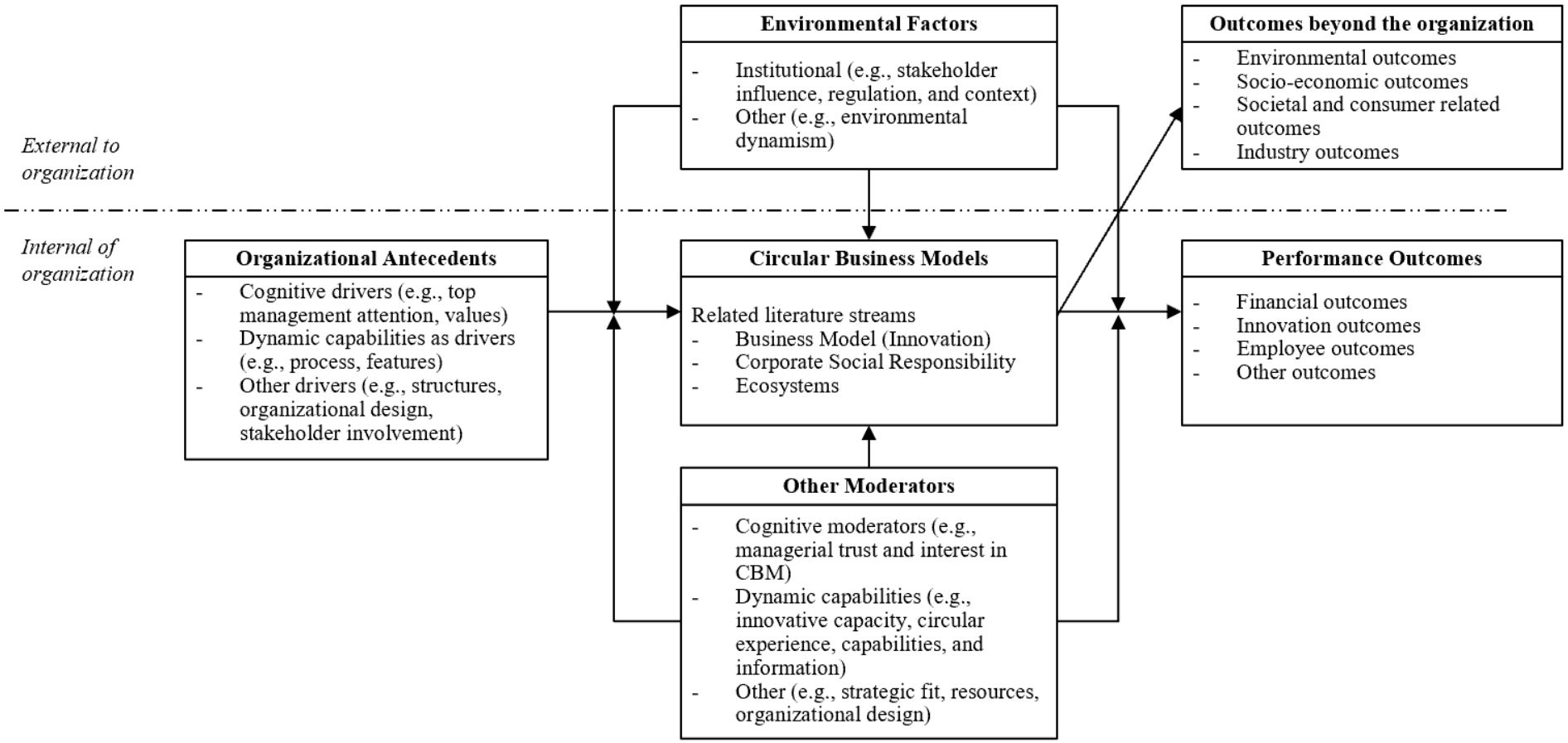
We conducted a thorough literature review, as displayed in Fig. 2. The three-step approach of data search, analysis, and reporting (de Almeida Biolchini, Mian, Natali, Conte, & Travassos, 2007; Denyer & Tranfield, 2009) follows a standard used by other CE researchers (e.g., Geissdoerfer *et al.*, 2020).

Figure 2 Methodology for literature review



We followed other management authors' approaches of data search (e.g., Raisch & Birkinshaw, 2008). We identified the top influential studies for each research field (CBM, IT, MC, DC, CSR, BM(I), ES), also considering articles referring to the same fundamental ideas, but using slightly different terms such as Circular Economy Business Models instead of Circular Business Model. We searched in premier management journals (e.g., Academy of Management Journal, Academy of Management Review, Administrative Science Quarterly, Journal of Management, Journal of Management Studies, Organization Science, and Strategic Management Journal) or in leading CE journals (e.g., Journal of Cleaner Production, Journal of Industrial Ecology, Sustainability, Sustainable production and consumption, Resources Conservation and Recycling, Waste management, Environmental Quality Management, Business Strategy and the Environment). We then screened these publications' titles and abstracts for two relevancy criteria (Jacsó, 2005): Firstly, studies must essentially address the respective concept, i.e., no other concept should be more prominent than the search string used. Secondly, studies must entail conceptual contributions regarding the research framework, informing about related variables of the respective concept. Next, we considered publications resulting from backward- and forward snowballing techniques (Wohlin, 2014) and repeated the screening for relevancy. The content analysis followed the literature search to develop our CBM framework integrating antecedents, outcomes, moderators, and environmental factors, as displayed in Fig. 2.

Figure 3 A framework to understand circular business models



2.3 Results – a comprehensive research framework

Most articles present structural or process-related antecedents and discuss outcomes, such as firm performance and contributions beyond the firm, inspired mainly by the discussed IT, MC, and DC theories. Complementing existing CBM literature, these articles provide promising propositions of how firms can build adequate CBMs (Geissdoerfer et al., 2020; Pieroni et al., 2019b).

Insights on more complex environmental or other moderating factors are relatively scarce. Hence, our research framework informs scholars on potential relationships and highlights gaps in the literature. We used the theoretic lenses (i.e., IT, MC, DC) to cluster the individual factors. Besides the framework (Fig. 3), we summarize selected and important articles informing CBM literature in Table 3.

Table 3 Summary of selected influential articles for CBM research

Studies (Year)	**Research focus**	**Domain & method**	**Key findings**
DiMaggio & Powell (1983)	Antecedents, outcomes, moderators, environ. factors	IT, conceptual	Conceptual paper introducing institutional isomorphism to organizational theory to explain similarity amongst organizations, differentiating between coercive, normative, and mimetic forces of isomorphism
Scott (1987)	Antecedents, outcomes, moderators, environ. factors	IT, review/ conceptual	Literature review about theoretical and empirical contributions towards IT, exploration of the relationship between institutions and interests showing how institutional features of organizational environments shape both the goals and means of actors
Daft & Weick (1984)	Antecedents, outcomes, moderators, environ. factors	MC, conceptual	Proposition of a comparative model of organizations as interpretation system, with four interpretation modes (enacting, discovering, undirected viewing, conditioned viewing) and their determinants (managerial beliefs of the environment, organizational intrusiveness)
Nadkarni & Barr (2008)	Antecedents, outcomes, moderators, environ. factors	MC, quant., conceptual	Comparison and connection of economic and cognitive view, hypothesis testing, and development of an integrated model to explain the interrelation of cognitive views and economic industry views on strategic action
Teece et al. (1997)	Antecedents, outcomes,	DC, conceptual	Presentation of the DC framework explaining the mechanisms for private wealth creation in times of technological change through firm internal

Studies (Year)	Research focus	Domain & method	Key findings
	moderators, environ. factors		factors like technological, organizational, and managerial processes
Barreto (2010)	Antecedents, outcomes, moderators, environ. factors	DC, review	Literature review on DC view considering diverse research streams on DC, identification of main limitations and challenges, proposition of a new conceptualization of DC as an aggregate multidimensional construct, suggestion for future research
Aguinis & Glavas (2012)	Antecedents, outcomes, moderators, environ. factors	CSR, review	Literature review about existing CSR publications presenting a multi-level and multi-factor framework, summarizing predictors, moderators, mediators, and outcomes of CSR
McWilliams et al. (2006)	Outcomes, environ. factors	CSR, conceptual	Conceptualization and summary of strategic implications for firm performance when deploying CSR in firm strategy making
Liang & Renneboog (2017)	Outcomes, environ. factors	CSR, quant.	Analysis of global CSR ratings from various countries revealing interdependencies, such as between CSR rating and legal origin of country
Flammer (2013)	Outcomes, environ. factors	CSR, quant.	Analysis of shareholder reaction to CSR initiatives and boundary conditions
Vishwanathan	Outcomes, environ.	CSR, meta-	Meta analysis identifying four mechanisms on how CSR positively affects

Studies (Year)	Research focus	Domain & method	Key findings
et al. (2020)	factors, moderators	analysis	financial performance (reputation, stakeholder reciprocation, less firm risk, innovation capacity)
Massa et al. (2017)	Antecedents, outcomes, environ. factors	BM, review /conceptual	Literature review and categorization into three BM lenses and discussion of BM concept value for strategy literature through value capture on the demand and supply-side
Foss & Saebi (2016)	Antecedents, outcomes, environ. factors, moderators	BMI, review	Literature review on BMI research, revealing gaps regarding construct clarity, antecedent conditions, contingencies, and outcomes
Wirtz et al. (2016)	Antecedents, outcomes, environ. factors, moderators	BM, review, qualitative	Literature review and identification of four foci (innovation, change & evolution, performance & controlling and design); synthesis of expert interviews for three research avenues (innovation, change, and evolution, design)
Zhang et al. (2020)	Antecedents, outcomes, environ. factors	BMI, meta-analysis	Meta-analysis confirming a positive BMI-performance association, a moderating effect of environ. uncertainty and impact of both internal and external antecedents
Evans et al. (2017)	Antecedents, outcomes, environ. factors	BM, conceptual	Development of a theoretical perspective on BMI leading to improved org., economic, environ. and social performance; suggestion of five alternative BMs for sustainable firms

Studies (Year)	**Research focus**	**Domain & method**	**Key findings**
Adner (2017)	Environ. factors	ES, conceptual	Structuralist conceptualization of ES and an ES strategy; comparison of ES to other concepts (e.g., BMs, platforms, networks, and alliances)
Jacobides et al. (2018)	Antecedents, outcome, environ. factors	ES, conceptual	Theoretical analysis of ES emergence and characteristics, e.g., modularity and complementary of interdependences
Kapoor (2018)	Antecedents, environ. factors, moderators	ES, conceptual/review	Comparison of ES to other similar concepts (e.g., networks) and outline of implications for value creation and organizational design
Granstrand & Holgersson (2020)	Outcome, environ. factors, moderators	ES, review/ conceptual	Literature review on innovation ES; proposition of a new definition and illustration based on empirical cases
Hannah & Eisenhardt (2018)	Environ. factors	ES, qualitative	Case study analysis of five US firms and induction of a theoretical framework explaining firm behavior over time and the role of competition and cooperation

2.3.1 Research on organizational antecedents of circular business models

Which conditions can corporations influence internally to enhance CBM development? Scholars have identified various barriers for CBMs, such as high investment cost or mindset issues (Ghisellini, Ripa, & Ulgiati, 2018; Guldmann & Huulgaard, 2020; Rizos et al., 2016; Tura et al., 2019; Vermunt, Negro, Verweij, Kuppens, & Hekkert, 2019). Its catalysts can be summarized through (1) cognitive drivers such as top management attention and values, (2) through DC drivers such as processes, and features; and (3) through other drivers such as structures, organizational design, and stakeholder involvement. Other direct effects outside of the organization will be discussed in the section on environmental factors.

2.3.1.1 ***Cognitive drivers***

The literature agrees that *top management attention*, communicated through a clear vision focusing on circularity and reducing sustainability pressures, positively affects the creation of CBMs (e.g., Bocken et al., 2016). This top management attention means setting concrete goals, such as developing circular designs and challenging planned obsolescence or other unsustainability, and contributes to the managerial sensemaking (Scherer, Rasche, Palazzo, & Spicer, 2016). Also, freeing adequate resources for a CBM transformation, e.g., for the setup of new delivery models for CBMs, is crucial (Tukker, 2015), and an entrepreneurial mentorship culture influences subordinates to develop "radical service innovation" for CBMs (Tukker, 2015, p. 85). To summarize, without adequate top management attention, a firm risks running "decoupled CSR initiatives" (Weaver, TreviÑo, & Cochran, 1999, p. 539) – which also applies to CBMs.

Furthermore, *values* are fundamental. *Contributing to the CE* as a shared responsibility feeling among employees is a key motivator and antecedent for CBM (Geissdoerfer et al., 2017). According to the CSR review of Aguinis and Glavas (2012), normative values such as a sense of responsibility and duty (Bansal & Roth, 2000; Sharma, 2000), adhering to higher-order or morals (Aguilera, Rupp, Williams, & Ganapathi, 2007) and a sense of stewardship (Marquis, Glynn, & Davis, 2007) are driving sustainability from within the organization. Indeed, the existence of such employee values (Mudrack, 2007) and their congruence with organizational values together can drive CBMs (Bansal, 2003). Hence, explicitly setting CSR or CE

orientation as a social norm from a human resource perspective may enhance CBMs (Shen & Benson, 2016).

2.3.1.2 ***Dynamic capabilities***

The dynamic capability to respond to significant changes in the environment (Zott et al., 2011), such as the increased climate risk (Ibn-Mohammed et al., 2021), is anteceding the creation of CBMs. For this purpose, several processes and features are essential: A holistic innovation process and practitioner tools allow employees to generate creative ideas (Evans & Johnson, 2013). For example, the theory of inventive problem solving (TRIZ) process (Kim & Yoon, 2012) helps to design products, testing processes, and ensures feedback loops (Tukker, 2015). Learning how to set up multi-disciplinary teams that include CE experts in the design phase (Bocken et al., 2016a), and building the capability to design for modularity or non-generic complementarities (Jacobides et al., 2018) is critical: It enables a "collaborative arrangement [or ES] through which firms combine their individual offerings into a coherent, customer-facing solution" or CBM (Adner, 2006, p. 2).

With these cross-organizational processes, companies can cooperate according to their competencies and modules (Tukker, 2015) while still owning enough autonomy over their respective module to avoid coordination struggles (Baldwin, 2012; Jacobides et al., 2018). Complementary modularity with customers enables indirect network effects (Parker & Van Alstyne, 2005), increasing overall ES effectiveness and co-specialization for mutual dependency (Teece, 2018b).

2.3.1.3 ***Other drivers***

A CBM requires certain organizational *structures*. These structures may often mirror the CBM's *servitization* (Parida et al., 2019): cross-functional structures aiming at short response times and repair facilities near clients (Baines et al., 2009). Also, as the new CBM might require organizational changes, organizational *design flexibility* allows acceptance of new CBM innovations (Bocken & Geradts, 2020; Foss & Saebi, 2016). Furthermore, a more open design of corporate governance practices may positively influence CSR initiatives or CBMs as more *stakeholders* get a say (Aguilera & Jackson, 2003; Aguinis & Glavas, 2012; Johnson & Greening, 1999).

2.3.2 Research on outcomes

Firstly, we present performance outcomes that refer to the organization. Secondly, we discuss outcomes beyond the organizational boundaries. These effects cover all three Ps of the triple bottom line framework (Elkington, 1998).

2.3.2.1 *Research on performance outcomes within the organization*

One can broadly differentiate between financial, innovation, employee, and other outcomes. First, scholars expect a positive business case outcome for corporations engaging in the CE (Geissdoerfer et al., 2017). This finding mirrors CSR research, where 59% of studies report a positive CSR-financial outcomes relationship (Orlitzky, Schmidt, & Rynes, 2003; Peloza, 2009; Vishwanathan et al., 2020). This positive relation can derive, firstly, from various value creation effects: On the revenue side, value is created from waste itself (Bocken et al., 2016a) or through classical BM innovation by suggesting new value propositions to customers, such as high-quality products (Bocken et al., 2016a), for which customers are willing to pay more (Baldassarre, Calabretta, Bocken, & Jaskiewicz, 2017; Schäufele & Hamm, 2017) or "new repair and service markets" that are typical for long life and sufficiency encouragement CBMs (Bocken et al., 2016a). These high-margin BMs may translate into higher market equity value (Aboulamer, 2018). Secondly, on the cost side, efficiencies through less material usage, more efficient processes, or even shared communal services such as cleaning in new collaborative CBM networks can decrease cost (Bocken et al., 2016a). However, most likely, setting up a new CBM occurs significant upfront investment cost in the short term – which represents an essential barrier to CBM implementation (Kirchherr et al., 2018; Masi, Kumar, Garza-Reyes, & Godsell, 2018). In the long-term, though, CBMs are expected to pay off through "new revenues, resource productivity, and business continuity benefits" (Hopkinson, Zils, Hawkins, & Roper, 2018, p. 71). In the meantime, environmental subsidies, such as the German Renewables Energy Act (Frondel, Ritter, Schmidt, & Vance, 2010), may contribute to the business case. To summarize, CBMs offer differentiation opportunities (Lahti et al., 2018; Tukker, 2015), thus increasing firm competitiveness (Alix & Vallespir, 2010) and potentially contributing to higher revenues.

Secondly, regarding innovation outcomes, CBMs represent a great differentiation opportunity (Lahti et al., 2018; Tukker, 2015). Accordingly, Tukker (2015, p. 85) summarizes that "PSS [Product-Service-Systems, that are similar to CBMs] typically lead to higher client loyalty," and make the product "more appealing

to certain customers (…) with a "green" interest" (Bocken et al., 2016a, p. 314). Hence, new customer group acquisitions seem possible based on consumer choice of company/product (Aguinis & Glavas, 2012; Arora & Henderson, 2007). With a "long-term customer loyalty" (Bocken et al., 2016a, p. 314) and improved customer relationship (Sousa-Zomer, Magalhães, Zancul, Campos, & Cauchick-Miguel, 2018) comes the opportunity to build "more dedicated and unique knowledge about clients and consequently, greater potential to innovate" (Tukker, 2015, p. 85), hence increasing innovation performance for novelty-centered BM (Zott & Amit, 2007), and overall innovation capacity for future growth (Vishwanathan et al., 2020). CBMs are lastly expected to improve the offering's reputation (Orlitzky et al., 2003; Vishwanathan et al., 2020) and the firm's reputation as a whole (Aguinis & Glavas, 2012; Brammer & Millington, 2008).

Thirdly, similar to CSR, CBMs may affect both internal and external employee-related outcomes: Internally, CSR contributes to increased organizational identification and pride (Carmeli, Gilat, & Waldman, 2007; Jones, 2010), employee engagement (Mirvis, 2012), organizational citizenship behavior (Jones, 2010; Newman, Miao, Hofman, & Zhu, 2016), in-role performance (Lee, Park, & Lee, 2013), employee satisfaction (Barakat, Isabella, Boaventura, & Mazzon, 2016), and retention (Bode, Singh, & Rogan, 2015). Externally, these initiatives can help attract future employees that care about the environment (Klimkiewicz & Oltra, 2017; Weber, 2008).

Lastly, other effects may be achieved through CBM: For example, CBM firms may have access to further funds: More and more private impact investors are looking for sustainable investments and several institutional funds, for example, the Norwegian pension fund, tie their investments to sustainability standards (Bugg-Levine & Emerson, 2011). Besides, circularity and local loops in supply chains can decrease dependence on suppliers and input materials and, thus, decrease risk deriving from complicated supply chains and scarce resources (De Angelis, Howard, & Miemczyk, 2018).

2.3.2.2 *Research on outcomes beyond the organization*

These outcomes refer to (1) environmental, (2) socio-economic, (3) consumer, and (4) industry-related effects. Firstly, improved environmental quality (Kirchherr et al., 2017; Moraga et al., 2019; Saidani, Yannou, Leroy, Cluzel, & Kendall, 2019), less resource depletion, reduced toxicity, and pollution (Geissdoerfer et al., 2017; Saidani, Kim, Cluzel, Leroy, & Yannou, 2020), and sustainable development towards the CE

(Kirchherr et al., 2017) are the positive effects of CBMs. Potential adverse consequences derive from consumers' rebound effects (Druckman, Chitnis, Sorrell, & Jackson, 2011; Zink & Geyer, 2017): The awareness to use a sustainable product may induce rebound effects in the usage of the products and services and may trigger customers spend their cost savings on other "polluting activities" (Bocken, Boons, & Baldassarre, 2019a, p. 315).

Secondly, socio-economic prosperity is an outcome for the CBM-firm itself, the partnering firms contributing to the circular loop (Veleva & Bodkin, 2018), and the macro-economic system (Kirchherr et al., 2017). The growth induced by CBMs is inclusive (Spiess-Knafl, Mast, & Jansen, 2015) as it, for example, increases employment (Cooper & Hammond, 2018), which could potentially balance the job losses caused by automation trends (Schröder et al., 2020). As CBMs diversify the economic setup, it also contributes to economic resilience (Esposito, Tse, & Soufani, 2018).

Thirdly, both tangible and intangible consumer benefits derive from CBMs: Economic benefits such as lower prices of service-driven offerings (Camacho-Otero, Boks, & Pettersen, 2018) or the opportunity to stretch spending for the utility over time, in case of a subscription (Tukker, 2015) appeal to the utilitarian consumer perspective. Doing so induces intangible values, such as access to a good that otherwise might have been too expensive to pay for upfront. One main benefit for them is the positive feeling that derives from participating in "creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations" (Kirchherr et al., 2017, p. 225).

Fourthly, if one industry player changes the industry standards towards a circular business logic, this might induce mimetic forces and a new institutional isomorphism towards the industry's new operating model (DiMaggio & Powell, 1983; Oliver, 1991). If the CBM is successful, a virtuous cycle of sustainability may likely be started within the industry as competitors are afraid to miss the next wave of (circular) innovations.

2.3.3 Research on environmental factors

Environmental factors are considered vital influencing variables in management theory with environmental dynamism and regulatory dynamics (Chan, Yee, Dai, & Lim, 2016; Goll & Rasheed, 2004; Ranta et al., 2018b; Rueda-Manzanares, Aragón-Correa, & Sharma, 2008). We differentiate direct effects on CBMs, moderating or mediating effects on the CBM-performance, or antecedents-CBM relationship.

2.3.3.1 *Direct effects of environmental factors on CBM*

Especially the institutional theory lens allows us to identify direct effects on CBMs stemming from environmental dynamism and uncertainty (Zhang et al., 2021). Pressure from various stakeholders may drive the development of sustainable offerings: e.g., from shareholders (David, Bloom, & Hillman, 2007; Rehbein, Waddock, & Graves, 2004), large funds owners (Neubaum & Zahra, 2006); third party evaluators, e.g., for environmental ratings (Chatterji & Toffel, 2010); external activist groups (den Hond & de Bakker, 2007); local communities (Marquis et al., 2007), or from responsible consumers with increasingly sustainable customer needs (Kirchherr et al., 2017). Accordingly, if monitoring through customers (Christmann & Taylor, 2006) and firm visibility are high (Chiu & Sharfman, 2011), CBM development seems more likely. Industry-specific factors as a broader firm context (e.g., Jakhar, Mangla, Luthra, & Kusi-Sarpong, 2019) can also influence CBMs (Aguinis & Glavas, 2012; Brammer & Pavelin, 2006; Brammer, Pavelin, & Porter, 2009). For example, if the level of differentiation within the industry is low, a CBM will stand out and hence promise increased performance (Hull & Rothenberg, 2008). According to this view, CBM innovation might occur as a response to, for example, competitive pressure (Doz & Kosonen, 2010; Johnson, Christensen, & Kagermann, 2008) and induce mimetic forces of sustainable industry behaviors (Nikolaeva & Bicho, 2011).

Besides, scholars agree that CE regulation plays an essential role for CSR initiatives, CBMs, and the CE as a whole (Campbell, 2007; Geissdoerfer et al., 2017; Kirchherr et al., 2018; McDowall et al., 2017; Milios, 2018; Shubham, Charan, & Murty, 2018). Accordingly, trade policy-related sustainability standards (Muller & Kolk, 2010) or other sustainable certification requirements (Christmann & Taylor, 2006) positively influence CBM development. Furthermore, the context of the firm matters: country-specific aspects of organizational culture (Brammer et al., 2009), corporate governance requirements, politics, financial, labor, and education systems and practices (Aguilera & Jackson, 2003; Aguinis & Glavas, 2012) may drive or hinder CBM development.

2.3.3.2 *Moderation and mediation of the CBM-performance relationship*

Environmental dynamism, defined as the degree of instability (Eroglu & Hofer, 2014) and "change in technologies, variations in customer preferences, and fluctuations in product demand or supply of materials" in the external firm environment (Jansen, Van Den Bosch, & Volberda, 2006, p. 1664), has a positive

moderating effect on the relationship between green product innovation and firm performance, both in terms of profitability and cost efficiency (Chan et al., 2016). Furthermore, specific awards and other third-party praise/ attention (Klassen & McLaughlin, 1996), institutional pressure for sustainable supply chains (Zeng et al., 2017), or subsidies (Chen, Dimitrov, & Pun, 2019) can strengthen positive organizational performance outcomes.

Consumers' role in this constellation is especially critical: If consumers' sustainability preferences or at least acceptance for reused products grows (Ghisellini et al., 2016; Kirchherr et al., 2017; Tukker, 2015), or if the customer-organization-fit is large (Sen & Bhattacharya, 2001), this can positively moderate the CBM-outcome linkage. As mediators, customer satisfaction mediates the philanthropy-outcome linkage concerning sales (Lev, Petrovits, & Radhakrishnan, 2010); consumer trust mediates the CSR attribution and recommendation-intention linkage (Vlachos, Tsamakos, Vrechopoulos, & Avramidis, 2009); and reputation mediates the corporate social performance-outcome association (Orlitzky et al., 2003). These relationships could thus be similar for the CBM-outcome linkage.

2.3.3.3 *Moderation through environmental factors of the antecedent-CBM relationship*

While various CBM studies mention the importance of boundary conditions, referring to the importance of ESs collaboration (Geissdoerfer et al., 2020) or the influence of legislative measures (Donner, Verniquet, Broeze, Kayser, & De Vries, 2021), we have not identified studies that meaningfully investigated external factors' effect on the antecedent-CBM relationship. For example, one could hypothesize that solid innovation processes will lead to CBMs when environmental dynamism moderator is high, as a changing environment increases the need for innovation. However, to the best of our knowledge, there is no empirical evidence or study on this topic. This represents a large research gap.

2.3.4 Research on other moderating factors

Both barriers to the CE and potential organizational catalysts have been identified (Kircherr et al., 2017; Sarja, Onkila, & Mäkelä, 2021). However, the literature on organizational moderators is still scarce – especially in its empirical evidence. Nevertheless, we hypothesize and enrich the CBM knowledge deriving insights from existing research streams, summarizing the most prominent factors, once

again clustering the factors into three categories: MC, DC, and other moderators like strategic fit and resources.

2.3.4.1 *Cognitive moderators*

Managerial willingness to try disruptively new (circular) business logic and a general *interest in CBMs* can positively moderate the antecedent-CBM linkage. This often requires trust in the idea and value of CBMs and those individual employees managing the CBM initiative (Frishammar & Parida, 2019; Martins et al., 2015; Olsson et al., 2018). As listed above (e.g., high top management attention and strong sustainability values), cognitive antecedents may also represent moderators for the antecedent-CBM linkage: For example, strong *innovation processes* are more likely to lead to CBMs (instead of linear BMs) when sustainability is central to employee *values*.

2.3.4.2 *Dynamic capabilities moderators*

As CBMs may need to be implemented in an ES, firms with the right organizational design for sustainability (Bocken & Geradts, 2020) develop needed dynamic capabilities, such as open innovation and effective collaboration with partners and suppliers (Annunziata et al., 2018). A high level of technological innovation or other creative, *innovative capacity*, e.g., the use of big data to create additional value through, e.g., product innovation (Annunziata et al., 2018) and process improvements, can positively moderate the CBM-outcome relationship (Del Giudice et al., 2021). Technological innovation, e.g., concerning recycling know-how or waste management, is also critical to reach environmental sustainability (Geissdoerfer et al., 2017) and hence should also positively moderate the antecedent-CBM linkage. Those factors, in return hence positively moderate the CBM-outcome link in an ES setup (Berglund & Sandström, 2013). Likewise, a solid buyer-seller relationship positively moderates the CBM-outcome linkage in a B2B context (Brown, Sichtmann, & Musante, 2011) as firms learn to commercialize external resources in an ES (Chesbrough, 2010; Chesbrough & Crowther, 2006).

Besides that, *capabilities* to manage the change inherent to the BMI process (Achtenhagen, Melin, & Naldi, 2013), to identify the strategically best fitting BM design enhances firm performance of the CBM (Foss & Saebi, 2018). For this purpose, scholars expect experimentation and learning capabilities to moderate the antecedent-CBM linkage positively (Andries & Debackere, 2013; Cavalcante, 2014; Cavalcante,

Kesting, & Ulhøi, 2011; Günzel & Holm, 2013). Overall, DC, such as sensing, seizing, and reconfiguring capabilities at the micro foundation, is essential (Khan et al., 2020b, 2020a). More operationally, practical capabilities such as environmental management systems (Scarpellini et al., 2020), as well as competencies, standards, and information (Fernandez de Arroyabe et al., 2021), or strong marketing capabilities for radically new CBM offerings (Tukker, 2015) positively affect the CBM-outcome linkage. Given the often performance-based services of a CBM, the operational delivery benefits from deep experience in customer-service provision (Datta & Roy, 2011), and a strong service culture (Brown et al., 2011; Johnstone, Dainty, & Wilkinson, 2009).

2.3.4.3 *Other moderators*

Firstly, the *strategic fit* to the overall firm strategy (Foss & Saebi, 2016) of a CBM will positively moderate the CBM-performance linkage. For example, a novel CBM will be more successful if the new product portfolio constellation avoids internal cannibalization and if both tangible and intangible consumer benefits, such as price advantages or brand value, are provided (Tukker, 2015).

Secondly, the availability of slack resources in the organization (Bansal, 2003) positively moderates both the antecedent-CBM linkage and the CBM-performance linkage. In other words, with more organizational resources, antecedents like top management attention can more likely lead to the development of CBMs as top management decides to cover initial investment costs. Furthermore, as running CBMs might need ad-hoc financial support to be effective, slack resources also positively influence the CBM-performance linkage. Therefore firm size, often related to larger budgets and slack resources for experimentation (Daniel, Lohrke, Fornaciari, & Turner, 2004), affects CSR or CBM antecedent and performance outcome linkages (Godfrey, Merrill, & Hansen, 2009).

2.4 Synthesis of circular business model research

CBM scholars have produced many publications in a short amount of time. Core articles still deal with definitions and typologies of CBMs (see Table 2). Hence, to reach paradigmatic status, the CBM concept needs to develop further: According to Kuhn (2012), a paradigm, being understood as a theoretical framework of a scientific discipline, must produce generalizable insights, theories, and methods to test these. Following the approach taken by previous management authors (e.g., Raisch & Birkinshaw, 2008), we use the four conditions defined by Fry and Smith (1987) to

show how the CBM is still at the conceptual (pre-paradigmatic) level of development but is on a good path to eventually reach the paradigmatic stage (see also Dubin, 1978). We suggest avenues for future research by listing the main insights deriving from the four conditions on variables of interest, congruence, boundaries, and contingency effects. We also exemplify relevant research questions based on this assessment of the four conditions in Table 4.

Table 4 Suggested avenues for future research based on the paradigmatic assessment according to Fry and Smith (1987)

Paradigmatic category	**Suggested avenues for future research and exemplary research questions**
Variables of interest	1) Multi-level analysis: - How can CBMs be implemented best in an ES, e.g., in cooperation or alliance with other stakeholders? What kind of different circular ESs exist? Which context requests which kind of circular ES setup to optimize value co-creation? - What are the micro-foundations on the individual employee level that contribute to the success of CBMs? - How do (project) team dynamics play into the concept of CBM implementation? - What are micro-foundations, behavioral mechanisms, or heuristics on the consumer side to be aware of to design effective CBMs? - How do circular activities on these respective levels contribute to systemic institutional change towards a complete CE? 2) CBM concept: - How can further strategic management insights enrich the concept of CBM itself? - How can the concept be enriched or more clearly differentiated to other ideas such as non-profit orientation or shared value ideas?

Congruence	3) Interrelation of antecedents: - How do various antecedents interrelate with each other, and what is their respective weight in contributing to CBMs? - To which extent can antecedents also moderate another antecedent-CBM relationship? 4) Effects on performance: - How do CBMs influence both tangible and intangible outcomes? - What kind of empirical evidence can we find for current propositions on value creation, and what are managerial implications?
Boundaries	5) Granular view on boundaries: - What are mediating and moderating factors concerning CBMs in varying contexts? - What are boundary objects in the field of CBMs that ensure a common understanding of CBMs in varying groups? 6) Impact of culture: - How does culture influence the implementation of CBMs? - How does culture influence the outcome and performance dimensions of a CBM?
Contingency	- What are further contingency factors of CBMs? - What can the CBM literature learn by deploying other theoretic lenses, e.g., path dependency theory, transaction cost, and stakeholder theory? - Do these contingency hypotheses prove valid in empirical tests?

2.4.1 Variables of interest

Evaluating the paradigmatic dimension of "variables of interest", we suggest that researchers take a multi-level perspective and clarify shortcomings in the discussions on the CBM concept itself.

2.4.1.1 *Multi-level analysis*

CBM scholars mostly take an organizational or business model perspective (e.g., Bocken et al., 2016; Weissbrod and Bocken, 2017; Diaz Lopez, Bastein and Tukker, 2019), while CE studies consider structures from a macro or institutional lens (Govindan & Hasanagic, 2018; Kirchherr et al., 2018) and ES literature offers meso-level implications of CBMs (Jacobides et al., 2018). As scholars looked at these levels mostly in isolation, CBM research would benefit from multi-level studies examining their interrelations: Challenges on one level are solvable on another level. For example, a firm might struggle to organize the collection service of a reuse CBM. However, managing collection in an ES might solve this dilemma as firms coordinate to collect materials at scale. Also, an extensive research gap represents CBM studies on the individual or team level. Neither topics such as CBM specific leadership behavior nor employee attitude nor team dynamics have been truly examined yet. While it is typical for a research field to start from a macro or institutional perspective and only develop its micro-foundations later (e.g., see the development of CSR research outlined by Aguinis & Glavas (2012)), we expect a great benefit in cumulating knowledge on the micro-level.

2.4.1.2 *CBM concept*

Despite the vast growth of CBM literature in the last few years, it has not meaningfully incorporated strategic management and strategy literature ideas. CBMs are primarily discussed in sustainability-related journals (Kirchherr et al., 2018). However, extending the CBM concept for further strategic facets beyond the BMI literature will help gather further ideas on the concept and allow a broader discussion of sustainability in strategy literature, increasing the CBM concept's impact.

2.4.2 Congruence

To reach congruence, cumulative theorizing should be proved empirically by identifying causal relationships. So at least antecedents and consequences of the phenomenon and propositions about their cause-effect relationships must be formulated (Fry & Smith, 1987). The CBM literature has started to suggest relationships, however, with limited empirical evidence. By learning from CBM related research streams, we proposed relationships between antecedents, moderators, and outcomes of CBMs. Besides this synthesis, a research gap remains regarding the interrelation of antecedents, the effects on performance, and the complexity of CBMs.

2.4.2.1 *Interrelation of antecedents*

The CBM literature has hypothesized antecedents and discussed barriers to CBM implementation (e.g., Tura *et al.*, 2019; Vermunt *et al.*, 2019; Guldmann and Huulgaard, 2020). However, there has not been an investigation of antecedents' interrelation and their respective weight in contributing to CBMs. Most of the current studies just hypothesize antecedents or analyze them ex-post through case studies. Conversely, future research could theoretically develop and empirically test propositions on how different antecedents interact and complement each other. Doing so could potentially generate insights for the multi-level CBM setup, as described in the previous section.

2.4.2.2 *Effects on performance*

As the expected environmental benefit through the CE (Geissdoerfer et al., 2020) is the initial motivation of the CBM domain, the literature on CBM specific organizational performance outcomes is still scarce. Nevertheless, understanding the effects on various firm performance indicators is crucial for two reasons: Firstly, it brings the concept closer to paradigmatic status (Fry & Smith, 1987), and secondly, it represents a strong motivation for firm adoption in practice. While the literature recognizes that CBMs can increase revenues by addressing new markets and customers, and reduce cost through fewer material needs (Nußholz, 2018; Ranta et al., 2018a), different non-financial outcomes such as higher employee satisfaction, also need further investigation. Simultaneously, scholars must explore potential adverse outcomes to inform the mitigation of underlying harmful mechanisms in practice – even if this is difficult due to various uncertainties and complexity of variables (Linder & Williander, 2017).

2.4.3 Boundaries

The CBM concept mostly understands its boundaries tied to a company (Geissdoerfer et al., 2020). However, it is critical to understand better broader boundary conditions as CBMs might have different effects in different firms or environments. To clarify boundaries, we suggest how a differentiated view of boundary conditions could help understand the various contexts and how culture's impact could influence the concept and its implementation.

2.4.3.1 *Granular view on boundaries*

While various CBM and CE scholars ask for a systems-level approach to accumulate knowledge in the field (Bocken et al., 2016b; Desing et al., 2020; Velis, 2018), understanding the concept of CBM in a smaller context may be just as insightful to generate new insights: Companies' ability to develop and implement CBMs might be influenced by other factors depending on whether it is, for example, an incumbent or startup firm.

Besides, variables described as boundary conditions may occur in different functions and may vary over time, calling for a more active investigation of CBMs: For example, regulation can be an antecedent if a new directive prescribes recycling standards but can also positively moderate the CBM-outcome linkage if the regulation comes in the form of a subsidy., e.g., a reduced revenue tax burden for circular offerings. Besides this granular view on and specification of antecedents and moderators as boundary conditions, it will become crucial to differentiate between their moderating or mediating effects (Baron & Kenny, 1986). For example, customer satisfaction may mediate the CBM-outcome relationship for highly competitive markets and moderate the linkage for less competitive markets. The available literature on moderators and mediators is still thin in CBM research. This calls for more qualitative research in case studies or interviews to propose further relationships.

2.4.3.2 *Impact of culture*

Best to our knowledge, no CBM specific study to this date assesses the cultural impact on CBM. However, as we see in the related literature streams, the various dimensions and levels of culture, e.g., international country culture, industry culture, organizational culture, personality styles or consumer culture, and more play a significant role (for CSR, see Mohamed Adnan, Hay, & van Staden (2018). Future studies should investigate cultural antecedents for CBMs and enrich the CBM

knowledge for individual-level evidence from various stakeholder groups, such as consumers, managers, or policymakers.

2.4.4 Contingency

To reach paradigmatic status, scholars must formulate contingency hypotheses. These hypotheses promise the generalizability of relationships in a pre-defined model (Donaldson, 2001). Thus, exciting avenues for future research are to validate the current propositions related to CBM by testing those in various organization types and testing these propositions with different CBM types. We suggest doing so both through empirical qualitative and quantitative studies. To formulate further contingency hypotheses deploying other established organizational theories (e.g., transaction cost theory) could prove beneficial. With the integrated research framework of this article, CBM scholars hopefully find a) an insightful starting point to guide their efforts of testing proposed relationships; or b) further inspiration to propose new hypotheses.

2.5 Conclusion

Despite the general trend to conduct relatively narrow and specialized studies in sustainability and management research, this review provides a bigger picture of the CBM concept. To summarize, this paper generates three novel insights and contributions to the field: First, it links relevant, but thus far, not meaningfully connected research streams to the CBM research field: By highlighting the influences of CE, CSR, BMI, and ESs, we provide an integrated research framework for CBM. Second, we show how not just one single management theory can enlighten the progress of CBMs research and thereby highlight the need for a more integrated debate of systemic challenges as addressed by CBMs, such as climate change. Third, we systematically showcase that the CBM concept, despite its recent surge of publications, still has various challenges to overcome before reaching a paradigmatic status.

With this paper, we hope to spark more extensive discussions and inspiration for future research on the CBM concept without the need to reinvent the wheel. Thereby, we want to encourage a more systematic knowledge accumulation and hope to move the young and emergent concept of CBM to a paradigmatic level faster.

3 Circular Ecosystems: A review

Abstract: The idea of a circular economy has become increasingly popular among scholars, practitioners, and policy-makers. It promises to reduce greenhouse gas emissions and resource depletion for a more nature-friendly economy. Despite the increasingly widespread use of the term, the implementation of the circular economy is falling behind, as barriers persist. One promising avenue for future research stems from the potential of circular ecosystems and the systematic coordination among stakeholders to implement circularity. This review introduces the circular economy and ecosystems literature, analyzes the literature on the circular ecosystem concept, and contributes by suggesting a classification of circular ecosystems, and synthesizing main success factors in circular ecosystems literature. The classification and success factor analysis thereby decreases the current uncertainty around what a circular ecosystem is and what may make it successful.

Keywords: Circular ecosystem, circular economy, ecosystem, review, classification

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3.1 Introduction

Transitioning to a more sustainable system like the circular economy (*CE* hereafter) has been deemed a vital solution (e.g., Ellen MacArthur Foundation, 2019; Gallego-Schmid et al., 2020) to one of our time's most difficult challenges: climate change (European Environment Agency, 2021). Policy-makers push the topic (e.g., Chinese Circular Economy Promotion Law, the EU 2015 Action Plan for the Circular Economy) (McDowall et al., 2017), companies contribute to circularity and display their efforts in dedicated environmental reports (e.g., Apple, 2020), and academics investigate the concept (Geisendorf & Pietrulla, 2018; Geissdoerfer et al., 2017). Despite all these efforts, the world's circularity level declined from 9.1 percent in 2018 to 8.6 percent in 2020 (Circle Economy, 2020). In fact, various barriers for the implementation of the CE have been identified (Caldera, Desha, & Dawes, 2019). While circular business models are considered strong enablers of the CE (Atasu et al., 2021; Bocken et al., 2019b), research of circular business models often takes a single firm view (Evans et al., 2017a) and is thus limited in its ability to show the systemic implementation of CE principles that often spans across firms and other actors (Kanda, Geissdoerfer, & Hjelm, 2021a; Magnusson, Andersson, & Ottosson, 2019). Therefore, an increasing number of scholars agree that collaborative networks (Tukker, 2015), multi-stakeholder collaboration (Elia, Margherita, & Petti, 2020), effective ecosystems for agent coordination (Geissdoerfer et al., 2017), and a generally more systemic approach to CE (Stewart & Niero, 2018) are needed for the transformation from a linear economy to a CE (Geissdoerfer et al., 2020). However, while so many scholars stress the value of such an ecosystem approach to the CE, the research community does not have a clear understanding of circular ecosystems.

The aim of this review is to bring clarity to this topic, by reviewing the existing literature, providing a classification of circular ecosystems and summarizing the main success factors of circular ecosystems as identified in the literature. The review is structured into four parts: First, the two most influential literature streams for circular ecosystems, circular economy research and ecosystems research, are introduced. Second, the review's methodology is presented. Third, the results section synthesizes the development and roots of the concept, suggests a new classification framework of circular ecosystems, and summarizes the mostly discussed success factors in the literature. After discussing the review, policy implications and future avenues for research are proposed in the conclusion.

.

3.2 Context

The two fundamental concepts of CE and ecosystems inspire the idea of circular ecosystems. This section presents the two concepts and introduces their most influential literature.

3.2.1 What is the circular economy?

The CE concept arose in the sustainability literature (Pearce and Turner, 1990), and was later defined as "an industrial system that is restorative or regenerative by intention and design" (Ellen MacArthur Foundation, 2015, p. 19). By formulating the CE concept, Pearce and Turner (1990) summarized earlier similar concepts, such as Boulding's (1966) closed-loop systems and Stahel and Reday's (1981) industrial economy loops. The CE concept's features are also found in other circularity concepts (Geisendorf & Pietrulla, 2018), such as industrial ecology (Ayres & Ayres, 1996; Erkman, 1997; Graedel & Allenby, 1995), product-service systems (Tukker, 2004), cradle-2-cradle (Braungart et al., 2007; McDonough and Braungart, 2010), the blue economy (Pauli, 2010), regenerative design (Cole, 2012; Lyle, 1996), natural capitalism (Collins, 2000), the performance economy (Stahel, 2010), biomimicry (Benyus, 1997), closed-loop supply chains (Savaskan, Bhattacharya, & Van Wassenhove, 2004), reverse logistics (Fleischmann et al., 1997), and life cycle assessment (Hauschild, Jeswiet, & Alting, 2005). As CE publications grew (Geissdoerfer et al., 2017), they remained in their own niche (Kirchherr et al., 2018), discussing inward-oriented topics like the concept definition of CE itself (Ghisellini et al., 2016; Kirchherr et al., 2017; Padilla-Rivera, Russo-Garrido, & Merveille, 2020) and indices and measurements of CE and environmental performance (Corona, Shen, Reike, Rosales Carreón, & Worrell, 2019; Elia, Gnoni, & Tornese, 2017; Saidani et al., 2020, 2019). Only more current publications, for example, discuss to which extent the CE definition should include aspects of social sustainability (Padilla-Rivera et al., 2020). Comparatively few publications take a more outward-oriented view investigating, for example, enablers or barriers to the implementation of CE (Kirchherr et al., 2018), CE benefits in various sectors (Ghisellini et al., 2018), the impact of a macro-economic policy (Calisto Friant, Vermeulen, & Salomone, 2021), and policy-firm interactions (Pietrulla, 2022b).

Within the CE literature, a dynamic discussion on circular business models has developed. Circular business models incorporate CE-related principles like resource circularity and waste elimination (Bocken et al., 2016; Bocken et al., 2014; Bocken et

al., 2016; Evans et al., 2017; Lewandowski, 2016; Lüdeke-Freund et al., 2019; Manninen et al., 2018; Rizos et al., 2016). At the same time, scholarly voices highlight the value of implementing circular business models in circular ecosystems to mirror the need to coordinate circularity among various stakeholders (Bertassini, Zanon, Azarias, Gerolamo, & Ometto, 2021). Systemic approaches (e.g., Bassi, Bianchi, Guzzetti, Pallaske, & Tapia, 2021) and ecosystem approaches (Parida et al., 2019) are expected to accelerate the implementation of CE. However, the (eco-) systemic approach to CE is still in its infancy, and the literature on circular ecosystems remains comparatively scarce.

3.2.2 What is an ecosystem?

An ecosystem view on strategy adds value by recognizing the management of multilateral dependencies (Jacobides et al., 2018) and the alignment with partners as fundamental strategic challenges (Adner, 2017). Introduced by the social scientist Amos Hawley, "ecosystems" are "an arrangement of mutual dependencies in a population by which the whole operates as a unit and thereby maintains a viable environmental relationship" (Hawley, 1986, p. 26). In the corporate context, then, ecosystems have been defined as "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (Adner, 2017, p. 40). Complementarities and dependencies typically characterize the actors of an ecosystem such that only together can the complete value creation be achieved through a systems-level architecture (Adner & Kapoor, 2010b; Kapoor, 2018; Kapoor & Lee, 2013). Therefore, Jacobides et al. (2018, p. 2264) defined ecosystems as "a set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled."

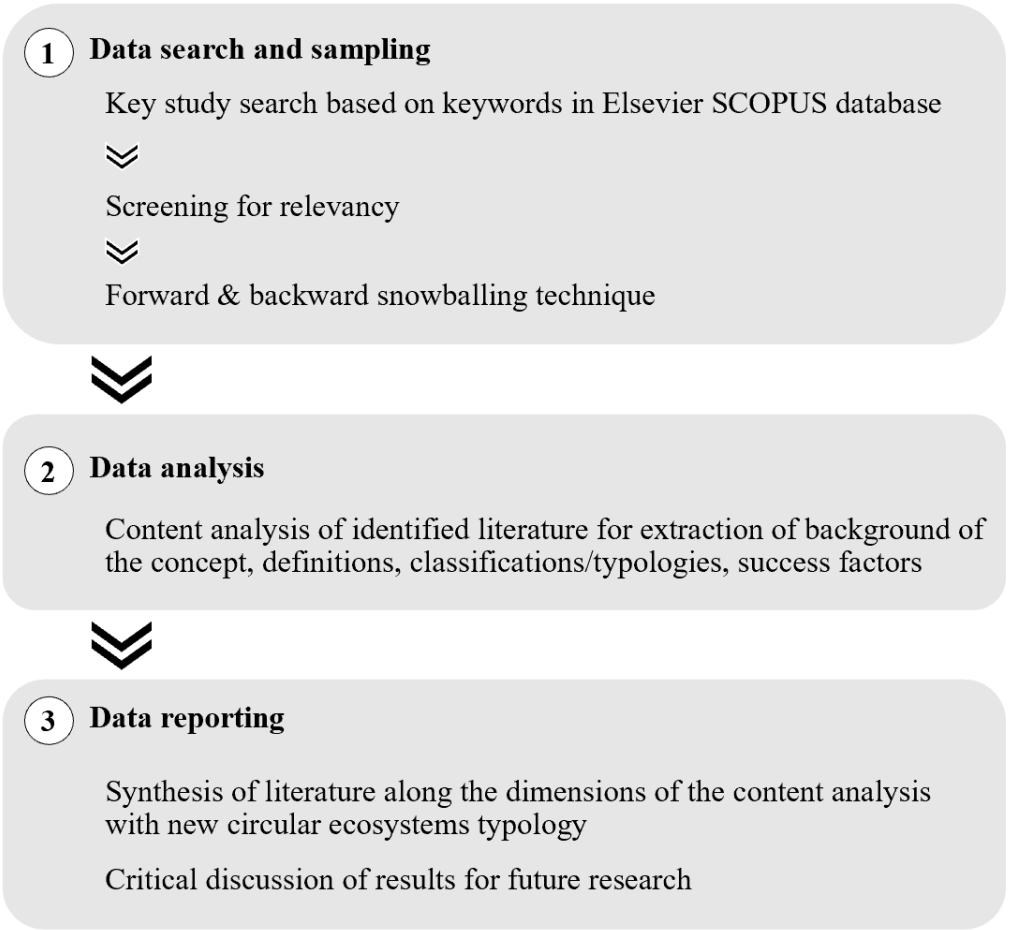
There are two views on the ecosystem concept: the actor-centric view of "ecosystem as affiliation" and, the activity-centric view of interdependences or "ecosystem as structure" (Adner, 2017). Ecosystem as affiliation in the CE context means that all relevant stakeholders along the material flow chain (or loop) must be considered to make circularity a reality. Ecosystem as structure focuses on the activities needed per stakeholder and, hence, the interdependent coordination of activities like the collection of materials at the end of a product's lifecycle and their reintroduction into the circular flow. Managing this challenge of coordination along the value chain has been named a significant barrier to CE (Bocken et al., 2013; Mentink, 2014). Minimizing transaction costs or implementing revenue-sharing contracts among ecosystem actors in an efficient value network can create a

competitive advantage (Barnett, 2006; Clarysse et al., 2014). In that sense, the ecosystem logic that is particularly relevant to CE is inspired by the value network literature (Christensen & Rosenbloom, 1995) and relies on the innovation potential in innovation ecosystems (Gomes et al., 2018; Granstrand & Holgersson, 2020). The ecosystem perspective for value creation applies both externally as coordination across organizations and internally as management of various business models in a portfolio, for example, to avoid cannibalization (Velu & Stiles, 2013). The latter is especially important when an incumbent firm complements its product portfolio with a circular product that addresses the same market as a traditional (linear) product.

3.3 Methodology for the literature review

By systematically analyzing the circular ecosystems literature, we seek to bring clarity to the field. To conduct the literature review, the article follows a three-step approach consisting of data search, data analysis, and data reporting, as shown in Figure 4 (de Almeida Biolchini et al., 2007). This approach is similar to other authors (e.g., Geissdoerfer et al., 2018b).

Figure 4 Methodology for literature review



The data search consists of three phases: First, the search string "circular ecosystem" or "circular economy ecosystems" were inserted in the SCOPUS Elsevier database, one of the preferred databases among CE researchers because of its wide coverage of topics (e.g., Ferasso et al., 2020; Homrich et al., 2018). The strings' search was limited to the title, abstract, and keywords of peer-reviewed English journal articles and reviews. Duplicates were eliminated and the remaining articles were screened for relevance. Articles are considered relevant if they mention the term, bring conceptual contributions to the topic, and are not only a pure case study. Based on forward-and backward snowballing techniques (e.g., Wohlin, 2014), the initial sample's references were screened for relevance which added 33 articles, making a final sample of 50 articles. Table 5 shows the outcome of the data search.

Table 5 Data search results

Keywords used	**Search results**	**Screening deletions**	**Snowballing**	**Total sample**
"Circular ecosystem"	12	-4	+25	50
"Circular economy ecosystem"	10	-1	+8	

For the data analysis, a content analysis was performed by scanning and coding the papers for four elements (Neuendorf, 2002):

1) Development and roots of the circular ecosystem concept: This element scans for information regarding the development, roots and evolution of the concept.

2) Definitions: This element scans for explicit definitions or concrete interpretations of the term "circular ecosystems" or "circular economy ecosystems".

3) Classifications/typologies of the circular ecosystem concept: This element primarily scans for conceptual contributions in the form of classification frameworks and typologies of the circular ecosystem concept.

4) Success factors or enablers of circular ecosystems: This element takes a practice-oriented lens and filters out the main drivers or enablers of a successful circular ecosystem implementation and its management.

For the data reporting, findings are synthesized, as discussed in the next section.

3.4 Results of the literature review

The results of the literature review are presented in the following order: First, the review elaborates on the development and roots of the circular ecosystem concept, including the current state of the art in terms of definitions and typologies. Then, based on the literature review, the article synthesizes and proposes a classification framework on circular ecosystems and describes four sub-types in detail. This section also refers to examples and case studies in the literature. Finally, the main critical success factors for circular ecosystems that have been identified in the current circular ecosystems literature are summarized.

3.4.1 Development and roots of the concept of circular ecosystems

This section first presents the development of publications related to circular ecosystems and then describes its roots and related concepts.

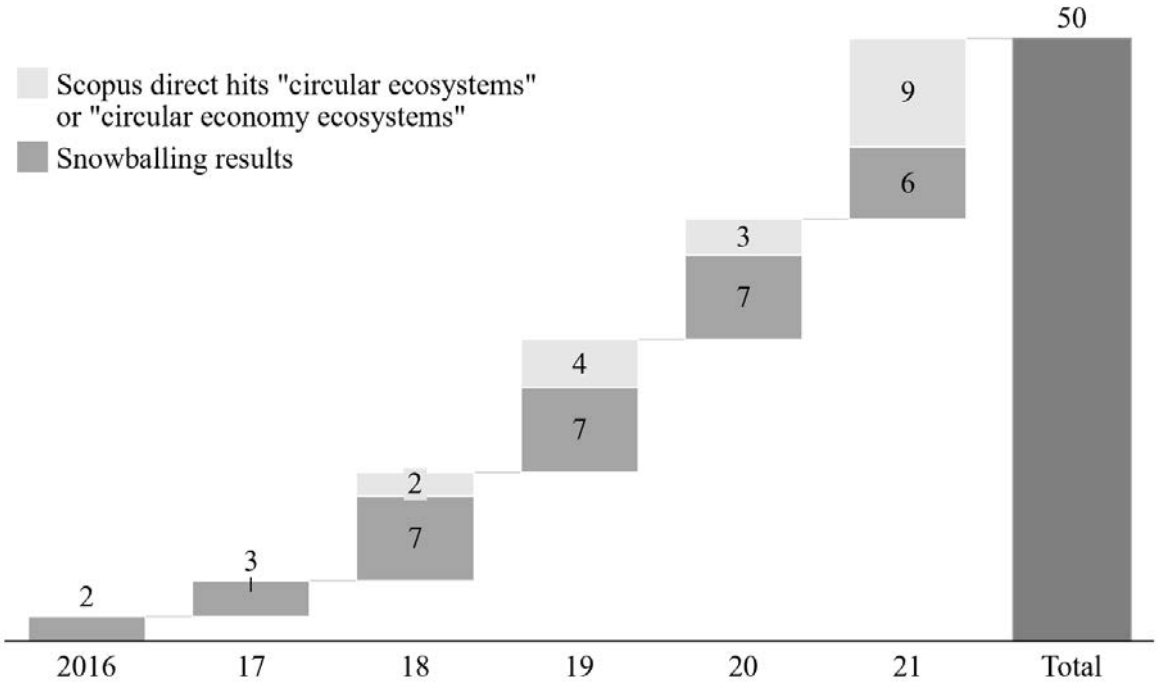
3.4.1.1 *Development*

As displayed in Figure 5, the number of publications related to the circular ecosystem and CE that were direct hits from searching "circular ecosystems" or "circular economy ecosystems" went from two in 2018 to nine in 2021. All articles considered for this study, as identified including snowballing technique, went from only two relevant papers in 2016 through a steady increase to fifteen papers in 2021.

Most of the earlier publications take a practice-oriented and regionally focused approach: Whicher et al. (2018) deploy the theory of innovation ecosystems to derive CE principles that stakeholders in Scotland can adopt to transition to a CE. Staicu and Pop (2018) describe the circular ecosystem for the textile industry in Romania, Hsieh et al. (2017) analyze how a Taiwanese glass-recycling firm manages its ecosystem overtime, Türkeli et al. (2019) compare local mobile repair ecosystems, and Stewart et al. (2018) explore the circular ecosystem of aluminum cans in the United Kingdom. Only two earlier publications take a more conceptual lens by suggesting a model for interorganizational cooperation for the CE transition (Ruggieri, Braccini, Poponi, &

Mosconi, 2016) or by connecting the ecosystems, sustainability and CE literature from a political economics perspective (Martins, 2016).

Figure 5 Count of publications related to "circular ecosystems" or "circular economy ecosystems" over time



Source: Elsevier Scopus database

Later publications take on a variety of perspectives. Parida et al. (2019) use a *business ecosystem lens* (Moore, 1993) to determine how manufacturing firms should coordinate with other players to move toward a circular ecosystem. Similarly, Galvão et al. (2020) assess the value streams of circular business models and their position in a business ecosystem. In contrast, Tate et al. (2019) take a natural ecosystems lens, inspired by concepts like biomimicry (Benyus, 1997), to describe the various roles in a circular business ecosystem. Kasulaitis et al. (2019) review the product ecosystem for consumer electronics to assess circularity. Another view is the *platform ecosystems* perspective (Gawer, 2014), applied to smart and circular cities (Mahesa, Yudoko, & Anggoro, 2019; Prendeville, Cherim, & Bocken, 2018), or the collaborations between entrepreneurs and corporations to advance the CE (Veleva & Bodkin, 2018). The literature review by Bertassini et al. (2021) provides a valuable overview and guide for mapping stakeholders in circular collaborative relationships. Table 6 provides an overview of selected contributions which inform the current circular ecosystems knowledge.

Table 6 Selected significant publications on circular ecosystems

Source	Title and description
Kanda et al. (2021)	"From circular business models to circular business ecosystems" ➔ Empiric investigation of biogas companies revealing the shortcomings of the circular business model as unit of analysis and suggesting a circular ecosystem lens
Asgari and Asgari (2021)	"How circular economy transforms business models in a transition towards circular ecosystem: the barriers and incentives" ➔ Literature review and interview that reveals the most prominent barriers to and incentives for a transition to a circular ecosystem; presentation of a conceptual framework to develop a CE ecosystem
Bertassini et al. (2021)	"Circular business ecosystem innovation: A guide for mapping stakeholders, capturing values, and finding new opportunities" ➔ Proposition of a circular ecosystems guide based on a literature review, a fuzzy cognitive map of values and principles, and case studies
Boldrini and Antheaume (2021)	"Designing and testing a new sustainable business model tool for multi-actor, multi-level, circular, and collaborative contexts" ➔ Presentation and validation of a process and tools for visualizing and connecting different circular business models and their stakeholders
Kapsalis et al. (2019)	"Investigation of ecosystem services and circular economy interactions under an inter-organizational framework" ➔ Presentation of social and people-related barriers for circular ecosystems and review of other technical elements
Konietzko et al. (2020)	"Circular ecosystem innovation: An initial set of principles" ➔ Principles for circular ecosystem innovation (collaboration, experimentation, and "platformization") based on a literature review and mobility case study
Moggi and Dameri	"Circular business model evolution: Stakeholder matters for a self-

(2021)	sufficient ecosystem" ➔ Presentation of circular ecosystem case study RiCibo in Genoa and abstraction of conditions leading to a self-sufficient circular ecosystem
Parida et al. (2019)	"Orchestrating industrial ecosystem in circular economy: A two-stage transformation model for large manufacturing companies" ➔ Development of a two-phased process model—an ecosystem readiness assessment and ecosystem transformation—for a circular ecosystem transition based on six qualitative case studies in the manufacturing industry
Tate et al. (2019)	"Seeing the forest and not the trees: Learning from nature's circular economy" ➔ Analysis of circular business ecosystems from a natural ecosystems perspective based on ideas from biomimicry; deploys complex adaptive systems and network theory to describe different roles
Uusikartano et al. (2020)	"Public agency in changing industrial circular economy ecosystems: Roles, modes and structures" ➔ Investigation of public agents' role in a circular ecosystem and review of multiple case studies and a Finnish eco-industrial park

While these publications constitute a good foundation of knowledge about CE on the ecosystem level, the field seems to lack a discussion on nomenclature and definitions. As the data search shows, only a few publications have systematically used the terms *circular ecosystem* (e.g., Alhola et al., 2019) or *CE ecosystem* (e.g., Min et al., 2021). Various studies identified through snowballing have used terms like *circular economy business ecosystem* (e.g., Bertassini et al., 2021), *circular networks* (Domenech, Bleischwitz, Doranova, Panayotopoulos, & Roman, 2019; Zucchella & Previtali, 2019), *eco-industrial networks* (Patala, Hämäläinen, Jalkala, & Pesonen, 2014), or *inter-organizational relationships for sustainability* (e.g., Kapsalis et al., 2019; Lopes de Sousa Jabbour et al., 2019; Ruggieri et al., 2016) or prefer to summarize the ecosystem aspects of coordination in the *circular business model* framework (Fehrer & Wieland, 2021; Frishammar & Parida, 2019; Galvão et al., 2020; Mostaghel & Chirumalla, 2021). Sometimes terms are used interchangeably, which

might contribute to conceptual confusion (Zucchella & Previtali, 2019). Building on this non-systematic use of terms, the literature seems to lack a clear standard for firstly, defining, and secondly, classifying circular ecosystems. Only one publication in the sample provided both a definition and a typology of circular ecosystems: According to Aarikka-Stenroos et al. (2021, p. 33),

> *"[A] circular economy (CE) ecosystem is a multi-actor entity in which interdependent actors play complementary roles. The actors can include companies, industry actors, public and government actors (such as cities and municipalities), and ministries, universities, non-profit organizations, and citizen-consumers. A CE ecosystem emerges or is created around a common, system-level goal related to resource circularity, circular economy knowledge, or circular economy business and business models. The agency varies from focal actor-driven ecosystems to distributed agency, and the ecosystem structure varies from tightly coordinated CE business models to loosely coupled affiliation structures around CE-oriented goals."*

This definition is comprehensive and inclusive, and the authors differentiate among five types of circular ecosystems as shown in Table 7.

Apart from this conceptual contribution, only Domenech et al. (2019) deployed a network typology from Baas (2011) that differentiates among types of governance: a) self-organized activity networks that emerge from direct interactions between stakeholders, b) facilitated networks with a third-party orchestrator that is responsible for overall coordination, and c) planned networks with a central plan or vision for, for example, a specific geography, including common infrastructures and services.

Table 7 Circular economy ecosystem definitions (Aarikka-Stenroos et al., 2021)

Term/category	Definition
CE Industrial Ecosystem	A regional community of a hierarchically independent, yet interdependent, heterogeneous set of actors that sustainably produce industrial goods and services in symbiotic collaboration and resource use
CE Urban Ecosystem	An urban community of a hierarchically independent, yet interdependent, heterogeneous set of actors that collectively produce sustainable urban amenities
CE Entrepreneurial Ecosystem	A regional community of a hierarchically independent, yet interdependent, heterogeneous set of actors that facilitate the start-up and scale-up of entrepreneurial new ventures that are focused on sustainable business opportunities
CE Knowledge Ecosystem	A regional community of a hierarchically independent, yet interdependent, heterogeneous set of actors that advance the translation of advances in CE research knowledge into sustainable products and services
CE Innovation/Business Ecosystem	A community of a hierarchically independent, yet interdependent, heterogeneous set of actors that collectively deliver a sustainable value offering that is typified by resource recycling, reuse, and/or reduction

3.4.1.2 ***Roots***

Analyzing the type of journals where the reviewed articles have been published shows that the roots of circular ecosystem research are rather located in the community of CE scholars, but less so in the community of ecosystems scholars. The journals covering circular ecosystems topics are for example called "Business Strategy and the Environment", "Journal of Industrial Ecology", "Resources, Conservation and Recycling", and "Journal of Cleaner Production" – all of which are known to be welcoming outlets for CE related research. Most of the sample's publications have been published in these journals. Only a few publications stem from typical management literature that would be a typical ecosystems-literature outlet (e.g., Management and Marketing, Journal of Business Research, Management Decision). To conclude, the emerging discussion on circular ecosystems appears to be rather an

offspring of the CE literature, but less so from the ecosystems literature. The following thus describes how the circular ecosystem discussion emerged in the much broader CE research field: Previously, CE scholars predominantly discussed other levels of a CE, moving from the circularity of materials (Fellner et al., 2017; Haupt, Vadenbo, & Hellweg, 2017), to products (Hollander et al., 2017), to circular business models (Nußholz, 2017), to firms (Masi et al., 2018), or focused on the policy perspective (McDowall et al., 2017). Nevertheless, these earlier publications have also emphasized that the ecosystems perspective for the CE is highly relevant for both practice and research (e.g., Frishammar and Parida, 2019; Su et al., 2013). Besides these calls for investigating the ecosystem level (Bocken, Olivetti, Cullen, Potting, & Lifset, 2017), no discourse took place before 2018 that used the term *circular ecosystems*.

However, the idea of circular ecosystems is not new: Related and more mature concepts have features that are similar to those one would expect in a circular ecosystem. These publications are a source of inspiration for the circular ecosystem concept: For example, the *industrial ecology* research domain investigates "production processes of goods and services from the perspectives of nature (…) [and makes] every effort to imitate a natural system through conserving and recycling resources" (Zhao et al., 2017, p. 2262; see also Chertow, 2000)**.** Researchers in the field coined the terms *industrial symbiosis* and *eco-industrial parks*: In eco-industrial parks and other industrial symbiosis networks (Herczeg, Akkerman, & Hauschild, 2018; Patala et al., 2014), co-located firms work in industrial symbiosis, as they use each other's waste products as inputs. Based on mutual alignment and dependency the material flow changes from a linear to a closed-loop flow (Gibbs & Deutz, 2007; Jung, Dodbiba, Chae, & Fujita, 2013; Wen & Meng, 2015), increasing resources' productivity, minimizing waste, and ideally leading to environmental and financial gains (Zhao et al., 2017). More recent publications on eco-industrial parks have focused on impact evaluation and deriving best practices (Nuhu, Manan, Wan Alwi, & Md Reba, 2021; Tseng, Negash, Nagypál, Iranmanesh, & Tan, 2021). Similarly, product-service Systems (PSSs), defined as "a mix of tangible products and intangible services designed and combined so that they are jointly capable of fulfilling final customer needs" (Tukker and Tischner, 2006, p. 1552), have been widely discussed as types of circular business models that require some form of business network or ecosystem to function (Tukker, 2004, 2015). This definition of PSSs shows that the boundary between circular business models and circular ecosystems is not a clear line so much as a co-dependent relationship. Green or closed-loop supply chains are also of significant interest to CE scholars and have been analyzed extensively (Geissdoerfer et

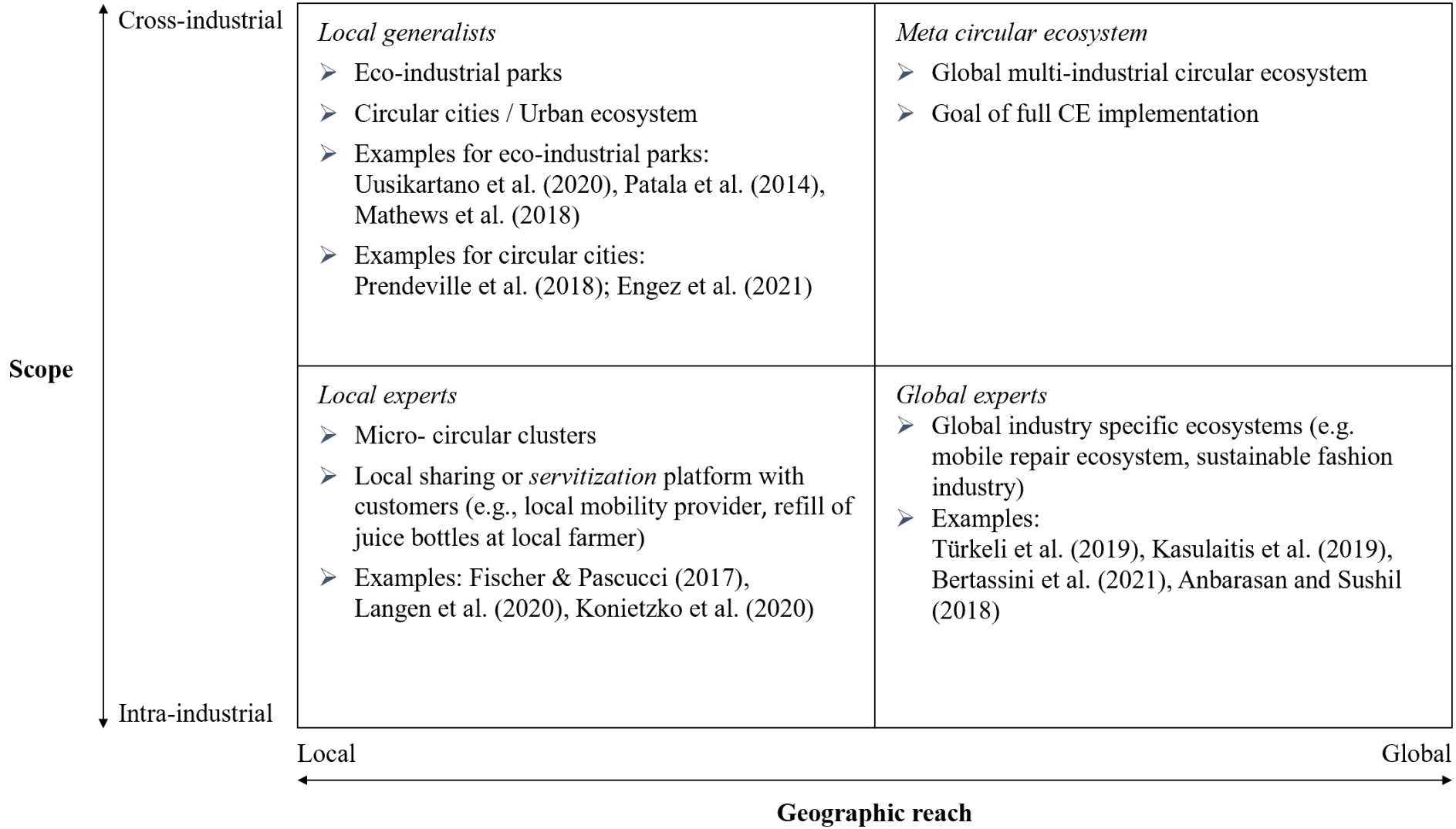
al., 2018a; Hussain & Malik, 2020). While the detailed review of these related concepts is beyond the scope of this review, they have the same overarching goal – that is, *sustainable development* – as circular ecosystems do (Brundtland, 1988).

To conclude, the concept of circular ecosystems is at the beginning of its development but the continued growth of publications can be expected to continue if it follows the development of the field of circular business models (Geissdoerfer et al., 2020). Increased research funding, which has already propelled other sub fields of general CE research has not stopped yet and may therefore continue to foster publications of circular ecosystem research, the new frontier of CE research (Lopez et al., 2019).

3.4.2 A proposed classification of circular ecosystems

Based on the literature analysis, a classification framework for circular ecosystems is derived as shown in Figure 6.

Figure 6 A classification framework for circular ecosystem



As portrayed in the literature, circular ecosystems may come in various forms and constellations have various features. This complexity is typical for the field of CE research because of its systemic nature (e.g., Pieroni et al., 2021) and makes navigation of the field often difficult for both practitioners and academics. As a starting point for a discussion on circular ecosystems, the proposed framework attempts to reduce the inherent complexity with this high-level classification based on two variables as identified in the literature. The first variable refers to the geographic reach (from local to global), and the second variable refers to the scope of industries covered (intra-industrial, cross-industrial). Both of these variables should not be understood as a black-or-white classification but as a continuum. According to Domenech et al. (2019), the geographic scope depends on other factors, such as the type of by-product, related transportation costs, and the market value of these materials. In other words, a by-product that is in high demand (i.e., can be sold for high prices and easily transported) widens the circular ecosystem's geographic reach. With a broader geographic reach, the need for coordination and the legal barriers related to different markets becomes more complicated and requires a different handling than less global circular ecosystems (Govindan & Hasanagic, 2018). Similarly, if players from differing industries are involved, coordination may become more challenging. In what follows, the article describes the resulting four categories of circular ecosystems, and discusses examples found in the literature. The proposed classification addresses set-ups where circularity (vs. a one-way control system of information, value, and resources across regions or industries) is in place through one or several mechanisms (e.g., 3R-principles Reduce, Reuse, Recycle (e.g., De Pascale, Arbolino, Szopik-Depczyńska, Limosani, & Ioppolo, 2021; Rosa et al., 2019)). The review aims to build on Aarikka-Stenroos et al.'s (2021) typology, which provided a classification that focused on the purpose of a specific ecosystem, rather than the features and set-up of a circular ecosystem.

3.4.2.1 *Local and intra-industrial circular ecosystems*

This category of circular ecosystem operates locally or regionally in a geographically limited area, and its actors are part of the same industry, i.e., they are local experts. The participating firms often form a local cluster and share services, resources, and expertise to create efficiencies. Fischer and Pascucci (2017) present the fashion industry in Denmark as a case of the local and intra-industrial archetype. While the geographic scope in this case study is already large, micro-clusters or small local clusters may also belong to this category. For example, Grimstad and Burgess

(2014) describe a micro-cluster in the Australian wine industry where the actors established environmentally promising practices like water conservation and shared equipment to intensify usage. Another example is a local mobility case that uses circular principles to innovate in an ecosystem (Konietzko et al., 2020). Similarly, Langen et al. (2020) described the circular activities in the port of Amsterdam. This case study also demonstrates a smooth transition between an intra-industrial and a cross-industrial circular ecosystem. Even though the port's circular activities may be considered part of the logistics industry, they impact the sustainability goals of firms outside of the logistics field that demand and transport their goods through this port. This particularly applies to the often more indirectly perceived scope of carbon emissions as per the 2021 Greenhouse Gas Protocol.

While not all of these networks have the means to close the loop on their material flow entirely, they may still be considered impactful steps to creating a circular ecosystem, as they contribute to sustainable development and at least partly close the loop of material flows. These local circular networks often benefit from a solid regional identification and a reliable base for mutual understanding, as they belong to the same industry.

3.4.2.2 *Local and cross-industrial circular ecosystems*

This section describes two archetypes of local generalist ecosystems as they are both geographically bounded and cross-industrial circular ecosystems: eco-industrial parks and circular cities. Eco-industrial parks, which are circular industrial ecosystems, have been widely researched (Uusikartano et al., 2020). While eco-industrial parks may themselves have a high degree of variability (Mathews, Tan, & Hu, 2018), they best fit into the local and cross-industrial circular ecosystem classification. They are typically geographically limited and usually take place in a business-to-business (B2B) context (Patala et al., 2014). The eco-industrial park in Kalundborg in Denmark is a classic example of industrial symbiosis (Ehrenfeld & Gertler, 1997). As Uusikartano et al. (2020) highlight, the role of public office as an overarching orchestrator or coordinator is often crucial in these set-ups.

Circular cities are also archetypal geographically limited and cross-industrial circular ecosystems. Unlike the typical eco-industrial park, a circular city includes all local stakeholders, including end consumers (Prendeville et al., 2018). The idea of urban living labs has gained momentum in the category of circular cities: They address various urban challenges in the field of environmental sustainability and CE (Engez et

al., 2021) and are set up as open innovation networks. In these networks different local stakeholders contribute to the idea generation and later implementation. Similar to eco-industrial parks, the governance model is critical, especially the effective involvement of users (Florez Ayala, Alberton, & Ersoy, 2022).

3.4.2.3 *Global and intra-industrial circular ecosystems*

Instead of choosing a complete vertical integration to manage supply chains (Atalay, Hortaçsu, & Syverson, 2014; Perry, 1989), companies may want to implement a circular ecosystem with other industry players along a circular supply loop (instead of a supply chain). These circular ecosystems differ from the geographically limited eco-industrial park, as they can cover multiple countries when ecosystem actors along the circular supply loop are located in different markets. This kind of set-up is typical for global industries that want to benefit from cost advantages arising from, for example, wage disparities between markets. However, this kind of global set-up brings environmental disadvantages as it likely incurs additional carbon dioxide due to the necessary transportation. In order to be considered a global and intra-industrial circular ecosystem (vs. any other control system) it is required that a circular mechanism is in place: This can for example be achieved by handling waste with any of the 3R-principles Reduce, Reuse, Recycle (e.g., De Pascale et al., 2021; Rosa et al., 2019). Implementing these principles will require specific mechanisms and formats which depend mostly on the industry characteristics: Examples can be found in the mobile phone repair ecosystems (Türkeli et al., 2019), larger consumer electronics ecosystem (Kasulaitis et al., 2019), the sustainable fashion industry networks (Ellen MacArthur Foundation, 2017; Sandvik and Stubbs, 2019), global circular ecosystems in the steel industry (Bertassini et al., 2021), or even in the global tobacco industry (Anbarasan & Sushil, 2018). A strong customer orientation with a clear value proposition is particularly important. To do so, ensuring transparency in processes and product traceability is often critical, as the ecosystem may include customers in a business-to-consumer (B2C) context, as in the case of the fashion industry.

3.4.2.4 *Global and cross-industrial circular ecosystems*

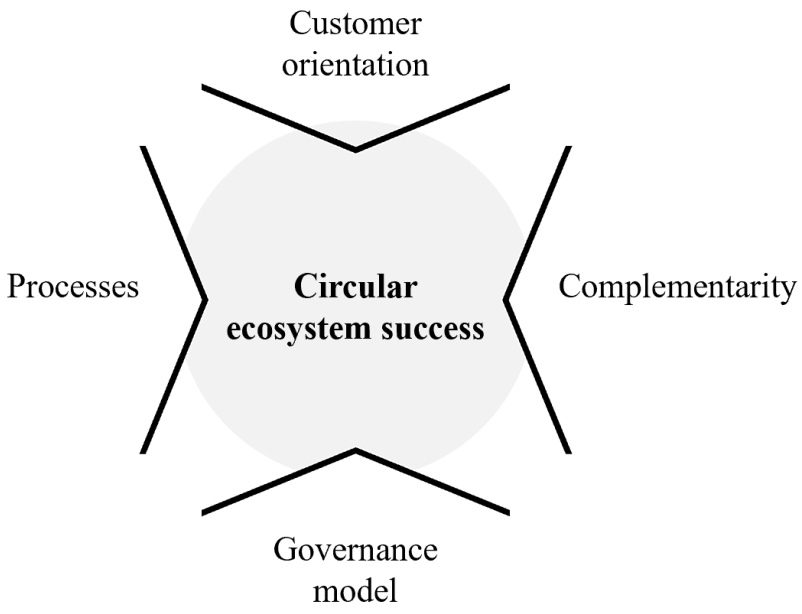
A CE in its fully implemented and ideal state falls into the category of a global and cross-industrial circular ecosystem spanning various companies and other community stakeholders. This category combines all circular ecosystems into one meta-circular ecosystem that operates on both a global scale and across industries. In

other words, this meta- circular ecosystem is a system with an economy that operates within planetary boundaries (Rockström et al., 2009). Therefore, this category is the goal and end state of all circular ecosystems in combination. Ecosystems in this category contribute to human well-being, balance scarcity and surplus in the long run (Martins, 2016), and ensure sustainable development (Brundtland, 1988). When we reach this level of material circularity, only the law of thermodynamics remains as the natural limitation of the CE as a whole if we cannot add further energy to the system (Fellner et al., 2017; Korhonen, Honkasalo, & Seppälä, 2018).

3.4.3 Considerations for success in circular ecosystems

Connecting the knowledge retrieved from our current sample of studies on circular ecosystems in the two research domains of CE and ecosystems, we highlight the main enablers and success factors that practitioners should consider when they engage in a circular ecosystem. We draw on other reviews (Govindan & Hasanagic, 2018; Gusmerotti, Testa, Corsini, Pretner, & Iraldo, 2019; Kirchherr et al., 2018; Lopez et al., 2019; Pietrulla & Frankenberger, 2021) to consolidate knowledge on critical enablers that play a role in circular ecosystems. As these enablers and critical success factors have not been specifically identified only in one particular circular ecosystem subtype as described in the previous section, their impact per circular ecosystem category may vary. Four recurring themes were identified in the course of the literature review related to governance, processes, complementarity, and customer orientation (Figure 7).

Figure 7 Key enabling categories for circular ecosystems



3.4.3.1 *Governance*

Clear roles and responsibilities are essential for a circular ecosystem to function. A circular ecosystem is typically coordinated by an orchestrating firm (Parida et al., 2019) that may also be called a "hub", a "lead" (Williamson & De Meyer, 2012), an "architect," or a "keystone" firm (Barnett, 2006). These orchestrators set the systems-level goal and hierarchy among members and establish standards and processes (Gulati, Puranam, & Tushman, 2012) using, for example, well-defined contract models for a smooth (circular) supply chain (Fehrer & Wieland, 2021; Herczeg et al., 2018). They also manage knowledge mobility, innovation capability, and network stability (Azzam, Ayerbe, & Dang, 2017; Dhanaraj & Parkhe, 2006; Pellinen, Ritala, Järvi, & Sainio, 2012). However, the hub firm should not have complete hierarchical control. For example, price or quantities can be determined mainly by individual firms, not by the hub; otherwise, the ecosystem would be a supply chain where the buyer has hierarchical control over the seller or supplier (Jacobides et al., 2018). A multidisciplinary circular ecosystem community brings various perspectives and expertise that contribute to an effective circular ecosystem (Whicher et al., 2018), including the supply chain entities and surrounding community entities (Asgari & Asgari, 2021). Establishing regular touchpoints and supporting social relationships between diverse supply chain partners (Bocken et al., 2016a) can be a critical contributor to how the ecosystem is managed (Leten, Vanhaverbeke, Roijakkers, Clerix, & Van Helleputte, 2013; West & Wood, 2013).

3.4.3.2 *Processes*

Clarity, transparency and fairness in processes are the basis for trust and success in a circular ecosystem. The benefits of the circular ecosystem must be shared fairly in inter-firm relationships (Zhang, Jiang, Zhu, & Cao, 2012), risks must be divided equally (Velter, Bitzer, Bocken, & Kemp, 2020) and knowledge and information shared freely (Alexy, George, & Salter, 2013; Brusoni & Prencipe, 2013; Frankort, 2014; Moggi & Dameri, 2021). Therefore, stakeholders must have a collective understanding of value and openly discuss and align diverging interests (Velter et al., 2020). For example, in eco-industrial parks (Shi et al., 2010; Zhijun & Nailing, 2007), the purpose of contributing to a CE is usually clear (Bocken et al., 2016), but how the players want to cooperate might not be, so standards and interfaces must be managed properly (Baldwin, 2012) and (platform) governance must be strict (Cennamo, 2018; Cennamo & Santalo, 2013; Wareham, Fox, & Giner, 2014). To establish clarity,

transparency, and fairness (Jabłoński, 2016), tech-enabled solutions like tracking or tracing via Blockchain, can support the circular ecosystem (Upadhyay, Mukhuty, Kumar, & Kazancoglu, 2021). Finally, the coordination in the ecosystem must feel and be adequate and appropriate; otherwise, circular ecosystem innovations are bound to fail (Adner & Kapoor, 2010b; Kapoor & Lee, 2013). The circular ecosystem can achieve this goal by communicating a "shared fate" of the ecosystem community as a whole (Iansiti & Levien, 2004b: p. 69) and tying individual members' performance to the overall ecosystem's performance (Barnett, 2006; Jacobides et al., 2018).

3.4.3.3 *Clear complementarity*

Research has found that ecosystems work especially well when modularity or non-generic complementarities are established (Jacobides et al., 2018), i.e., when components and complements merge in a "collaborative arrangement through which firms combine their offerings into a coherent, customer-facing solution" (Adner, 2006, p. 2). Hence, modularity allows two aspects: Firstly, coordination along the production process to facilitate joint adjustments of the offering's configuration (Kapoor & Agarwal, 2017), and secondly, enough autonomy for each ecosystem's players to make decisions regarding their modules, such as setting the price or specifying the design (Baldwin, Clark, & Clark, 2000). Clear complementarity is key if this kind of autonomy is to avoid conflicts of interest. Aligning the responsibilities of all value-circle actors – starting from raw materials sourcing to design, producers, end-users, and service providers – is key to ensuring clear complementarity (Leising et al., 2018). For this purpose, a comprehensive operations management lens must be used to coordinate these diverse stakeholders by avoiding redundancy when it is not needed but to allowing for enough slack when necessary (Lopes de Sousa Jabbour et al., 2019). In addition to complementarity between actors regarding their contribution to the joint offering, diversity in the knowledge contributed is key. For example, Ghinoi et al. (2020) highlight the importance of local stakeholders in circular networks, as they can contribute specific local expertise.

3.4.3.4 *Customer orientation*

Like in any business model, the offerings that result from a circular ecosystem must have a substantial customer value (Pieroni, C. McAloone, & C. A. Pigosso, 2019a). Ideally, the value proposition to customers that derives from the arrangement among ecosystem participants delivers more value than the offering from a single firm

would (Adner, 2017). Targeting customer segments that have a strong awareness of circularity may be a significant success factor for the circular ecosystem (Tunn, Bocken, van den Hende, & Schoormans, 2019), but if such customers are not the target, the ecosystem's players must communicate with customers to create awareness of the value of circularity (Shih, Lin, & Lin, 2021). The resulting economic promise of such a value proposition drives a firm's attachment to the ecosystem (e.g., Cennamo, Ozalp, and Kretschmer, 2018). Joint intellectual property and other contractual forums (Alexy et al., 2013; Brusoni & Prencipe, 2013; Leten et al., 2013; Ritala, Agouridas, Assimakopoulos, & Gies, 2013) are important enablers for ecosystem participants. Finally, collaborative arrangements between the innovator and its ecosystem participants have a positive influence on the circular ecosystem's long-term functioning, as the actors of the ecosystem can jointly invest in new technology and its commercialization (Leten et al., 2013).

3.5 Discussion

With only two publications mentioning the term of circular ecosystems in 2018 the field is indeed still relatively young. However, given the fields almost exponential trajectory since then (i.e., nine publications mentioning the term in 2021), it seems an extremely promising emerging research area for CE scholars. This review also shows that the literature on circular ecosystems is still in its infancy, with few publications elaborating on the concept's concrete definition or specific typologies. This fact leads to two significant challenges for the concept of circular ecosystems: Firstly, the terminology in the field is fuzzy, with some authors referring to "circular ecosystems" and others referring to "circular economy ecosystems" or "circular business ecosystems." These terms seem to be used more or less interchangeably, without real common ground yet on a precise nomenclature to describe the idea of circular ecosystems. As long as there is no alignment on the exact terms to be used and their meaning, it will be difficult for the concept to move to the next level of informed insights for research and practice. Secondly, with only one extant publication providing a definition and typology of the concept (Aarikka-Stenroos et al., 2021), the academic community lacks different perspectives, ideas and framework proposals for circular ecosystems which could allow a more informed discussion leading to conceptual clarity.

Besides, the missing academic conceptual discussion on the circular ecosystems, it also appears that a lot of the relevant insights for practice are rather covered within the circular business model literature (Geissdoerfer et al., 2020).

However, as Fehrer and Wieland (2021) suggest, circular business models require a systemic logic which demands for a continued discussion on circular ecosystems. Reviewing the literature also showed that knowledge on success factors or enablers is rather covered in case studies at this stage (Frishammar & Parida, 2019; Konietzko et al., 2020; Moggi & Dameri, 2021). Usually these studies cover one specific industry and it is not clear yet whether these findings apply also elsewhere. Furthermore, while first research on barriers and incentives for circular ecosystems have been explored, e.g., showing that working with supply chain entities and sur- rounding community entities is critical when transitioning towards a circular ecosystem (Asgari & Asgari, 2021), it is not clear yet how the process of such a transition should ideally be designed.

3.6 Conclusions and avenues for future research

To enable the potential of circular ecosystems, this review suggests certain p*olicy implications* : Firstly, given the still ongoing research funding for CE research (Lopez et al., 2019) and the identified gap for circular ecosystem specific knowledge, future grants should be focused on research taking ecosystem approaches to narrow and eventually close this gap. Future research can thus conduct multi-company or multi-stakeholder analysis, partly also across industries to advance circular ecosystems knowledge. Secondly, given the crucial role of governance and often the various roles of public agents (Uusikartano et al., 2020), it appears favorable if local governments or institutions kick-off local circular ecosystems and get more involved to improve orchestration in existing circular ecosystems. This may require additional financial resources, but also significant upskilling and capability building as practical knowledge on circular ecosystems might still be scarce in local governments. Thirdly, policy-makers should encourage local clusters of circular ecosystems that enable local closed loop systems (Camilleri, 2020), and build platforms for circular ecosystem innovation (Konietzko et al., 2020) that may or may not be constrained to the local or industry-specific context. This state-led circular ecosystem innovation should be accompanied by various educative interventions for skill building and in cooperation with research institutions to be set up for success (Mortensen & Kørnøv, 2019; Tseng et al., 2021).

3.6.1 Avenues for future research

Connecting further literature from both the management and the industrial ecology sphere with circular ecosystems may be a promising avenue for future research: in management literature, stakeholder management theory (Donaldson & Preston, 1995), and value networks (Velu & Stiles, 2013) can likely inform the concept of circular ecosystems. From an industrial ecology perspective, this review also showed that several (more mature) concepts, such as eco-industrial parks, can be deployed to investigate factors that might also be impactful for a wider range of circular ecosystems. For example, some of these insights on enablers and barriers might also be relevant for the success or failure of circular ecosystem management. Future research should also take a process lens, analyzing the transition process from kicking-off a circular ecosystem to a more mature state. Investigating the evolution from a circular business model (single-firm view) to a circular ecosystem (multi- firm or stakeholder view) is also a process that should be investigated. These investigations should also differentiate between different kind of circular ecosystems. Depending on the circular ecosystem type, each circular ecosystem has its own challenges, that might require other enablers or different weighting of enablers. While the boundaries between the different categories as proposed in this review may be blurry, they might still be a good starting point. Nevertheless, as so far there is only one publication that provides both a definition and typology of circular ecosystems, the research community should invest into the discussion of the concept itself and develop further proposition of such frameworks. Furthermore, future research may also advance insights into innovation in circular ecosystems (Konietzko et al., 2020). Hence, connecting the innovation ecosystem literature (beyond business ecosystem literature) seems a promising avenue for future research (Gomes et al., 2018).

3.6.2 Key contributions

This paper contributes to the discussion of circular ecosystems by firstly, explaining the development and roots of the concept; secondly, reviewing the literature for definitions and typologies; thirdly, proposing a classification of circular ecosystems; and fourthly, presenting the most prominent success factors for circular ecosystems. Thereby this review reveals the conceptual knowledge gap on circular ecosystems, and also helps other researchers of the field to systematically identify relevant publications. The review also showed that the concept of circular ecosystems is rather rooted in CE literature than in the ecosystem literature. Furthermore, the

proposed classification of circular ecosystems as identified in the literature equips academics and practitioners with a common language and a framework with two defining variables (geographic and industrial scope) that help classify different kind of circular ecosystems. This classification can also help practitioners to clarify what kind of circular ecosystem best fits their overall strategy and may inspire conversations on potential implications for future strategy or competitive advantage in light of environmental ambitions. Besides, the overview of success factors as highlighted in the literature may provide inspiration for practitioners as how to plan and manage a circular ecosystem, but also points researchers to further questions that need additional empirical testing. In addition to the discussion of results, policy implications and avenues for future research are proposed in the conclusion. To conclude, with the continued interest in CE research, the concept of the circular ecosystem has become an emerging subfield in CE research. Taking the ecosystem perspective on the CE presents a promising avenue for research, but most importantly, can support the CE implementation in practice. This paper can hopefully help to orient academics and firms in such a way that they can contribute to sustainable development by starting or expanding their engagement in circular ecosystems.

4 Private firm support for circular economy regulation in the EU policy context

Abstract: As an empirical investigation of firm support for circular economy regulation in the European Union (EU) context, this paper is the first to connect the research field on corporate political activity with the growing research field on the circular economy. The paper presents these two research streams, draws on theories such as the resource-based view, and employs a hierarchical regression framework to formulate and test six hypotheses on what drives firms to support circular economy regulation. We find that smaller firms show more support for circular economy regulation than larger firms do and identify two moderating effects: the stock listing seems to moderate the relationship between firm size and a firm's support for circular economy regulation; and a firm's supply chain position has a counterintuitive negative moderating effect on the relationship between slack resources and a firm's support for circular economy regulation. We discuss null findings and suggest avenues for future research at this under-researched intersection of policies and firms in the circular economy context.

Keywords: Circular economy, corporate political activity, regulation, policy, EU

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Pietrulla, F. (2022). Private firm support for circular economy regulation in the EU policy context. *Sustainability*, *14*(14), 8427.

4.1 Introduction

Policies that encourage the economy's decarbonization, such as the European Green Deal (European Commission, 2019) and the Circular Economy Action plan (European Commission, 2020), target climate change, one of our time's most significant challenges (WBCSD, 2020). The circular economy (CE), which the Ellen MacArthur Foundation (2015a, p. 19) defines as "an industrial system that is restorative or regenerative by intention and design", is often seen as a promising solution. In pursuit of such a system, firms are expected to contribute to the CE transition (Whiteman, Walker, & Perego, 2013), which should ideally be supported by an intelligent design of CE regulations and policy incentives for effective implementation (e.g., Kirchherr et al., 2018). Therefore, companies frequently support green regulation efforts and engage with policy-makers to shape such regulations, despite the cost firms may incur when such regulations are implemented. Research shows that doing so might pay off for firms, whether in the form of competitive first-mover advantage (Kennard, 2020) or increased reputation effects (Vishwanathan et al., 2020).

However, little empirical research addresses corporate political activity (CPA) in the CE context, so an extensive research gap remains regarding whether and how firms engage with and influence socio-political stakeholders to manage regulatory uncertainties – more specifically, CE regulation. The CE concept has received growing interest from policy-makers, practitioners, and academia (Bocken et al., 2019b; Geisendorf & Pietrulla, 2018; Mishra et al., 2021; Morone & Yilan, 2020), but has not yet been subject to investigations on the level of interactions between firms and policy-makers. Earlier CE studies often take an industrial ecology lens (Corona et al., 2019) or a pure policy perspective (e.g., McDowall et al., 2017). With more recent publications, the field has entered the organizational literature by discussing circular business models (Bocken et al., 2019b; Donner et al., 2021; Pieroni et al., 2019b) and circular ecosystems of firm consortia (Kanda et al., 2021b; Konietzko et al., 2020). However, little to no research takes a multi-level perspective in investigating the interaction effects and relationships between the firm level and policy level. While the broader literature explores the interrelationships between lobbying and corporate social responsibility (CSR) (Anastasiadis, 2014; Scherer, Palazzo, & Matten, 2014), none of these studies investigate the CE context. For example, we do not yet know what drives firms to manage relationships with socio-political stakeholders or how these firms influence CE policy-making. To the best of our knowledge, to date no other study investigates what determines firm-level political support for CE regulation.

Therefore, we deploy the CE-EU Commission context of public consultations in 2015 to investigate empirically our research question: What determines a firm's support for CE regulation?

We create a novel indicator of firms' support for CE regulation that stems from the EU Commission's data set on public consultations regarding CE. To our knowledge, this data set has not been deployed in this context so far. We connect the data with additional company information to derive insights into what drives firms' support of CE regulation and test our hypotheses empirically in a hierarchical regression framework that pays special attention to robustness. As our investigation may only be understood as an early start to opening the field of CPA research in the CE context, we discuss the limitations of this paper in detail and suggest a research agenda for the field.

4.2 Theoretical background and literature

This study investigates an area at the intersection of CPA and the CE and takes a predominantly resource-based view to develop hypotheses. Here, we describe the theoretical background and literature that is relevant to these three aspects.

4.2.1 Circular economy

Pearce and Turner (1990) first introduced the CE concept as part of the sustainability literature. The concept found its roots in earlier concepts, like Boulding's (1966) closed-loop systems and Stahel & Reday's (1981) industrial economy loops. While similar in some ways to concepts like industrial ecology (Ayres & Ayres, 1996; Erkman, 1997; Graedel & Allenby, 1995) and cradle-2-cradle (Braungart et al., 2007; Mcdonough and Braungart, 2010; Geisendorf and Pietrulla, 2018), in the firm context, the CE concept refers to maintaining the value of firms' resources over time, thereby reaching environmental sustainability without compromising inclusive growth. Circular business models are a vital tool in the pursuit of growth on the firm level of the CE (Bocken et al., 2016a, 2016b, 2014; Evans et al., 2017a; Geissdoerfer et al., 2020; Lewandowski, 2016; Lüdeke-Freund et al., 2019; Manninen et al., 2018; Rizos et al., 2016). Publications on CE in general have also grown significantly (Geissdoerfer et al., 2017). They discuss CE's concept definition in detail (Ghisellini et al., 2016; Kirchherr et al., 2017; Padilla-Rivera et al., 2020), social implications of the CE (Padilla-Rivera et al., 2020), enablers of and barriers to the implementation of circularity (Kirchherr et al., 2018), the benefits of CE to various sectors (Ghisellini et

al., 2018), indices and measurement of circular performance (Corona et al., 2019; Elia et al., 2017; Saidani et al., 2020, 2019), cross-collaboration in circular ecosystems (Kanda et al., 2021b; Konietzko et al., 2020), systemic approaches to regional implementation (Bassi et al., 2021; Drejerska, Vrontis, Siachou, & Golebiewski, 2020) (e.g., from a waste management perspective (Ghimire, Flury, Scheenstra, & Miles, 2020; Golebiewska, 2018; Redlingshöfer, Barles, & Weisz, 2020)), and the CE's progress through policy-making (e.g., for European context, see Calisto Friant et al., 2021). However, we found no study that analyzes how CPA takes place in the context of CE regulation.

4.2.2 Corporate political activities

CPA is rooted in the idea of firms' so-called non-market strategy as a complement to their market strategy (Baron, 1995), i.e., "managing the institutional or societal context of economic competition" to enhance performance (Mellahi et al., 2016, p. 144, see also Lux, Crook & Woehr, 2011). CPA more specifically is defined as "corporate attempts to shape government policy" (Hillman et al., 2004, p. 837; see also Lawton et al., 2013; Scherer et al., 2016) and led to Barley's theory of an institutional field of political influence (Barley, 2010). As Barley (2010) notes, firms' interest in shaping policy is a global and flourishing phenomenon and is performed either directly by corporations or indirectly through intermediaries (Tyllström & Murray, 2021). CPA together with corporate social responsibility (CSR) (e.g., Aguinis & Glavas, 2012), defined as "context-specific organizational actions and policies that take into account stakeholders' expectations and the triple bottom line of economic, social, and environmental performance" (Aguinis, 2011, p. 855), are responses to the growing expectations that firms engage with and in environmentally friendly activities (Helmig, Spraul, & Ingenhoff, 2016; Mathiyazhagan, Diabat, Al-Refaie, & Xu, 2015). Scholars find that these activities positively correlate with performance outcomes (Ambec & Lanoie, 2008; Flammer, 2013; Stoian & Gilman, 2017).

Recent game-theoretical articles shed light on the underlying mechanism and contextual dynamism that motivate firms' engagement in or support for social or green regulation (Choi, Taleizadeh, & Yue, 2020; Kennard, 2020; Palafox-Alcantar, Hunt, & Rogers, 2020). These studies show that lobbying for green regulation can improve a firm's competitive advantage and have positive impacts on performance indicators (e.g., Younis et al., 2016). Other research finds that a position in the supply chain that is closer to consumers leads to more sustainable practices (e.g., Schmidt et al., 2017) because of the increased visibility to end consumers. Besides, research has identified

organizational variables such as firm size, age, and slack resources to influence firms' attitude toward sustainability (Chen, Zeng, Lin, & Ma, 2017). To date, there is no research that addresses the intersection of CPA and CE in particular.

4.2.3 Resource-based view

The resource-based view (RBV) of the firm investigates firms from the "resource side rather than from the product side" (Wernerfelt, 1984, p. 171). It analyzes how firms deploy resources which may develop into capabilities or even core competencies, which in return can explain differences in firm performance (Barney, 2001a). A set of valuable, rare, inimitable, and non-substitutable (VRIN) resources creates a competitive advantage (Barney, 1991), so the classic RBV of the firm interprets strategy as a translation of companies' core competencies and the effective and efficient deployment of resources such as internal firm capabilities and assets (Barney, 2001a; Prahalad & Hamel, 1990).

The extension of this theory is the natural RBV (NRBV) of the firm, which theorizes that competitive advantage is based on the firm's relationship to the natural environment (Hart, 1995). The NRBV suggests a positive influence of three sustainability-related interconnected strategies on firm performance (Hart, 1995; Hart & Dowell, 2011): pollution prevention, product stewardship, and sustainable development.

Within the RBV literature, the field of dynamic capabilities research (Teece, 2007, 2018a; Wang & Ahmed, 2007) has gained importance. Dynamic capabilities are the "ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece et al., 1997, p. 516), a logic that has also influenced the NRBV (Hart & Dowell, 2011). The dynamic capabilities approach is thus also quite helpful to explain the adoption and outcome of CE practices in firms (Khan et al., 2020a). According to the broader RBV perspective, firms' engagement in a CE could create a long-term advantage (Chan, 2005; Portillo-Tarragona, Scarpellini, Moneva, Valero-Gil, & Aranda-Usón, 2018).

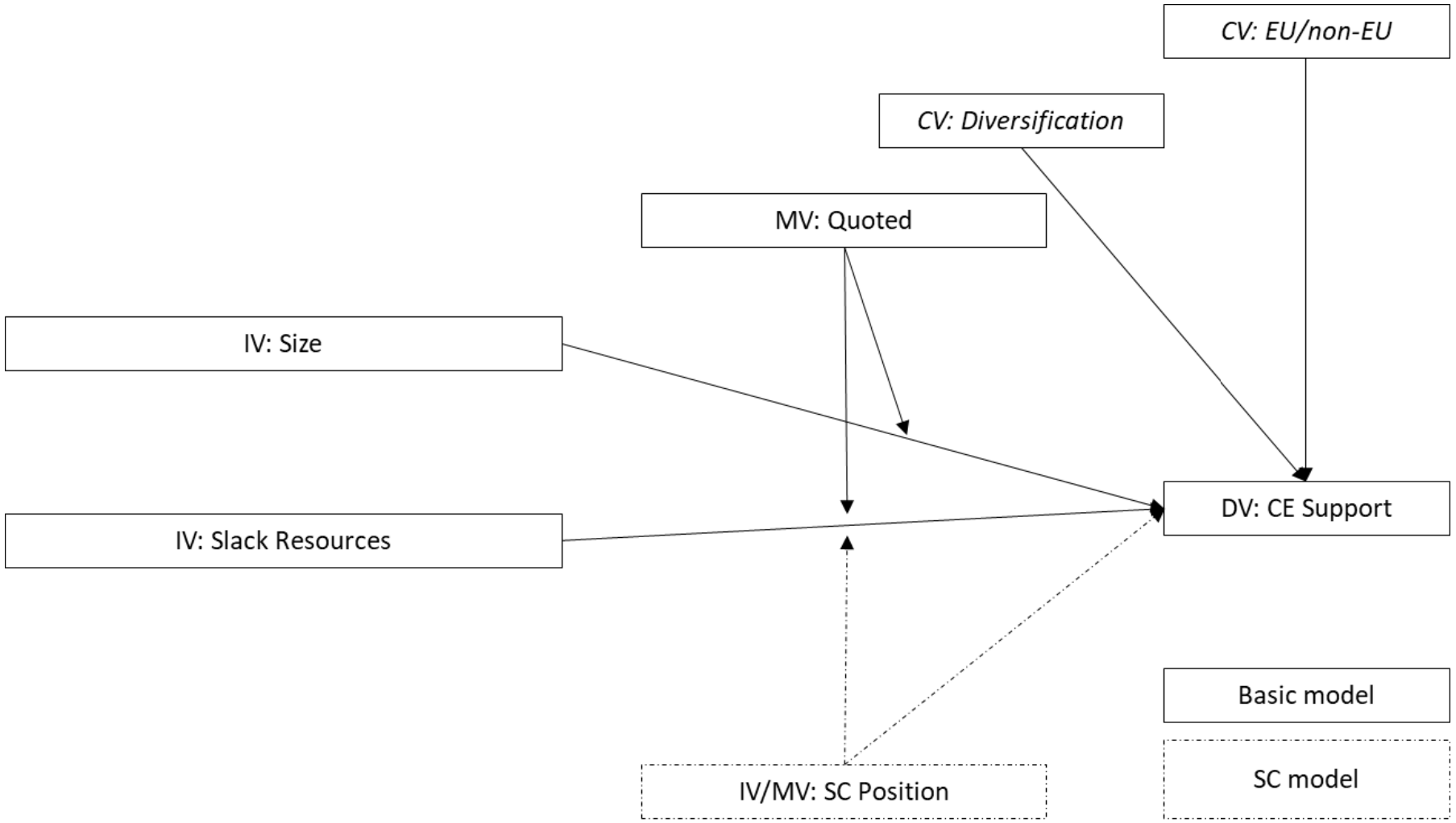
4.3 Development of hypotheses

Given the CE's growing importance to reach the sustainable development goals (Corona et al., 2019; Rodríguez-Antón, Rubio-Andrada, Celemín-Pedroche, & Ruíz-Peñalver, 2022), we investigate what drives firm support for CE regulation in the EU context and at the intersection of the literature fields of CE and CPA. This study is a

starting point in the examination of what drives firms to support CE regulation (i.e., CE-specific CPA) and the moderating factors of these relationships. To investigate these drivers and moderators, we deploy the theoretical logic of the RBV and propose a model for a regression framework, shown in Figure 8.

We formulate six hypotheses that refer to firms' organizational characteristics. Our models take a standard view of companies as profit-maximizers (e.g., Friedman, 2007) that are more willing to engage in CE when they expect benefits for doing so. These benefits could come in the form of, for example, increased market share, increased independence from suppliers, and improved reputation with end customers This cost-benefit calculation should reflect the firms' political statements in CE-related consultations. The hypotheses development follows, and the measures and constructs are described in the subsequent research methods section.

Figure 8 The research model of the regression framework



IV (Independent Variable), MV (Moderating Variable), CV (Control Variable), DV (Dependent Variable) , CE (Circular Economy regulation), SC (Supply Chain)

The study's first hypothesis refers to firm size as an independent variable. While earlier work on corporate sustainable development often uses firm size as control (Bansal, 2005) we find it first of all relevant to understand the consistent association with the dependent variable. Hence, we explore whether size has a direct effect on firms' support for CE regulation. Taking a predominantly RBV of the firm, we build on other research analyzing the impact of firm size on corporate sustainability activities (Chen et al., 2017) that generally found that larger firms take on more environmental responsibility as they are subject to larger public scrutiny (Gallo & Christensen, 2011; Gray, Javad, Power, & Sinclair, 2001). At the same time, larger firms develop more bureaucratic mechanisms and the cost to change these may be higher than for smaller firms who have fewer such control mechanisms in place (Gallo & Christensen, 2011). In addition, smaller firms tend to be more agile (Shin, Lee, Kim, & Rhim, 2015), enabling them to transform their linear business models into circular business models relatively quickly. Hence, if smaller, potentially more dynamic organizations will have fewer struggles to adapt to CE regulations than slower, large corporations (Lopez et al., 2019), they may expect to gain a competitive advantage through increased CE regulation. Similarly, from a game-theoretical point of view, smaller, more agile firms that can adapt to regulatory change faster would lobby for green regulation to give themselves an advantage over their larger competitors by capturing larger firms' market share when they cannot implement the regulatory requirements fast enough (Keivanpour, Ait-Kadi, & Mascle, 2017; Kennard, 2020). In addition, given that fewer employees are involved in smaller firms, resistance to change may be less of a burden (Hannan & Freeman, 1984). While firm size may also stand for other aspects of a firm, we hypothesize the following based on the above reasons:

H1: Firm size is negatively related to its support for CE regulation.

Investing in and implementing the CE is a risky endeavor that requires the will to experiment. High amounts of slack resources compared to the firm's size reduce its investment risks (Chen et al., 2017; Rajagopalan, 1997). Firms that have dynamic capabilities can generate slack resources faster than their less dynamic peers, so they are more likely to change their strategy to supporting environmental initiatives like the CE (Pavlou & El Sawy, 2011; Winter, 2003). Zhang et al. (2018) also show that slack financial resources strongly correlate with CSR efforts. Accordingly, we formulate our second hypothesis:

H2: A firm's slack resources are positively related to its support for CE regulation.

In line with these proposals, we also formulate a moderation hypothesis that a stock listing increases a firm's support for CE regulation, as listed firms will want to keep their position in ESG (environmental, social, governance) ratings. Gallo and Christensen (2011) show empirically that a firm's size and its stock market quotation are significantly positively related to its support of sustainability, and Loderer et al. (2010) show that large and listed firms disclose a lot more information to shareholders than non-listed firms to render themselves attractive to investors, which is consistent with Buzby's (1975) earlier findings. Because of the hypothesized negative relationship between firm size and CE support, we state our third hypothesis as:

H3: Listing on a stock market increases the negative association between a firm's size and its support for CE regulation.

Empirical evidence from the United Kingdom (Brav, 2009) and the United States (Gao, Harford, & Li, 2013) shows that listed firms have higher cash ratios (cash divided by total assets) than their unlisted peers. Cash is considered a slack resource (George, 2005). Schoubben and Van Hulle (2004) point in a similar direction, showing that firms that are listed on the stock market have comparatively less debt than private firms do, suggesting that these firms have more slack resources. Therefore, we formulate our fourth hypothesis as:

H4: Listing on a stock market increases the positive association between a firm's slack resources and its support for CE regulation.

We also suggest a supply chain (SC) model in which we examine the role of a firm's position in the SC in its support of CE regulation. We formulate two hypotheses.

A specific SC position comes with a specific context, stakeholders, and regulations that explain variances in environmentally favorable behavior between actors along the SC (Lo, 2014; Schmidt et al., 2017). Companies that are at the downstream end of the SC and whose brands are thus more visible to the end consumer (Diabat & Govindan, 2011; Laari, Töyli, & Ojala, 2017; Min & Galle, 2001;

Schmidt et al., 2017) are penalized most from not adhering to environmental standards or causing environmental scandals. One example is the ongoing Volkswagen Dieselgate emissions scandal (Siano, Vollero, Conte, & Amabile, 2017) and the Deepwater Horizon tragedy (Harlow, Brantley, & Harlow, 2011), where Volkswagen paid approximately three times as much as BP, even though BP may have caused more environmental damage. However, Volkswagen is closer to the end consumer, so it is exposed to a higher risk of punishment from the consumer. Both companies still suffer from reputational consequences (Che, Katayama, & Lee, 2020), but Volkswagen has paid a higher price. We also expect companies that are engaged at the early steps of today's linear economy – that is, those that are involved in resource extraction – to feel the most disruption and need for adaptation during a CE implementation. Therefore, these companies are most likely to oppose binding CE regulations. They would have to adapt quickly to CE regulations, incurring high transition costs and possibly even destroying their core business proposition.

Similarly, we argue that, from a game-theory perspective, firms could support CE regulations to hurt their direct competitors (Kennard, 2020). This especially holds if the firms they want to attack have a highly globalized or long SC because such SCs often have cost advantages. Accordingly, cost-conscious firms with shorter, more local SCs (sourcing closer to the end consumer) may use a CE-support strategy to hurt their globally acting competitors. We also find support for this logic from an RBV perspective, as supporting CE regulation could mean that being an early adopter, and building critical expertise and capabilities in the CE would be a valuable resource (Barney, 1991). Indeed, a firm's competitive advantage from supporting the CE will likely be based on a set of valuable and inimitable resources, as Fernando et al. 's (2018) study of Malaysian firms with new renewable energy SCs shows. The hypothesis positively connects the position in the SC and support of CE regulation because renewable-energy SCs are shorter and closer to the customer.

H5: A downstream supply chain position is positively related to a firm's support for CE regulation.

H6: A downstream supply chain position increases the positive association between a firm's slack resources and its support for CE regulation.

4.4 Research Methods

We first describe the data collection process. Next, we explain the deployed variables in the model, and lastly, we describe the data analysis approach of our investigation.

4.4.1 Data collection

We combined data points from three sources: We collected EU Commission data on public consultations regarding CE in 2015. This data is publicly available on the EU Commission's website and can be retrieved in an Excel file containing text information. While this data also entails public statements of non-governmental organizations and other institutions, this study focuses on private firms, so we limited our dataset to the 142 private firms that disclosed their names. We also collected data on firm-level covariates – assets, number of employees, revenue, industry, and assets – from the Bureau van Dijk ORBIS database (Orbis, 2021), which covers the last fiscal year preceding the public consultation (2014). Finally, based on a company's NAICS industry identifier, we connected our firm data to a metric for SC position developed by Delgado and Mills (2020) that measures how close NAICS industries are to the end consumer.

4.4.2 Measures

The following section describes dependent, independent, and control variables of the models.

4.4.2.1 *Dependent variable*

We deployed the public positions the 142 companies took in the 2015 public consultations process, with the companies' names as the dependent variable. As companies' opinions are displayed in these public consultation files, we used seven questions asked in these public consultations to create a variable that captures the firms' support of CE regulations. We selected these questions based on their relevance to firms' positions regarding CE regulation and excluded purely descriptive (open text field) questions. Firms answered these questions on a Likert scale from 1 to 5, so we treated the questions as continuous variables and summed the answers to obtain our CE regulation-support index. Table 8 provides a list of these questions and their coding.

Table 8 Index for firms' support for CE regulation

#	**Question**	**Coding of answers**
1	Assess the importance of the following measure to promote circular economy principles in product design at the EU level: Establish binding rules on product design (e.g., minimum requirements on "durability" under Ecodesign Directive 2009/1).	From 5 = very important (highest support for CE) to 1 = not important (least support for CE)
2	Assess the importance of the following measure to promote circular economy principles in product design at the EU level: Encourage industry-led initiatives (i.e., self-regulation).	From 5 = very important (highest support for CE) to 1 = not very important (least support for CE)
3	Assess the importance of the following measure to promote circular economy principles in product design at the EU level: Develop standards for voluntary use.	From 5 = very important (highest support for CE) to 1 = not very support (least support for CE)
4	Should the action listed below be given priority at the EU level to promote circular economy solutions in production processes? Address potential regulatory obstacles in EU legislation.	From 5 = very important (highest support for CE) to 1 = not very important (least support for CE)
5	Should the action listed below be given priority at the EU level to promote circular economy solutions in production processes? Address potential regulatory gaps in EU legislation.	From 5 = very important (highest support for CE) to 1= not important (least support for CE)
6	How effective do you think the action at the EU level listed below would be in promoting sustainable production and sourcing of raw materials? Establishing a legally binding framework at the EU level (e.g., sustainability criteria).	From 5 = very effective (highest support for CE) to 1 = not effective (least support)
7	How effective do you think the action at the EU level listed below would be in promoting sustainable production and sourcing of raw materials? Developing and promoting voluntary compliance schemes.	From 5 = very effective (least support for CE regulation) to 1 = not effective (highest support)

4.4.2.2 *Independent variables*

The model's independent variables are the firm-level variables. *Firm size* is measured by either the number of employees or total assets. Both operationalizations are deployed as proxies for firm size to test for the respective measures' robustness. Both proxies are log-transformed to level out their skewed distributions. In line with previous studies (Chen et al., 2017; George, 2005; Peng, Li, Xie, & Su, 2010), *slack resources* are calculated as the inverse ratio of debt to total assets. We employed stock market listing as *quoted* variable, from the ORBIS data as a dummy variable coded as 1 when the firm is listed (i.e., a public company) and 0 if not.

We used the *SC position* (from Delgado and Mills, 2020) as an explanatory variable in our SC deep-dive model. The measure, which ranges from 0 to 1, proxies for how close the firm's industry is to the end consumer in the SC. Higher values signify closer proximity to the end consumer. We merged the data sets based on the NAICS identifiers (NAICS, 2021).

4.4.2.3 *Controls*

We controlled for two variables, *EU/non-EU* and *business diversification*. We chose the variable *EU/non-EU* as a control, as Kennard (2020) suggests that non-EU firms, i.e., firms with headquarters outside of the EU, could favor strict CE regulation to increase the regulatory burden of their EU competitors in their home markets. *EU/non-EU* is a binary measure coded as 0 for non-EU and 1 for EU. We also chose *business diversification* as a control, as a proxy for industry type (Alabdullah, Laadjal, Ries, & Al-Asadi, 2018). The more diversified a company, the more diversified the risk for the firm as a whole, as some business activities may not be affected by CE regulation. Hence, we expect these firms to take a position less opposed to circular economy regulation than non-diversified firms. *Business diversification* ranges from one to eight active industries per firm, per the self-reporting in the public consultation data set.

4.4.3 Data analysis approach

Our data analysis approach consists of five steps. First, we checked for missing values and calculated the descriptive statistics for all variables by creating a correlation matrix to check for strong bi-variate relationships and histograms to check for normal distributions. Second, we investigated the hypotheses empirically in a hierarchical regression framework (Seber & Lee, 2012) using ordinary least squares (OLS)

estimation. We started by regressing CE support on the independent variables, then added the control variables to the model, and finally added interaction terms. This procedure was repeated for hypotheses 5 and 6 in a separate SC model. Third, we recalculated the models and replaced the employee variable with assets to assess the robustness of employees as a proxy for firm size. Fourth, we assessed the error terms of all models' regression outputs to validate essential OLS assumptions (i.e., regular distribution of error terms). Fifth, we assessed variance inflation factors to check for multicollinearity issues. Motivated by potential selection bias in our sample, we tested the robustness of our results further using a Heckman selection model (Heckman, 1976).

The next section describes the results of each of those steps and provides descriptive statistics of the variables.

4.5 Results

This section provides the descriptive statistics of the data set, discusses the results, and presents the robustness tests.

4.5.1 Descriptive statistics

Approximately half of our 142 data points have at least one missing entry. Missing values are common in survey research and lead to various challenges. A common response to missing values is list-wise deletion, where every incomplete dataset is deleted. This procedure leads to a high amount of data loss and can lead to critically small sample sizes, which would have been our case had we not employed the multivariate imputation by chained equations (MICE) procedure introduced by Van Buuren and Groothuis-Oudshoorn (2011) to preserve the sample size. This procedure draws values randomly from the underlying distribution and imputes them by means of predictive mean matching (Buuren & Groothuis-Oudshoorn, 2011; Little, 1988; Rubin, 2004). Unlike list-wise deletion or simple mean imputation, this procedure preserves the random variance of the complete data and offers plausible values that are assumed to be free of bias.

Not all 142 firms, such as professional services firms, have SC positions, so we excluded firms that did not have SC positions from the SC model, leading to a smaller sample of 124 firms.

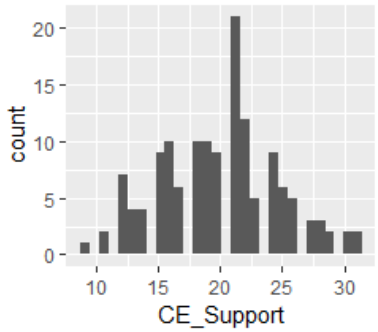
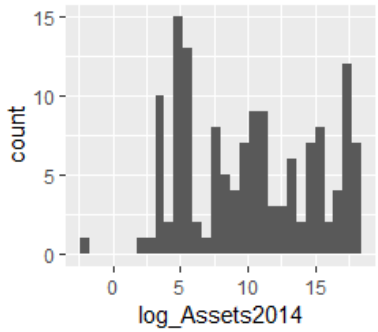
Table 9 Correlation Matrix

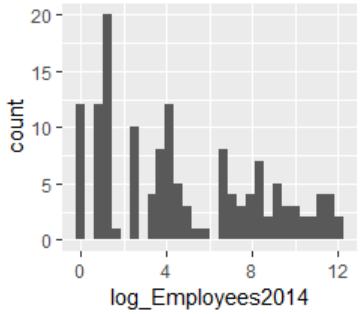
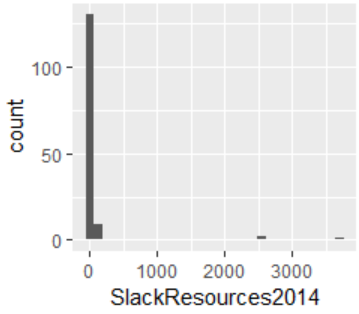
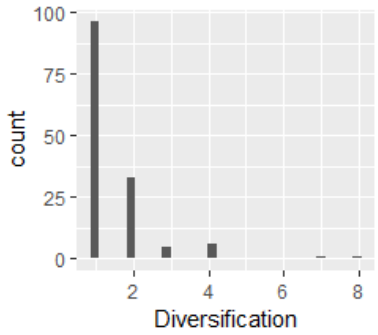
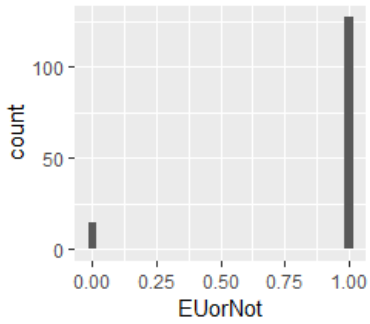
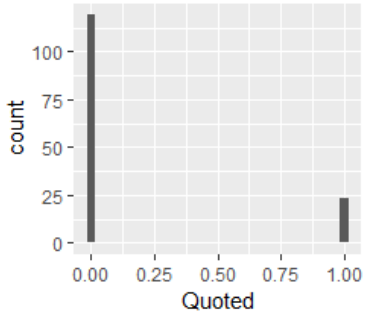
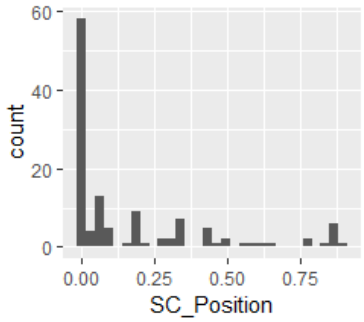
	# obs.	Mean	SD	CE_Support	Assets	Employees	SlackResources	EUorNot	Diversification	Quoted
CE_Support	142	19,9	4,7							
Assets	142	10,2	4,9	Cor: -0.364 (p: 0 ****)						
Employees	142	4,7	3,7	Cor: -0.38 (p: 0 ****)	Cor: 0.942 (p: 0 ****)					
SlackResources	142	73,9	424,5	Cor: -0.02 (p: 0.8151)	Cor: -0.065 (p: 0.4404)	Cor: -0.015 (p: 0.8638)				
EUorNot	142	0,9	0,3	Cor: -0.064 (p: 0.4521)	Cor: -0.165 (p: 0.0496 **)	Cor: -0.173 (p: 0.0397 **)	Cor: 0.056 (p: 0.5048)			
Diversification	142	1,5	1,0	Cor: 0.03 (p: 0.7226)	Cor: 0.02 (p: 0.8168)	Cor: 0.031 (p: 0.7176)	Cor: -0.022 (p: 0.7983)	Cor: -0.114 (p: 0.1758)		
Quoted	142	0,2	0,4	Cor: -0.223 (p: 0.0075 ***)	Cor: 0.564 (p: 0 ****)	Cor: 0.68 (p: 0 ****)	Cor: -0.063 (p: 0.4567)	Cor: -0.222 (p: 0.0079 ***)	Cor: 0 (p: 0.9976)	
SC_Position	124	0,2	0,3	Cor: -0.096 (p: 0.2897)	Cor: 0.098 (p: 0.2813)	Cor: 0.161 (p: 0.0734 *)	Cor: -0.04 (p: 0.6573)	Cor: -0.123 (p: 0.172)	Cor: -0.131 (p: 0.1468)	Cor: 0.169 (p: 0.0607 *)

****p<0.001; ***p<0.01;**p<0.05;*p<0.1

After completing our data set, we calculated means, standard deviations, and a correlation matrix (Table 9). Next, we checked for normal distributions of the individual variables of our dataset by visually inspecting the histograms of each variable. Rahman and Govindarajulu (2010) suggest using the Shapiro-Wilks test to assess the normality of the data further, which is especially important for smaller samples. The Shapiro-Wilk test is a significance test with the null hypothesis of a normally-distributed population. A significance level of $p < 0.05$ is recommended as a cut-off value. As Table 10 shows, normality of the data is given only for the *CE_Support* variable; the remaining variables are non-normally distributed.

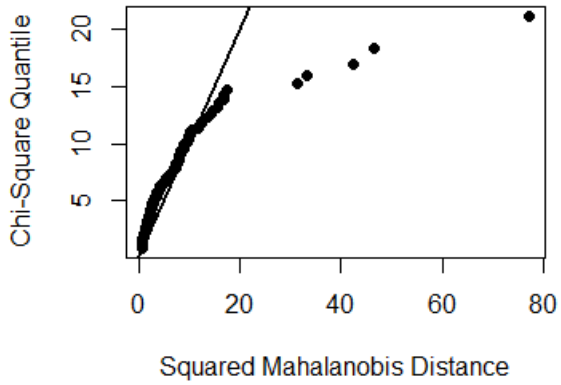
Table 10 Histograms of variables and Shapiro-Wilks test statistics

a) CE_Support	b) Log_Assets2014
	
W = 0.9866, p-value = 0.1844	W = 0.9461, p-value = 2.624e-05

c) Log_Employees2014  W = 0.91988, p-value = 3.894e-07	d) SlackResources2014  W = 0.15765, p-value < 2.2e-16
e) Diversification  W = 0.54351, p-value < 2.2e-16	f) EU/non-EU  W = 0.35296, p-value < 2.2e-16
g) Quoted  W = 0.44293, p-value < 2.2e-16	h) Supply Chain Position  W = 0.71204, p-value = 2.791e-14

After assessing univariate normality, we assessed multivariate normality using Mardia's (1970) test because we employ a multiple regression procedure. The test statistics for skewness (Mardia Skewness= 1078, p-value=0) and kurtosis (Mardia Kurtosis=18, p-value=0) both indicate a lack of support for the tests' null hypothesis of multivariate normally distributed data (Figure 9).

Figure 9 Q-Q-plot of multivariate normality



We consider these findings unproblematic at this stage, given the central limit theorem, which posits that resampling of non-normally distributed data will result in a normally distributed probability distribution (Billingsley, 1995). Nevertheless, these insights suggest being cautious concerning the regression models' error terms and critically assessing their normal distributions in detail. This ex-post validation of normally distributed error terms in OLS regression is a critical model assumption, as non-conformance is not covered by the central limit theorem.

4.5.2 Results of hypotheses tests

Table 11 shows our findings for Hypotheses 1-4, and Table 12 shows our finding for Hypotheses 5 and 6.

Table 11 Results: Unstandardized regression coefficients

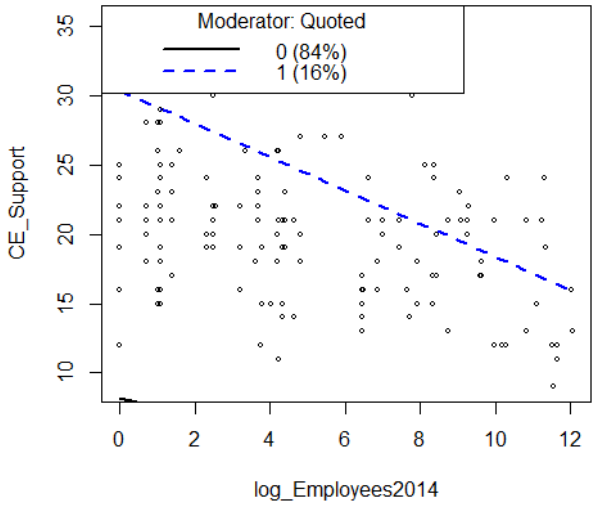
	Control-variable model	IV-only model	Base model	Interaction model
Intercept	0 (0.08)	0 (0.08)	0 (0.08)	0.41** (0.17)
Diversification	0.02 (0.09)		0.03 (0.08)	0.05 (0.08)
EUorNot	-0.06 (0.09)		-0.13 (0.08)	-0.09 (0.08)
Employees		-0.38*** (0.08)	-0.40*** (0.08)	-0.62*** (0.13)
SlackResources		-0.03 (0.08)	-0.02 (0.08)	0.11 (0.44)
Quoted				0.94*** (0.34)
Employees x Quoted				-0.58*** (0.21)
SlackResources x Quoted				0.29 (1)
R^2	0	0,14	0,16	0,21
Adj. R^2	-0,01	0,13	0,14	0,17
Num.obs	142	142	142	142

***p<0.01;**p<0.05;*p<0.1

Note: Standard errors are in brackets.

To summarize, in our first model, which excludes the SC position, two of four hypotheses are significant. H1 shows a significant negative effect in all three models of the hierarchical regression framework and is confirmed. Hypothesis 2 is not confirmed because the results do not show a significant positive effect between slack resources and CE support. Hypothesis 3 is significant and confirmed, suggesting that large, unlisted firms show low support for CE regulation, whereas small, listed firms show high support for CE regulation. Figure 10 shows the moderation plot. In general, we find that listing on the stock market is significantly and positively related to support for CE regulation. Hypothesis 4 cannot be accepted because of a non-significant coefficient.

Figure 10 Moderation effect of stock market quotation on the Employees-CE-support relation



The Supply Chain model in Table 12 provides further support for Hypothesis 3, so a stock market listing is related to support for CE regulation, as shown in the previous models.

However, we do not find support for Hypothesis 5, as we find no significant relationship between a downstream position in the SC and support for CE regulation.

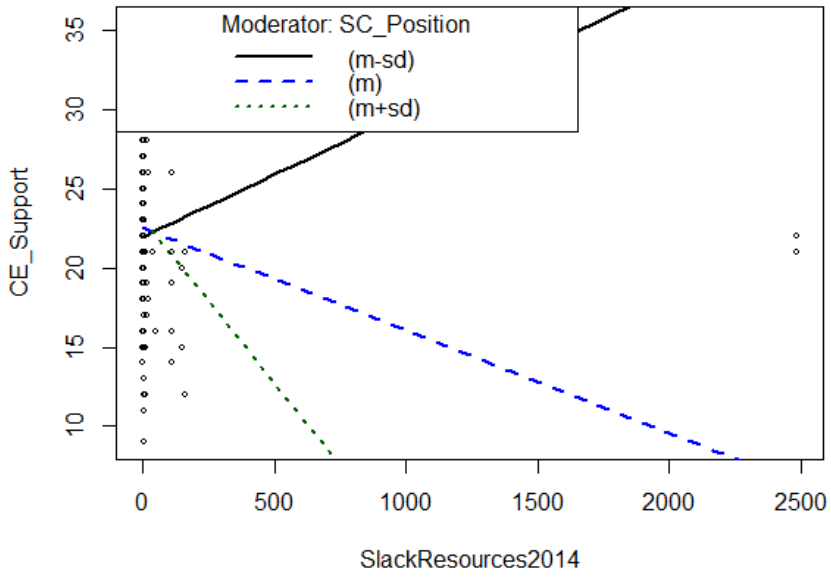
Table 12 Unstandardized regression coefficients (Supply Chain Model)

	Control-variable model	IV-only model	Base model	Interaction model
Intercept	20.61***(1.41)	22.43***(0.68)	25.12***(1.61)	23.43***(1.63)
Diversification	0.1(0.38)		0.01(0.37)	0.16(0.35)
EUorNot	-0.93(1.29)		-2.80**(1.30)	-1.76(1.32)
Employees		-0.47***(0.11)	-0.51***(0.11)	-0.42***(0.16)
SlackResources		0(0)	0(0)	0(0)
SC Position		-0.66(1.55)	-0.98(1.56)	2.32(1.81)
Quoted				20.99***(7.70)
Employees x Quoted				-2.12**(0.74)
SlackResources x Quoted				0.01(0.03)
SlackResources x SC Position				-0.05**(0.02)
R^2	0	0,14	0,18	0.27
Adj.R^2	-0,01	0,12	0,14	0.21
Num.obs.	142	124	124	124

***p<0.01;**p<0.05;*p<0.1
Note: Standard errors are in brackets.

Table 12 also directs our attention to Hypothesis 6, where we find a significant effect, although the effect is small and in the opposite direction than hypothesized. Figure 11 shows that the relationship between a high amount of slack resources and CE support for the mean SC position is negative. However, this relationship becomes positive when the SC is far from the end consumer. In other words, firms with high amounts of slack resources and with a considerable distance from end consumers are likely to support CE regulation. This counterintuitive finding sheds new light on firms that are positioned upstream in the SC, which are usually considered polluters because of less visibility and less reputational risk derived from increased consumer awareness (Sim & Kim, 2021). One possible explanation could stem from the overall increased public awareness that now also induces pressure on more upstream firms (Liu, Anderson, & Cruz, 2012).

Figure 11 Moderation effect of SC Position on the Slack resources-CE-support relation (based on employee model)



4.5.3 Tests for robustness

After running our hierarchical regression models, we employ four procedures to test their quality ex-post: We assess the robustness of the size indicator by recalculating the models with assets instead of employees, check the normality of error terms, examine variance inflation factors to check for multicollinearity, and run the Heckman model to account for the potential selection bias of the sample.

To check the robustness of the firm size measure, Tables 13 and 14 use assets, much as Tables 11 and 12 use the number of employees, to model firm size. By and large, the coefficients go in the same directions and reach the same significance levels. These results give us confidence that the initial models with the number of employees as a measure of firm size are robust.

Table 13 Hierarchical regressions with assets as a proxy for firm size

	Control-variable model	IV-only model	Base model	Interaction model
Intercept	20.61*** (1.41)	23.55*** (0.86)	25.26*** (1.62)	24.61*** (1.57)
Diversification	0.1 (0.38)		0.1 (0.36)	0.15 (0.34)
EUorNot	-0.93 (1.29)		-1.86 (1.22)	-1.83 (1.19)
Assets		-0.35*** (0.08)	-0.37*** (0.08)	-0.30*** (0.09)
SlackResources		0 (0)	0 (0)	0 (0)
Quoted				43.34*** (-12)
Assets x Quoted				-2.69*** (-0.72)
SlackResources x Quoted				-0.01 (-0.03)
R^2	0	0,13	0,15	0,23
Adj.R^2	-0,01	0,12	0,13	0,19
Num.obs.	142	142	142	142

***p<0.01;**p<0.05;*p<0.1
Note: Unstandardized coefficients are shown. Standard errors are in brackets.

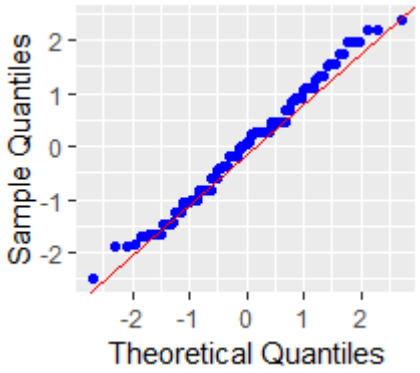
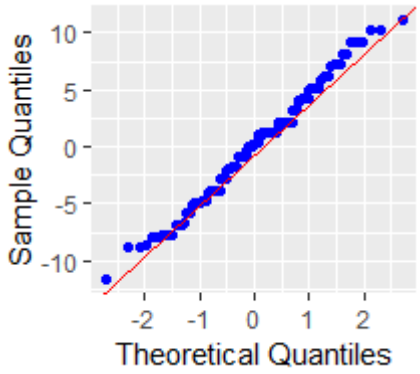
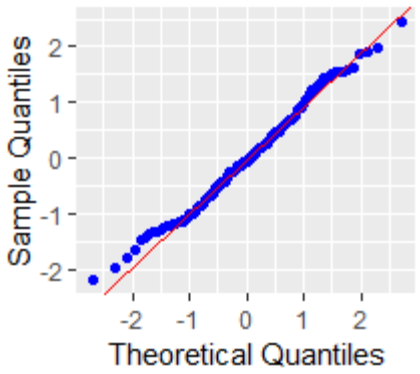
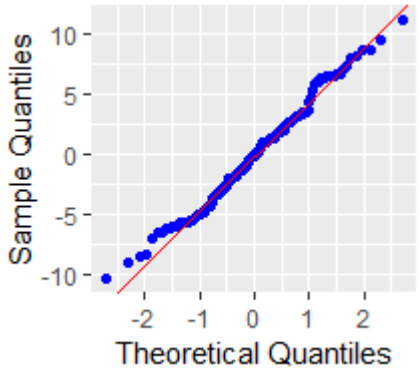
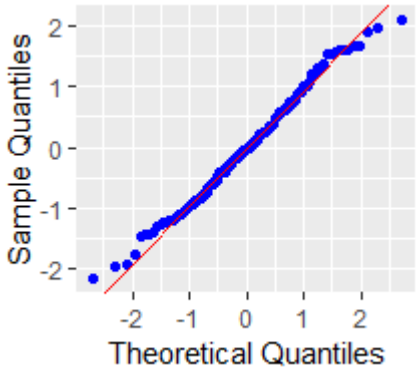
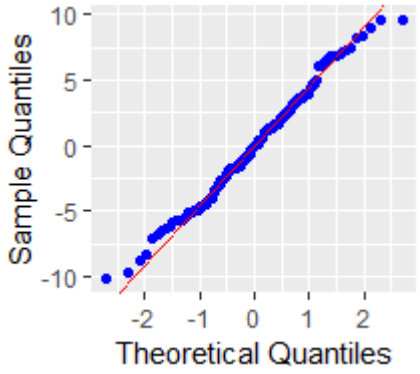
Table 14 Hierarchical regressions with assets as a proxy for firm size for the SC models

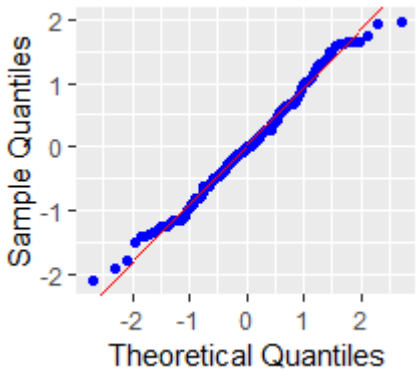
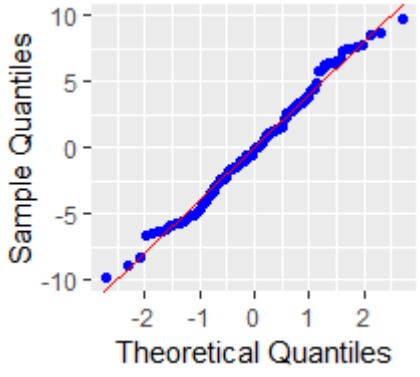
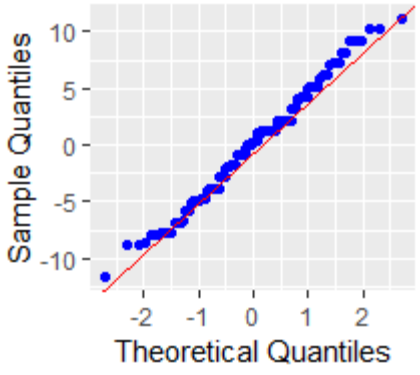
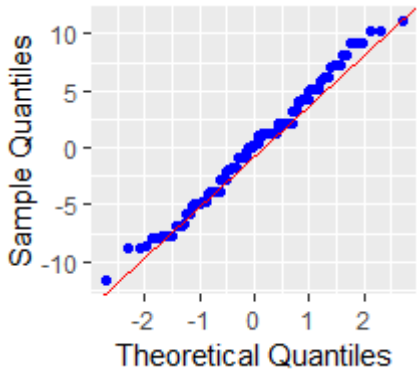
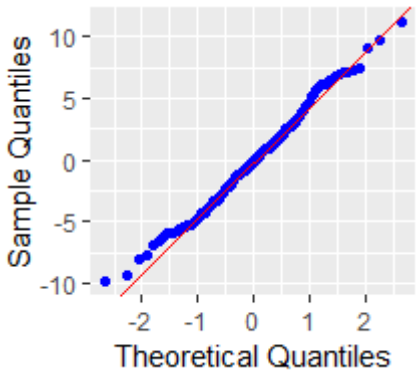
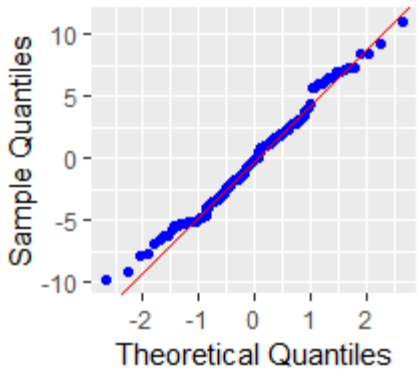
	Control-variable model	IV-only model	Base model	Interaction model
Intercept	20.61***(1.41)	23.98***(0.96)	26.75***(1.78)	25.18***(1.71)
Diversification	0.1(0.38)		-0.03(0.37)	0.08(0.34)
EUorNot	-0.93(1.29)		-2.73**(1.30)	-2.29**(1.25)
Assets		-0.37***(0.08)	-0.39***(0.08)	-0.30***(0.10)
SlackResources		0(0)	0(0)	0(0)
SC Position		-1.11(1.53)	-1.48(1.55)	-2.10(1.74)
Quoted				44.55***(11.73)
Assets x Quoted				-2.80***(0.71)
SlackResources x Quoted				-0.00(0.02)
SlackResources x SC Position				-0.06***(0.02)
R^2	0	0,14	0,18	0.31
Adj.R^2	-0,01	0,12	0,14	0.25
Num.obs.	142	124	124	124

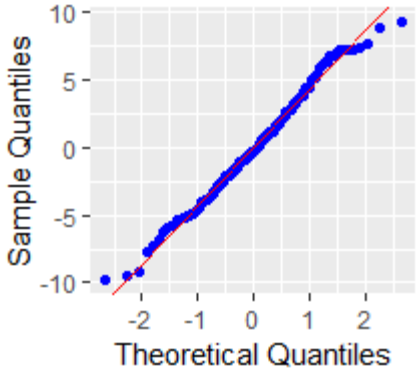
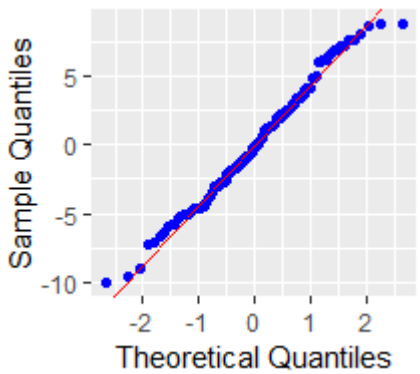
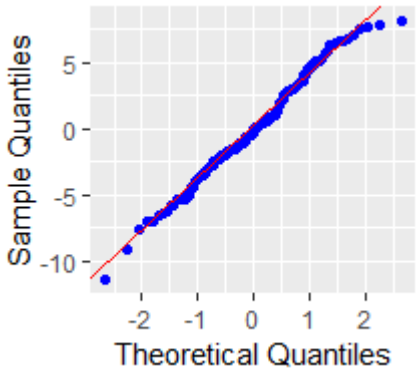
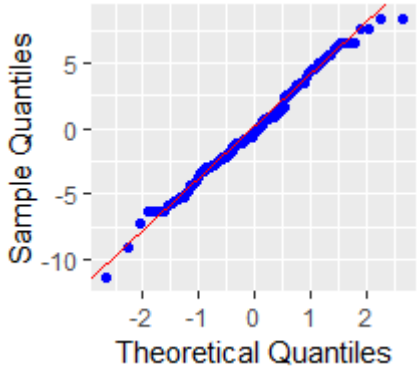
***p<0.01;**p<0.05;*p<0.1
Note: Unstandardized coefficients are shown. Standard errors are in brackets.

Williams et al. (2019) clarify that OLS estimation requires normally distributed error terms. We assessed the normality of the error terms quantitatively using the Shapiro-Wilks test and visually using Q-Q-plots (Table 15). These results show that the models' error terms are normally distributed, suggesting reliable estimates.

Table 15 Shapiro-Wilks test of error terms and corresponding Q-Q-plots

Basic Models	**Test statistics & Q-Q-plot: Employee models**	**Test statistics & Q-Q-plot: Asset models**
Control variable model	 SW:0.99 p-value: 0.35	 SW:0.99 p-value: 0.35
IV-only model	 SW:0.99 p-value: 0.44	 SW:0.99 p-value: 0.31
Base model	 SW:0.99 p-value: 0.38	 SW:0.99 p-value: 0.37

Interaction model	 SW:0.99 p-value: 0.29	 SW:0.99 p-value: 0.36
SC-deep-dive models	**Test statistics & Q-Q-plot: Employee models**	**Test statistics & Q-Q-plot: Asset models**
Control variable model	 SW:0.99 p-value: 0.35	 SW:0.99 p-value: 0.35
IV-only model	 SW:0.99 p-value: 0.63	 SW:0.99 p-value: 0.34

Base model	 SW:0.99 p-value: 0.43	 SW:0.99 p-value: 0.32
Interaction model	 SW:0.99 p-value: 0.41	 SW:0.99 p-value: 0.64

Note: SW= Shapiro-Wilk test statistic

Next, we check for multicollinearity. Variance inflation factors (VIFs) measure how much multicollinearity the independent variables bring into the model, that is, how much multicollinearity is caused by an individual independent variable. O'Brien (2007) argues that the typical threshold of VIF > 10 should be used with caution, especially for exploratory studies with small sample sizes. Only the interaction effect for being listed in a stock market causes concern (Tables 16 and 17). We elaborate on this topic in the limitations section.

Table 16 Assessment of variance inflation factors for the employee model

	Basic models				SC models			
	Control-variable model	IV-only model	Base model	Interaction model	Control-variable model	IV-only model	Base model	Interaction model
Diversification	1,01		1,01	1,03	1,01		1,04	1,06
EUorNot	1,01		1,05	1,11	1,01		1,06	1,17
Employees		1,00	1,03	2,76		1,04	1,06	2,32
SlackResources		1,00	1,00	33,51		1,01	1,02	1,22
SC Position						1,03	1,06	1,55
Quoted				19,93				64,25
Employees x Quoted				13,43				65,47
SlackResources x Quoted				35,59				1,20
SlackResources x SC Position								1,60

Table 17 Assessment of variance inflation factors for the asset model

	Basic models				SC models			
	Control-variable model	IV-only model	Base model	Interaction model	Control-variable model	IV-only model	Base model	Interaction model
Diversification	1,01		1,01	1,02	1,01		1,04	1,05
EUorNot	1,01		1,04	1,08	1,01		1,05	1,12
Assets		1,00	1,03	1,50		1,05	1,07	1,83
SlackResources		1,00	1,01	1,01		1,04	1,05	1,26
SC Position						1,01	1,05	1,53
Quoted				157,10				158,20
Assets x Quoted				155,67				158,61
SlackResources x Quoted				1,26				1,26
SlackResources x SC Position								1,60

To assess robustness further, we turned our attention to potential selection biases, as the EU Action Plan survey was filled out as "opt-in", i.e., voluntarily by the respective firms. Furthermore, Podsakoff et al. (2003) explain that non-anonymous survey responses are often biased for reasons related to social desirability and consistency. Accordingly, we recalculated each of the previous models using a Heckman selection model (Heckman, 1976, 1979).

Here, we introduce the Heckman model; outline the set-up of our selection model; describe the results of the Heckman outcome models, which are all based on

the same selection model, and compare them to our previous models' outcomes; and assess the robustness of the models' outcomes.

The Heckman selection model (Heckman, 1976, 1979) follows the idea that certain characteristics are common to the sample n but are not common in the overarching population N. Accordingly, Heckman (1976) formulates

$$y_i^* = x_i'\beta + \mu_i \qquad (1)$$

$$s_i^* = z_i'\gamma + \vartheta_i \qquad (2)$$

where y_i^* and s_i^* are unobserved latent variables, and x_i' and z_i' are vectors of the explanatory variables. Equation (1) describes the selection process, and Equation (2) is the model of research interest. Heckman proposes using a Probit model to describe the selection:

$$y_i = \begin{pmatrix} 1 \; if \; y_i^* > 0 \\ 0 \; if \; y_i^* \leq 0 \end{pmatrix} \qquad (3)$$

The Probit model yields the inverse Mills ratio $\lambda(\cdot) = \phi(\cdot)/\Phi(\cdot)$, which enters the outcome model to account for the selection bias (Koné, Bonfoh, Dao, Koné, & Fink, 2019; Toomet & Henningsen, 2008). The outcome model is a two-step set-up that is calculated with the OLS estimator.

The Heckman procedure also tests the MICE procedure for its consistency and robustness: Koné et al.'s (2019) simulation study shows that MICE procedures can yield biased estimates, while Heckman procedures yield unbiased estimates. In other words, the use a Heckman procedure is also an ex-post test for MICE procedures.

Our probit model regresses a binary "anonymity" variable on three variables: self-identification as a small or medium-sized enterprise (SME), diversification of business, and headquarters located in the EU. The data for the selection model consists of 210 observations (Table 18).

For these models, instead of log-transforming the size variables, we scaled all variables to make them standard normal. This common procedure, which is used to remedy skewed distributions, changes the interpretation of the coefficients, as changes are not in their initial units but in standard deviations (Kalnins, 2018).

Table 18 Correlation, standard deviations, and means for the Heckman model

	Mean	SD	CE_Support	Assets	Employees	SlackResources	EUorNot	Diversification	Quoted	SME
CE_Support	19,67	4,66								
Assets	9.035.060,76	19.712.316,74	-0.428 (p: 1e-04 ****) n=78							
Employees	18.633,87	38.892,40	-0.422 (p: 3e-04 ****) n=68	0.69 (p: 0 ****) n=71						
SlackResources	94,33	513,48	-0.013 (p: 0.9159) n=66	-0.068 (p: 0.5649) n=74	-0.058 (p: 0.6541) n=62					
EUorNot	0,89	0,31	0.1 (p: 0.1785) n=182	-0.137 (p: 0.197) n=90	-0.125 (p: 0.284) n=75	0.061 (p: 0.6045) n=74				
Diversification	1,53	1,19	-0.004 (p: 0.9584) n=182	-0.038 (p: 0.7241) n=90	0.146 (p: 0.2117) n=75	-0.002 (p: 0.9891) n=74	-0.163 (p: 0.0178 **) n=210			
Quoted	0,11	0,31	-0.194 (p: 0.0086 ***) n=182	0.484 (p: 0 ****) n=90	0.67 (p: 0 ****) n=75	-0.107 (p: 0.3659) n=74	-0.17 (p: 0.0137 **) n=210	-0.003 (p: 0.9607) n=210		
SME	0,52	0,50	0.335 (p: 0 ****) n=182	-0.403 (p: 1e-04 ****) n=90	-0.301 (p: 0.0088 ***) n=75	0.006 (p: 0.9603) n=74	0.151 (p: 0.029 **) n=210	-0.073 (p: 0.2905) n=210	-0.334 (p: 0 ****) n=210	
SC_Position	0,11	0,22	-0.001 (p: 0.9871) n=165	0.228 (p: 0.0348 **) n=86	0.368 (p: 0.0015 ***) n=72	-0.047 (p: 0.696) n=71	-0.092 (p: 0.2032) n=191	-0.087 (p: 0.2308) n=191	0.253 (p: 4e-04 ****) n=191	-0.102 (p: 0.1621) n=191

****p<0.001; ***p<0.01;**p<0.05;*p<0.1

The outcome models for Hypotheses 1, 2, 3, and 4 – number of employees or assets as proxies for firm size – are summarized in Tables 19 and 20. Tables 21 and 22 summarize the outcomes models that address Hypotheses 5 and 6.

Table 19 Outcome models for H1 (with number of employees) from the Heckman selection model

	Control-variable model	IV-only model	Base model	Interaction model
Intercept	-5.07(7.32)	-0.28(0.59)	-0.28(0.58)	-0.85(0.98)
Diversification	0(0.44)		0.20(0.18)	0.20(0.18)
EUorNot	-0.07(0.49)		-0.07(0.13)	-0.07(0.14)
Employees		-0.38***(0.12)	-0.41***(0.12)	-2.38(2.14)
SlackResources		-0.09(0.13)	-0.10(0.13)	1.07(1.44)
Quoted				0.89(0.76)
Employees x Quoted				0.68(0.76)
SlackResources x Quoted				3.26(4.10)
Inverse Mill's ratio	8.93(12.73)	0.15(0.69)	0.15(0.68)	0.00(0.76)
R^2	0.11	0.18	0.20	0.22
Adj. R^2	0.09	0.14	0.12	0.09
Num.obs	193	125	125	125

***p<0.01;**p<0.05;*p<0.1
Note: Standard errors are in brackets.

Table 20 Outcome models for H1 (with assets) from the Heckman selection model

	Control-variable model	IV-only model	Base model	Interaction model
Intercept	-5.07(7.32)	-0.58(0.80)	-0.53(0.79)	-0.53(0.88)
Diversification	0(0.44)		0.01(0.13)	0.03(0.13)
EUorNot	-0.07(0.49)		-0.10(0.13)	-0.12(0.14)
Assets		-0.39***(0.12)	-0.41***(0.12)	-0.14(0.17)
SlackResources		-0.04(0.11)	-0.04(0.11)	0.04(0.14)
Quoted				0.04(0.69)
Assets x Quoted				-0.17**(0.08)
SlackResources x Quoted				0.23(4.11)
Inverse Mill's ratio	8.93(12.73)	0.65(0.99)	0.59(0.97)	0.78(1.04)
R^2	0.11	0.19	0.20	0.26
Adj.R^2	0.09	0.15	0.13	0.16
Num.obs.	193	134	134	134

***p<0.01;**p<0.05;*p<0.1
Note: Standard errors are in brackets.

The results show consistent support for both proxies for the size variable in the base models. However, adding the quoted variable and the associated interaction terms

destabilizes the effect sizes and significance levels. We attribute these changes to the quoted variable, so we are confident in accepting Hypothesis 1 because of the identified effect and robustness.

As for Hypothesis 2, all models confirm that Hypothesis 2 cannot be accepted. It seems that slack resources and CE support are perfectly uncorrelated.

Adding the quoted variable to the model and measuring the hypothesized effects yield mixed results, as the effects are significant and in the hypothesized direction in both initial models, but the effects and standard errors in the asset model seem unusually high. This effect is present only in the non-Heckman model that uses assets for firm size. The Heckman models' effects are non-significant and have the usual standard errors, so we cannot accept with confidence Hypothesis 3's assertion. that a stock market listing moderates the negative relationship between firm size and support for CE regulation.

In all models, the effect proposed in Hypothesis 4 is non-significant, confirming that Hypothesis 4, which proposes that a stock market listing moderates the relationship between slack resources and CE regulation support, is not supported.

Table 21 Outcome models for H2 (with number of employees) from the Heckman selection model

	Control-variable model	IV-only model	Base model	Interaction model
Intercept	-5.07(7.32)	-1.49(0.92)	-1.49(0.92)	-1.45(1.50)
Diversification	0(0.44)		0.18(0.19)	0.20(0.19)
EUorNot	-0.07(0.49)		-0.06(0.13)	-0.06(0.14)
Employees		-0.39(0.12)	-0.41***(0.12)	-1.92(2.17)
SlackResources		-5.45(3.09)	-5.44(3.11)	-1.11(8.33)
SC Position		0.04(0.13)	0.05(0.13)	-1.17(0.50)
Quoted				1.21(0.82)
Employees x Quoted				0.51(0.77)
SlackResources x Quoted				5.33(4.30)
SlackResources x SC Position				-0.93(2.90)
Inverse Mill's ratio	8.92(12.73)	0.48(0.78)	0.48(0.77)	0.49(0.89)
R^2	0.11	0.22	0.24	0.27
Adj.R^2	0.09	0.16	0.14	0.10
Num.obs.	193	122	122	122

***p<0.01;**p<0.05;*p<0.1
Note: Standard errors are in brackets.

Table 22 Outcome models for H2 (with assets) from the Heckman selection model

	Control-variable model	IV-only model	Base model	Interaction model
Intercept	-5.07(7.32)	-0.62(0.93)	-0.54(0.91)	-1.09(1.16)
Diversification	0(0.44)		0(0.13)	0.04(0.15)
EUorNot	-0.07(0.49)		-0.15(0.13)	-0.11(0.16)
Assets		-0.49***(0.13)	-0.52***(0.13)	-0.28(0.33)
SlackResources		0.03(0.19)	0.04(0.19)	-0.14(1.54)
SC Position		-0.03(0.11)	-0.06(0.11)	-0.28*(0.15)
Quoted				0.39(0.74)
Assets x Quoted				-0.12(0.13)
SlackResources x Quoted				2.05(4.30)
SlackResources x SC Position				-1.79**(0.87)
Inverse Mill's ratio	8.92(12.73)	0.65(1.13)	0.56(1.10)	1.30(1.35)
R^2	0.11	0.24	0.26	0.32
Adj.R^2	0.09	0.19	0.19	0.19
Num.obs.	193	131	131	131

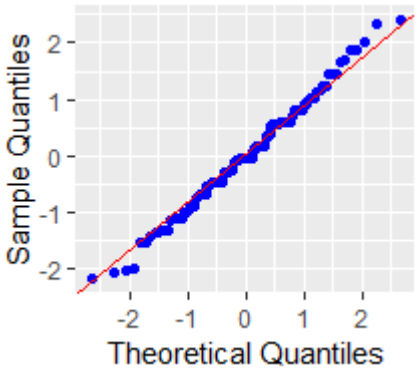
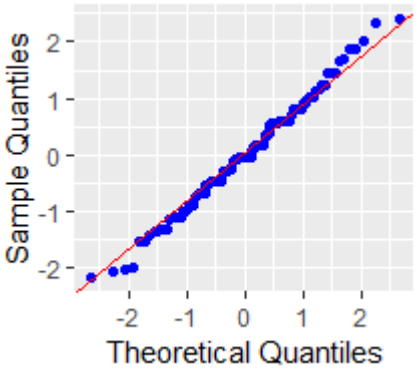
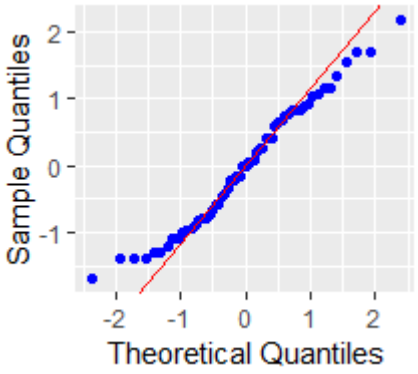
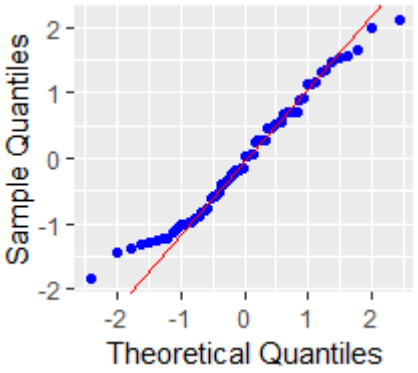
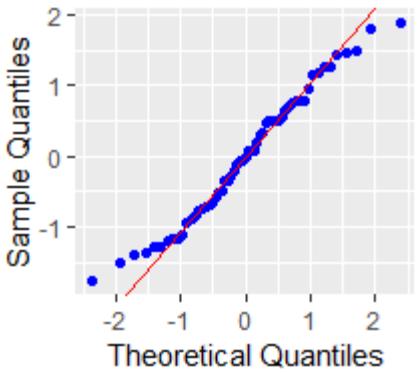
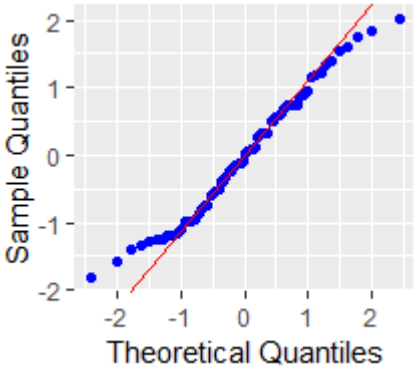
***p<0.01;**p<0.05;*p<0.1
Note: Standard errors are in brackets.

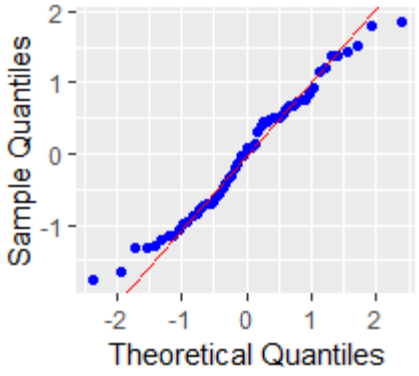
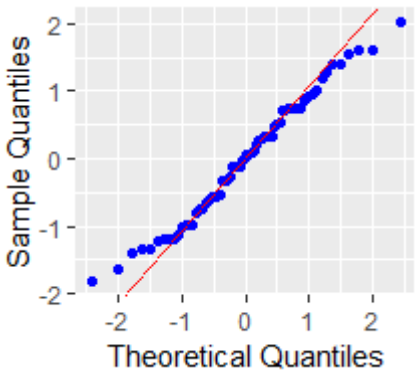
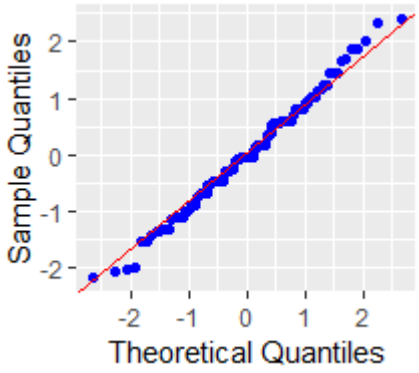
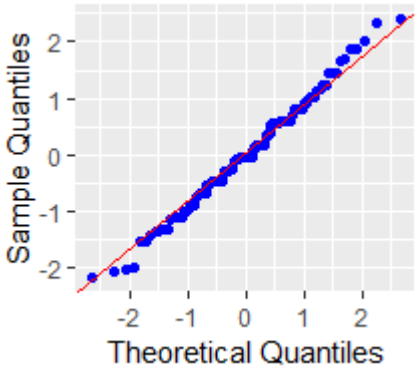
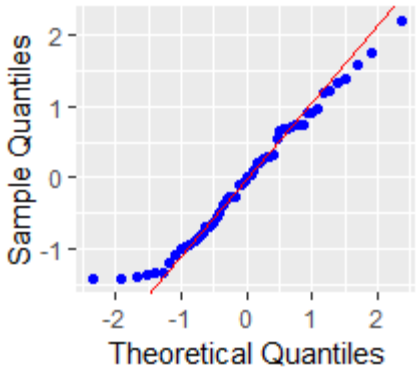
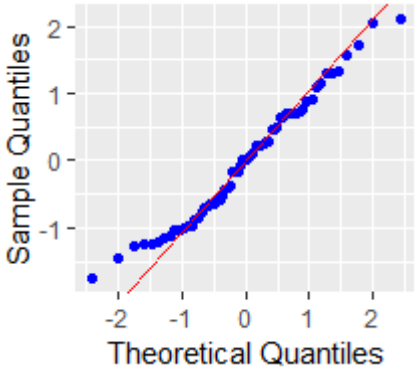
The effect of a firm's position in its SC on its support for CE is consistently non-significant. However, in the Heckman models, some of the effects change their signs, so Hypothesis 5 is not supported.

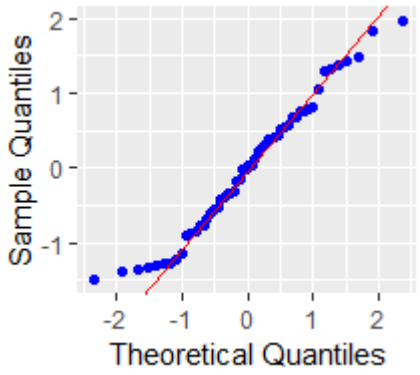
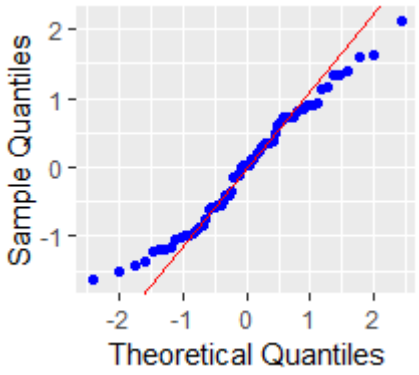
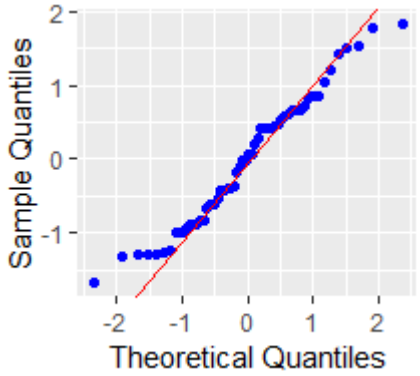
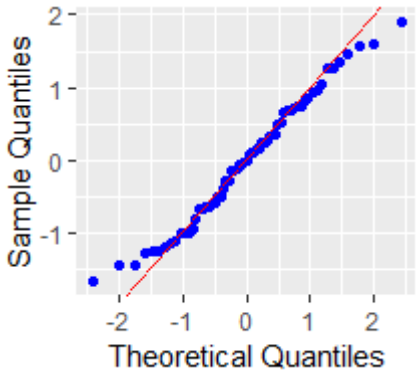
In both initial models, the moderation effect of the firm's position in its SC on the relationship between the firm's slack resources and its support for CE is negative and significant. The negative sign is also found consistently in the Heckman models, but in the Heckman model that uses the number of employees for firm size, the effect is non-significant and has a high standard error, possibly signaling measurement or model convergence issues. After this additional analysis, we feel more confident in identifying a counter-intuitive effect for Hypothesis 6's proposal that a more downstream position in a firm's SC increases the positive association between slack resources and support for CE regulation than we did after our initial analysis.

Finally, we checked the robustness of the robustness models themselves. As we used the OLS estimator, we validated the normal distribution assumption of the error terms by employing the Shapiro–Wilk test and visually inspecting the Q-Q plots. None of the tests is significant and the Q-Q plots look satisfactory (Table 23), providing confidence in our previous analyses.

Table 23 Q-Q-plots and Shapiro-Wilks tests of residuals for Heckman outcome models

Basic models	**Test statistics & Q-Q-plots: Number of employees**	**Test statistics & Q-Q-plots: Assets**
Control-variable model	 SW:0.99 p-value: 0.72	 SW:0.99 p-value: 0.72
IV-only model	 SW:0.97 p-value: 0.23	 SW:0.98 p-value: 0.22
Base model	 SW:0.97 p-value: 0.27	 SW:0.98 p-value: 0.28

Interaction model	 SW:0.98 p-value: 0.30	 SW:0.98 p-value: 0.48
SC Models	**Test statistics & Q-Q-plots: Number of employees**	**Test statistics & Q-Q-plots: Assets**
Control-variable model	 SW:0.99 p-value: 0.72	 SW:0.99 p-value: 0.72
IV-only model	 SW:0.97 p-value: 0.20	 SW:0.98 p-value: 0.23

Base model	 SW:0.97 p-value: 0.19	 SW:0.98 p-value: 0.23
Interaction model	 SW:0.97 p-value: 0.19	 SW:0.98 p-value: 0.23

Note: SW=Shapiro-Wilks statistic

4.6 Discussion

This research advances the CE literature by providing evidence of what drives firms' support of CE regulation. We contribute to the CE literature and also contextualize it with the RBV of the firm, which leads to insights into the firm's non-market behavior in the environmental sustainability context. Our research also provides practical contributions at the policy and firm levels that encourage a more systemic perspective of CE research.

We present three findings: First, we found evidence that smaller firms show stronger support for CE regulation than larger firms do. Second, while not significant throughout all models, we found evidence that a firm's being listed on the stock market is an antecedent of support for CE regulation and its influence as a moderating factor that increases smaller firms' support for CE regulation. Third, we presented counterintuitive findings that firms that are farther away from the consumer in their

SCs and that have high amounts of slack resources tend to have more support for CE regulation than do firms that have a position in their SCs that are closer to the consumer.

We discuss the theoretical and practical implications of these three findings in the next section.

4.6.1 Theoretical implications

Our first finding, that smaller firms show more support for CE regulation than large firms do, suggests that the theory that smaller organizations tend to be more agile than larger ones and expect higher pay-off from CE regulation, is supported (Conforto, Amaral, da Silva, Di Felippo, & Kamikawachi, 2016; Ismail, Poolton, & Sharifi, 2011; Shin et al., 2015). Thus, this finding contributes to the literature of agile organizations in the context of RBV and corporate environmental sustainability (Keivanpour et al., 2017; Kennard, 2020; Lopez et al., 2019). The finding is also of value since other research finds that larger firms, which tend to have more financial resources, tend to invest more in sustainability efforts than smaller firms do (Aranda-Usón, Portillo-Tarragona, Marín-Vinuesa, & Scarpellini, 2019; Bowen, 2002; Darnall, Henriques, & Sadorsky, 2010; Elsayed, 2006). Despite the "agile advantage" smaller firms have over potentially slower and larger firms, one could interpret smaller firms' stronger support for CE regulation as a way small firms can increase their access to funding that might enable them to invest in sustainability initiatives. However, firm size may stand for many firm aspects and hence investigating other potentially related variables, such as ownership structure, might be necessary to better understand this relationship.

Even though it is not significant in all robustness models, the moderation effect of a stock market listing on the relationship between firm size and support for CE regulation points to the importance of access to capital in the CE context. The identified direction of the (non-significant) effect contributes to the value of the RBV of the firm, as this result suggests that financial resources are vital in making the CE a reality in the private sector (Aranda-Usón et al., 2019). However, given the non-significant effect in the Heckman selection model, we should not overinterpret this effect.

The other significant moderation effect – that a more upstream position in the SC increases the positive association between slack resources and support for CE regulation – contributes to the intersection of the SC management literature, the slack resources literature, and the CPA literature in the CE context. This moderation effect is counterintuitive, as other studies find that a position in the SC that is closer to the

consumer tends to increase a firm's environmental welfare activity. Therefore, we understand that slack resources are only one contributor to a firm's support for CE regulation if the firm holds a more upstream position in its SC. While one could argue that firms that are positioned upstream would support CE regulation only if they have enough slack resources, we suggest that future research investigates this topic further before drawing conclusions. One reason could for example stem from the increasing compliance pressure of large corporations in the B2B context that forces companies (also those farther away from consumers) to increase sustainability standards.

We do not find support for Hypothesis 5, as we find no significant relationship between a downstream position in the SC and support for CE regulation. Bozarth, Warsing, Flynn, & Flynn (2009) provide a possible explanation in showing that the complexity of a SC is negatively associated with performance in a manufacturing plant, especially if the complexity is dynamic. Their results suggest that upstream complexity has a larger impact than downstream complexity and that firms that are closer to the end consumer will be impacted more by CE regulation because such regulation provides room to attack longer upstream SCs. A theoretical explanation for a null result could be that a paradigm change toward more sustainability (Geissdoerfer et al., 2017) is agnostic to position in a SC, so that position does not affect a firm's support for CE. Another explanation stems from the fact that firms tend to become more vertically integrated if they expect more extensive benefits (Lafontaine & Slade, 2007). These firms are positioned along the entire SC, so they cannot be located in just one position.

4.6.2 Practical implications

Our paper offers valuable insights for practitioners in policy-making and firm management. For policy-makers, our findings suggest that tailoring policies to specific firm sizes is a promising way to maximize adoption of and adherence to future CE regulation. These findings also have implications for how policy-makers engage and communicate with different types of firms. For example, while smaller firms may be intrigued by the idea of CE regulation, larger firms need additional targeted communication, especially because the environmental impact of large firms is generally higher than that of small firms. Hence, inviting large firms to policy discussions and proactively engaging them in policy-shaping can help to advance the adoption of CE principles.

Furthermore, even though the findings on the moderation effect of a stock market listing on the relationship between firm size and support for CE regulation

were not significant in all robustness models, our results should sensitize policy-makers to capital market structures' regulating effects (e.g., through ESG ratings). Hence, instead of targeting firms directly with regulation, another promising area of regulation and collaboration lies in stricter capital market ESG ratings (Howard-Grenville, 2021). Access to further funding on the capital markets (Cheng, Ioannou, & Serafeim, 2014) can motivate support for CE regulation firms' adoption of CE principles. These preliminary findings should also sensitize policy-makers to how they can target non-listed firms, as these firms' motivation for supporting CE activities might be lower, given that capital market ESG regulations do not give them incentive to do so.

Our paper also provides insights for managers as it may alert them regarding the potential impact of CPA in the CE context. The study may increase managers' awareness of how other firms position themselves regarding support for CE regulation, depending on their size. Having such awareness can bring managers valuable insights into a firm's competitive landscape and the potential market dynamics that may arise from CE regulations. Managers should also keep an eye open for further CE regulation and its potential impact on ESG ratings and access to capital, given that ESG ratings are an active field of policy regulation. Finally, we suggest that firms aim to be ahead of the curve by becoming more circular before regulation hits and they have advantages over late movers. This approach would also lead to earlier positive environmental outcomes.

4.7 Limitations and future research

Because of the data set and complexity of the research question, we discuss four limitations that lead to suggestions for future research. We also propose avenues for future research beyond these limitations.

First, issues related to the granularity of measurement of selected variables arise from using the NAICS codes for industry classification, as we cannot differentiate whether firms cater to customer segments with or without dedicated business units. Future research that can capture a more granular view on customer segments would be useful in challenging our results.

Second, the hierarchical regression framework does not confirm all of our hypothesized relationships. While no effect is possible, the finding of no effect could also mean that the method used was not sufficient. In addition, the CE concept needs to be addressed on various levels, from the level of the individual mindset to intra- and interfirm levels and global policy levels, which brings an extremely high level of

complexity to the research field. Accordingly, a method that can cope better with high complexity, such as fuzzy-set qualitative comparative analysis (fsQCA) (Fiss, 2011), might yield more evident results.

Third, some of the questions asked in the survey were not clear in showing participants how to interpret the scale. In particular, questions six and seven, which contributed to our CE support index, had ambiguous choices for participants: the position of "no opinion" and "neutral" was not explained to participants, as whether "no opinion" actually meant "no opinion" and should be excluded from the analysis or was somewhere in the middle of the scale was not clear. Future surveys should avoid such ambiguity by clearly showing the choices on a scale or using more precise formulations.

Finally, the VIFs of our moderation effects are beyond the threshold of 10. As Robinson and Schumacker (2009) show, centering has a major impact on VIFs, which would likely decrease our VIFs significantly, maybe even under the threshold. However, centering would change the interpretation of the variables from their natural units to standard deviations, and we decided to forgo this approach.

Beyond these limitations and implications for future research, we have suggestions for further qualitative and quantitative empirical research. In particular, we suggest investigating additional external factors, internal micro-foundations, and their relationship to firm performance as an outcome. Finally, we suggest applying our data set to additional research questions.

For example, given that this study deploys primarily the internally oriented RBV of the firm to formulate hypotheses, future research could also incorporate external factors like environmental dynamism and industry munificence as controls or potential moderators (Chan et al., 2016; Chen et al., 2017; Goll & Rasheed, 2004). To eventually achieve the Sustainable Development Goals, it is also quite relevant in today's environment to understand how the context of COVID-19 (Ibn-Mohammed et al., 2021; Khan et al., 2021) and external factors such as sustainability assessment (Popescu, 2020) have influenced firms' support for CE regulation in the EU.

Analyzing the micro-foundations for CE regulation support is also a promising future avenue for research. As research on CSR suggests, top management's orientation toward sustainability and a visionary approach are significant drivers of CSR (e.g., Aguinis and Glavas, 2012; Walls and Berrone, 2017). Managers' values and long-term orientation foster sustainable initiatives and pay off in the end (e.g., Lin et al., 2019). Indeed, when it comes to firm performance as an outcome variable, studies support the finding that it pays to be green (e.g., Ambec & Lanoie, 2008;

Burke & Logsdon, 1996). Accordingly, we also expect a positive relationship between a firm's support of CE regulation, an environmentally positive CPA (Mellahi et al., 2016), and various organizational performance indicators, at least in the long run.

Finally, the data set of public consultations and the derived indicator of support for CE regulation that are deployed in this study could also be used to test more common ESG indicators (Veenstra & Ellemers, 2020). As some of these indicators may be based on firms' potentially "greenwashed" sustainability reports (Wu, Zhang, & Xie, 2020), the CE regulation support indicator formed by the public consultation data set could challenge these indicators and point out potential discrepancies (Torelli, Balluchi, & Lazzini, 2020).

4.8 Conclusion

While our analysis can be considered only the beginning of a much-needed investigation into the intersection of CPA and CE, we believe that this analysis is critically important to stakeholders such as practitioners in policy-making and management, as well as academics. Our findings sensitize policy-makers to the need to design programs that are tailored to certain types of firms, such as firms of different sizes, firms with different positions in their SCs, and firms that have stock market listings.

Furthermore, the null findings regarding the direct relationship between slack resources and support for CE regulation and the significant moderation of a firm's position in its SC in terms of that relationship highlight the field's complexity in investigations of the interaction level of firms and policies. This result is also counterintuitive, as it contradicts the understanding that firms that are farther away from the end consumers tend to care less about CE regulation because of their relative invisibility.

In addition to discussing these theoretical and practical implications, we set out our paper's limitations and suggested a research agenda of factors that should be investigated to determine what drives a firm's support for CE regulation and what influences these relationships.

5 Discussion and concluding remarks

This thesis suggests that a multi-level understanding of circular business models, ecosystems, and firm-policy interactions is required in order to move towards a circular economy. The key finding of the three papers that make up the core of this thesis is that it is difficult to view these levels in isolation. Therefore, this thesis suggests taking a broader and holistic perspective to avoid neglecting the interactions between levels. While each publication has a specific focus, they each elaborate on the interfaces to adjacent levels and potential interaction effects. The goal of this chapter is not to repeat the discussion and conclusion of each of the papers, but to critically discuss the overarching insights in the categories of theoretical implications and avenues for future research (5.1) and practical implications (5.2). Section 5.3 discusses the thesis' limitations, and Section 5.4 concludes.

5.1 Theoretical implications and avenues for future research

The following sections describe the implications for theory and outline avenues for future research structured along the literature streams that are most relevant to this thesis: the circular economy literature (5.1.1), the business model literature (5.1.2), the ecosystems literature (5.1.3), and the corporate political activities literature (5.1.4).

5.1.1 Contributions to the circular economy literature

This thesis shows how a multi-level lens can help explain how circularity in firms may be established. While circular business models have been considered to have a systemic nature (Lüdeke-Freund et al., 2019), this systemic nature has not been explored in detail. Therefore, this thesis contributes to the circular economy literature by explaining a) what influences circular business models in its broader research framework, b) how circular ecosystems and the co-existence of business models contribute to circularity, and c) how specific company characteristics and contextual conditions may influence a company's stance on circular economy regulations. Especially the condensed knowledge that combines the circular business model with the ecosystem perspective helps to explain circularity as a collective outcome that requires collaboration across various stakeholders and levels (Konietzko et al., 2020; Leising et al., 2018). As the second paper (Chapter 3) summarizes and derives success factors for managing circular ecosystems, this thesis also explains how this knowledge can translate into action. While this systemic approach is only a starting point that will hopefully be followed by further research, it sheds first light on how the various

factors influence the creation and implementation of circular business models and ecosystems.

Future research could explore this multi-level perspective by analyzing the role of the end consumer in such a circular ecosystem (Gazzola, Pavione, Pezzetti, & Grechi, 2020; Singh & Giacosa, 2019). How should the circular ecosystem shape its concrete value proposition, and how should it be positioned (Aboulamer, 2018)? Researchers could also explore a process and activity perspective on the alignment and collaboration mechanisms for certain circular ecosystem subtypes (Elia et al., 2020): How should revenue and cost-sharing be organized to be fair? What is the best organizational design and governance structure for the different kind of set-ups? And what can the circular economy learn from the growing platform literature regarding effective coordination mechanisms (Kapoor et al., 2021)? In addition, future research could address how other theories, such as complexity theory and stakeholder theory, can enrich our understanding of circularity implementation on varying levels (Jakhar et al., 2019; Moggi & Dameri, 2021). Finally, future research could determine how to define the impact of circularity implementation in ecosystems, and which indicators have proven meaningful (Elia et al., 2017). While previous studies have touched on some of these questions, they represent promising avenues for more detailed research on what can make the circular economy a reality.

5.1.2 Contributions to business model literature

The broader business model literature has grown significantly (Foss & Saebi, 2016), as has the sub-literature on sustainable business models (Geissdoerfer et al., 2018b). Our derived research framework for circular business models and the critical assessment of its paradigmatic status contribute to another subtype of the sustainable business model literature. While scholars often criticize the broader business model literature for being atheoretical, the first paper (Chapter 2) at least connects circular business models to well-established theories, such as institutional theory, managerial cognition theory, and dynamic capabilities theory. The paper shows how not just one theory can explain such complex phenomena as circular business models. This thesis also contributes to the discussion on why the analysis of business models, especially those that aim at sustainability and circularity, should not take only the dominant, single-firm view (Evans et al., 2017b). Instead, especially Chapter 3, the review on circular ecosystems shows the importance of taking a more extensive view, beyond the firm's boundaries, to innovate, plan, and execute business models (Magnusson et al., 2019): This approach is critical, as in circular business models, various actors establish

circularity in complex value networks where multiple system elements may be interrelated (Zucchella & Previtali, 2019). However, when only a single-firm perspective is taken, many of these factors will remain unaddressed, even though they could be decisive for the success of a circular business model.

The extant research includes first case studies and evidence on circular business models and ecosystems, as well as the relevant interfaces between these two levels (e.g., Kanda, Geissdoerfer, & Hjelm, 2021), but these studies are scarce. The new frontier of circular business model research will include both more empirical work and conceptual studies. Through case studies, researchers can build a better understanding of how firms can implement the circular economy's principles in practice (Fraccascia, Giannoccaro, Agarwal, & Hansen, 2019). Quantitative empirical studies on the effectiveness of certain subtypes of circular business models and ecosystems in terms of environmental and firm performance should also be conducted to advance the strategy aspect of this discussion. Researchers should also carry out conceptual studies to find a common language and clear definitions of the circular business models and ecosystem level. Given the novelty of this multi-level and interaction research, terms and boundaries are still vague and carry the risk of having a confounding effect on the research landscape.

5.1.3 Contributions to the ecosystem literature

This thesis contributes to the ecosystems literature in the business context (Barnett, 2006; Iansiti & Levien, 2004) with less focus on other large literature streams for which the broader ecosystem perspective is also relevant, such as industrial symbiosis (Chertow, 2000, 2007), industrial ecology (Ashton, 2008; Ehrenfeld & Gertler, 1997), classical ecology, and biodiversity (Evers et al., 2018), and more (Seppanen, Hyrynsalmi, Manikas, & Suominen, 2017). The first and second paper of this thesis on circular business models and circular ecosystems respectively use ideas from the field of business ecosystems. By elaborating on the specific subtypes of circular ecosystems, the thesis contributes to the broader business ecosystem context by applying it to the circular economy context and by combining the two previously only lightly linked literature streams. For that purpose, the second paper (Chapter 3) discusses circular complementarities of products, services, and providers that together keep the value of material as high as possible (Shaw & Allen, 2018). Unlike the classical business ecosystem literature that typically focuses on the core business, Chapter 3 elaborates on how circular activities can occur at any point in the circular

loop, even for residual/side streams like resale production waste through a contractor or other partners (Geissdoerfer et al., 2017).

Future research could look at the empirical evidence of business ecosystems and their collaboration mechanisms and governance structures that enable circularity. While this thesis addresses some of the conceptual shortcomings of circular ecosystems, a significant research gap remains for in-depth case studies and the micro-foundations of circular management that can help those circular ecosystems thrive. Another research gap concerns the impact assessment of circular ecosystems. While indicators at the product/service level like life cycle assessment (Finnveden et al., 2009; Ghisellini et al., 2018) may be helpful, no coherent measurement of impact delivered in circular ecosystems has been developed yet. The dynamic processes and interactions that stem from many actors are difficult to measure (Boons & Bocken, 2017), and the overall effects on the environmental system often lack a systemic approach to monitoring and data-gathering.

5.1.4 Contributions to the corporate political activity literature

Finally, the interaction between firms and policies in the circular economy context is largely underexplored. The third paper (Chapter 4) seeks to identify the drivers of firms' support for circular economy regulation. The study finds that smaller firms show higher support for circular economy regulation and identifies a moderating effect of stock listings on this relationship. Furthermore, it also finds a significant negative moderating effect of the supply chain position of a firm on the relationship between slack resources and circular economy regulation support. Besides these results, the study finds several null findings, which may be explained by the highly complex nature of the interaction level between firms on the micro-level and policy-makers on the macro-level. Using standard regression frameworks may have difficulty in identifying clear effects because of the abundance of potentially relevant confounding factors that cannot be captured in such a model.

Nevertheless, since various governments and intergovernmental organizations plan to implement further environmental sustainability regulations, researchers should not abandon the field. Instead, future research could evaluate the influence of the lobbying mechanism as corporate political activity on corporate social responsibility activities. More concretely, future research could analyze the effects on competitive firm advantage and other performance factors when firms work with policy-makers to design environmental sustainability regulations. Investigating the motivations for this

behavior through in-depth case studies and interviews could reveal how organizational micro-foundations, such as management values or a joint vision, influence green policy-making.

5.2 Practical implications

Asking organizations to take a more holistic and integrated view of their circularity initiatives might seem complicated or abstract. Therefore, this section describes the practical implications and insights for practitioners derived from this thesis.

5.2.1 Integrated circular business model and ecosystem perspectives in management

To sustain their organizations in the long term, managers must face the harsh reality that resource scarcity has become the norm (Krautkraemer, 1998). Hence, it is in managers' best interest to grow their businesses independent of scarce resources and environmental constraints like global supply chain insecurities that are due to changing weather conditions and other circumstances. In addition, organizations have the societal responsibility to operate sustainably, to bring benefits to people, to the planet, and to profit (Elkington, 1998). Contributing to the circular economy is an extremely promising avenue for companies to deliver on all of these three responsibilities.

To embed circular economy principles in their business practices, managers can take a circular product/service approach, a circular business model lens, or a circular ecosystem lens. The potential of circularity (and the level of complexity) generally increases along these three dimensions. The next section describes the three dimensions along a highly simplified example of a bakery.

Starting on the product level often means that managers will take an incremental approach to implementing circularity, particularly when they are not familiar with the principles of a circular economy. In the case of a classical German bakery, this approach could mean using more locally grown superfood grains (e.g., linseeds) instead of international superfoods like chia seeds or goji berries, decreasing its negative environmental impact, as the transportation emissions for more locally sourced ingredients are lower. If the bakery wanted to go farther in its environmental sustainability ambitions (now entering the business model sphere), it may decide to offer a fully sustainably designed Sunday-breakfast-delivery service to its local customers. As all breakfast baskets would be delivered by one vehicle instead of

multiple people taking their cars to the bakery store, transportation-related emissions are reduced (when assuming that customers come by car instead of more sustainable transport options like bikes or public transport). The bakery could also establish a subscription model to ensure another source of stable income besides their in-store sales and to increase the predictability of demand. This initiative could also reduce the use of packaging material if the bakery works with refillable baskets or cloth bags that people hang out of their front doors on Saturday night so the delivery team can place the buns and croissants in them on Sunday morning. To implement this idea, the bakery would need to collaborate with a delivery service contractor and a supplier of reusable bread baskets/cloth bags (thereby entering the ecosystems sphere).

The ecosystem lens assists organizations in assessing whether their partner organizations are complementors that are relevant to one particular activity or orchestrators that may help manage the ecosystem in the future (Frishammar & Parida, 2019; Jacobides et al., 2018). Besides, the bakery could reduce its food waste by cooperating with platforms like *TooGoodToGo* (Too Good To Go, 2021), which connects restaurants, supermarkets, and other food providers with conscious consumers that buy the remaining food at reduced prices before it goes to waste. The side streams of manufacturing bread and other bakery products could be reintroduced into an agri-food loop by, for example, sending unsold items to a black soldier fly (*Hermetia illucens*) or a mealworm farm (*Tenebrio molitor*) to feed the insects (Taglieri et al., 2022). These insects then produce larvae that can be used to feed local farmers' animal stock, such as in sustainable poultry production (Dorper, Veldkamp, & Dicke, 2021), aquaculture (Zarantoniello et al., 2019), or even human consumption (Wang & Shelomi, 2017).

Through options like these even a small local bakery can contribute to the circular economy and reduce its disruptive impact on the environment significantly. As product/design choices might be comparatively easy to implement, this thesis provides guidance for managers on other relevant factors to consider when implementing a circular business model (Chapter 2) or a circular ecosystem (Chapter 3).

5.2.2 Challenges of the integrated perspective

Complementing the product/service lens with a business model and ecosystem lens increases the complexity of the many factors organizations must consider when working on circularity. Therefore, taking an integrated circular business model and ecosystem perspective does not come without its challenges. While the circular

initiatives of the bakery (discussed in the previous section) sound great in theory, things often get more complicated in practice. The next section describes some of these potential challenges using the bakery example: capabilities and innovation capacity (1), governance and collaboration mechanisms (2), business proposition and scalability (3), consumer acceptance (4), and regulatory hurdles (5).

Capabilities and innovation capacity (1): First, the bakery must have the capabilities to innovate, develop, and then execute such ideas, as well as the mindset for system leadership to drive that change (Senge, Hamilton, & Kania, 2015). Hence, talent and a well-established innovation process and culture are critical to begin the process but are not always given.

Governance and collaboration mechanisms (2): When working with contractors, such as those who would provide delivery services, the bakery faces the challenges of governance and collaboration mechanisms. How should the two companies align on risk-sharing if, for example, clients cancel their subscriptions and delivery becomes less profitable? Who is responsible for replacing the baskets or cloth bags if they break, and who bears the cost? Is the value creation and capture for all actors involved fair and transparent? As these questions show, transparency in governance and contract structures is key to aligning the actors' interests and eliminating the ecosystem's inherent uncertainties (Adner, 2017; Adner & Kapoor, 2010a). One promising (but still uncommon) avenue for solving some of these issues may be the blockchain technology and smart contracts that automatically trigger equitable sharing of revenues through earlier transparency (Narayan & Tidström, 2020). Furthermore, especially when collaboration occurs across sectors, such as if the bakery sends its unsold bakery goods to the insect farm for animal feedstock production, cross-sector governance must be well established with acceptable risk and revenue sharing in place (Heuer, 2011). For such scenarios, the bakery must, for example, determine with various other stakeholders who is in charge of setting up such a virtuous cycle in the first place and who orchestrates the consortium in the long-run (Selsky & Parker, 2005).

Business proposition and scalability (3): If only the bakery joins the circular insect-farm initiative, the farm may not scale sufficiently and may not represent a reliable business opportunity in a sustainable profit-making sense. In our bakery example with the insect farm, further challenges relate, among other aspects, to motivating other local food providers to give their unsold nutritional items to the insect farm and organizing a sustainable joint transportation.

Consumer acceptance (4): Consumer acceptance can be another challenge for circular offerings. In our example of the bakery and insect farm, the consumer is critical, as they must accept that poultry or fish will be fed with insects. At least in European consumer culture, insects are not yet common in the food industry, and it might take years for some consumers to accept it (Camacho-Otero et al., 2018). Even if consumers accept insect larvae as animal feed because of the positive environmental impacts balancing potential rebound effects (Schröder et al., 2019; Zink & Geyer, 2017) is another challenge that firms should be aware of. Consumers might feel so great about supporting a circular food system so that they might order more of these items than actually needed (potentially resulting in overall larger negative environmental impacts).

Regulatory hurdles (5): Finally, regulatory uncertainty can be a significant hurdle that may stop firms from engaging in circular initiatives. For example, in the food sector, regulations on *best before* dates are strict and often force supermarkets to discard food after that date even when the products are still good (Teigiserova, Hamelin, & Thomsen, 2020). Therefore, many firms might give up before even getting started in setting up such a circular ecosystem, as they must have both the innovative and legal capacity (e.g., as corporate political activity) to work hand-in-hand with policy-makers or to develop compliant workarounds.

To summarize, as the bakery example shows, difficult questions can arise when a firm sets up and engages in a circular business model and ecosystem. Therefore, managers must anticipate the coordination effort needed to establish them. Building an integrated circular business model in a circular ecosystem takes time and energy and relies on various success factors (Moktadir et al., 2020). Especially given that problems like resource scarcity are expected to increase even more together with the progressing climate change (Lenton et al., 2019), the earlier organizations start to engage in circular business models and ecosystem efforts, the better. Not only do such firms contribute to improved environmental outcomes (Adams et al., 2016; Ceschin & Gaziulusoy, 2016), they may also have a significant first-mover advantage when they identify the right partners, establish solid circular loops, and lock loyal customers into their new and innovative circular business models (Jabbour et al., 2020).

5.3 Limitations of the thesis

Each of the publications in this thesis has limitations, which are discussed in their respective discussion and conclusion sections. The main limitation of the first

paper (Chapter 2) is its unconventional research approach, which takes a broad perspective in reviewing several literature streams and theories for their value to the central circular business model concept. Typical research drills into just one aspect of the literature and theory and conducts highly detail-oriented research. However, because of the papers space constraints and design, such a deep level of detail for every theory and literature stream introduced is impracticable. The main limitation of the second paper (Chapter 3) stems from the focused review of the two core concepts of circular ecosystems, the circular economy and ecosystems research, as its evolutionary sources. It would have been beneficial to analyze other concepts, such as platform business models or theories like complexity or stakeholder theory for their value for circular ecosystem research, but doing so would have gone beyond the scope of this paper. The main limitation of the third paper (Chapter 4) stems from the limited data points available in the public consultation data set. Because of the nature of the consultation, we can look only at a snapshot in time and not time series data. Furthermore, the possibility of a self-selection bias in the sample cannot be dismissed.

Besides those chapter-specific limitations, the overall thesis has two primary limitations. First, because of the limited nature of any thesis, not all potentially relevant theories and literature streams for circularity implementation in firms can be covered. In the management domain, this thesis omits several literature streams that might be highly relevant to the field. For example, we did not include transition theory (Sarasini & Linder, 2018) even though its value in understanding the final implementation of the circular economy as a far-reaching societal transition may lead to useful insights. Another broad perspective not explicitly covered in this thesis is stakeholder theory (Donaldson & Preston, 1995), which could clarify the notion of circularity as a collective outcome. In addition, from a single firm level perspective, the broader organizational structure (Jacobides, 2007) and literature on the functioning of innovation system literature (Adner & Kapoor, 2010c; Oh, Phillips, Park, & Lee, 2016) were omitted, although they could help to explain the micro-level processes and structures that must be in place to make circularity more achievable on a firm level. In the broader sustainability domain, the thesis touches only lightly on literature streams like industrial ecology (Erkman, 1997) and even less on the environmental science perspective, although incorporating this perspective could help to explain circular ecosystems as a complex adaptive system, similar to nature (Phillips & Ritala, 2019).

Second, while the overall thesis takes a holistic view of circularity by using three lenses on circularity (business model, ecosystem, and firm-policy interactions), its insights concerning the interfaces between these lenses can only be considered a

starting point. Further multi-level research based on empirical work, such as case studies, was out of scope for this thesis but would be very useful in further research.

5.4 Conclusion

This thesis provides a holistic perspective on the circular economy for firms by offering three papers on the levels of business models, ecosystems, and firm-policy interactions. One paper (Pietrulla & Frankenberger, 2022) reviews the literature streams that are relevant to circular business models, creates an integrated and holistic framework for circular business models, and analyzes its academic status at the pre-paradigmatic level. The second paper (Pietrulla, 2022a) addresses the ecosystems level beyond organizational boundaries, providing insights into the concept of circular ecosystems by reviewing its evolution and suggesting a classification framework that may help practitioners and academics formulate their goals related to circular ecosystems. The third paper (Pietrulla, 2022b) incorporates a macro-level perspective and investigates firm-policy interactions by showing empirically what drives firms' support for circular economy regulation in the EU context. The overall conclusion of the thesis is that a multi-lens, multi-level, and multi-domain perspective is needed to advance both the research field and the practical implementation of the circular economy. Only when we embrace the complexity of our current economic and societal system with the various interrelationships between various stakeholders can circularity be explored meaningfully in research and then be practiced by organizations. With this thesis, I genuinely hope to have contributed to the circular economy research community and to organizational practitioners who are curious about how they can do their part in the transition to the circular economy.

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About the author

Felicitas Pietrulla

Felicitas was born in Karlsruhe *(*Baden-Württemberg, Germany) and was raised primarily in the rural wine region of *Südpfalz* near *Landau in der Pfalz*. After completing high school, Felicitas completed a six-month internship in the automotive sector in Beijing, China. Falling sick from the air pollution just after one month, she felt for the first time personally affected by the pollution caused by our current economic system. Besides her natural connection to nature from being raised in the countryside, this experience contributed to her interest in sustainability. Returning to Germany, Felicitas studied Political Science and Public Administration, focusing on International Relations to understand how nations can work together to achieve goals like environmental sustainability. After various exchange semesters and internships abroad in Dubai, Shanghai, Paris, Cambridge (Massachusetts), Lyon, and Budapest, Felicitas completed her B.A. and M.A. in Political Science and Public Administration. Still appreciative of the university and learning context, she went on to study business administration at the ESCP Europe. In completing her M.Sc. in Business Studies, Felicitas wrote her M.Sc. thesis on the circular economy and co-published a paper that has been cited more than 300 times to date (according to Google Scholar). She also wrote her M.A. thesis on pharmaceutical price regulation at Harvard University and published a paper. After completing her Master degrees, Felicitas worked on founding her own company in a German-Israeli Accelerator program briefly before joining the strategy consulting firm of McKinsey as a generalist consultant. Curious to learn more, she embarked on her Ph.D. journey at the University of St. Gallen at the Institute of Strategy and Management. This thesis records the majority of the output of this intense journey.