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A qualitative framework for mapping rebound effects of different circular business model archetypes

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Abstract: Circular business models have gained popularity in recent years due to their perceived environmental benefits. However, they can have unintended negative environmental impacts that might undermine their intended positive ones. For example, customers might buy more clothes on a second-hand clothing exchange platform, assuming it is sustainable, potentially causing negative environmental rebound effects. While the concept of rebound effects is not new, research on how they affect circular business models is still limited. Companies are increasingly experimenting with new circular business model ideas. Yet, professionals tend to use rules of thumb to determine the environmental impact of these business models due to high uncertainty during the experimentation phase. This can lead to inaccurate forecasts, with no net environmental benefit or at times even worse outcomes (backfire effects). There is a need to categorise rebound effects of different circular business model archetypes so that they can be mitigated from the outset. In this study, we propose a qualitative framework that maps circular rebound effects for different circular business models, based on a detailed review of empirical academic studies. The framework can help practitioners to be well informed while making decisions about which circular strategies to pursue while in the experimentation phase. The study aims to scope out a relatively unexplored field in circular business model literature, and to help practitioners avoid common pitfalls and mistakes in the crucial experimentation stage where impact can get locked in.

Background

The plethora of unsustainable business models across different sectors from food to clothing and finance, has given rise to sustainable business model responses, most notably the 'circular business model' (Urbinati et al., 2017). A circular business model sets out to slow, close, narrow and regenerate resource flows (Bocken & Geradts, 2022; Konietzko et al., 2020). Yet previous work has suggested that the interpretation of circular economy in business often narrowly focuses on recycling (Allwood, 2014). Furthermore, circular business models need to be designed as such to achieve the desired results to avoid negative rebound effects (Figge & Thorpe, 2019). To illustrate, knowing that a product is made of recycled materials or secondhand, consumers might replace these more quickly (Catlin & Wang, 2013).

The first problem with well-intended sustainable and circular business models is that their impact is only measured by business on a cursory level, if measured at all (Das et al., 2022). Second, companies typically experiment to develop desirable, feasible and viable business models (Baldassarre et al., 2020), but circularity appears to be an under-explored area still (Bocken et al., 2021). This means that circular business models might be developed with good intent, but that the actual environmental impacts and worse, negative rebound effects, remain unaccounted for.

The phenomenon of rebound effects is not new with origins in energy economics literature in the 1860s when it was first called the Jevon's paradox (Jevons, 1866). More recently, the topic has been explored in the context of circular economy by Zink & Geyer (2017), Figge & Thorpe (2019), Castro et al. (2022), Metic & Pigosso (2022), and Zerbino (2022). Zink & Geyer (2017) were the first to help understand the circular economy rebound effects, by classifying them based on direct, indirect, system-wide, and transformational effects.

Castro et al. (2022) and Metic & Pigosso (2022) have gone a step further in identifying existing research gaps and establishing a research agenda in this field. And most recently, Zerbino (2022) has contributed a conceptual methodology to manage circular rebound effects, including anticipating them, monitoring impact, designing policies, and engaging stakeholders.

While there is increasing research on this topic, the awareness around rebound effects among businesses is quite low at present. However, if companies do not account for rebound effects when designing and implementing their circular business models, they risk not achieving their intended environmental goals and targets at all, specifically when accounting for their upstream (e.g., logistics, raw material sourcing) and downstream impacts (consumer behavior). This can have serious consequences down the line with anti-greenwashing laws and environmental impact reporting laws, that could potentially see companies penalized for misreporting of environmental outcomes. Additionally, companies that take a proactive approach to addressing their rebound effects early on in the experimentation phase, may also gain a competitive advantage in the marketplace, by demonstrating their commitment to sustainability and advancing their environmental agenda (Schaltegger et al., 2012).

In light of these recent developments in the field of sustainable and circular business models, and the increasing levels of experimentation by business in practice (Bocken & Geradts, 2022), this study focuses on categorizing important rebound effects of circular business model archetypes. This could help companies in having a better understanding of the true environmental impact potential and associated rebound effects of their new business idea, in the experimentation phase. This could be a step further towards mitigating them when (re)designing circular business models. We aim to answer the following research question: what are the typical rebound effects of circular business models?

Method

This paper follows a systematic literature review approach (Bryman & Bell, 2011; Tranfield et al., 2003) to identify empirical studies of rebound effects for circular business models, with the aim to develop an emerging ‘circular rebound framework’ for future research.

Data Collection

Data collection was done by searching Scopus and Web of Science using two search strings in order to be comprehensive. The search was further refined by research areas to exclude articles from research areas deemed to be irrelevant to circular economy (e.g., biomedical sciences). The detailed research protocol is described in Table 1.

Research Protocol	Description
Search string #1	("circular economy" OR "circular*" OR "circular business*" OR "sustainable business*") AND ("rebound effect*" OR "rebound*" OR "unintended consequence*" OR "backfire effect*" OR "take-back effect*" OR "spillover effect*" OR "indirect effect*" OR "secondary effect*")
Search string #2	("circular economy" OR "circular*" OR "circular business model*" OR "sustainab*" OR "business model*" OR "business*") AND ("rebound effect*" OR "rebound*" OR "unintended consequence*" OR "backfire effect*" OR "take-back effect*" OR "spillover effect*" OR "indirect effect*" OR "secondary effect*") AND ("environment* impact*")
Refined by Research Areas	Engineering, Environmental Sciences, Ecology, Science Technology, Business Economics, Materials Science, Energy Fuels, Public Environmental Occupational Health, Biodiversity Conservation, Behavioral Sciences, Social Issues, Psychology, Automation Control Systems, Public Administration, Transportation, Communication, Education Educational Research, Telecommunications, History, Philosophy of Science, International Relations, Philosophy, Urban Studies
Scan of	Title, Abstract, Keywords

Table 1. Literature Search Protocol.

The search included all articles, conference papers, and book chapters that were published on the topic until 1st February 2023 in the English language. The search resulted in 669 results from Scopus and 678 from WoS, with a total of 1347 articles. The list was scanned for duplicates (499) and resulted in a final of 848 articles.

The titles and abstracts of the articles were then scanned for relevance. The inclusion criterion was that the articles needed to clearly measure and identify rebound effects of circular business models through quantitative methods. This resulted in 56 articles being selected for a full reading. Four articles were also identified through snowball sampling. The full reading phase resulted in 27 articles being rejected. As a result, a final total of 33 articles were reviewed for this study. The process is described in detail in Figure 1.

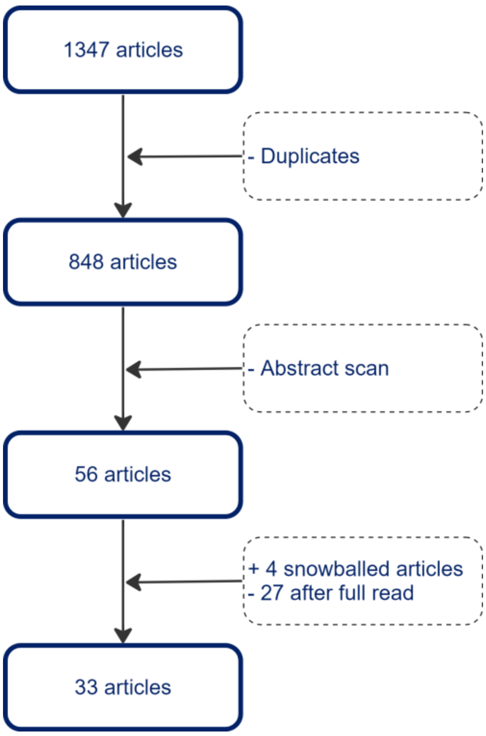

Figure 1. Literature Review Process

Data Analysis

These final articles were then reviewed and analysed through coding in Excel for characteristics such as country focus, sector focus, data analysis methodology employed, core circular business model strategy, and rebound effects reported. The circular business model archetype typology proposed by Pieroni et al. (2020) was used for classification in the emerging framework (Table 2). These broad archetypes were: Dematerialized or Efficiency, Collaborative Consumption, product-Service Systems, Long Life, Next Life, Circular Production and Distribution, and Circular Sourcing. The codes on the rebound effects recorded were further refined based on the systematic qualitative coding protocol described by Patten & Newhart (2017). This meant that first, open coding was done to identify the prominent rebound effects, these were then consolidated through core coding into the broader categories presented in Table 2.

Results

This study reviewed 33 articles from 2002 to 2023. The oldest article was Fons et al. (2003) on industrial symbiosis, the most recent one was Meshulam et al. (2023) on a peer-to-peer food-sharing platform. The top sectors for which rebound effects were reported were mobility, electronics and clothing/textile. The circular business model archetypes with the most empirical research on rebound effects was *Circular Production and Distribution*, with 10 articles. The least explored archetypes in research were '*Dematerialized or Sufficiency*', and *'Long life'*. Unsurprisingly, the most common rebound effect described was increase in consumption based on consumer's perceptions that the product or service in consideration is a 'greener' alternative. Table 2 lists the rebound effects observed for the different circular business model archetypes.

Circular Business Model Archetypes	Rebound Effects	Sources
Dematerialised or Sufficiency	- Increased exports to other markets with less environmental awareness to make up for reduced consumption.	(Grabs, 2015; Tukker et al., 2011)

(E.g., Dematerialised services, Demand reduction services, Encourage sufficiency)	- Re-spending (of time, money and energy) by consumers in other areas due to economic savings	
Collaborative Consumption (E.g., Sharing economy, Co-access, Co-ownership)	- Increased logistics (and subsequently related energy and financial costs) required to maintain sharing services. - Increased cleaning costs in terms of heat, water, energy, etc. - In the case of car sharing, modal shift away from previously environmentally friendly activities such as biking, public transport, and walking. - Increase in consumption due to improved accessibility of products.	(Amatuni et al., 2020; Levänen et al., 2021; Medina-Tapia & Robusté, 2018; Meshulam et al., n.d.; Realini et al., 2021; Vélez, 2023; Warmington-Lundström & Laurenti, 2020)
Product-Service Systems (E.g., Product-as-a-service, Rental, Hire, Leasing, Pay-per-use, functional sales)	- Increased logistics (and subsequently related energy and financial costs) required to maintain sharing services. - Increased cleaning costs in terms of heat, water, energy, etc.	(Bridgens et al., 2019; Johnson & Plepys, 2021; Vélez, 2023)
Long Life (E.g., Long life products, Products with life extension services, Reduce, Repair, Modular design, Refill, Upgrading)	- Increased energy and raw material use in product life extension services. - In the case of modularity, could encourage replacement leading to higher rate of upgrade than conventional products. Also, a more complex design can mean the product does not work as intended. - If product is replaced earlier rather than repaired, then the value is lost - Potential for overproduction of components to keep in sync with demand could increase impact.	(Levänen et al., 2021; Proske & Jaeger-Erben, 2019)
Next Life (E.g., Direct reuse, Next life sales, Product transformation, Refurbish, Remanufacture, Incentivised return & reuse, Recycling, Waste Management)	- High energy use in manufacturing. - Imperfect substitution of primary materials with secondary materials. - Increased CO_2 emissions if recycling rate is slow and inefficient. - Remanufacturing may prolong the life of outdated technologies that are more polluting (for e.g., old car engines or refrigerators).	(Catlin & Wang, 2013; Levänen et al., 2021; Makov & Font Vivanco, 2018; Morimoto et al., 2021; Siderius & Poldner, 2021; Wiprächtiger et al., 2022; Zhang & Chen, 2015)
Circular Sourcing (E.g., Source circular supplies, Industrial Symbiosis, Renewable energy, Using bio-materials)	- Increased consumption based on the assumption of products being 'greener' alternatives. - Increased food spoilage rates in plant-based packaging compared to conventional plastic packaging.	(Fons et al., 2003; Gerassimidou et al., 2021; Heller et al., 2019; Hutchings et al., 2021; Siderius & Poldner, 2021)
Circular Production & Distribution (E.g., Take-back & reprocessing used products, Cleaner production, Eco-efficiency, Energy efficiency, On demand production)	- Re-spending (of time, money and energy) by consumers in other areas due to economic savings - Adopting new technologies may lead to increased waste and shorter product life times. - New innovations cannibalizing existing environmentally friendly alternatives - Reduced consumption may lead to increased exports to markets with less environmental awareness.	(Albizzati et al., 2022; Conte et al., 2015; Dzombak et al., 2019; Font Vivanco et al., 2014; Joyce et al., 2019; Kagawa et al., 2013; Naumov et al., 2020; Spielmann et al., 2008; Walzberg et al., 2020; Wiprächtiger et al., 2022)

Table 2. Framework of rebound effects observed in different circular business model archetypes (based on circular business model archetypes by Pieroni et al. (2020)).

Discussion & Conclusion

Past research on this topic has provided general classifications of rebound effects in the circular economy (Castro et al., 2022; Zink & Geyer, 2017). This paper takes it a step further by providing a classification of rebound effects for specific circular business model archetypes. These findings can act as a starting point for research and practice on designing truly sustainable circular business models. Further, awareness in business of rebound effects is limited as of now. And so, another aim of this framework is educational, in order to make the concept of circular rebound effects more accessible to business practitioners. Accessible information about circular rebound effects in the early experimentation stages is important for practitioners as otherwise they can lead to poor business outcomes, such as lower profits or damage to the company's reputation. The proposed framework could allow companies to make more informed business decisions, and to pivot away as necessary from a proposed pilot idea that might not give enough environmental savings, or even has backfire effects. This can ensure that good intentions also become impactful.

While we found several possible rebounds from circular business models in the literature, only some can be directly mitigated by businesses. For example, a potential rebound effect of remanufacturing, is lifetime extension of outdated, more polluting technologies, such as old car engines or old refrigerators. This could be mitigated easily through rigorous monitoring to phase out product components that are deemed harmful (Zerbino, 2022). However, it can be argued that others like indirect or system-wide rebound effects (Zink & Geyer, 2017) might be beyond the direct influence of companies. For example, re-spending of time, money and energy by consumers in other areas due to savings from efficiency, can only be somewhat influenced by companies if they employ awareness and/or sufficiency marketing campaigns, and requires more societal or policy level interventions.

Future research can look at improving this framework further by exploring mitigation strategies for the rebound effects that are in this direct zone of influence of companies.

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