

Review

Breaking circular economy barriers

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ARTICLE INFO

Article history:

Received 25 August 2020

Received in revised form

12 January 2021

Accepted 13 January 2021

Available online 21 January 2021

Handling editor: Prof. Jiri Jaromir Klemes

JEL classification:

K23

L11

Q2

P18

Keywords:

Circular economy

Barriers

Sustainability

Markets

Recycling

ABSTRACT

Despite high estimated gains of a circular economy implementation, progress on the macro, meso and micro level is sluggish. The purpose of this paper is to examine, from a theoretical economics perspective, how four barriers – technological, market, institutional and cultural – can prevent the implementation of a circular economy. The barriers that currently hinder a circular economy from developing are identified and a mapping of these barriers is performed to understand how they are interdependent and entangled. The conclusion is that even small barriers could stop the emergence of a circular economy. Even though a circular economy is different from our traditional “linear” economy, the theoretical analysis in this paper gives no reason to believe that a circular economy will not follow the same rules as a traditional economy. There will be property rights, rule of law and price signals guiding the economy. If some of the essential parts of a market are lacking, a weaker circular economy than otherwise possible will materialize.

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1. Introduction

The estimates of gains from a circular economy (henceforth CE) are substantial. The European Commission estimates that the manufacturing sector would gain 600 billion euros annually (European Commission, 2014). On a national level Finland is estimated to gain 2.5 billion euros per year from a national CE transition, and the global economy would benefit by 1000 billion US dollars annually (Arponen et al., 2015). Through policy decisions a path away from a linear economic model, characterised to some extent by take-make-use-destroy, should be well under way (the EU Circular Economy Package in 2015 European Commission 2015; Korhonen, Honkasalo and Seppälä, 2018). Despite potential gains the CE implementation is slow in practice and actions get stifled by various barriers (Ellen MacArthur Foundation, 2013; 2019; Enkvist and Klevnas, 2018; Ghisellini et al., 2016; Govindan and Hasanagic, 2018; Kirchherr et al., 2018).

To illustrate let us contemplate an old economist joke told to first year students that involves two economists – one young and one old – walking down the street together. The young economist looks down and sees a \$20 bill on the street and says “Hey, look, a twenty-dollar bill!”. Without even looking, his older colleague replies “Nonsense. If there had been a twenty-dollar bill lying on the street, someone would have already picked it up by now”. The point is that in an efficient market, a large opportunity for profit will be absent, since someone would have already taken advantage of the opportunity (Fama, 1970; 1991). The joke is a reference to the Nobel prize winner Eugene Fama’s efficient market hypothesis stating that it is impossible for an investor to outperform the market, and that market anomalies will immediately be arbitrated away. The validity of this hypothesis is hotly debated. For the context of this paper, the joke helps us to envision why competitive firms let resources, that they pay money for, go to waste which is not a profit maximizing behaviour. The puzzle in the case of a CE is why are there billion-dollar bills on the street but nobody picks them up?

The purpose of this paper is to examine, from a theoretical economics perspective, how four barriers – technological, market, institutional and cultural – can prevent the implementation of a CE. The main contribution is the economist’s perspective and utilization of economic theory to understand and explain the barriers to CE.¹ Our knowledge is expanded in three senses: (a) a theoretical reasoning of what needs to be done to prevent CE barriers, and (b) identification of barriers and to show how even very small barriers can prevent the creation of a CE. Our unit of analysis is the macro and meso level, which is found to be required to function well for a CE to occur on the micro level.

A framework adopted from de Jesus and Mendonça (2018) was used to classify findings from a range of studies into four categories of technological, market barriers, institutional and cultural barriers (more on this in Section 3). Subsequently, a model illustrating barriers and their inter-dependencies focusing on the market for virgin- and recycled material is constructed. The model provides an overview of how barriers create a negative loop hindering a CE from developing and the model illustrates how each of these barriers, on its own, could be enough to stop the creation of a CE system.

The remainder of the paper is organized as follows. Section 2 introduces previous literature and the broad concepts considered.

Section 3 presents the methodology and approach; section 4 provides the results. Section 5 synthesizes the findings and discusses the results. Section 6 contains concluding remarks and implications.

2. Concepts and theory

2.1. Circular economy – a broad concept

The CE has a diverse conceptual background. The fact that the existing definitions of a CE are broad, and include all activities carried out in a society, may explain why there is no consensus among scholars about the interpretation of a CE. Understanding the broad concept of a CE, including the macro, meso and micro level related to production and consumption, one might see that the barriers of implementing CE strategies are varied and complex.

The key characteristic of a CE, which distinguishes a CE from other attempts to reduce energy and material consumption, is a holistic approach with the creation of circular loops of material, energy and waste flows encompassing all societal activities (Bonciu, 2014; Masi et al., 2018). The CE entered academic literature in 1966 when the ecological economist Kenneth E. Boulding criticised the linear “cowboy economy” of the past and described a future as a “spaceship economy” where all used resources were returned into the system (Boulding, 1966; Ghisellini et al., 2016). A CE, built on the theory of Boulding, was later initiated by the environmental economists Pearce and Turner (1989) who discuss the lack of price and markets for environmental goods (e.g. air and water quality, public goods), and stress the need of internalizing these externalities. By internalizing these externalities, a transition towards a CE would be more probable (Ghisellini et al., 2016).

To analyse the barriers related to a CE, a discussion about the concept and its definition is essential. Among researchers, there is no consensus on neither the scope nor the nature of a CE. In fact, earlier researchers identified 114 different definitions (Kirchherr et al., 2017; Masi et al., 2018). Prieto-Sandoval, Jaca and Ormazabal (2018) tried to review the literature and construct a definition based on all previous definitions:

“The circular economy is an economic system that represents a change of paradigm in the way that human society is interrelated with nature and aims to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions and governments) levels. Attaining this circular model requires cyclical and regenerative environmental innovations in the way society legislates, produces and consumes.” (p. 610)

The practical implementations of a CE can be divided into initiatives on three levels: the micro-level, the meso-level, and the macro-level (Masi et al., 2018): The micro-level refers to the firm-specific initiatives that usually emerge in the literature as a 3R Principles: Reduction, Reuse and Recycle. Reduction implies minimizing the inputs of energy, raw materials, and waste. Initiatives related to a 3R principle might be product design favouring zero waste (Ranta et al., 2018; De Pascale et al., 2020). The reuse principle indicates that resources should be used multiple times to decrease resources, energy, and labour in manufacturing goods. Moreover, the recycle principle refers to the reprocessing of waste materials, in other words the materials that cannot be reused as is, into products for either original or other purposes (Directive, 2008/98/EC, 2008).

On the meso-level, or the inter-firm level, initiatives related to cross-chain and cross-sector collaboration can be found. Initiatives

¹ A caveat is that all industries are different and that very country will have its own constitutional framework. These differences will remedy some barriers while strengthening others. A policy maker should still find value in this paper since a general conceptualisation is presented which to some extent should fit as a thought model for any country.

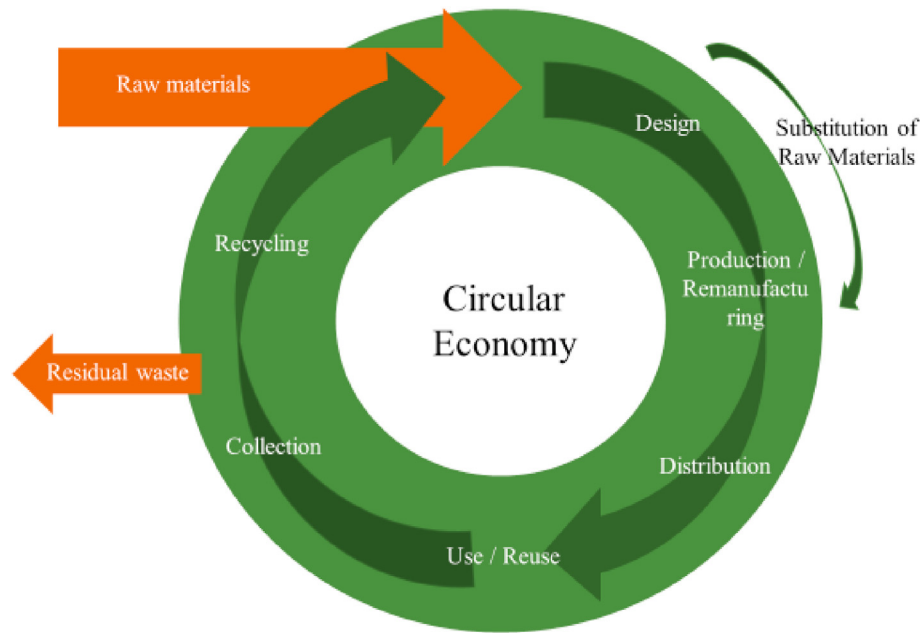


Fig. 1. Illustration of the Circular Economy with its different components.

like eco-industrial parks, a common property where businesses cooperate to use resources more efficiently, are also CE activities linked to the meso-level (Masi et al., 2018). Macro-level initiatives can be described as the implementations made by governments and policymakers (Masi et al., 2018). EU Circular Economy Package, the action plan undertaken by the European Commission in 2014, is an example of these initiatives (European Commission, 2015).

Masi et al. (2018) showed that the perception of a CE differs among scholars. Some see CE as a new label for old concepts, others as a combination of established concepts, and a third as a new set of guiding principles for economic activity. The different levels of implementation are interdependent and connected, since initiatives on the macro-level can affect both micro and meso-levels, and initiatives on the micro-level might have importance for collaborations on a meso-level. Hence, the barriers are also expected to be interdependent and related (Kirchherr et al., 2018; de Jesus and Mendonça, 2018).

Fig. 1 is meant to showcase a schematic CE that can represent many industries. One may comprehend that a successful implementation of a CE requires actions from all levels – micro, meso, macro – to obtain circularity. For example, on the micro level, the individual firms can design their products based on raw material availability. Firms are also constrained by raw material priced on the macro level where supply and demand will determine a market price. Government policy will also affect prices and raw material decisions. When the product is used, collection and recycling should be performed, how it is done will depend on the product. A leased car is a product that is returned to a dealership while a can of soda is a too small an object to spend money to keep track of and therefore a recycle policy where the consumer pays a small deposit fee might be a more suitable solution otherwise the product will become residual waste at the side of a road (Fig. 2) (see Fig. 2).

Other reasons beside environmental concerns for implementing a CE in a country include limited availability of raw materials, dependence of the country's economy on the import of raw materials, high prices, market volatility and an uncertain political situation.

2.2. Economic theory

To understand why a CE is not established, in some areas of the macro, meso and micro levels, the market process must be understood. In the introduction a billion-dollar bill on the sidewalk, that no one picked up, was presented and the question of why no entrepreneur rushed to the occasion to make a profit? To analyse the lack of a market, an understanding of the entrepreneur and what is needed for a market to work is required.

A prerequisite for successful entrepreneurial action is guidance by relative price signals and the attraction of pure profit (which requires the calculation of profit and loss accounting). The price system economizes information which economic decision-makers must process. Without these indicators the economic actor is lost (Mises, 1949). These indicators are a product of specific institutional configurations. Without the institutional context of a private property market society, economic actors will still strive to achieve their goals, as best they can (North, 1990). Profit informs producers that consumers value their use of those scarce resources in that use as compared to other alternatives (in the case of profits) or that they do not value them in that use (in the case of losses) as compared to alternative resource uses. (von Mises, 1929; Kirzner, 1982).

The Schumpeterian view of the entrepreneur emphasizes the entrepreneur as a creator of new combinations of knowledge (Klein, 2008). In Schumpeter's work, ideas about an economy's creative response to changes in external conditions are highlighted (Schumpeter, 1934, 1942, 1947). Under the existing institutions of any society, the entrepreneurs will act to better their position e.g., money, position, promotions, or future advancement (Boettke and Coyne, 2009; Redford, 2020). Schumpeter's entrepreneur is essentially disruptive, destroying the pre-existing state of equilibrium, while Kirzner's entrepreneur spots opportunities in a disequilibrium and moves the economy towards an equilibrium. In Kirzner (1999) it is argued that the two types of entrepreneurs are not that different, rather they are different in a glass half full - half empty way.

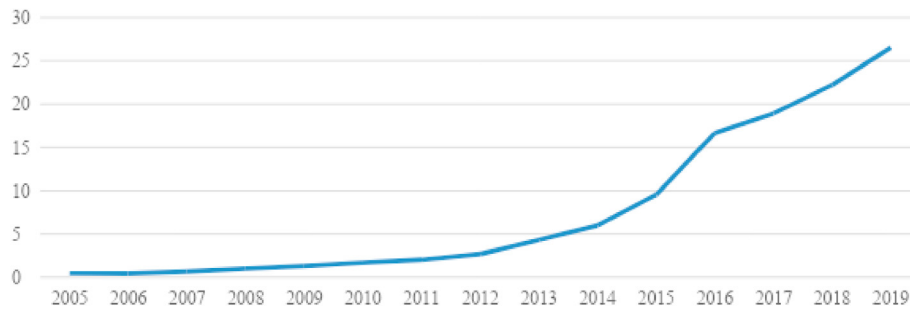


Fig. 2. Google Ngram count of the occurrence of "Circular Economy".

Institutions create rules which incentivize certain behaviours by changing the payoffs. Institutions consequently influence the entrepreneur's actions and are instrumental in economic activity (Boettke and Coyne 2003, 2009). Institutions that are emphasized as important in economic literature to create market conditions are: 1) well-defined and enforceable private property rights, 2) the rule of law, and 3) a moral code of behaviour that legitimizes and recognizes these traditions. For example, Hayek's (1937, 1945, 1948) property rights argument revolved around the information problem. Without private property, exchange is distorted. Without market competition the discovery process will be hampered (Hayek, 1968/2002).

A status quo bias is a common occurrence in all parts of decision making and could be an explanation for a hesitant company culture. Status quo bias refers to when people prefer things to stay the same by doing nothing, or by sticking with a decision made previously (Samuelson and Zeckhauser, 1988). Status quo bias is consistent with the observation that people feel greater remorse for bad outcomes resulting from actions taken, than they do for bad consequences that result from inaction (Kahneman and Tversky, 1982).

In the technological development literature, the rationale for why government support to R&D is well established. Several researchers have demonstrated that economic markets can fail to provide the socially efficient amount of resources to generate new technological and scientific knowledge (Nelson, 1959; Arrow, 1962). Knowledge is often characterized as being a public good with spillovers that the original creator cannot keep, implying knowledge spillovers benefit the public more than the inventor. As a result, incentives for private firms are reduced and an efficient level of R&D activity is not reached. Due to societally sub-optimal R&D spending, government support to R&D can mitigate technology market failures (Corradini et al., 2015; Grafström, 2018; Popp, 2019).

Information problems lead to a market that cannot exist in some cases. Akerlof (1970) showed by using the example of the used car market where quality uncertainty makes a market break down. In Akerlof's example there are both high-quality used cars and low quality used cars, and the consumer cannot tell the difference. Hence, they will be willing to pay an average price, and an owner of a high-quality car will not accept that price and take the product off the market. The market equilibrium will go to the lowest quality car with a low price. Buchanan (1982) emphasized that market "data" emerge after people interact with each other, before the participants enter the process, their choices are unknown. Hence, some knowledge cannot be gathered by regulators and planners until after the interactions have taken place.

Relying on economic theory presented above by among others Hayek, Schumpeter and Kirzner a crude checklist, seen in Table 1, can be constructed to forecast if a CE is expected to grow. If one of

the boxes cannot be checked then the opportunity for a change from a linear economy to a CE is smaller. The first step, private ownership would be necessary for a market, since without ownership you cannot sell a product and without ownership you do not have any means to buy either. An example is the case of household waste, that in Sweden is by law owned by the municipalities (Återvinningsindustrierna, 2019). The municipalities do not have to economize the resource and burn it as free fuel for heating. It is not argued that the household waste could have a better use, rather that no entrepreneurs can get into the non-existent market and prove otherwise. This order is not the worst in the world, but a downside is that there are few incentives for a local government to economize on the potentially valuable product, there are basically few uses for the product (Buchanan, 1968).

Functioning rule of law is rather self-explanatory. Without rule of law one can emit pollution at will and few companies or efforts to make a circular economy will exist. However, quality differences in the rule of law will exist and the better the rule of law we see the likelier it is that CE is taken seriously.

Freedom of enterprise can be either formal or nominal. It can be legal on paper to enter the market, however monopoly barriers may exist due to political interference. New firms can also be held at bay by cooperating incumbent firms exerting influence over the market. In a competitive market firms must reduce resource use to stay alive. If the price is set by the market, we can expect a certain equilibrium, if it is set by the state then the price might be too high or low and incentivize a suboptimal behaviour.

In Bureaucracy Mises contrasts different economic organizations and shows what happens when there is no profit motive. Mises argued that "Bureaucratic management is the method applied in the conduct of administrative affairs the result of which has no cash value on the market. ... Bureaucratic management is management of affairs which cannot be checked by economic calculation" (1944, p. 47–48). Absent profits and losses as a guide demand one to follow a rigid rule system. These rule systems will not allow for flexibility and will rather force compliance, no matter if the result makes sense or not. Profits and losses create constant feedback which generates socially desirable outcomes, without coordination. Knowledge of the optimal use of scarce resources is not given ex ante, but instead must be discovered through the process of individual choice (Mises, 1949; Hayek 1945).

3. Methodology and approach

In the first step a review of research articles is undertaken to identify the current state of academic insight with regard to the barriers hindering the growth of a CE. A desktop research is performed to identify academic articles on the barriers to a CE transition. These studies were read, and barriers were extracted and

Table 1
Necessary conditions for the establishment of a market.

Is there private ownership?	Is there a functioning rule of law?	Is there freedom of enterprise, freedom of establishment and freedom of contract?	Is the price set in a market today?	Is there a functioning competition? (either between actors or between products from different sources)?	Does profit work as a signal system?
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classified into the frameworks constructed by [de Jesus and Mendonça \(2018\)](#). Literature reviews should be replicable, scientific, have transparent methods, and allow readers to follow the path researchers took ([Tranfield et al., 2003](#)). [Tranfield's et al. \(2003\)](#) process is followed which comprises three steps: planning, execution, and reporting. In the planning step, the keywords of interest and a protocol for realizing the chosen approach is defined.

Three search engines were used to identify relevant studies: Elsevier's Scopus, Google Scholar and Elsevier's ScienceDirect. The preferred search engine was Google Scholar which had both pros and cons. The average result was, in our judgement, significantly less relevant in Google Scholar compared to e.g., ScienceDirect who delivered few but mostly good hits. Google Scholar, however, provided more accessible metrics such as citation counts directly viewable and used as an indication of the value of the paper where the citations represented both journal articles, books, and reports etc. so the quality of the citations was lower, but still an indicator of relevance.

For the snowball extension of the considered papers, where we looked at the citing research, Google Scholar had some advantages such as an easy overview of published and working papers of authors. Being aware of what Working papers researchers have published recently is important to comprehend development in the field. Sometimes a working paper might be an upcoming journal article.

The focus was on the last decade i.e., 2010 to 2019 with an emphasis on recent papers, since reviews about different aspects of the CE have been done in the past ([Govindan and Hasanagic, 2018](#)). Following the communication of the EU Circular Economy Package in 2015 ([European Commission, 2015](#)), the academic literature on a CE has increased rapidly ([Wautelet, 2018](#)). The choice to focus on newer findings is motivated by the fact that problems from two decades ago are less relevant today but also that a CE was not much talked about ten years ago and much less twenty years ago (as seen in [Fig. 1](#)).

A weakness with this approach is that some fields utilize a CE but do not talk about it as such. For example, in a paper by [Pajunen et al. \(2012\)](#) they talk about barriers to efficient material use in the mining sector. Their terminology could have been updated to today's talk about a CE without changing the message of the article. For example, they talk about "A challenge faced by economies today is to integrate the paths of environmental sustainability and economic growth. To achieve savings of primary raw materials or energy, industrial by-products need to be recycled to become valuable, useful raw materials or consumables (p. 39)." Hence, many sectors probably engage in activities that we today would call a circular economy, but without the CE vocabulary. This insight is of interest for anyone studying the development of a CE. Nonetheless, for the ideas aimed to be conveyed in this article, our limited approach suffices to show a generalization of barriers.

Search terms containing "circular economy" and "barriers" as well as synonyms of barriers were used in different orders to avoid missing out on relevant articles. The paper focus on CE and what stops or hinders its development. Hence, the synonyms have focused on the barrier part where synonyms have been words such as impediment, obstacle, limit, blockage, hurdle and hinder.

Different phrasing combination was also used such as "barriers to a circular economy" and "circular economy barriers". The different search engines omitted a varying amount of hits depending on the phrasing. The same word combinations were also searched on without "", rendering an almost unworkable amount of hits but usually relevant hits early.

A search on circular economy barriers on Scopus, for example, generated 241 results and 24 results on Science Direct. In a first step the abstracts of these studies were then read to eliminate all irrelevant articles that did not contain any empirical investigation of barriers. As this review is limited to journal publications in English the language filter has been set to "English" where possible. Google Scholar provided significantly more findings for example, "circular economy" +barriers rendered 17,400 hits but after the first 100 suggestions the relevance for this paper fell fast.

Next a selection of academic articles commenced. Academic articles are expected to embody a serious research work aiming at expanding knowledge and the articles have been validated by the scientific community through the peer-review processes ([Murray, 2013](#)). All articles were evaluated to fit the research topic. Some articles from non-reputable journals were not included since they seemed to have sub-par quality, e.g. a one-week period from first submission to publication. Any article that did not deal with the topic area or that played a minor role was not considered. However, articles in which the topic appeared as a significant sub-theme were included.

In the second step, articles with applications in strict niche markets, such as Brazilian Polystyrene, were removed while studies investigating a broader sector, such as plastics, manufacturing, or different supply-chains, were chosen for in-depth analysis. The choice to look at more broad papers was due to our ambition to be able to interest a broader readership. Those studies whose barriers were only mentioned because they had been identified in previous studies were not considered, only their original source, to avoid one barrier being counted twice although only empirically valid once. Based on our action we arrived at fifteen suitable articles. [Suárez-Eiroa et al. \(2019\)](#) conducted a literature review focused on CE in general and found 68 articles in the field, hence our smaller finding in a subfield is in line with expectations. A similar conclusion could be drawn from a review by [De Pascale et al. \(2020\)](#).

A "snowball" technique was used to identify studies not found in the initial desktop research. Then a content analysis defined as: "A research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use" ([Krippendorff, 2004](#), p.18) was applied. When the studies were gathered, we proceeded with a content analysis that consisted of procedures which are expected to be reliable, replicable, and valid ([Seuring and Gold, 2012](#)). In the analysis multiple research assistants and then a researcher read the content to ensure the validity and reliability of the results rather than trusting the judgements of a single person.

Based on the articles the barriers are divided into four categories: technological, economic, institutional, and cultural barriers. Other papers that have conducted reviews on the subject have done similar sorting (see e.g., [Paletta et al., 2019](#); [Kirchherr et al., 2018](#)). Some papers have more categories or specified the categories more

distinctly. The choice of barrier categorization is in line with previous research which usually has divided up the world into four spheres of barriers. The names are different but in essence they capture the same phenomena. For example, [Paletta et al. \(2019\)](#) used Technical-technological, Legislative, Economic and Socio-cultural barriers and [Kirchherr et al. \(2018\)](#) used Technological, Regulatory, Market and Cultural barriers. Since the reviewed literature varies in scope, the identified factors apply to different stages in the supply chain and to a wide variety of sectors in the economy. Our categories are a bit broader since some of them include two words, for example, institutional and regulatory is equivalent to what the two previously mentioned studies would call regulatory and legislative.

4. Results

4.1. Technological barriers

Design for product-life extension or design for opportunities for repair is crucial, as opposed to e.g. fast fashion ([Ellen MacArthur Foundation, 2017](#)). Some current product design is a major obstacle for remanufacturing, re-use, and recycling ([Masi et al., 2018](#); [Vanner et al., 2014](#)). Life-cycle cost analysis suggests that a large share of cost reduction opportunities for a project or product pertains to the early stages in its development ([Water Environment Research Foundation, 2011](#)). The same is true for environmental impacts.

In many countries, separation of waste is limited, which causes real or perceived problems with the quality of recycled goods and materials. One issue, described by [Milios et al. \(2018\)](#) who investigated plastics in three Scandinavian countries, is how recycled goods can be of lower quality or less flexible than virgin material. Another issue is the reliability of supply of recycled goods making virgin material preferred by many producers ([Kinnunen and Kaksonen, 2019](#)). The infrastructure for effective waste management is lacking in many places. Many recyclables are not separately collected. Food waste is especially difficult to separate ([Ranta, 2018](#)). There is not always capacity to handle all the collected recycled goods which are instead placed in landfill ([Milios et al., 2018](#)). The goods that are recycled, however, may lack proper standards and therefore customers willing to purchase what is recycled. This is only partly due to insufficient separation.

Historically, the CE literature has been more focused on availability of technological enablers ([de Jesus and Mendonça, 2018](#)). Although various necessary technologies have been developed, several studies cite the lack of know-how among the practitioners of these solutions ([Agyemang et al., 2018](#); or [Tura et al., 2019](#)). CE technologies may involve niche technologies that differ from the expertise within the firm, especially evident in SMEs ([Rizos et al., 2015](#)). Lacking IT-systems for measuring and monitoring progress is an obstacle. Although specific software for detecting waste may exist, it appears not to have spread to all businesses or not been used due to the lack of waste stream data ([Kirchherr et al., 2018](#)). IT systems are also necessary for the shift from a physical-goods dependent economy to a service economy and less resource-intensive immaterial satisfiers of human needs ([de Jesus and Mendonça, 2018](#)).

4.2. Market barriers

Market barriers are obstacles to a CE adoption due to non-

existent or ill-functioning markets. Economic barriers are financial barriers for CE adoption and include difficulties for funding CE business models, high up-front investment costs and low virgin material prices.

The barriers concerning a lack of market is twofold. As mentioned by [Tura et al. \(2019\)](#), the market mechanism for product recovery is not in place which is particularly evident in the market for recycled goods, which fails due to a combination of factors including quality standards (leading to the classic lemons problem in resale markets (see [Akerlof, 1970](#)), perceptions of quality, supply uncertainties and lack of economic incentives. It can also be the case that an actor has a clear mission statement and is not allowed to or lacks incentives for branching out. For example, wastewater plants receive possible valuable phosphate or other minerals from the sewage water, they might however not have the expertise or scale to make use of the by-product. The perceived quality of recycled materials makes the price-performance ratio insufficiently beneficial to switch to CE operations ([Kinnunen and Kaksonen, 2019](#)). One reason often cited in the literature for low perceived benefits (and another example of poorly internalised externalities) is low virgin material prices ([Kirchherr et al., 2018](#)). The lower perceived prices of raw materials are due to lock-in-effects into current linear infrastructure and due to the fact that externalities are not internalised through taxes or economic incentives ([Preston, 2012](#); [Masi et al., 2018](#)).

The supply of virgin materials adapts more easily to price changes than the supply of recycled material since new mines can start as material price rises. Recycled materials are dependent on previous consumption patterns and therefore have an inelastic supply. Thus, the price volatility of recycled materials is larger which creates uncertainty ([Åkesson, 2014](#); [Blomberg and Söderholm, 2009](#)). Uncertainty decreases willingness to invest in recycled material markets, and the substitution to recycled material markets stays low.

In a survey study with business leaders by [Masi et al. \(2018\)](#), high up-front investment costs were often mentioned as the second most important barrier (after lack of awareness and sense of urgency). Any major shift in a society requires switching costs and these costs can vary. Reversing the supply-chain, renegotiating contracts, adapting technology to suit new inputs or high development costs for new product design are just some examples. [Rizos et al. \(2015\)](#) found that the funding issue is particularly difficult for SMEs when data on the benefits is missing.

4.3. Institutional barriers

The institutional (and regulatory) barriers include inconsistent policy-messages and poor institutional infrastructure. An often-cited barrier is that the institutional infrastructure is path dependent and favours a linear economy.

Since many supply-chains are highly internationally integrated, the consistency of policies between countries is crucial for CE adoption in large firms. Heterogeneity in policies between countries is a main hindrance. By-products are often legally classified as waste before the end of its life cycle which switches ownership from private to public ([de Jesus and Mendonça, 2018](#)). High administrative costs of reporting waste streams, complex waste legislations and poor implementation of existing CE policies are mentioned by several researchers as a barrier ([de Jesus and Mendonça, 2018](#); [Milios et al., 2019](#); [Tura et al., 2019](#)). [Milios et al. \(2018\)](#) mentions high research and development costs for



Fig. 3. Most common barriers.

making better use of recycled plastics. Too little R&D, lack of support with training, poor physical infrastructure for reversed logistics and lack of CE management tools for SMEs are problematic (de Jesus and Mendonça, 2018; Masi et al., 2018).

Unintentional effects of policies also create problems. Stimulating use of energy-efficient appliances may also be inconsistent with a CE, since existing products are replaced earlier, sometimes not compensating for the saved energy (de Jesus and Mendonça, 2018). The North-South trade of goods for reuse, recovery, and recycling from the Basel Convention of hazardous waste from 1992 fails to recognize the value of waste (Krueger, 1999).

4.4. Social barriers

Three categories of social (and cultural) barriers to CE adoption are resistant company culture, lack of consumer awareness and weak cooperation throughout the supply-chain. The CE-resistant company culture plays out on three levels: resistance from managers, CE initiatives in isolation from main operations and low engagement in management strategies. Top and mid-management resisted initiatives in a CE direction as change may not be in line with their incentive schemes (Mangla et al., 2018; Agyemang et al., 2018). Mangla et al. (2018) found that whilst CE initiatives may be happening within a larger firm, all divisions are not aware of the changes. Some firms report that a CE is not a part of their current innovation strategy and they do not have any measurable goals related to a CE, indicating low strategic engagement.

A framework to explain the low consumer awareness and interest in a CE was provided by Singh and Giacosa (2019) who concluded that psychological ownership of products, strong status-quo bias, consumerist culture to satisfy needs and status were key factors behind negative attitudes toward CE goods. Rizos et al. (2015), found that CE was a low priority in consumers' decision process and many reported lacking awareness both about the meaning of the concept and about the circularity of their purchased goods.

Confidentiality about processes and volumes in production hampers industrial symbiosis and exchange of by-products (Masi et al., 2018). Cooperation across the supply-chain is viewed as intrusive on business models, not economically beneficial and hampering the competitive nature throughout the supply-chain (Agyemang et al., 2018).

4.5. The barriers summarised

Some general trends with more prevalent topics were found and represented in a keyword form in Fig. 3. The desktop research that was organised into a panel in Word and Excel. The words are highly dependent on the researchers' interpretation of the material and choices of organisation. Hence, some other researchers would have likely presented other words and expressions of the same material, the illustration is purely for pedagogical purpose.

Additional papers would have to be reviewed to pinpoint the weight that different barriers have. Nevertheless, commonly cited barriers found were:

- 1) Lack of a market and bad institutions.
- 2) Inconsistent policies across countries and for trade.
- 3) High up-front investment costs with poor access to finance.
- 4) Low consumer awareness.
- 5) Externalities not internalised through taxes (and subsidies).

The empirical findings show that the most cited barriers were those linked to institutions and culture. The diversity and quantity of barriers presented under institutional and cultural barriers were higher. Inconsistent policy and poor institutions for cooperation throughout the supply chain were commonly cited institutional barriers. A further analysis reveals that these barriers are closely connected to market and technological barriers. The connection might indicate that removing barriers in one of these categories could be a catalyst for a disentanglement. Still, the question of "where to start" remains, and with the obtained information one can just theorize about it. A suggestion would be (based on the cases presented in section 5) to stimulate supply for recycled materials which could increase reliability of supply and drive down acquisition costs. Adherence to the suggestion would reinforce the demand on recycled material, which in turn would foster the positive desired loop and thereby create new business opportunities and innovation-openings for entrepreneurs. As noted by Kirchherr et al. (2018), the awareness and enthusiasm among consumers seems to be low, which is a factor often cited in surveys with business managers. Still, the barriers are interlaced and have inter-dependencies. The fact that the institutional and cultural barriers might be affected by the economic and technological barriers must be considered when analysing the obstacles hindering a CE to develop. A modular overview of the situation and the possible inter-dependencies will now be presented.

Study background	Technological barriers	Market/Economic barriers	Institutional/Regulatory barriers	Social/cultural barriers
(Preston, 2012) analysed grey literature – exploratory work on barriers and opportunities.	Intellectual property and information sharing of resource use	High up-front costs	Lock-in to linear infrastructure Political obstacles to putting an optimal price on resource use Poor institutional cooperation across international supply-chains	Lack of consumer enthusiasm Low willingness for cooperation throughout the supply chain
(Vanner et al., 2014) performed a literature review on barriers to CE implementation in the EU.	Lack of skills and investment in CE product design Lack of know-how in product design	Low raw material prices Challenges in obtaining finance for CE investment	Lacking policies to internalize externalities Insufficient waste separation at source Limited public procurement incentives Insufficient in infrastructure for recovery and innovation Weak policy coherence	Limited cooperation throughout supply chain Limited community and business acceptance for sharing models Lacking consumer awareness and interest Lacking knowledge for implementation of CE policies
(Kirchherr et al., 2018) performed a desktop research, 47 semi-structured interviews and a survey with 208 respondents in EU-countries.	Poor quality of recycled goods Products not designed for CE Too few large-scale demonstrations projects Lack of data on impacts	Low raw material prices High up-front investment costs Limited funding for CE business models	Obstructing laws and regulations Lacking global consensus Lacking standardization of recycled goods	Hesitant company culture Limited cooperation throughout supply chain Lacking consumer awareness and interest Lock-in in current linear system Limited circular procurement Some SMEs have neutral/negative attitudes to “green business” Lack of knowledge about CE benefits Lack of understanding of CE concept Low priority in consumers’ decision process
(Rizos et al., 2015) Literature review on barriers to CE implementation in SMEs.	Lack of know-how and technical skills to implement CE practices	High up-front costs No excess human resources for CE focus Lack of access for funding	Lack of support for funding, training and taxation policy Lack of eco-management tools for SMEs	Prices of recyclables sometimes unknown Uncertainty about quality of recycled goods Mindset to focus on maximizing extraction
(Kinnunen and Kaksonen, 2019) Workshop and theme interviews with representatives in the mining industry.	Difficult to scale up use of recycled materials Some materials difficult to separate	High investment costs and long payback-periods Cheap virgin material High logistics costs Low concentrations of valuable material in recyclables	Too strict regulation on dangerous waste that could be reused Heterogenous regulations across countries Poor cooperation between companies	No demand for environmentally superior technologies Lack of awareness within firms about CE initiatives Lack of involvement from middle managers
(Mangla et al., 2018) Modelled interrelation between supply chain barriers to CE in India, based on literature review and expert interviews.	Lack of information system for follow-up	Lack of short-run rewards Lack of technology diffusion No incentives for CE adoption	Lack of training for HR and supply-chain managers Lack of regulatory pressures and taxation for CE promotion	Lack of long termism among stakeholders Not a part of innovation policies Lack of measurable goals Lack of stakeholder awareness Competition rather than cooperation within supply-chain – confidentiality
(Masi et al., 2018) Exploratory surveys with international government officials and firm representatives.	Limited attention to end-of-life design Limited availability and quality of recyclables	High up-front costs Cheap virgin material Benefits external to the firm Diverts focus from management	Government incentivises linear economy Difficult to separate bio-waste Recycling policies insufficient for high-quality use of recyclables Weak capacity for reversed logistics Path dependency to linear system	Lack of long termism among stakeholders Not a part of innovation policies Lack of measurable goals Lack of stakeholder awareness Competition rather than cooperation within supply-chain – confidentiality
(Milios et al., 2018) Literature review and semi-structured interviews with experts on the Nordic plastics markets.	Recycled plastic less adaptable Lacking technology to sort plastics	Expensive with separate collection of plastics Development cost of switching to recycled plastics Uncertainty about supply reliability of recycled plastic	Lacking capacity to handle all plastic waste Difficult to identify consumers of recycled plastics	Effort needed from consumer to separate plastics Poor awareness about types of plastics
(Milios et al., 2019) Exploratory semi-structured interviews with experts in the Nordic maritime sector.	Recycled products less flexible		Waste rules and time-consuming administration	Customers prefer new materials
(Agyemang et al., 2018) Survey and expert interviews in Pakistan’s automobile manufacturing industry.	Lack of technical capacities and technical skills	High costs and difficulties with financing	Lack of supply-chain integration	Resistance from top management
(Tura et al., 2019) Literature review and case studies based on interviews with firms across industries.	Lacking skills and technology for using of recyclables	High costs and lack of funding possibilities Unmeasurable benefits Lack of market mechanism for recovery Lack of incentives	Complex regulations Lack of government support Poor knowledge among decision makers No supply chain networks/collaboration	Lack of awareness Industrial focus still on linear models Risk aversion, low management support and business model acceptance
(de Jesus and Mendonça, 2018) Reviews academic and grey literature to analyse trends of CE in the wider literature.	Lag between design and diffusion Lack of training and support	Up-front costs Capital requirements Uncertainty about profitability	Materials classified as waste when they can still be reused Lacking knowledge for	Inertia in consumer behaviour and business culture

(continued)

Study background	Technological barriers	Market/Economic barriers	Institutional/Regulatory barriers	Social/cultural barriers
(Ranta et al., 2018) Case studies and interviews across EU, US and China, primarily focused on institutional barriers.		Low perceived business impacts	implementation of CE policies Not enough R&D Difficult to separate food waste Variation in regulation across countries No accreditation system Low enforcement of legislation Logistics of materials classified as waste	Customers prefer new products Informal recycling makes formal system difficult to measure Sustainability-performance trade-off Separate from strategic objectives
(Mahpour, 2018) literature review focused on construction and demolition waste management.	Ineffective technologies for separation Very little accessible data	Lack of incentives for sorting Lack of funding for CE transition Competition for (human) resources Not profitable Costs of threatened supplier relationships Unmeasurable benefits	No monitoring of waste management Lack of producer-responsibility Ownership issues of waste	Projects not designed for CE Lock-in to non-recyclable goods No targets for reducing waste Low CE concept understanding Consumers prefer new materials Low management commitment Risk aversion Perception of sustainability Inertia toward new CE business models Sustainability work separate from operations No clear responsibility within firm and in value-chain Low priority for customers
(Ritzén and Sandström, 2017) investigated the organisational perspective using interviews with two large manufacturing firms.	Linear product design Low CE integration into production processes Uncertainty about price and quality of recycled material			

5. Discussion

5.1. Theory

The macroeconomic potential for a CE has been estimated to be around \$600 billion globally per year from 2025 (0.71 percent of world GDP) due to a multiple of reasons, e.g. net savings on material, energy, an improved mitigation of volatility and resource supply. Despite the possible gains, individual firms face difficulties in funding CE economy business models (Ellen MacArthur Foundation, 2013). Part of the explanation is related to the lack of markets. A lack of markets will hinder the entrepreneur from contributing with solutions by providing creative responses to new opportunities (Schumpeter, 1934, 1942).

A market brings competition which increases incentives for decreased input use. If two firms have basically the same product the one which has lower material use will be the one that prevails in the long run. Coca cola cans have an interesting history that illustrates in tangible terms changing natural resources use. Coca cola recently introduced long, narrow cans that replaced the classic short and chubby ones. At the end of the 1950s, the weight of an aluminium can was 85 g. Today, an average can weighs 14–16 g (Grafström et al., 2020). Hence, four to five more cans are produced with the same amount of aluminium. Less aluminium means reduced cost, both in transportation and in use of raw materials. The reduction of raw material is a typical micro level 3R (Reduction, Reuse and Recycle) improvement as mentioned by Ranta et al. (2017) earlier. The firm introduces the reduction but to make it circular the meso and macro level also must play a part. An example is a deposit scheme for returnable aluminium cans present in some countries. The deposit could be equivalent to ten cents that the customer gets back upon returning the can at a sorting station (Hage, 2007). Such a deposit internalises some of the cost and a market for recovering is established.

An institutional factor is property rights (as discussed by Hayek 1937, 1945, 1948). A lack of property rights can be explained by old legislation, which forces individuals and firms to deposit waste products in a particular way. The old legislation might have been suitable when introduced, since it was a way to internalize externalities (e.g. take control over trash that was dumped in the countryside, or in other ways not handled properly). It could also

have been the case that there was an information problem that made a market impossible. For example, before the development of information technology it was harder for a company to find a buyer of some unexpected waste material if the customer was not geographically nearby. However, for a CE, the legislation of yesterday is inadequate. An example is municipalities that have the right (monopoly) to collect household trash, and the citizens are not allowed to dispose of it themselves. The monopoly creates distorted competition and hinders private actors from developing new business models as well as investing in new technology (Återvinningssindustrierna, 2019; Hayek, 1968/2002).

Another institutional barrier, mentioned earlier, is inconsistent policy throughout the value chain. Inconsistent policy constitutes an information problem. Policy inconsistency has been found to be a large hindrance to a successful development and diffusion of a green technology and policy inconsistency have been found to prompt dozens of bankruptcies and job losses (de La Tour et al., 2013; Strambo, Nilsson and Månsson, 2015). Policies naturally differ between countries due to a lack of harmonization, and since the value chain is often global, CE firms sometimes cannot scale up and become more than just local. The institutional barriers are also related to the economic and market barriers. For example, inconsistent policies would create problems on any market, since if a firm does not know what to expect in the near future the investment risk increases and hence investment cost (Kydland and Prescott, 1977; Nemet et al., 2014; Nemet et al., 2017).

Going from a linear economy to a CE necessitates investments. These investments are characterized by high upfront costs and increasing returns from technology adoption. The choice of technology becomes self-reinforcing, meaning that firms are likely to stay within an existing technology framework (Arthur, 1989).

There is a correlation and inter-dependency between institutional and cultural barriers, where regulations can follow culture whilst culture can be a product of regulations (Kirchherr et al., 2018). Economic barriers closely connect to other barriers. Kirchherr et al. (2018) point out that a low virgin material price affects the consumer interest and attitudes to recycled material, which is a cultural barrier. Consumers of recycled materials are almost certainly, as all other consumers, cost conscious. Thus, a difference between the price on virgin raw material and recycled material will result in a lack of interest in final goods made from

recycled material. That in turn incentivises a more hesitant company culture. The lack of consumer interest in recycled material products equates to higher risks for companies if substituting virgin raw material with recycled material. The company culture will therefore remain hesitant if the consumer interest is low (Kahneman and Tversky, 1982; Samuelson and Zeckhauser, 1988).

One of the market barriers, decreasing the demand for recycled materials, is the low price of virgin raw material (yellow circles in Fig. 6). Virgin raw material has an advantage in a linear economic system since the consumers will not bear the full price, i.e. in many cases the external costs are not internalised. One example is if non-degradable materials, or even toxic materials, are put in a landfill where future generations must finance the clean-up. Another explanation is the inelastic supply of waste, which makes the substitution of virgin raw materials less beneficial. Both these factors result in a price volatility correlated with uncertainty on the market for recycled material. Milios et al. (2018) argue that the recycled plastic is ultimately more costly since there is a need for a quality control of the recycled plastic compared to the virgin plastic. The need for a quality control is an indicator of another barrier: asymmetric information triggering “the market for lemons” which is a typical market failure (Akerlof, 1970). Uncertainty on the quality of recycled materials impedes market demand, consequently it becomes easier to meet customer specifications with virgin raw material.

There are also concerns about the costs of operating a CE business model, such as the need for new human resources capabilities or increased costs of logistics in reversed supply-chains and many firms report small or no economic benefits, at least in the short run (Mangla et al., 2018). Difficulties in measuring the impact of a CE and the lack of such data, which are technological barriers, increases a hesitant company culture and the limited funding for a CE (Kirchherr et al., 2018). High upfront investment costs seem like a good technical “excuse” for not implementing CE strategies and embracing these investments.

Going back to Table 1 presented in section 2.2, we can see that there are many instances where barriers indicate that obstacles remain within specific industries. In some cases, the property rights are not established and in other information problems make profit signals weak as a guideline for firm decisions. It is not always a governmental problem, sometimes the market failure is a lack of investment in R&D and the government has a role, and in other cases the government could help to reduce the power of previous monopolies (Nelson, 1959; Arrow, 1962).

5.2. How can barriers be solved?

In Section 4 the barriers found in earlier research were identified, the current section will visualize the inter-dependencies of these barriers. An ill-functioning market is a barrier connected to all levels of implementation in the economy. Returning to Fig. 1 of a CE from section two, the left upper corner of the circle is crucial (Fig. 4 below). Both the inflow and outflow from the desired closed-loop system occur there. The identified barriers came from several markets, but the barriers could all have been present in a single market as illustrated. Thus, as a point of departure for the mapping of the interlaced barriers, a theoretical market with recycled material and a virgin raw material will be discussed where both serves as a possible choice of input in production.

By theorizing around a single market, the barriers that might hinder the substitution of virgin raw materials with recycled materials are highlighted. The market is driven by demand from producers, who will use either virgin or recycled materials in their products, as well as demand from consumers, who will buy the final goods. To create a functioning CE the virgin raw materials need

to be substituted with recycled materials, which means that the demand for recycled materials must exceed the demand for virgin raw materials. A market for recycled materials is an essential factor in developing a CE on a micro-level as well as on an inter-firm level. Additionally, market-failures are commonly solved through operations on a macro-level.

The demand from public and private actors forms the basis for a well-functioning market. If demand exists, a market should emerge. Optimally there will be several actors competing, which should decrease the price on the market (Kirzner, 1978). Increased competition creates new opportunities when it comes to business strategies and innovations. Entrepreneurs can afford to take some risks and invest in new innovations that foster economic advantages in using recycled material, resulting in an increased demand for recycled material creating a positive feedback-loop. Fig. 5 illustrates the desired loop, i.e. a best-case scenario:

In Fig. 5 a closed circle is present where a positive cycle can be maintained and developed. Fig. 5 will now be inserted into Fig. 6, which illustrates how the desired loop is disrupted by several barriers. The red arrows symbolize a reinforcement of the virgin raw material market, while the green arrows symbolize a reinforcement of the recycled material market. The coloured circles are all disablers for a well-functioning recycled material market and the non-coloured circles are enablers. In Fig. 6, “leaks” from the desired loop can be observed, where the demand from private and public actors can take two paths. The filled coloured circles (yellow, green, red and dotted) introduce some of the barriers previously identified to showcase why the demand for virgin raw materials exceeds the demand for recycled materials.

Major potential underlying barriers are the institutional factors, marked as a dashed circle around the two markets in Fig. 6. The institutional factors vary across countries, as well as across sectors, which make them hard to generalize. The institutional conditions related to the specific markets might create barriers, whilst also having a large potential to foster the positive loop.

6. Concluding remarks and implications for theory and practice

The main contribution is the economist's perspective and utilization of economic theory to understand and explain the barriers to CE. Just as several CE definitions exist, multiple CE principles were found. Economist's engagement with the field is underwhelming, so far, and hence it is useful to present a framework for economists. Another insight, that to some extent is obvious is that the concept of a CE existed way before 2010, but the different industries used different words to describe it. If one could identify what vocabulary industries have for CE then more studies could be done, either by combining older data with new or to investigate success stories from before.

There are implications for theory surrounding what a CE is and how it should be defined. Having Fig. 6 in mind, it is clear that for a successful CE to materialize an implementation of a concurrent top-down and bottom-up strategy is required to engage all stakeholders, i.e. policy makers, governmental bodies, manufacturing industries and individual firms. If we can identify an industry with a working CE, without the classical market failure problem in one country and an ill functioning similar industry in another country where a CE is absent then a CE should be treated as an ordinary economy that has managed to internalize externalities. Even though a circular economy is different from our traditional “linear” economy, the theoretical analysis in this paper gives no reason to believe that a circular economy will not follow the same rules as a traditional economy. There will be property rights, rule of law and price signals that guide the economy. If some of the essential parts

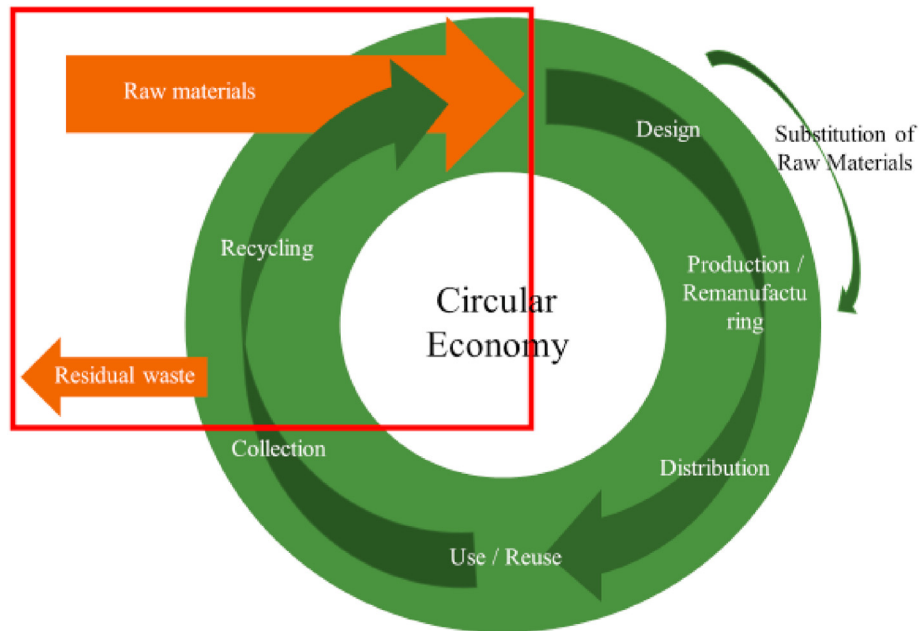


Fig. 4. Illustration of the Circular Economy with a focus on the in- and outflow.

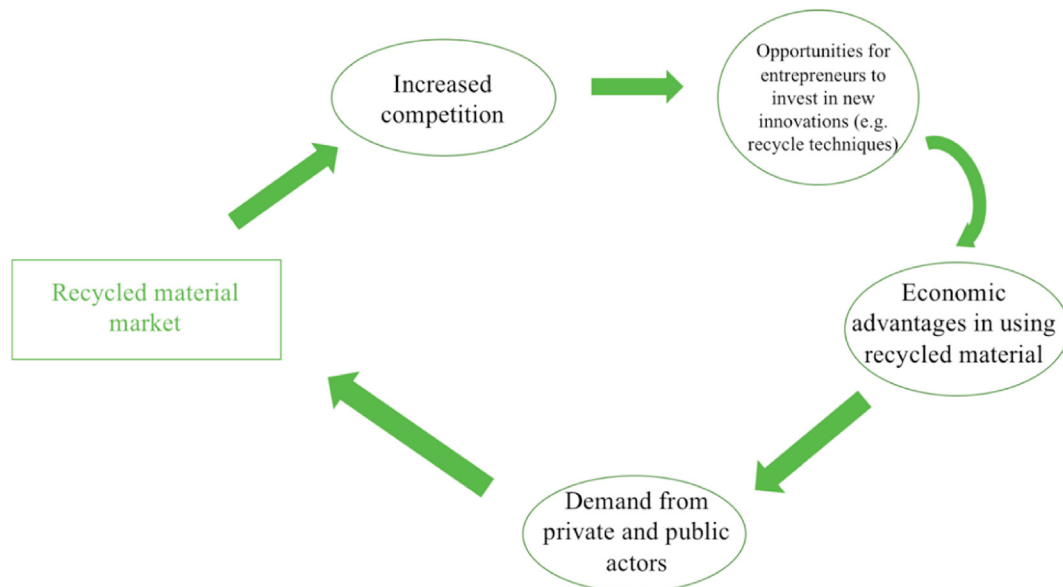


Fig. 5. A desired loop for the recycled material market.

of a market are lacking, a weaker circular economy than otherwise possible will materialize.

There are concrete implications for cleaner production policy makers. This study raises awareness about the presence of a broader portfolio of CE barriers and emphasise that policy makers and industry leaders as well as firm directors should be aware of the diversity of options to overcome these barriers. We reiterate, however, that different CE barrier solutions rely on very particular contextual conditions, including jurisdictions, consumer preferences and the presence or absence of various other institutional settings. To decrease the potential alternatives and identify a barrier breaking strategy, practitioners are recommended to start by analysing the distinct national context first. The proposed framework in Fig. 6 set a contextual initial guidance in facilitating this

analysis.

With this awareness in mind, policymakers should step up their work on taking down barriers if they want to create momentum for a CE. There is plenty of room for governmental interventions regarding the identified market barriers. For example, enable entrepreneurs to exist on the market and creating a possibility for property rights, price signals and the easing-out of subsidies that favour linear products. Even with this push, however, there is no guarantee that the CE concept will succeed unless we are able to internalize some of the costs a linear economy creates. Learning from other countries and understanding the heterogeneity in the challenges faced in different sectors is crucial for successful national implementation of a CE. To be able to accelerate the development towards a CE, it is of relevance to map and distinguish these

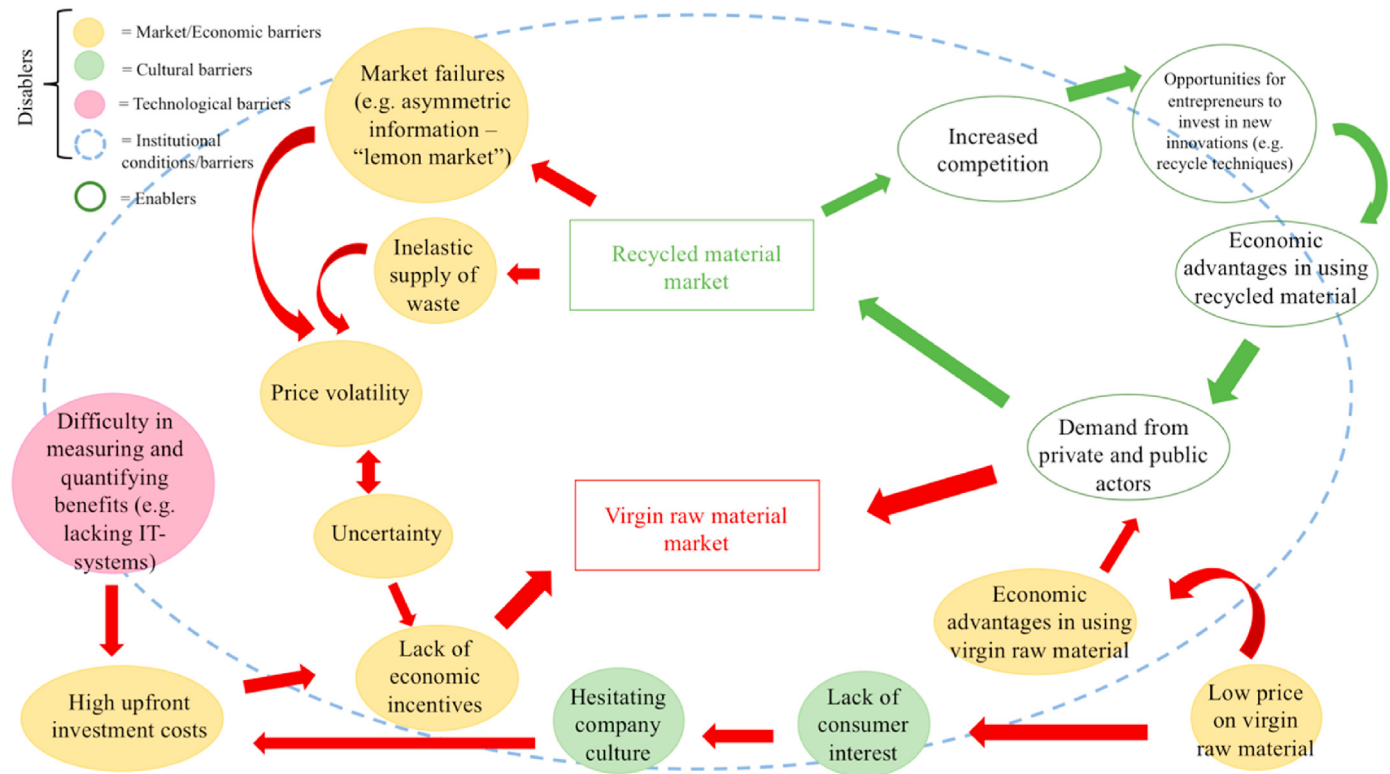


Fig. 6. Scheme of the markets and the related barriers. Green arrows symbolize the desired loop, while the red arrows symbolize the current loops and the barriers expected to enhance these loops.

barriers.

Admittedly, the study has limitations. First, the sample size is constrained by maturity of the research field but also by our inclusion decisions. As discussed in Section 3, another limitation is that the focus is on the commonly used concept CE which earlier in history was going under other names to some extent. The issue is investigated from a helicopter perspective and few case studies of issues on a national level are so far performed, caution is thus justified regarding the external validity of the findings. However, success in conveying the idea that some barriers, even seemingly small, could prevent the opportunity for a market to form which impedes economic activity.

Sometimes it seems like no one picks up the billion-dollar bill on the street but when looking at the issue from a market perspective a picture of why is revealed. The subjective assessment of the articles and their description of CE barriers are our interpretation of the researchers' analysis which could contain some misunderstandings, however, since we look to broad categories and in many cases found similar barrier descriptions this problem might be small.

While conducting the study, several knowledge gaps were identified that need to be researched in the future. Research on CE is still in its infancy and knowledge is needed about which barriers are either necessary or sufficient for a CE to go ahead. A future research agenda on the barriers for a CE should include a comprehensive industry level investigation to see what barriers they face and to see if the barriers are of a similar kind. Based on the review and analysis of prevailing research in the context of barriers to CE, this paper concludes that CE barrier relevant research is an active field, but the research is far from all-compensating. However, the research must evolve outside the most obvious industries such as waste generation, resource use and environmental. Research

should also incorporate the impact on business and economic perspectives. This neglect poses the risk of inhibiting CE implementation since advantages for industry are inexplicit and not always obvious.

Future research should aim to explain how theoretical knowledge can be disseminated to practitioners and how the CE enhancers can be supported to break down barriers through the micro, meso and macro levels.

Declaration of competing interest

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

Acknowledgement

Valuable comments and help from Marcus Lindeberg Goni and participants at the Ratio Brown bag seminar October 21, 2019 are highly appreciated. Responsibility for any remaining errors, however, resides solely with the author. Declaration of financial interests or funding - non.

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