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An Exploratory Research into the Impact of Circular Economy on Enterprise Resilience

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EXECUTIVE SUMMARY

Increasingly complex and global supply chains have resulted in unpredictable disruptions spreading through economies and supply chains, think of COVID-19, the financial crisis or 9/11. In order to survive and thrive in such a dynamic environment, firms need to build resilience; the ability to survive, adapt and grow in the face of turbulent change. At the same time, there is an urgent need to transition towards a more sustainable, and circular way of doing business. It is therefore interesting to explore how circular economy (CE) can impact enterprise resilience, and to identify potential synergies. To this end, semi-structured interviews were conducted with 22 specialists on CE and/or resilience. Analysis of interviews combined with a thorough understanding of existing literature has resulted in a set of impacts CE can have on enterprise resilience.

CE is a regenerative system aimed at narrowing, slowing and closing material and energy loops through long-lasting design, repair, reuse, remanufacturing, refurbishing, and recycling of products and materials. The aim of CE is thus to keep materials at their highest possible value and in this way decouple economic growth from finite resource consumption. Resource scarcity and volatility in price, a long-identified threat to economies and businesses alike, can therefore be effectively mitigated by adopting a CE approach and can build resilience to shocks in the supply of virgin materials. This is no news, since organizations like the Ellen MacArthur Foundation have long regarded this as a source of resilience for businesses. However, this research has uncovered other possible interactions that have not yet been discussed.

An effective circular system that slows and closes loops is rarely formed by a single company, just as companies are rarely (or never) alone in a supply chain. More often a network of firms needs to work together in order to reconfigure existing supply chains and form closed loops. CE would therefore result in an interconnected web of material use where one firm’s waste can be another’s food and where close connections will need to be established to set up reverse logistics. Structurally, this raises concerns about interconnectedness, which is the source of unpredictability and uncertainty in economic systems. In this regard, a CE system is vulnerable to disturbance, and in order to survive and thrive in a dynamic and interconnected world, investments in resilient capabilities such as visibility, diversity, collaboration and flexibility would be required. And it intends to do so indeed. CE requires a thorough understanding of supply chains which would increase visibility, moreover, it also requires collaborative efforts between supply chain members for a successful implementation. These mutual benefits then can be a source of resilience, especially when compared to often invisible, complex and competitive supply chains seen today.

Additionally, stakeholders increasingly demand the consideration of environmental sustainability; a societal change that firms will need to adapt to. CE has potential to significantly advance the environmental sustainability of firms and therefore CE firms have the potential to form better stakeholder relations, which would provide access to informational resources of a broader network and increase enterprise resilience. Meanwhile, CE firms can also mitigate transition risks such as reputational damage, decreased demand and regulatory pressure.

At the same time, the transition to a more sustainable economy is not yet completed and effective legislation are still largely lacking, which often results in a competitive disadvantage for CE firms today. This can hurt their profitability, which is a prerequisite for a for-profit company to be resilient. Clearly, there are synergies but there are also trade-offs. By understanding the different interactions proposed by this thesis, managers can ensure that their ambitions towards CE and resilience can reinforce each other and enable a circular and resilient company. Even stronger, since more positive interactions than negative ones were found, this research could even convince linear firms aiming at resilience to consider CE as a way of achieving this goal.

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CHAPTER 1

INTRODUCTION

Both the concept of circular economy (CE) and enterprise resilience have gained increased attention in the last decade; CE because of the need to transition towards a more sustainable economy (Geissdoerfer, Savaget, Bocken, & Hultink, 2017); and resilience because the increasingly interconnected nature of our economy often results in turbulent change disrupting business-as-usual (Linnenluecke, 2017). These two trends together call for a sustainable and resilient way of doing business, which raises interest into possible synergies or trade-offs between the two concepts. And while the relationship between sustainability and resilience has been researched academically (e.g.: Fiksel, 2003; Marchese et al., 2018; Redman, 2014), CE and resilience have not yet been linked together.

That is academically. In so-called grey media, the two are more easily seen as a synergy. For example, the Ellen MacArthur Foundation (EMF), leading advocator and popularizer of CE, claims that CE can increase resilience of economic systems by reducing the use of virgin material and thus exposure to volatile prices and shocks in supply, for example due to natural disasters or geopolitical tumult (EMF, 2015). Following a similar argument, the World Economic Forum (WEF) recently published an article titled "To build a resilient world, we must go circular. Here's how to do it" (Ishii & van Houten, 2020). This thesis will uncover whether these claims are justified and explore other potential impacts of CE on resilience.

Since CE and resilience can both apply to systems at different scales, it is imperative to define the scope of the research by defining the system of interest. Arguably, macro-economic resilience is of greater societal interest, and will be discussed shortly during the literature review. However, since "overall resilience ultimately depends on the private sector's ability to adopt and profitably develop the relevant business models" (EMF, 2012b, p. 2), this thesis will focus on impacts of CE on the resilience of private companies, also referred to as enterprise resilience. Therefore, this thesis aims to answer the following research question: *what is the impact of CE on enterprise resilience?* Where enterprise resilience will be defined as the "capacity for an enterprise to survive, adapt and grow in the face of turbulent change" (Fiksel, 2006). And CE will be defined as "a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling." (Geissdoerfer et al., 2017, pp. 3). In order to form an answer

to the research question, a qualitative approach was used by interviewing CE and/or resilience specialists.

In the following section, I will provide an extensive literature review on both resilience, CE, and their interactions. The second section will comprise the methodology of this research. The third section will provide the findings of the research in the form of a set of 7 propositions, motivated by quotes obtained from interviews. Subsequently, the findings and the relative significance of the propositions will be discussed, as well as managerial implications and tracks for further research. And finally, a conclusion will summarize the most important insights.

CHAPTER 2

LITERATURE REVIEW

2.1 Resilience

To understand the concept of enterprise resilience, it is important to first review the origins and foundational ideas of resilience. This way a broader understanding of resilience as a system property will be generated, after which the concept will be applied to the enterprise.

2.1.1 Key ideas and origins

The term "resilience" gained popularity through the field of ecology and the work of C.S. Holling in the 1970's where it was used to describe the dynamics of ecological systems (e.g.: Folke et al., 2010). Resilience is essentially a systems property and can be applied to any system; a forest, a person, an organization, a country, the economy etc. Consequently, resilience lends itself to a number of interpretations in a wide variety of research fields ranging from natural sciences to engineering and social sciences.

Generally, there are two ways in which the notion of resilience can be defined (e.g. Folke et al., 2010; Frone, 2018; Meerow & Newell, 2015; Walker, Holling, Carpenter, & Kinzig, 2004). The first is so-called 'engineering resilience', which focuses on stability, resistance to shock, also called robustness, and the speed of return to the system's equilibrium state after disturbance. This equilibrium-focused definition of resilience has however limited applicability to systems that are dynamic and lack a single equilibrium such as social-ecological systems (Walker et al., 2004) and economic systems (Simmie & Martin, 2010). A second definition of resilience; so-called 'ecological resilience' is more applicable as it acknowledges the dynamic nature of systems by emphasizing adaptive capacity, alongside more static properties like robustness and speed of recovery (Fiksel, 2006).

This dynamic nature of systems can be described in the 'adaptive cycle' which is a conceptual model used to describe change in complex adaptive systems such as social-ecological systems (e.g.: Walker et al., 2004). The cycle passes through four phases known as exploitation, conservation, release and reorganization, where each phase is characterized by a different level of resilience. Even though the adaptive cycle is mainly used in socio-ecological literature, the original idea of the adaptive cycle came from economist Joseph Schumpeter who analyzed the economy's boom and bust cycles and coined the term 'creative destruction' to describe the process of industrial mutation that

constantly changes economic systems from within (Walker & Salt, 2006). When applied to economies, the adaptive cycle can be illustrated as follows (Simmie & Martin, 2010; Walker & Salt, 2006). During the exploitation phase, new technologies and knowledge create opportunities for entrepreneurs resulting in innovative start-ups. The economy is characterized by weak interconnectedness, high adaptive capacity and resilience. Gradually, opportunities disappear, growth slows, and competitive edge is increasingly obtained by boosting efficiency at the cost of flexibility. This is called the conservation phase, characterized by interconnected companies and established supply chains, which reduces responsiveness to external shocks. At this point, disturbance posed by new technology or a market shock can have major consequences and force an industry or economy to go into release phase where companies go bust, connections break and capital leaks out of the system. As a result, resources again become available and opportunities for innovation present themselves; the reorganization phase can now begin, and resilience re-emerges.

This conceptual model is widely used, but resilience scholars warn that is merely a descriptive model that is not absolute nor without limitations, for example, Walker & Salt (2006) emphasize that variations can occur, meaning that not every system goes through all of the phases, in that order. For example, an economic system could prevent release and destruction by generating reorganization at lower scales (Folke et al., 2010; Perrings, 1998), i.e. at the business level.

To understand the interaction between these different scales, the concept of panarchy was developed as an integrative theory (Gunderson & Holling, 2002). No system exists in isolation, rather systems function at different scales of time, space and social organization, and they influence each other through a nested hierarchical structure. Panarchy, named after Pan – the Greek god of nature who evokes unpredictable change, refers to the interaction between these systems at different scales, which is the source of change and disturbance. According to panarchy theory, systems at lower hierarchical scales are small and go through the different phases of the adaptive cycle at a relatively high pace. In contrast, higher, larger hierarchical levels change at a slower pace and are more stable (e.g. companies arise and bankrupt constantly while the global economy is relatively stable). It is these larger, more stable scales that set the conditions for the smaller scales to operate in, influencing them directly. At the same time, renewals in lower hierarchical scales result in adaptation at higher levels, increasing higher-scale resilience. This explains how an economic system can prevent release and maintain resilience through renewal at smaller scales.

Panarchy theory, and resilience, are very closely related to complex systems theory, where complexity emerges from interactions between individual components in

unexpected and nonlinear ways (Meerow & Newell, 2015). Indeed, if our economic system were not complex and self-organizing, there would be no unpredictability, no uncertainty and the notion of resilience would be uncalled for in economic and management literature. Even stronger, it is the increasingly connected and complex nature of our global economy that has raised uncertainty and unpredictability for its components, and with that, the need for enterprises to build in resilience (Annarelli & Nonino, 2016; Burnard & Bhamra, 2011).

2.1.2 Enterprise resilience

Resilience has been discussed in management science since its popularization in 1973, but it was not until more recently, since the global financial crisis of 2008, that the topic reached higher levels of academic publication (Annarelli & Nonino, 2016). The crisis indeed reminded us how vulnerable our economic system really is, including the economic agents composing that system. The increasingly connected and complex nature of our world has resulted in turbulent change and disruptions spreading throughout supply chains and global economies (Linnenluecke, 2017); think of geopolitical shocks, regulatory upheaval, 9/11, abrupt changes in consumer behavior, natural disasters etc. The current rise of COVID-19 is a perfect example of how a low-probability event can have a major impact on the daily life of millions of people and the survival of companies all over the world. To prepare for such black swans, rare events with severe consequences, traditional risk management, which identifies risks and accords a probability to their occurrence, often falls short as we are not able to identify all possible risks to an organization and the risk accorded to such events is often underestimated (Taleb, 2007; van der Vegt, Essens, Wahlström, & George, 2015). It is therefore more interesting to build resilience, a more general ability to deal with change and risk events when they occur, without necessarily knowing in advance what the change or risk event will entail.

In management literature, a multitude of definitions on resilience can be found, however systematic literature search has revealed that there is a consensus on its meaning (Annarelli & Nonino, 2016). Chosen for its simplicity and clarity, enterprise resilience in this thesis will be defined as the “capacity for an enterprise to survive, adapt and grow in the face of turbulent change” (Fiksel, 2006). Further, a distinction in this thesis will be made between specified resilience and general resilience, where specified resilience refers to resilience towards a specific and identifiable shock, whereas general resilience refers to the ability to respond to all kinds of shocks (Folke et al., 2010).

Before going into the constructs of enterprise resilience, it is important to re-emphasize that companies don’t exist in isolation, rather they are part of supply chains which are in turn part of larger industrial and economic systems, with these larger systems

representing the source of disturbance and change to a firm. It is because of the embeddedness of firms in complex and unpredictable supply chains (T. Y. Choi, Dooley, & Rungtusanatham, 2001; M. Allen, Priya Datta, & Christopher, 2006), that supply chain resilience has become the dominant subfield of organizational resilience research (Annarelli & Nonino, 2016). This perspective will also be the dominant one in this thesis; the enterprise as part of a supply chain network, embedded in our natural, social and economic ecosystem. As Christopher & Peck (2004) noted; "no organization is an island and even the most carefully controlled processes are only as good as the links and nodes that support them" (pp. 1). And also Sheffi & Rice (2005); "A company's resilience is a function of its competitive position and the responsiveness of its supply chain". Hence, attention must be given to the supply chain.

T. Pettit, Fiksel, & Croxton (2010) conceptualized in their highly cited paper that supply chain resilience should be seen as a balance between managerial capabilities at one end, and the inherent vulnerabilities of a supply chain dependent on the environment in which it operates on the other. The authors identified seven categories of vulnerability; 1) external pressures, such as innovation, social change, political change, environmental change; 2) connectivity, defined as the interdependence and reliance on outside entities; 3) resource limits, in raw materials, human resources or capacity; 4) sensitivity, i.e. the importance of carefully controlled conditions for manufacturing processes; 5) turbulence, representing change in external factors beyond your control; 6) susceptibility of suppliers/customers to disruptions; 7) deliberate threats like terrorism or theft.

Especially connectivity and external pressures were revealed to have strong effects on the vulnerability of a supply chain (T. J. Pettit, Croxton, & Fiksel, 2013). This is in line with the earlier discussed conceptual model of the adaptive cycle which posits that increased connectedness of a system, during the conservation and release phase, leads to lower resilience. Similarly, Craighead, Blackhurst, Rungtusanatham, & Handfield (2007) found that node criticality and complexity of a supply chain aggravate the effects of a supply chain disruption. Where node criticality refers to the increased importance of one node (i.e. company) relative to others within a supply chain, resulting in a higher dependence on this one firm; and complexity refers to the number of nodes and material flows between these nodes, also leading to increased dependence on various firms throughout the chain. It is this dependence on other entities, also referred to as connectivity or connectedness, that renders companies and their supply chain more vulnerable to disruptions (Craighead et al., 2007; T. Pettit et al., 2010; Rice Jr & Caniato, 2003; van der Vegt et al., 2015).

In order to balance this vulnerability, firms can either focus on redesigning their supply by decreasing dependence, however often not desirable or feasible, or they can focus on building management capabilities that restore and increase resilience (T. Pettit et al., 2010). There are many different conceptualized capabilities, sometimes also called formative elements or constructs of resilience, with most mentioned constructs being diversity, flexibility, visibility, collaboration and redundancy.

2.1.2.1 visibility

For one, having an understanding of the surrounding supply chain and having an insight in system dynamics is an important precedent of resilience (e.g.: Christopher & Peck, 2004; Perrings, 2006; Sargut & McGrath, 2011; Scholten, Scott, & Fynes, 2014). For example, being able to map out the different entities in the supply chain and understanding their relative importance and susceptibility for disruptions, can increase a firm's visibility considerably. Visibility, the knowledge on the identity, location and status of supply chain members (Jüttner & Maklan, 2011), builds resilience by enabling event readiness and preventing ineffective decisions in a risk event (Soni, Jain, & Kumar, 2014). The lack of understanding of the wide supply network is seen as a fundamental issue and is aggravated by thinking of supply chains as linear, while in reality they are more like trees, with branches and complex root systems (Christopher & Peck, 2004). In sum, visibility in supply networks is closely related to understanding system dynamics, it helps identify vulnerabilities, provides early warning and enables effective decisions during risk events.

2.1.2.2 Collaboration

The lack of visibility in supply networks is closely related to a lack of information exchange between entities in a supply network, and the isolated forecast-based decision-making that is often seen in organizations. Resilience scholars agree that a higher level of collaboration between supply chain members will be needed to identify and manage risk events, reduce uncertainty, increase event readiness, and finally, increase resilience (e.g.: T. Pettit et al., 2010; Scholten et al., 2014; Soni et al., 2014). Collaborative efforts may include synergies among partners, joint planning, information exchange, mutual benefit and risk sharing (Scholten & Schilder, 2015). Jüttner & Maklan (2011) called collaboration the "glue that holds supply chain organizations in a crisis together"; it is the level of collaboration that will decide whether a disruption is aggravated as a result of independent and opportunistic decision making or is alleviated through joint decision making and risk sharing. Similarly, Rice Jr & Caniato (2003) noted that deeper relationships need to be developed with suppliers and customers to co-create a more secure and resilient network. Chan, Wang, Luong, & Chan (2009) found that "a lack of trust and collaboration are main barriers to successfully introducing flexibility in the

supply chain". Ponomarov & Holcomb (2009) also concluded that the sharing of risks and rewards between members of a supply chain is key for resilience as it enables more effective decision-making under uncertainty. Finally, collaboration is found to be an antecedent of multiple constructs of resilience such as visibility, velocity (the speed at which an organization responds to a disruption), and flexibility (Scholten & Schilder, 2015).

2.1.2.3 Flexibility and Redundancy

Flexibility then, may be the most fundamental element of resilience (Burnard & Bhamra, 2011; Ponomarov & Holcomb, 2009; Sheffi & Rice, 2005), even though it is difficult to define and its origins are manifold. Nonetheless, there is a consensus that the ability to quickly process feedback, flexibly rearrange or transfer knowledge and resources to deal with situations, is critical in sensing threats and responding to them quickly (Sheffi & Rice, 2005). By investing in resources that can serve multiple purposes, organizations increase their capability to adapt quickly to new circumstances. Some researchers found that flexible capabilities can arise from the development of a multi-skilled workforce, avoiding rigid job descriptions and avoiding centralization of decision-making (Rice Jr & Caniato, 2003; Sutcliffe & Vogus, 2003; van der Vegt et al., 2015); by having somewhat informal working conditions, workers are empowered to take decisions themselves and can act quickly in face of a disturbance (Sheffi & Rice, 2005). Moreover, nurturing a multi-skilled workforce allows a certain diversity in responses available to a disruption, increasing the probability of a successful response. Other flexible capabilities can originate from designing production systems in a way that can accommodate multiple products and real-time changes, or from being able to switch suppliers quickly (Rice Jr & Caniato, 2003).

Redundancy is sometimes mentioned as an immediate element of resilience, other times mentioned as a contributor to flexibility. Redundancy refers to unused production capacity and inventory, or having redundant suppliers (Johnson, Elliott, & Drake, 2013; Rice Jr & Caniato, 2003). Having multiple suppliers can decrease dependence and therefore is a positive force of resilience, however Sheffi & Rice (2005) stress that cutting the number of suppliers, and deepening relationships with single suppliers is an equally resilient strategy. There is also an inevitable trade-off to be made between redundancy and efficiency, by balancing the cost coming from maintaining slack "just-in-case" with the probability and likely impact of a negative event (Christopher & Peck, 2004; Scholten et al., 2014).

2.1.2.4 Diversity

Finally, diversity can offer resilience in the sense that you shouldn't 'put all your eggs in the same basket'. Its adoption as a source of resilience comes mainly from the importance of biodiversity for the resilience of natural systems; no matter what particular future unfolds there will be at least some species fit for this environment (Perrings, 2006). A good exemplification of the importance of diversity for resilience in the context of business can be seen in asset portfolios; if you want to play safe and ensure that you don't lose all of your money, you usually choose to 'diversify' your investments. When one of your investments goes badly wrong, which is often extremely unpredictable, you still have the other investments that can buffer the effects and limit exposure to risks. To this end, Hamel & Liisa (2003) argue that companies should explore a wide range of strategic alternatives and make smaller bets in order to achieve what they call 'zero trauma' and strategic resilience. Others stress the importance of diversity of thought and employee capabilities (Sutcliffe & Vogus, 2003) and -as also mentioned as construct of flexibility and redundancy- having a variety of suppliers and/or facilities can increase resilience by being able to switch easily in case of disruption (Fiksel, 2006).

In conclusion, resilience is a dynamic property of systems. It is the ability to deal with -often unpredictable- change inherent to complex and dynamic systems such as our economic and ecological system. One system resilience applies to is the enterprise, which is a component in complex economic systems and is therefore often confronted with disturbance and external change. We have discussed what makes enterprises vulnerable to disturbance, with a focus on dependence on external entities, and we have also discussed capabilities that can balance vulnerabilities such as flexibility, collaboration, diversity, redundancy and visibility.

2.2 Circular economy

CE is a sustainability paradigm with the ultimate goal of decoupling economic growth from consumption of finite resources (Ghisellini, Cialani, & Ulgiati, 2016), presenting a solution to harmonize ambitions for economic growth and environmental protection (Lieder & Rashid, 2016). It is best understood as a direct counterreaction to our current linear take-make-waste economy that assumes unlimited reservoirs of resources and an endless sink for waste. Boulding (1966) refers to this as the cowboy economy; symbolic of illimitable plains and reckless behavior. Of course, the world's resources and waste sinks are not endless, rather, our planet is a closed system with the only input being energy from the sun. Therefore, Boulding proposed the spaceman economy, which views earth as a single spaceship "in which man must find his place in a cyclical ecological system which is capable of continuous reproduction of material" (pp. 7-8).

From this idea, alongside influences like the Performance Economy (Stahel, 2010), Cradle-to-Cradle (McDonough & Braungart, 2002), Biomimicry (Benyus, 1997) and Industrial Ecology, rose the umbrella concept of the Circular Economy (Blomsma & Brennan, 2017; Geissdoerfer et al., 2017; Ghisellini et al., 2016).

In an effort to solve issues like unsustainable resource management, and the lack of end-of-life considerations, CE predominantly seeks to extend resource life through strategies as long-lasting design, reuse, repair, remanufacturing, servitisation, refurbishing and recycling (Blomsma & Brennan, 2017; Ghisellini et al., 2016). These strategies have been regrouped by the EMF into four fundamental building blocks of CE: (1) Circular product design: supporting the capacity of a product and its components to be kept at their highest value through practices like repair, refurbishing and recycling; (2) New Business Models: especially those that prioritize access over ownership such as product-service systems (PSS), where manufacturers are incentivized to extend resource life and minimize energy usage as they keep the ownership over the product; (3) Reverse logistics: the recovery of used products and; (4) Enablers and favorable conditions: such as collaborative platforms across sectors, between businesses and policymakers and the development of a new economic framework (Bressanelli, Perona, & Saccani, 2018; EMF, 2015).

Before giving a definition of CE, it is important to note that the concept is still in a developing phase where CE can mean different things to different people and no universal definition exists; Blomsma & Brennan (2017) argue that CE is currently in a validity challenge period, characterized by critical engagement where critics mainly demand clearer distinctions between different life-extending strategies, and a better understanding of CE's relationship with social aspects of sustainability (Geissdoerfer et al., 2017).

The EMF defines CE as "an economy that is restorative and regenerative by design". Since this is quite a vague definition for the purpose of this thesis, a more comprehensive definition was chosen by a highly cited paper on the topic: CE is "a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling." (Geissdoerfer et al., 2017, pp. 3). The different business models pertaining to this definition were categorized by Bocken, de Pauw, Bakker, & van der Grinten (2016) and will be summarized hereafter. Slowing loops refers to the slowdown of the flow of resources by extending the utilization period of products. Business models for slowing loops are PSS that provide access over ownership and all business models aimed at extending product value through repair, remanufacturing, or

design for long-life. Closing loops refers to recycling and closing the gap between post-use and production, resulting in a circular flow of resources. Business models for closing loops include extending resource value by sourcing otherwise wasted materials and extracting residual value from products, or from waste outputs such as in an industrial symbiosis. Finally, narrowing loops is aimed at using fewer resources per product.

For the purpose of this thesis a CE firm or CE company respond to the definition described above. However, following Bocken et al. (2016), a company that only invests in narrowing loops will not be considered as a CE company since this approach focuses too much on eco-efficiency and doesn't take a systems approach to sustainability. The difference between these two approaches will be expanded on in the next section.

Nonetheless, that does not entail that one firm needs to respond to all activities described in the definition; Bressanelli et al. (2018) emphasize that it is uncommon for one company to have complete control over a supply chain aimed at CE. More often a network of partners is formed with each partner carrying out a different value chain activity where companies need to cooperate over the supply chain to achieve a more effective circular pattern (Ghisellini et al., 2016). For example, so-called "scavengers", "decomposers" or "gap-exploiters" will be necessary to extract resources out of waste and redistribute these towards companies that can reuse or recycle such materials (Bocken et al., 2016; Ghisellini et al., 2016).

Finally, it is interesting to review a number of challenges found by academics with respect to implementing CE at the enterprise level. For one, challenges in implementing reverse logistics due to uncertainty about product retrieval have been widely acknowledged. At the same time, servitised business models with long-term contracts are seen as a potential solution (Bressanelli et al., 2018; Linder & Williander, 2017). Moreover, it has been found that to successfully implement reverse logistics, communication and information sharing will be necessary, which is seen as a challenge as willingness to share strategic and tactical data is sometimes not feasible or desirable (Huscroft, Hazen, Hall, Skipper, & Hanna, 2013). Further, lack of effective legislation supporting CE, lack of technological know-how and a lack of necessary capital have been identified as barriers to adopting circular initiatives at enterprise level (Rizos et al., 2016). To stimulate know-how, collaboration and partnerships among supply chain actors have been proposed as potential solutions (Bressanelli et al., 2018). Clearly there are challenges to CE, but there are many solutions as well.

To sum up, CE is ultimately a system aimed at environmental sustainability through a focus on resource and waste management. CE is more specific than sustainability

(Geissdoerfer et al., 2017) and only received broad academic attention very recently comparatively. Sustainability on the other hand has been more extensively researched and has therefore also been linked more often with resilience theory.

2.3 CE and resilience

Sustainability -the triple bottom line of environmental, social and economic considerations- and resilience have often been compared in a search to find possible synergies or trade-offs. Both concepts are system properties, both relate to global political events and therefore they often have overlapping goals and application areas (Marchese et al., 2018). The relation between CE, as a specific sustainability paradigm, and resilience is no different, yet has to a much lesser extent been researched in academic literature. In the following section, an overview will be provided of how sustainability, CE and resilience have been related in both academic literature and so-called grey literature, for example from non-government institutions or government agencies. Further, since CE and resilience both relate to systems at different scales of society, a distinction is made between the macro-level and the micro-level.

2.3.1. Differences and commonalities

The commonality between sustainability and resilience is twofold; first, both concepts emphasize the importance of understanding system dynamics (Fiksel, Goodman, & Hecht, 2014; Redman, 2014), and second, both value diverse perspectives, collaborating with other disciplines and engaging stakeholders to develop shared understanding (Redman, 2014). This commonality stems from the fact that both concepts gain their inspiration from nature and ecology. For resilience, it was the realization that systems designed by humans are vulnerable to natural disasters, technological failures and other disruptions, when compared to living systems that are remarkably capable of recovering from severe damage. This has inspired scholars to study nature for resilient systems design (Fiksel et al., 2014). Circular Economy similarly has roots in fields of study aiming to design industrial or economic systems in a way that mimics or reflects natural flows, such as through the fields of Industrial Ecology and Biomimicry (Blomsma & Brennan, 2017; Geissdoerfer et al., 2017; Ghisellini et al., 2016).

Literature review on resilience has revealed the importance of systems dynamics for the concept, but not enough attention has been given to CE and system dynamics. CE has immediate roots in General Systems Theory and systems thinking (Ghisellini et al., 2016; Ripanti & Tjahjono, 2019), calling for an understanding of the interrelationships between elements, rather than studying elements in isolation. Especially referring to an understanding that our ecological system and economic system are closely interrelated through feedback loops and interactions between stocks and flows of resources like

materials, money, knowledge and energy (Heinrich & Jamsin, 2017). Designing a sustainable system, such as a company, therefore requires understanding the interactions with our ecological and economic system and looking beyond the boundaries of the firm. A shared understanding between resilience and CE can thus be identified: companies do not exist in isolation, rather they are closely embedded in economic and ecological systems. CE's roots in systems thinking is also the reason why resilience is sometimes mentioned as a value of CE (Ripanti & Tjahjono, 2019).

The main difference between sustainability and resilience is that sustainability prioritizes outcomes while resilience prioritizes process; sustainability is about achieving positive social, environmental and economic outcomes, while resilience is about being flexible and adapting to a changing world. Being resilient can thus be the goal of a company or economic system, but it cannot aim at a certain outcome, it is merely a property of the system. Sustainability on the other hand can be the desired long-term outcome of a system.

Now that we have discussed more general commonalities and differences between sustainability, CE and resilience, it will be necessary to make a distinction between resilience at a macro-scale and at micro-scale.

2.3.2 Macro-economic level

Arguably, the most important relation between CE and resilience is situated on the macro-level; the resilience of our social and economic systems. Farley & Voinov (2016) point out that the central economic challenge for sustainability is to maintain the resilience of our current socio-ecological regime by reducing the impact of economic activities on our ecosystem and keeping distance to critical social and ecological thresholds. Whether CE can increase resilience and ensure continuity of our current socio-ecological regime consequently would depend on whether it achieves to be sustainable, and whether it could truly decouple economic growth from environmental pressures.

Throughout academic literature, many sustainability scientists agree that radical improvements in environmental sustainability can be achieved through a rearrangement of linear material flows into cyclical ones (Geissdoerfer et al., 2017). However, critics of CE question the extent to which CE is able to take us further from critical thresholds. The so-called rebound effect predicts that when efficiency in production and material use goes up, production costs will lower, consumption will rise, and economic growth could offset the initial environmental gains (Korhonen, Honkasalo, & Seppälä, 2018; Mayumi, Giampietro, & Gowdy, 1998). Hobson & Lynch (2016) similarly argue that CE fails to address the root problem of overconsumption. This is why a number of

sustainability advocators have called for more inclusion of social aspects in the vision of CE to form a more holistic approach to sustainability (Blomsma & Brennan, 2017; Geissdoerfer et al., 2017; Hobson & Lynch, 2016; Planing, 2014; Stockholm Resilience Center, 2016). As mentioned before, CE is now in a validity challenge period, meaning there is no academic consensus as to the contribution of CE to sustainability, and therefore no consensus on impacts on resilience of our current socio-ecological regime, including our economic system.

Meanwhile, gray media are more convinced in the resilience-increasing effects of CE. The World Economic Forum (WEF), an international organization for public-private cooperation, has recently published an article with title "To build a resilient world, we must go circular. Here's how to do it" (Ishii & van Houten, 2020). In this article the WEF argue that disruptions in the flow of resources leave our economic system exposed to "huge economic shocks", uncovering the need to reduce dependence on primary raw materials and build robustness to shocks in their supply, a promise made by CE. Additionally, the WEF argues that CE can effectively mitigate climate change by reducing greenhouse gas emissions, up to 45% according to this article, which adds to resilience as well by keeping away from critical ecological thresholds.

Likewise, the Ellen MacArthur foundation is convinced that CE will contribute to resilience; "the circular approach offers developed economies an avenue to resilient growth, a systemic answer to reducing dependency on resource markets, and a means to reduce exposure to resource price shocks as well as societal and environmental 'external' costs that are not picked up by companies" (EMF, 2012b, p.68). Adding to the significance of this, decoupling economic growth from primary raw materials is viewed as a source of strategic resilience for the EU, which is currently very dependent on foreign supplies of resources; "Access to resources is a strategic security question for Europe's ambition to deliver the Green Deal. Ensuring the supply of sustainable raw materials, especially critical raw materials necessary for clean technologies, digital, space and defense applications, by diversifying supply from both primary and secondary sources, is therefore one of the pre-requisites to make this transition happen."(European Commission, 2019, p.8). Clearly, from a macro-economic perspective it is imperative that we understand the risks posed by resource availability. CE offers a clear solution to decrease dependency on primary raw materials with concepts as slowing and closing loops.

To sum up, from a macro perspective, CE aims to contribute to the resilience of our current socio-ecological regime and economic systems by decoupling economic activity from resource extraction, and by reducing exposure to climate risks. However, whether it can succeed in this has no consensus in academic debate. Especially because of the

weak, almost non-existent link with social sustainability, it is difficult to predict macro-economic resilience of CE systems.

2.3.3 Micro-economic level

This thesis will from now on focus solely on enterprise resilience. After all, "success in increasing our overall resilience ultimately depends on the private sector's ability to adopt and profitably develop the relevant new business models" (EMF, 2012b, pp. 3). Enterprise resilience, the extended survival of a firm, is not necessarily a societal or macro-economic goal of CE, however it is interesting to research the relation as it could be a motivator for businesses to shift towards a more circular business model, a necessary shift for CE to become reality. Moreover, as we have seen with panarchy theory, transformational changes at smaller scales (businesses) can enable resilience at larger scales (our economic system) (Folke et al., 2010; Perrings, 1998).

So now the literature on the research question 'what are the impacts of CE on enterprise resilience' can be addressed. According to the EMF (2019) CE can increase the resilience of firms thanks to a reduction in risk posed by disruption in production because of shortages in key inputs. The basis of this argument is that the consumption of raw materials is vulnerable to disruptions originating from scarcity, political instability and effects of climate change in supplying regions. Meanwhile, adopting circular principles like reusing, remanufacturing and recycling can provide businesses with a more diverse and flexible supply, sourced from customers. This will consequently reduce and redistribute risks of climate-related disruptions along supply chains. Nonetheless, the EMF emphasizes that the impact on resilience "is context-specific since climate risks and vulnerability vary greatly by industry, geography, and socio-economic context" (p. 45).

CE can also provide protection from other climate-related risks, more specifically, transition risks. BSR, a global nonprofit network and consultancy dedicated to sustainability, found that supply chains and companies increasingly face risks related to the transition to a low-GHG economy (Wei & Chase, 2018). More specifically so-called transition risks can include policy and legal risks, market risks originating from shifts in customer preferences, and reputational risks. By switching to a sustainable business model, such as a circular one, businesses can mitigate these transition risks.

Apart from reduction of risks, a more positive impact CE could have on resilience is enabled by the trust that is created between sustainable firms and stakeholders at different levels of society. DesJardine, Bansal & Yang (2019) found a significant positive relationship between having a SEP strategy (Social and Environmental Practices) and being resilient to external shocks. The reason for this is that SEPs create

interdependencies with the macrolevel social and environmental systems by responding to stakeholders' needs and conforming to regulators' wishes. These interdependencies with diverse actors then foster flexibility in the organization through the accumulated creativity of different perspectives. Ortiz-de-Mandojana & Bansal (2016) similarly found that SEPs "help firms sense and seize long-term opportunities and mitigate threats, which contributes to their resilience" (p.1). The conceptualized reason for this is the increased willingness of stakeholders to share information about emerging issues with a firm that responds to their needs. These results were found by matching 121 corporations without SEPs with 121 corporations with high SEPs and then observing their performance over 15 years. The SEP-firms experienced higher long-term growth with less financial volatility, which shows that SEPs provide a buffer to shocks and thus are a source of resilience for a company. The central argument here is that caring about social and environmental issues creates trust, which is an important precedent of valuable connections with different actors and which is in its turn a source of resilience (Johnson et al., 2013; Soni et al., 2014).

On the negative side, some scholars with ecological backgrounds in resilience have warned for potential trade-offs between resilience and application of sustainability practices. Walker & Salt (2006) posit that sustainability is often too focused on being efficient with resources, even if efficiency will always be an important part of any approach to sustainability. They say the danger lies in optimizing certain values at the expense of others which can lead to vulnerability to change and disturbance if the dynamics of the larger system are not truly understood. For example, resilience scholars have found that the concept of 'eco-efficiency' at enterprise level can degrade their resilience (Korhonen & Seager, 2008; Walker & Salt, 2006). The aim of eco-efficiency is to minimize linear material flows such as waste, pollution and resource use, and is sometimes coined as a strategy of doing "less bad" (EMF, 2012a). This optimization has a tendency to reduce spare capacity, diversity or flexibility and with that, ways to adapt to changing circumstances. Instead of optimization of internal processes, a deeper understanding of surrounding systems, and consideration of diversity, flexibility and cohesion, can help sustainability to embrace uncertainty rather than attempting to eliminate it (Fiksel, 2003). CE, fortunately, does not endorse the popular notion of eco-efficiency, rather it promotes systems thinking and eco-effectiveness through cyclical flows where materials are kept at their highest value (EMF, 2012a; Ripanti & Tjahjono, 2019). This is also why narrowing loops is not enough in itself to be a circular firm, it needs to be complemented with a strategy of slowing or closing loops which requires a systems approach, and thus is more in line with resilience theory.

Michael Braungart, author of best-selling book cradle to cradle, uses the example of a cherry tree to denote the difference between eco-efficiency and eco-effectiveness; a single cherry tree produces thousands of cherry blossoms every spring, yet only a happy few will make it as a new cherry tree, while the vast majority of them will fall on the ground and rot. When looking at this from a management perspective, this process seems incredibly inefficient, yet when we look at it from a wider systems perspective it becomes clear that this 'waste' is necessary for micro-organisms and nourishment of the soil in order to support future plant life and the overall ecosystem. Sustainable companies then, instead of minimizing their waste, could find mutual benefits with other industries and create a more effective overall system. The key conclusion being that CE does not try to eliminate waste or produce zero emissions, but instead focuses on resource quality and productivity over multiple life cycles (Braungart, 2007).

In conclusion, CE and resilience both have roots in system thinking and gain inspiration from ecological systems. On the macro-economic level, CE aims to increase resilience by decoupling economic growth from the consumption of finite resources. And on the micro-economic level, decreased dependency on raw materials similarly can be a source of enterprises resilience. Moreover, by establishing trust with stakeholders, enterprises could mitigate transition risks and increase their ability to sense threats and recover quickly. Finally, by focusing attention on eco-effectiveness rather than eco-efficiency, CE addresses a trade-off between resilience and sustainability.

CHAPTER 3

METHODOLOGY

In this section the methodology that was used to respond to the research question 'what is the impact of CE on enterprise resilience?' will be discussed. First, an extensive review of the literature was done on both CE and resilience. From the literature, four possible effects of CE on enterprise resilience were identified;
H1: resilience to shocks in supply of primary raw materials increases because of decreased dependency on those materials;
H2: CE could result in more vulnerable supply chains because of increased connectivity and interdependence;
H3: CE could result in decreased flexibility because multiple lifecycles of products need to be considered;
H4: Capabilities linked to CE such as collaboration could counteract negative effects on resilience;
H5: CE allows firms to establish trust with stakeholders, which can increase enterprise resilience.

In order to test the validity of these hypothesized relationships on one hand, and to explore other possible relationships between the two concepts on the other hand, semi-structured interviews were conducted. The choice for a qualitative research method is justified in two ways. First, the exploratory nature of the research question and second, CE is still more a vision than a reality; there are firms embracing circularity, but truly circular and closed-loop systems are not yet widespread, which renders quantitative methods unfit.

The interviewees were selected on their knowledge of circular economy and/or resilience and based on their experience with practical CE implementations. In selecting the interviewees, attention was directed to include diversity of perspectives and a diversity of CE implementations (business models). To this end I interviewed civil servants specialized in CE, researchers specialized in CE and/or resilience, and managers at companies with a CE strategy. In total, 22 interviews were conducted with an average length between 30 and 45 minutes. All interviews were subsequently transcribed and analyzed.

The questions asked in the interview were semi-structured around the following initial categories; supply chain complexity, flexibility, collaboration, operational risks, resource-dependency, diversity. Over the course of the interviews, some categories were added as new insights emerged. Additionally, depending on the specialty of the interviewee, some categories were omitted from discussion while others were expanded upon. Independent of the interviewee's specialty, interviewees were asked what they thought the impact was of adopting a circular business strategy on the resilience of a company to allow exploration of interactions between resilience and CE.

Subsequently, interviews were thoroughly analyzed in multiple phases. In a first phase, a good understanding of the content was formed through manual subscription. Second, by summarizing insights and responses in separate word documents, a better understanding was formed on commonalities and differences between interview responses. And third, all interviews were color coded to enable comparisons and conclusions per hypothesized relationship. The color-coded transcriptions can be found in the annex of this thesis, alongside the list of interviewed people and their respective jobs and workplaces.

Finally, by combining literature and qualitative interview data, a set of propositions was formed that describe the different impacts of CE on enterprise resilience. They are called propositions because they are largely conceptual and untested as CE is not yet implemented on a large scale and effects of CE are therefore still ambiguous.

CHAPTER 4

FINDINGS

4.1 CE as an alternative to resource extraction

The main reason for the concept of CE to exist is because there are limits to the world's supply of non-renewable resources, raising a need for responsible management of resources (Blomsma & Brennan, 2017). Concerns and debate on the likelihood of resource depletion emerged during the last century, with the book "limits to growth" (Meadows et al., 1972) as a well-known example. Fueled by population growth and economic development, demand for raw materials (RM) is increasing and has marked security of supply of RM as a high priority on the agenda of the EU, especially since the EU is dependent on other continents for the supply of these materials (Mancini, De Camillis, & Pennington, 2013). Natural resource scarcity is also widely acknowledged to pose risks to supply chains if managers don't address this trend. To this end "closed-loop supply chain management will be increasingly viewed as a strategic capability" and a source of competitive advantage in an environment of scarce natural resources (Bell, Mollenkopf, & Stolze, 2013, p.9).

By slowing and closing material loops, CE provides a solution to mitigate risks attached to consumption of finite resources, more specifically, through end-of-life processes like recovering, reusing, refurbishing and recycling materials. Central to the idea of CE is thus to be less dependent on virgin materials, and the consequence for circular companies is that this makes them more resilient to shocks in supply of that particular input, either in terms of price volatility or unavailability. Therefore, in line with prior "grey literature" studies of the EMF (EMF, 2015, 2019), we propose that;

P1. CE companies are less dependent on primary raw materials which results in increased resilience to shocks in supply of those materials.

In contrast to general enterprise resilience, this is a case of specified resilience, referring to the resilience towards a specific shock, i.e. supply shocks in raw materials. Whether this increase in specified resilience is a significant source of general resilience is therefore inherently questionable. Analyzing interviews has uncovered that resilience to RM supply shocks may not be very significant to the general resilience of a firm today, however its significance is likely to increase in the near future.

> *[decreased dependency on raw materials] is a really good incentive in the longer term and that's maybe the difficulty… I'm pretty sure that there is a big advantage to companies that are circular now to be sure that they are ready for the coming years. But if I have to say what the biggest driver is for companies to think about CE, it's not yet about resources, it's more about consumers and the internal forces like workers that are striving to be part of the solution. (A. Naralingom, personal communication, February 26, 2020)*

Responses from interviews, such as this one, indicate that scarcity and volatility of raw materials are not significant drivers for circularity yet, which raises questions about the immediate threat it poses, and consequently about the potential for increasing general resilience based on reduced resource-dependence. Umicore, for example, a materials and technology group, embraced a circular strategy two decades ago with the following idea;

> *There are three megatrends that we respond to; one is the scarcity of resources, especially considering automotive electrification, wind energy and solar panels, so everything to do with renewable energy and sustainable transport. On the other side we respond to the limit on availability of resources with our recycling capabilities. Another megatrend is mobility of electricity […] and a third is clean air. (W. Ghyoot, personal communication, June 18, 2020).*

W. Ghyoot, group director of sustainable value chain at Umicore, emphasized that it was this vision of conforming to megatrends, rather than risk management, that was especially important in adopting CE in Umicore's strategy. This indicates that resource scarcity is a real societal and long-term problem which CE is trying to solve, while at the level of individual companies, it is not yet a significant risk, rather it is a trend to conform to.

This is reinforced by Tarkett, who believe decreased resource dependency will be critical to resilience in the future, even if it is not the case yet.

> *It is definitely a visionary perspective because to be honest, we have experienced some fluctuation in the price of raw materials in 2018, but it's still not big enough to start a CE approach. It's more visionary because the company really believes that a business in the future will have to shift to stay in business. […] It's not evident when you start reaching towards CE in the context of today, where the price of raw materials is so ridiculously low. It doesn't seem straightforward, but we absolutely believe that the context today will not be the context tomorrow. (Maria Lucia Portocarrero, personal communication, June 24, 2020)*

In conclusion, CE increases specified resilience against shocks in the supply of raw materials. However, the impact of this on general resilience may be insignificant today as

raw materials are still widely available at affordable prices. Nonetheless, decreased resource availability is predicted to become more and more of a threat to businesses and economies alike (e.g.: Bell et al., 2013; Mancini et al., 2013), suggesting that future resilience could be significantly impacted.

Finally, multiple respondents ascertained that even though you become less dependent on raw materials, you will become more dependent on partners, which poses its own risks and threats;

> *You will actually have to cooperate much more with subcontractors, and with clients to come to new solution […] so it's not because you are less dependent on raw materials that you are also less dependent on subcontractors; you will need them much more to brainstorm new solutions together. (T. de Romagnoli, personal communication, March 3, 2020)*

4.2 CE as an interconnected economic system

CE has the vision of an interconnected system where connections need to be made within and across supply chains to form a regenerative system. Kate Raworth, author of Doughnut Economics, expresses this idea in an interview; "the ecosystem approach to a CE [is one] in which all companies are deeply interconnected in a web of material use" (Disruptive Innovation Festival – DIF). This raises concerns about a rise in complexity; "circularity opens a whole new set of possibilities for generating and capturing value, coming at the price of close interconnection of actors and systems, making the complexity to oversee grow at least to the extent that new possibilities emerge" (Velte & Steinhilper, 2016, pp.3). In other words, because of an increase in connections necessary to close material loops and organize reverse logistics, the complexity and interconnectedness of supply chains could increase. At the same time, the same authors argue that for CE, complexity and interconnectivity is a key characteristic that should not be reduced, rather it should be embraced. Resilience could answer this need by offering supply chains the capabilities to balance vulnerabilities.

One example of hyper-connectivity and interdependence within a CE system is the connections making up an industrial symbiosis; a network of firms, often from different industrial sectors, that optimize resource flows at the collective level by exchanging by-products, sharing resources, infrastructure and collectively engaging in environmental projects (Bocken et al., 2016). Zhu & Ruth (2013) found that industrial ecosystems may be vulnerable to unforeseen disruptions due to high inter-firm dependence, more specifically due to supply dependency, asset specificity and organizational dependency. Supply dependency reflects the dependence on by-products from other symbiosis

members, while asset specificity refers to the very specific nature of these waste streams and by-products, rendering it often impossible to find the supply elsewhere and increasing dependence. Consequently, there is a lack of redundancy or backup supply in industrial ecosystems which increases its vulnerability. The authors therefore call for taking resilience into consideration by mitigating dependency, for example by increasing the variety and number of firms that are part of the symbiosis, but also by strengthening institutional capabilities that can identify disruptions early and mitigate their effects.

As we have seen in the literature review on resilience, interconnectedness is one of the more important characteristics which render supply chains vulnerable to disturbance. Therefore, building on findings by Velte & Steinhilper (2016) and Zhu & Ruth (2013) it is proposed that;

P2. CE may increase interconnectedness, which would increase vulnerability and thereby decrease enterprise resilience.

The proposition is careful not to predict with certainty that CE will increase interconnectedness, as multiple interviewees did not agree with this on the basis that our world already is very interconnected and complex. Other interviewees did see dangers in this close interconnectedness;

> *you are more connected to each other and so you're also more condemned to each other in a way because you are more dependent, so then on one side you can create something beautiful together, but on the other side if you have one player in the chain that is disrupted this can influence the other players, so that's the downside. (A. Fischer, personal communication, April 14, 2020)*

This quote points towards the double nature of being connected. On one side, it increases vulnerability to disturbance, but on the other side, capabilities such as collaboration and visibility can be formed to balance out this vulnerability (T. Pettit et al., 2010). Another strategy is to increase the diversity and variety of connections, allowing firms to quickly switch between suppliers (Johnson et al., 2013; T. J. Pettit et al., 2013; Rice Jr & Caniato, 2003; Sutcliffe & Vogus, 2003).

> *yes of course, connectivity increases the fact that spreading of shock can be much faster than otherwise, but here it really depends on how you are creating your connection, is there some diversity in your connection? Or is it all linked to one actor. I think it's really about that as well; do you have a diversified economy, or do you have one global player that is applying the same process, with the same key suppliers, with the same logic. Here is the problem, I think. If you think of a resilient economy, when you look at nature, when you want to avoid*

> *this kind of problem, you try to have diversity in the ecosystem, in order to make sure that if one thing fails, it will not involve your entire ecosystem. So, I think it's more about the diversity of your connection, and less about reducing your connectivity per se. (Anthony Naralingom, personal communication, February 26, 2020)*

This is also what the EMF proposes; "Build resilience through diversity" (EMF, 2012b, p.22). They oppose this to linear processes stemming from industrial revolution that focus on uniformity, instead of diversity. However, it is not argued that CE will necessarily be diverse, it something to be built in. The two authors that warned for a rise in complexity in CE also acknowledge that for CE it is more relevant to embrace complexity and connectivity -rather than attempting to reduce it- by designing in resilience through diversity and institutional capabilities (Velte & Steinhilper, 2016; Zhu & Ruth, 2013).

To sum up, CE raises concerns to system thinkers because of a potential rise in connectivity, which would increase the vulnerability of supply chains and our economic system. At the same time, interconnected systems can be very resilient if certain investments are made. In the next section, we will go deeper into some investments CE intends to make that can mitigate threats of interconnectivity.

4.3 CE as a collaborative system with visibility into supply chains

As discussed in the literature review on resilience, having an understanding of the supply chain and collaborating with other chain members can increase enterprise resilience significantly. For CE, understanding supply chains and collaborating with other members is indispensable to attain sustainability in a systematic manner (Braungart, 2007; Bressanelli et al., 2018; Faisal, 2010; Ghisellini et al., 2016; Huscroft et al., 2013; Velte & Steinhilper, 2016; Winkler, 2011). Moreover, collaborative platforms between firms is seen as an enabler of CE (EMF, 2015).

CE implies that the entire life cycle of a product needs to be considered and optimized from a total cost standpoint, which requires considering the extended form of supply chains, starting prior to the point of origin, and following the point of consumption (Faisal, 2010). More specifically, CE starts with the circular design of products. This requires knowledge on how input materials are made, what their composition is and where they are produced. A certain level of visibility in upstream operations will thus be required to design products in a circular manner. By designing products in such a way that allows repair and recycling, it constitutes the first step towards closing loops. The second step is ensuring that the products aren't just thrown away at the end of their life, but rather are recovered so that material loops can be closed. Therefore, a supply chain perspective will need to be established in collaboration with member firms (Winkler,

2011). Moreover, to organize reverse logistics (RL), it will be essential to communicate strategic and tactical data between partners in the RL process to manage the increased complexity (Bressanelli et al., 2018; Huscroft et al., 2013).

The global CE project lead at DSM, a global science-based company in Nutrition, Health and Sustainable Living that recently adopted a CE strategy, explained that CE requires an understanding of the value chain, both upstream and downstream.

> *CE is a chain transition and CE works only if the entire value chain cooperates, so if we at DSM say we want to be 100% circular then that won't work without getting our suppliers on board. We are now in conversation with suppliers of suppliers of suppliers, because early in the chain choices are made that are essential for our material and we need to know very well what type of material we precisely purchase and how it is treated etc. And the same works in the other direction, we deliver material to clients who in their turn supply an end producer […] and eventually who we want to reach is the customer of those parties because they will be the one using the product and also our material. And what happens at the end-of-use is crucial, because if it is designed to be recycled but it's thrown away, then you lose all potential. (R. Vissers, personal communication, June 25, 2020)*

This exemplifies how visibility needs to be established in supply chains, both upstream and downstream, to effectively close loops. This will result in more connections and opportunities for collaborations between supply chain members, as also CE consultant at Circle Economy, A. Fischer, explains;

> *There will be many more connections throughout the chain and also between certain chains that exchange resources or residuals. There will be more connectedness and there will be more information and data sharing between chain partners, you'll have to share more to receive correct information on where products are at which moment and what the status is when it comes back and how you can optimally reuse it. So internally in the chain, there will be more mutual dependencies and opportunities to work together and share information. (A. Fischer, personal communication, April 14, 2020)*

These collaborations and streams of information will allow better coordination and more effective decision making in the face of turbulent change, increasing enterprise resilience. This conclusion is shared with a CE specialist at the Brussels Environment office;

> *In a CE, you will never find a circular solution on your own. You will have to collaborate much more with your subcontractor, and with your clients, to come up with solutions. This will then ensure that your fabric*

> *becomes much stronger, which also makes you more resilient. (T. de Romagnoli, personal communication, March 3, 2020)*

The importance for collaboration for effective CE systems was mentioned by almost all interviewees and can be further exemplified with the case of Eurogypsum, a consortium of the gypsum industry that invests heavily in the recycling of gypsum. The secretary general explained that;

> *[…] you need to coordinate with all players, it is not just one industry, it is the whole supply chain that needs to be put in place" (Tristan Suffys, personal communication, March 5, 2020).*

Constructors of buildings, gypsum product designers, people in charge of demolition, recyclers, manufacturers, researchers, they are all actors you need to involve and cooperate with if you want to set up a closed-loop system for gypsum. This could then significantly increase the visibility into the wider supply chain and the collaborative efforts between members.

Industrial symbiosis networks, characterized by extreme connectivity, also need collaborative efforts between members to be successful. Interactions characterizing industrial symbiosis are much less transaction-based compared since waste streams are often highly variable and require communication of tacit knowledge (know-how), in addition to explicit knowledge (information), which means that for symbiosis members to work effectively together there is a prerequisite of social capital and trust (Grant, Seager, Massard, & Nies, 2010). The cohesion that results from these inter-firm linkages could result in enhanced adaptive capacity for when disruptions or changes occur (Korhonen & Seager, 2008).

By illustration, one of the most famous industrial symbiosis networks is the Kalundborg symbiosis, situated in Denmark. When asked about the dangers of dependency, the Project and Development Manager at Kalundborg, explained to me that this dependency is a condition, but not necessarily a problem. Since its start in 1961, the symbiosis has seen many changes with far-reaching consequences, but each time they have been able to adapt. These adaptations were possible because member firms are engaged in long-term negotiations where "there is a trust and transparency between the partners" which allows them to come together and brainstorm solutions when new situations present themselves, increasing their ability to survive, adapt and grow in the face of change.

> *If you want symbiosis to happen, you need people to work together, you need to share knowledge, you need to trust each other, and you need to bring people together. (Lisbeth Randers, personal communication, March 25, 2020)*

Sustaining an industrial symbiosis, or a circular value chain, clearly demands a certain level of energy and a willingness to work together in a meaningful way which is often not the norm in supply chains today. CE seems to inverse this trend.

Scholten & Schilder (2015) do point out that collaboration might not always be possible or wanted due to competitive reasons. Today, the difficulty of collaboration and information sharing in certain environments is often a barrier to circular opportunities (Bressanelli et al., 2018; Rizos et al., 2016). This is where some companies have seen blockchain technologies as a useful tool that can enable collaborative efforts by establishing a digital information flow. Circular IQ, for example, provide software that allows data and information sharing without revealing sensitive information that could damage competitiveness. This can help companies to create visibility and identify risk in their supply chain, at least as far as members in the supply chain are willing to cooperate. This visibility in its turn allows circular firms to track down unsustainable suppliers, poor design or sub-optimal materials of products and subsequently allows them to improve environmental performance in a targeted manner (R. Verceulen, personal communication, May 6, 2020). The ultimate goal in using such digital technologies in the context of CE is to create a deeper understanding of supply chains, increasing transparency and visibility and setting up collaborations to increase effectiveness (I. Konstatinov, personal communication, April 2, 2020).

In sum, CE could contribute to an economic system where companies increasingly have mutual benefits and engage in collaboration in order to optimize systems rather than components. This can have significant impacts on supply chain resilience through an increase in supply chain visibility and inter-firm collaboration.

P3. CE requires increased visibility and collaborative efforts between supply chain members, which would increase enterprise resilience.

4.4 CE as a more local economy

In this section the local versus global nature of CE will be discussed, as well as the impact on enterprise resilience. First of all, a more local economy is not necessarily the vision of CE nor included in most definitions of CE, yet many CE advocators (e.g.: Wijayasundara, 2020), as well as most interviewees, see it as an economic system that is likely to be more local. In the definition applied in this research it is included that CE narrows energy loops, meaning that energy usage should be minimized. Therefore, it will be important to minimize long-distance transportations.

> *If you include the resource of energy, then it definitely goes about localizing things and it's not against globalization but it's inversing the trend. (X. Marichal, personal communication, March 19, 2020)*

For the purpose of minimizing energy usage, circular supply chains are likely to be more local. But this need not always be the case. Especially in industries where economies of scale or geographic advantages favor more centralized production processes, supply chains will likely remain global. Nonetheless, it is interesting to explore what the effect of localization would be on the resilience of firms.

The current COVID-19 pandemic has uncovered the vulnerabilities that lie in complex, global supply chains, giving the impression that producing locally and choosing local suppliers will increase resilience. Nonetheless, this is not supported by literature on supply chain resilience. Localizing supply chains can provide resilience to certain disruptions, such as a global pandemic, but not all. On one side, local supply chains are less dependent on inputs coming from other countries and continents, which increases robustness to disruptions in foreign countries, and disruptions originating from geopolitical imbalances. Founder of BC materials, a circular start-up in the construction industry, explains how local chains can be more resilient;

> *In the case of concrete, a lot of materials are sometimes imported and then I wonder how resilient they actually are, also in reference to COVID nowadays, with their long internationally complex logistics chains, which are now in a phase where each country opens in a different way and their chain is therefore very vulnerable, while our standard is to work with local materials with a super simple technique, but a lot of expertise and know-how behind it. So yes, I think we are more resilient than a construction company that necessarily wants the cheapest product from another country because they think that will make a difference in their Excel sheet. (A. Maertens, personal communication, May 7, 2020)*

On the other hand, having a more local supply chain means that member firms are susceptible to the same local disruptions, which could hit the supply chain more severely if members are located closely to each other (Craighead et al., 2007). Another impact of localization is thus an increase in vulnerability of the supply chain to local disruption.

> *It's fairly simple to imagine a very circular, very small-scale food production, and we can see with the pandemic that those kind of production systems are not affected by the pandemic. So, to this specific threat, circularity seems to be in synergy with their resilience. But you could also have situations where you have something local that disrupts food production. Like a few summers ago we had a massive drought, which usually doesn't happen here, and we produced half of*

> *the amount of food we usually produce. So, the local food production system is not resilient to droughts and then it's better to import a lot of food. (D. Fagerlind, personal communication, April 8, 2020)*

What respective effect of localization on resilience is more significant will thus depend on specific circumstances and consequently no unambiguous conclusion can be formed.

Nonetheless, an indirect impact on resilience was found. Apart from minimizing energy usage, circular supply chains are often more local because of the need for increased information sharing and collaboration between different stakeholders, which is difficult to achieve on a global scale;

> *"At the moment the CE practices are primarily implemented on a local level. That is because in order to close a loop, one has to have a full control of the supply chain from the material production, to making the product, putting it on the market, collecting it post use and of course recycling. Having such control on scale is hardly possible, that's why when the CE will be carried out in global supply chains, collaboration will be an absolute necessity. That being said, in the future the circular economy will be not just local but a global practice" (I. Konstantinov, personal communication, April 2, 2020)*

And as discussed in the previous section, collaboration enhances enterprise resilience. It follows then that localization of supply chains can contribute to resilience in an indirect manner, by enabling collaborative efforts between supply chain members. This becomes even more clear when comparing local, collaborative supply chains to globally dispersed supply chain where trust, visibility and information exchange is more difficult to achieve.

> *Look at the corona virus in China, less ships are sailing, less production in China. I wonder how many weeks it will take before Volvo in Gent is disrupted. While, if you work together with local actors with good relations, you can control this much better, I think. Now you are connected to parties at the other side of the world, with whom you have a contract and a transaction, but that's where it ends. And especially, if all of a sudden there is a fly in the ointment, you are stuck. (T. Romagnoli, personal communication, March 3, 2020)*

To conclude this section; whether CE will localize supply chains is ambiguous and the direct effect on resilience is not straightforward as it can be both positive and negative. However, something is to be said about the indirect effects on resilience through the enabling and enhancing of collaborative efforts between supply chain members.

P4. CE is likely to localize supply chains, which can indirectly increase enterprise resilience by enabling collaborative efforts between supply chain members.

4.5 CE as a way of responding to stakeholder's needs

So far, we have focused on the implications CE has on the supply chain. Increased understanding, visibility and collaboration in supply chains are found to be positive for resilience as it allows firms to respond better to external shock. However, resilience is not only about being able to respond to sudden unpredictable shocks, it is also the ability to adapt to slower changes such as societal trends. And one of these trends is that stakeholders increasingly expect firms to care about environmental sustainability (EDF, 2019). A trend that poses significant risks to firms unable to adapt, while at the same time creating opportunities for conforming firms. First, we will discuss the risks, then the opportunities.

4.5.1 mitigating transition risks

The transition to a low carbon economy is underway and poses significant transition risks to companies unable to adapt (Climate Wise, 2019; Wei & Chase, 2018). Transition risks, the risks attached to the transition towards a more sustainable economy, could increase significantly in the following years and include risks attached to changes in preferences of consumers and the society in general towards green alternatives. More specifically, transition risks can come in the form of changes in regulation and policy, reputational damage and a decrease in demand for unsustainable products. Companies that change their business model to a more sustainable one, such as CE, can mitigate these transition risks and are resilient relative to companies unable to adapt. Therefore, building on the findings of Climate Wise (2019) and Wei & Chase (2018), this research proposes the following;

P5. CE allows firms to mitigate transition risks and are therefore comparatively more resilient than firms unable to adapt to sustainability.

This is also a form of specified resilience, yet interviewees mentioned it so abundantly that it seems it may be significant source of general resilience. This finding was also confirmed by T. Suffys, president of Eurogypsum, who explains that firms will have to adapt to CE as it progresses;

> *The more CE progresses, the more each company will have to think and revisit their processes. Some [business] models, some companies will be penalized or will not be able to adjust or to adapt to circularity and they will certainly suffer in terms of resilience. (T. Suffys, personal communication, March 5, 2020)*

Mitigating transition risks is very often the reason firms switch to a circular business model, demonstrating the significance of mitigating transition risks to the continuity, and resilience, of a firm;

> *most of [circular companies] are involved in CE because of the human drivers around them, the consumers, the workers they want to keep, the board of directors that is more and more sensitive to environmental aspects, that is what leads to change. (A. Naralingom, personal communication, February 26, 2020)*

This confirms that stakeholders increasingly demand environmental sustainability. Another example is Q-lite, producer of LED screens, who adopted a CE business model recently specifically in order to prepare for the transition towards a more sustainable economy. When asked if CE increases their resilience, Q-lite's CE responsible answered;

> *yes, because a new kind of economy is on the way, you can see it coming. […] We are actually preparing for the next 10 to 15 years, when there will be a switch in procurement and in the way of purchasing. This way we make ourselves resilient to the future. (J. Raeijmaekers, personal communication, February 2, 2020)*

In conclusion, many firms are adopting CE in order to conform to needs expressed by customers, employees, investors, governments; essentially all stakeholders of the firm. Firms unable to respond to these needs could face transition risks such as damage to reputation, regulatory pressure or decreased demand. CE firms on the other hand are able to mitigate these transition risks and are therefore resilient relative to firms unable to adapt.

4.4.2 stakeholder relationships

Moreover, responding to the needs of stakeholders doesn't only allow mitigation of transition risks, it also presents opportunities for better stakeholder relations and increased adaptive capacity. Implementing social and environmental practices is found to create trust in different stakeholder groups and subsequently allows sustainable firms to create connections across different scales of our social and economic system (DesJardine et al., 2019; Ortiz-de-Mandojana & Bansal, 2016), these improved stakeholder relations in their turn can prove to be valuable when disruptions or changes occur, increasing enterprise resilience by enabling access to diverse knowledge and information (J. Choi & Wang, 2009). These findings were also confirmed through interviews. For example;

> *There is a trend that is emerging to give [circular] firms more space and a helping hand when they bump into trouble, so in that sense there is more resilience because they do the right thing, because they*

> *contribute something and are more engaged with society, and so they will receive more goodwill from investors and clients and bankers. (A. Fischer, personal communication, April 14, 2020)*

In other words, circular firms are in a better position to respond to stakeholders' needs and therefore are more likely to receive a helping hand than an unsustainable firm that likely goes against the interests of stakeholders. This may also be seen in responses to COVID-19 with some politicians claiming they will give priority to sustainable companies in recovery plans; for example, the European Commission assured that the European Green Deal, of which the Circular Economy Action plan is a main block, will be a policy fundamental for EU's recovery strategy (European Commission, 2020). Nonetheless, whether CE firms will truly receive more support compared to unsustainable firms in the case of COVID-19 remains to be seen.

Additionally, many CE firms that were interviewed for this research noted that they were in close cooperation with regulators, advocacy groups and sometimes universities to accelerate the transition to a CE. This could, according to the quoted papers, aid their adaptive capacity through diversity of thought, adding to a firm's informational resources. One explicit example of this is provided by DSM, who were very quick to adapt to the new economic conditions imposed by COVID-19. This quick shift was reportedly thanks to their cooperation with governments, which was in place to stimulate more sustainable regulations and policies, and also thanks to their cooperation with Auping; a partnership set up for the production of circularly designed mattresses.

> *Thanks to that cooperation we had with the Dutch government, we were able to switch very quickly to the production of hand sanitizer. The demand came from the Dutch government in a group that we took part of, we said we could do that and so we set up a production line to produce hand sanitizer, and the same later happened for test sticks […]. Eventually a third demand came for mouth masks, and there we sought out our partnership with Auping because we don't do textile, and they do, while we have a technology for coating so that's how we started producing mouth masks. (R. Vissers, personal communication, June 25, 2020)*

This exemplifies how circularity enables closer connections with governments, who can provide valuable information and thereby increase adaptive capacity. Moreover, this quote strengthens proposition 3 which states that CE firms can enjoy enhanced resilience by having closer collaborations with supply chain members; in this case between DSM and Auping.

In conclusion, by investing in environmental practices, CE allows firms to respond to the needs of stakeholders, increasing their willingness to provide help and with that the

ability of a CE firm to recover. It is important to emphasize that CE only *enables* good stakeholder relations and doesn't imply them. Whether or not CE firms can benefit from this will depend on their level of sustainability (as a measure of responding to stakeholders' needs) and also the investment that is made to establish these relationships.

P5. CE enables firms to have better stakeholder relationships, thereby enabling an increase in enterprise resilience.

4.6. CE and profitability

As explained in the previous section, many companies are adopting circular principles in order to mitigate transition risks and to respond to a broader need for sustainable business. At the same time, the transition to a more sustainable economy is not yet completed, which means that today, circular companies often have a competitive disadvantage due to high operational risks and higher costs. This is not immediately related with the ability to adapt to, and recover from, external change. However, for a for-profit organization, profitability is a prerequisite to be able to survive in a competitive environment. On top of that, having high margins and financial reserves are seen as resilient capabilities that can help absorb disturbance (T. Pettit et al., 2010). In this regard, adopting circular principles can have a negative impact on the survival and resilience of a firm.

For one, because market hypotheses have not been established yet, probability of success for a circular business model is lower than for linear business models (Linder & Williander, 2017). Especially in the case of take-back systems, where critical business model hypotheses are stretched out over time. Assumptions like the lifetime of products, the quality of products after use, the required amount of repair during its lifetime and after recovery, all cannot be validated before investing and running operations for a certain amount of time. This can cause uncertainty and operational risks for companies adopting circular business models such as PSS, even though taking back products can significantly improve sustainability. For this reason, many CE advocators call for policy that rewards circular companies and disadvantages companies that don't consider the end-of-life of their products.

For now, taking back products at end-of-life is riskier than not considering what happens at the end-of-life of a product, however, this is likely to change with the development of new regulation and policy such as Extended Producer Responsibility, which places responsibility for disposal and treatment of post-consumer products with producers (Lacy & Rutqvist, 2016).

But it's not only take-back systems that disadvantage circular companies; being sustainable means limiting the externalization of costs to society such as emissions, waste and irresponsible resource use. This internalization of costs is not yet rewarded enough by current regulation; "Current regulations give the linear growth model an unfair advantage by making it more financially attractive to grow by expanding resource use." (Lacy & Rutqvist, 2016, p.175). Therefore, there is an urgent need for more effective legislation to support CE (Bressanelli et al., 2018; Rizos et al., 2016). There is essentially no level-playing field yet between polluters and sustainable companies, resulting in a competitive disadvantage;

> *Today, [circular companies] have a competitive disadvantage. The legal framework is not adapted for a circular economy and that makes it very difficult to be profitable today. (T. Romagnoli, personal communication, March 3, 2020)*

The founder of BC materials, producer of construction materials from excavation ground at construction sites, similarly explains that pricing currently disadvantages circularity;

> *Our loam stones are significantly more expensive. […] Of course, if you would take into account the externalities of brick stones or of concrete stone in the price of the product, there would be no discussion. It's a bit cynical that we have to say that we are more expensive, while we are not more expensive if you look at the full picture. In that sense it's very positive that LCA and EPD is increasingly considered, where we score very well. (A. Maertens, personal communication, May 7, 2020)*

To change these conditions in favor of sustainability, and enable profitable and resilient circular firms, it is imperative that the right regulatory incentives and policies are in place. As also the EU commission states in their communication of the green deal; "Well-designed tax reforms can boost economic growth and resilience to climate shocks and help contribute to a fairer society and to a just transition. They play a direct role by sending the right price signals and providing the right incentives for sustainable behavior by producers, users and consumers." (European Commission, 2019, p.17)

To sum up, there is no level-playing field today that allows fair competition between circular and non-sustainable companies. This implies that many circular companies struggle to reach profitability -a prerequisite of being resilient for a for-profit organization- and struggle to build healthy financial reserves that can help a firm absorb disturbance. For this reason, circular companies are often less resilient today than linear counterparts.

P7. Companies adopting CE may have a competitive disadvantage in the short-term because of a lack of economic and regulatory incentives, decreasing profitability and therefore resilience.

CHAPTER 5

DISCUSSION

There are many aspects to consider when contemplating the resilience of a firm. Resilience starts with a healthy business model that is profitable, and that is able to sustain itself. As soon as this prerequisite is met, one can start looking further. Is the firm flexible? Can it quickly rearrange resources? Can it adapt to societal trends? Is the firm very dependent on only a few suppliers or does it have diverse connections? Are there collaborative efforts between supply chain members? Is there a deep understanding of the supply chain? These are all questions that can gauge the resilience of a firm.

Clearly, no unambiguous statement can be made as to whether circular firms are resilient are not. Rather, the overall effect on resilience will be context-specific, depending on the relative significance of the different propositions to the specific application of CE. Potential interactions are presented as propositions in this thesis and can be visualized in the following graph. The following paragraphs will summarize the propositions in a coherent manner.

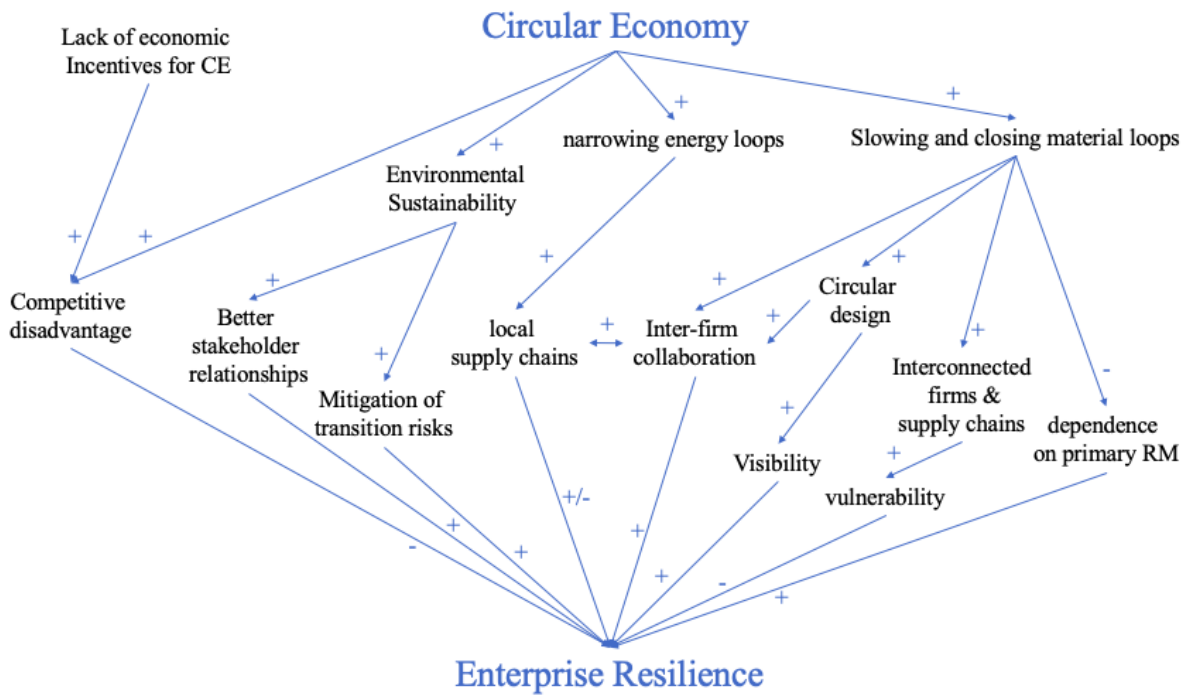

Figure 1: causal pathways between CE and enterprise resilience

CE means slowing and closing material loops, which provides four different impacts on resilience. First, extending the lifetime of products and materials starts with the circular design of the product so that it can be easily repaired or recycled. This requires knowledge about the material composition of different components and thus requires visibility in upstream production processes, which, if attained, builds resilience (P3). Second, to effectively close the loop and recover the product at the end of its life, collaboration with other firms in the supply chain is often necessary, which would increase adaptive capacity of the collaborating firms (P3). Third, if a CE firm recovers materials from customers it will be less dependent on virgin materials, which would provide resilience to shocks in supply of those materials (P1). At the same time, the close interconnection with other firms and sectors resulting from closing material loops could raise dependence on other entities, and therefore vulnerability to disturbance (P2), nonetheless, by having diversity in connections or by establishing deeper relationships with suppliers, resilience can be restored.

Next to slowing and closing material loops, some definitions of CE, such as the one used in this thesis, also include minimizing energy usage, which means supply chains will likely become more local in order to minimize transportation. Direct effects of having more local suppliers on resilience is dependent on the context and could be either positive or negative, however localization can influence resilience indirectly by enabling inter-firm collaboration (P4).

Finally, CE being a sustainability paradigm, it provides firms with the potential to respond to society's needs, enabling better stakeholder relationships (P6), and providing a solution to mitigate transition risks such as shifts in customer preferences and more stringent regulation (P5). Unfortunately, the transition to a more sustainable economy is still in an early phase, and economic incentives for CE are still largely lacking, which means companies adhering to CE still often have a competitive disadvantage, decreasing their potential for profitability and jeopardizing their survival and resilience (P7).

In sum, the impact of CE on enterprise resilience will depend on: the extent that resource dependency is decreased, the extent to which supply chain visibility and collaboration are increased, the impact on dependence on external firms, the impact on profitability and competitive advantage, the extent to which stakeholder relations are improved and, whether transitions risks are mitigated. Some of these relationships were hypothesized after literature review, others were added thanks to new insights from interviews, and yet others were omitted as they were not confirmed during interviews. This was the case for H3: 'CE could result in decreased flexibility because multiple lifecycles of products need to be considered'. This hypothesis was rejected as analysis of interviews uncovered that decreases in flexibility would be due to the choice for an inappropriate business model.

For example, products that are vulnerable to fashion changes or technology changes could pose flexibility issues if attempts are made to increase the lifetime of the product too much. Clearly, products' lifetime cannot be endlessly extended, however through circular design, their components could be replaced or recycled, or the product could be more intensively used during its lifetime through servitisation. These practices can then provide ways to avoid a decrease in flexibility and uphold resilience.

This research contributes to the current academic literature by summarizing seven potential impacts of CE on enterprise resilience. The findings of this research have two important managerial implications. First, managers who want to set up CE in such a way that maximizes positive impacts on resilience, can understand better how to achieve this with this framework. And second, the ample synergies found between resilience and CE can also motivate linear companies to transform into a more circular one.

Nonetheless, there are some noteworthy limitations to this research. First, many respondents were active CE advocators, which may have biased results towards the positive effects on resilience, even though critical questions were asked to limit this bias. Second, the list of effects that CE can have on enterprise resilience as found in this thesis may not be exhaustive; there may be other effects that the researcher and interviewees have not yet considered.

Further research will be needed to quantitively establish whether the relationship between CE and resilience at enterprise level is predominantly positive or negative. This could be done either through a survey study, or by comparing the quantified resilience of circular with non-circular firms. It would also be interesting to research the relative significance of different propositions in their contribution to enterprise resilience, which could be possible by establishing control variables in statistical regression. An interesting research would be to compare performance between CE firms and linear counterparts after the COVID-19 crisis. However, firms and value chains adopting CE today still have a long way ahead to attain 100% circularity and thus, impacts on resilience may not reach their full potential yet.

CHAPTER 6

CONCLUSION

This research aimed to explore how CE can contribute to enterprise resilience. Based on insights from relevant literature and qualitative data obtained through interviews, seven propositions were formed on the contribution of CE to enterprise resilience. These propositions indicate that CE can both have positive and negative effects on resilience, with the impact on general resilience dependent on the relative significance of different propositions, specific to the way CE is implemented at enterprise level.

CE advocators like the EMF and the WEF have long ascertained that CE would increase resilience to resource scarcity and volatility in prices of primary RM (EMF, 2012b; Ishii & van Houten, 2020). This thesis confirms this finding but has found other contributions of CE that may be more significant for the resilience of individual firms. The most original contribution of this thesis is the finding that CE can increase resilience by creating visibility in supply chains and increasing the level of inter-firm collaboration (P3), especially when compared to the invisible, complex, global supply chains characterizing our economy today.

Moreover, findings indicate that by responding to society's need for a more sustainable way of doing business, circular companies can mitigate transition risks and gain access to informational resources of their wider stakeholder network. Finally, as long as economic incentives are not aligned with CE, firms adopting CE will be competitively disadvantaged, which can jeopardize their survival. It is therefore important that corrective policies and regulations come into place aimed at a level-playing field between sustainable and unsustainable firms.

Based on these findings, managers can better understand synergies and trade-offs between their CE and resilience objectives. To this end, understanding the relative significance of the propositions to enterprise resilience would be helpful. A recommendation for further research is therefore to quantitively determine the significance of the different relationships that were explored during this research, ideally distinguishing between different circular business models.

CHAPTER 7

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