

From Waste to Wealth: Policies to Promote the Circular Economy

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Abstract

This policy article addresses the urgent need for a comprehensive policy framework to advance the circular economy, a crucial strategy in mitigating the global waste and pollution crisis. It seeks to bridge the research gap by evaluating and structuring circular economy policies across various governance levels, employing an ecological economics perspective. Through a synthesis of literature and case studies, the article examines the effectiveness of regulatory policies, economic incentives, and voluntary measures, and confronts the cultural, behavioral, economic, regulatory, technical, and logistical barriers to implementation. The findings underscore the importance of integrated policy approaches, such as extended producer responsibility, environmental taxes, and corporate sustainability practices, offering actionable insights for stakeholders. This contribution is significant for its strategic recommendations, which are vital for transitioning towards sustainable development and operationalizing the circular economy in practice.

Keywords: Circular economy, waste reduction, pollution reduction, policy

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1 Introduction

The World is facing an unprecedented waste and pollution crisis, with an estimated 2.01 billion metric tons of municipal solid waste generated annually (World Bank, 2018). This staggering figure highlights the urgent need for innovative solutions to reduce waste and promote sustainable development. One approach that has gained increasing attention in recent years is circular economy (Figge and Thorpe, 2023).

The circular economy is a new economic paradigm that plans to reduce waste and pollution, maintain products and materials in use, and restore natural systems (Ellen MacArthur Foundation, 2017). A circular economy may positively impact the environment, public health, and economy. For instance, it may reduce greenhouse gas emissions (European Environment Agency, 2020), enhance resource efficiency (World Economic Forum, 2014), create new business opportunities (IGNITE, 2021), protect human health, as well as foster social inclusion (World Economic Forum, 2021).

While the concept of the circular economy has been posited as a promising alternative to the prevailing linear economic model, which is dependent on the unsustainable cycle of resource extraction, utilization, and disposal (Figge et al., 2022), it is imperative to approach this narrative with a critical lens. The integration of sustainability principles and the adoption of circular energy devices, central to this concept, have been heralded as pivotal in the energy and ecological transition (Arias et al., 2023; Chen et al., 2023; Sultana et al., 2022). However, there remains a lack of comprehensive understanding of the complexities and real-world feasibility of such devices, which are often theoretically idealized to align with circular economy models, particularly in terms of leveraging renewable energy, enhancing efficiency, and promoting material reuse and recycling (Dung et al., 2023; Mendoza and Pigosso, 2023).

The overarching goal of the circular economy to eliminate waste and pollution, maintain the value of products and materials, and regenerate natural systems (Chenavaz et al.,

2023; Ellen MacArthur Foundation, 2020) is ambitious, and the literature may sometimes understate the challenges involved in achieving these objectives. The body of research exploring the benefits and challenges of the circular economy, particularly the environmental, societal, and economic implications of circular energy devices, often presents an optimistic view without adequately addressing the potential downsides or limitations (Debiagi et al., 2022; Ghisellini et al., 2016). For instance, Guo and Huang (2023) discuss the recycling of electric vehicle batteries, but the broader implications of such recycling processes in terms of economic viability and environmental impact are not fully explored.

Similarly, while further research on sustainable electricity and chemistry is being conducted (Eisa et al., 2022; Gandolfo et al., 2022; Magnani et al., 2022; Patil et al., 2022; Zaki and Hamdy, 2022), there is a need for more critical evaluations of these studies, questioning their scalability and practical applicability. The literature also tends to emphasize the role of circular energy devices in reducing reliance on non-renewable resources and mitigating environmental degradation (European Environment Agency, 2020; Mishra et al., 2022), but these assertions often lack a critical examination of the trade-offs and unintended consequences.

Finally, while proposed policy frameworks and instruments attempt to support the circular economy (European Commission, 2020; Organisation for Economic Co-operation and Development, 2021), there is a significant gap between policy aspirations and their actual implementation. This includes challenges related to technological innovation, market acceptance, and regulatory frameworks. Therefore, a more critical and nuanced approach is necessary to fully understand and realize the potential of the circular economy.

Despite the growing body of research on the circular economy, there remains a significant gap in the comprehensive understanding and application of policies that can promote its principles across different sectors and regions. This gap is particularly evident when considering the diverse challenges that impede the transition from a linear to a circular model, including cultural, behavioral, economic, and regulatory barriers (Euro-

pean Commission, 2020; Kjær et al., 2019; Organisation for Economic Co-operation and Development, 2021).

This policy article seeks to address this research gap by providing a structured analysis of circular economy policies from an ecological economics perspective, which acknowledges the finite nature of our planet’s resources and the need for a systemic shift towards sustainable economic practices (Kallis et al., 2018; Spash et al., 2019). The research method involves a thorough review of existing literature and case studies to evaluate the effectiveness of various policy instruments, such as regulatory measures, economic incentives, and voluntary programs.

This policy article contributes to the literature on the circular economy by providing a comprehensive understanding of the policies that can promote its implementation, including regulatory policies, economic incentives, and voluntary measures. Additionally, this article addresses the challenges of implementing a circular economy, including cultural and behavioral, economic, regulatory, and technical and logistical barriers. Finally, this paper provides case studies of failed circular economy initiatives to highlight the potential pitfalls and lessons learned. Overall, this paper aspires to provide insights into how to promote the circular economy implementation in practice and contribute to the ongoing efforts to promote sustainable development.

The structure of the article is the following. In Section 2, we introduce the concept of a circular economy, including its definition and principles as well as its potential benefits and challenges. In Section 3, we discuss the environmental challenges of waste and pollution, including their extent, environmental impacts, and economic costs. The methodology is presented in Section 4. Section 5 details the results in two subsections. In Section 5.1, we present a range of policies that can promote a circular economy, including regulatory policies such as extended producer responsibility and bans and restrictions, economic incentives such as environmental taxes and green procurement, and voluntary measures such as eco-labeling and corporate social responsibility. In Section 5.2, we address the

challenges of implementing a circular economy, including cultural, behavioral, economic, regulatory, technical, and logistical barriers. In section 6, we discuss the policy framework and the research agenda deriving from the article. Finally, in Section 7, we summarize the article’s main points and emphasize the importance of promoting a circular economy to achieve sustainable development and reduce waste and pollution.

2 The circular economy concept

A circular economy is a system solution framework that addresses global challenges such as waste, climate change, pollution, and biodiversity loss by transforming every element of the current take-make-waste system (Ellen MacArthur Foundation, 2021). The circular economy seeks to create a closed-loop system with efficient resource use, with minimal waste through reuse, recycling, and regeneration of products and materials (European Parliament, 2015). This section discusses the definition and principles of the circular economy, its benefits for the environment, society, and economy (World Economic Forum, 2021), and its implementation challenges (Kallis et al., 2018).

2.1 Definition and principles

A circular economy is an economic system that attempts to be restorative by design (Ellen MacArthur Foundation, 2015b). It relies on three core principles: designing waste and pollution, keeping products and materials in use, and regenerating natural systems. These principles can be applied in various ways across sectors and contexts (European Environment Agency, 2020; Murray et al., 2017). For example, designing waste and pollution can involve creating products that are durable, modular, and easy to repair or upgrade (Bhamra et al., 2011). Maintaining products and materials in use can involve implementing business models that promote the sharing, leasing, or remanufacturing of products (Bakker et al., 2014). Regenerating natural systems may involve adopting

practices that enhance soil health, biodiversity, and carbon sequestration (Geng et al., 2019). The circular economy offers multiple benefits to the environment, society, and economy, such as reducing greenhouse gas emissions (Ghisellini et al., 2016), creating jobs (Prendeville et al., 2018), and saving costs (Kallis et al., 2018).

2.2 Benefits and challenges

The circular economy is a concept that attempts to transform the linear economy of take-make-dispose into a circular economy of reduced-reuse-recycle. In doing so, it seeks to achieve a balanced interplay between environmental and economic systems (Geissdoerfer et al., 2017). The circular economy offers several environmental and economic benefits, but also faces several challenges that need to be addressed (Figge et al., 2021).

One of the main benefits of a circular economy is the reduction in waste and pollution. The circular economy minimizes the waste generated and resources consumed by keeping the materials and products in use for a long time. This situation leads to a lower environmental impact, such as reducing greenhouse gas emissions, land use, and water consumption (Kirchherr et al., 2017).

Another benefit of a circular economy is its creation of economic value. By using resources more efficiently, businesses can reduce costs and increase profitability. The circular economy also creates new business opportunities such as recycling and repair services, product-as-a-service models, and industrial symbiosis (Geissdoerfer et al., 2017). Moreover, a circular economy may create jobs in waste management, renewable energy, and green manufacturing (Murray et al., 2017).

However, several challenges are associated with circular economy implementation. The first is the need to change consumer behavior. For a circular economy to thrive, consumers must be willing to buy recycled products and engage in behaviors such as repair and reuse. This behavior requires raising awareness, providing incentives, and overcoming barriers, such as convenience and quality perceptions (Murray et al., 2017).

Another challenge is the need to invest in new technologies and infrastructure. Transitioning to a circular economy requires innovation in material design, product life extension, and waste management systems (Geissdoerfer et al., 2017). The transition can be particularly challenging for both small and medium-sized enterprises needing access to sufficient financial resources or technical expertise.

In summary, a circular economy represents a concept that holds great promise for achieving environmental and economic benefits. However, it also faces significant challenges in its implementation, especially regarding the need to alter consumer behavior and invest in new technologies and infrastructure. Despite these obstacles, the circular economy can be a crucial driver of sustainable development and more efficient use of resources.

3 Waste and pollution: the environmental challenge

Waste and pollution have become significant environmental challenges in recent years. It has become increasingly clear that our current linear economic model, which follows the “take-make-dispose” pattern, is unsustainable and leads to significant waste and pollution. This section discusses the extent of the problem, the environmental impacts of waste and pollution, and associated economic costs.

3.1 The waste and pollution challenge

Waste and pollution constitute a massive environmental challenge, with the amount and composition of waste generated worldwide rapidly changing (Awasthi et al., 2021). The World Bank (2018) forecasts that total waste generation will increase from 2.01 billion tons in 2016 to 3.40 billion tons in 2050, representing a 70% increase. This increase is driven mainly by population growth, urbanization, and economic development.

The waste composition is also shifting, producing more electronic and plastic waste.

Electronic waste (e-waste) is a fast-growing waste streams worldwide, reaching 53.6 million tons in 2019. Plastic waste is another primary source of pollution, accounting for approximately 12% of global municipal solid waste generation (Statista, 2021). Both e-waste and plastic waste pose significant environmental and health risks owing to their persistence, toxicity, and potential for leakage into natural systems.

A lack of proper management practices exacerbates the waste problem. The World Bank (2018) reports that around 33% of the World waste is not managed in an environmentally safe manner, meaning that it is either openly dumped, burned, or disposed of in uncontrolled landfills. This situation can release greenhouse gases, air pollutants, and leachate, which can contaminate the soil, water, and ecosystems. It is especially critical in developing countries, where only 19% of waste is collected and appropriately treated.

3.2 The environmental impacts

Waste and pollution have significant and wide-ranging environmental impacts on land, water, air, and biodiversity (Chen et al., 2020). One of the most visible impacts is the pollution of land and water resources by waste that is not correctly disposed of or treated (Abichou et al., 2009). For instance, landfills can leach harmful substances into the soil and groundwater, affecting drinking water quality and agricultural production (Ongondo et al., 2010). Moreover, hazardous wastes, such as batteries and electronic waste, can release toxic chemicals and heavy metals into the environment, endangering human health and wildlife (Figge et al., 2021).

Another significant impact of waste and pollution is the emission of greenhouse gases and the like, contributing to air pollution and climate change (Zhang et al., 2022). The burning of waste, either in open pits or incinerators, emits greenhouse gases, such as methane and carbon dioxide, as well as particulate matter, nitrogen oxides, sulfur dioxide, and dioxins (World Bank, 2018). These pollutants can adversely affect respiratory, cardiovascular, and cancer risks. Furthermore, producing new products to replace dis-

carded products requires energy and raw materials that generate greenhouse gases and deplete natural resources.

The third impact of waste and pollution is biodiversity loss due to habitat degradation, invasion of alien species, and overexploitation of natural resources. For example, plastic waste is one of the most pervasive forms of pollution that affects marine life. Every year, approximately 8 million tons of plastic waste are wasted into the seas from coastal nations, entangling, ingesting, and injuring marine animals (Brito et al., 2022). Plastic waste also breaks down into microplastics, accumulating in food webs and harming organisms at different trophic levels.

3.3 The economic costs

Waste and pollution entail high economic costs to society, both directly and indirectly. Direct costs refer to the expenses incurred by waste management activities such as collection, transportation, and disposal of waste. According to a report by the World Bank (2018), the global cost of waste management is projected to increase from \$205 billion in 2010 to \$375 billion in 2025, with most of this increase occurring in low-income and middle-income countries.

Indirect costs refer to the environmental and human health damage caused by waste and pollution. Waste and pollution can degrade natural resources, such as soil, water, air, and biodiversity, and reduce their capacity to provide ecosystem services (European Commission, 2021; United Nations Environment Programme and International Solid Waste Association, 2019). For example, landfills can contaminate groundwater with leachate and emit methane gas, contributing to climate change (Abichou et al., 2009). Waste and pollution can also affect human health through various pathways, such as respiratory diseases caused by air pollution (World Health Organization, 2016) and infectious diseases caused by water pollution (European Environment Agency, 2021; Ongondo et al., 2010).

Moreover, the economic costs of waste and pollution are distributed differently among

regions and groups. Low-income communities and developing countries often bear a disproportionate burden of waste and pollution owing to their limited access to adequate waste management infrastructure and healthcare services (Zhang et al., 2022). Furthermore, waste and pollution can exacerbate existing inequalities and vulnerabilities by affecting livelihood, education, gender equality, social cohesion, and human rights (United Nations Environment Programme and International Solid Waste Association, 2019).

In summary, waste and pollution pose serious environmental challenges that require urgent action. The magnitude of the problem is alarming, with the waste and pollution generated worldwide increasing annually. The environmental impacts of waste and pollution are severe and can harm human health, biodiversity, and ecosystems. The economic costs of waste and pollution are also substantial, with countries spending billions of dollars annually to manage and clean waste and pollution.

4 Methodology

This policy article adopts a systematic methodology to bridge the research gap in the analysis of circular economy policies, with a focus on the principles of ecological economics. The aim is to furnish a detailed understanding of the multifaceted policies that can foster the circular economy. The approach is crafted to be thorough and replicable, ensuring that the research can serve as a reliable foundation for future scholarly work in this domain.

More precisely, below is the list of our criteria:

1. **Publication Timeframe:** We focused primarily on recent publications, specifically those between 2020 and 2023, to ensure that our analysis reflects the most current research in the field. However, based on our readings, we also considered older publications when they remained relevant to our investigation.
2. **Keyword Search:** Our search criteria involved using the keywords “circular econ-

omy” combined with “(waste reduction OR pollution reduction) AND (policy OR policies)” to identify relevant academic literature.

3. **Database:** We conducted our literature search on Google Scholar by using “advanced search.”
4. **Exclusion Criteria:** Based on our reading, we excluded articles that were not relevant to our research. This involved a careful evaluation of abstracts and an initial reading of the articles to ensure their alignment with our study objectives.
5. **Selection of Journals:** We exclusively included articles from economic and business journals, maintaining a focus on our specific research domain.
6. **Case Study Selection:** Case studies were sourced from various reputable sources (mainly international institutions) through searches conducted on Google. Our selection process aimed to include diverse case studies representing different regions, industries, and policy tools. Selections were made following an initial review to ensure relevance and diversity.

At the heart of this research is the objective to critically evaluate and organize circular economy policies across different levels of governance (Abad-Segura et al., 2020; Alberich et al., 2023). The study is designed to measure the efficacy of various policy instruments—regulatory, economic, and voluntary—and to delve into the myriad barriers to their implementation. These barriers span cultural, behavioral, economic, regulatory, technical, and logistical challenges (Fatima and Elbanna, 2023; Ghisellini et al., 2016; Upadhyay et al., 2021). In addressing these, the research also seeks to provide actionable guidance for stakeholders to navigate and dismantle these obstacles, thereby advancing sustainable development.

The research employs a mixed-methods design, following a qualitative approach to yield a nuanced analysis of policy impacts. It begins with a comprehensive literature

review, forming the bedrock of the study by offering a critical examination of the current body of knowledge on circular economy policies (Kallis et al., 2018; Meis-Harris et al., 2021; Rosa et al., 2020). The process of literature review is meticulous, involving the identification of pertinent studies through keyword searches, the careful selection of literature based on stringent criteria, and the synthesis of the literature to unearth prevailing themes, knowledge gaps, and new avenues for research.

To complement the theoretical insights from the literature review, a series of case studies are curated to demonstrate the real-world application and outcomes of circular economy policies. These case studies are chosen for their diversity, covering a spectrum of regions, industries, and policy tools. They are gathered from a variety of sources, including official policy documents (Circular City Funding Guide, 2023; EU-Japan Centre for Industrial Cooperation, 2023; Eunomia, 2023; European Commission, 2023a; European Parliament, 2015; Federal Trade Commission, 2023), corporate disclosures (Deutsche Bank, 2021; GS1 UK, 2021), and stakeholder perspectives (1GNITE, 2021; Ellen MacArthur Foundation, 2021; Mishra et al., 2022). A uniform framework is applied to these case studies to distill the efficacy of policy measures and the specific conditions of their execution.

The evaluation of policy instruments is a critical component of the methodology, with a focus on their alignment with circular economy principles (Domenech and Bahn-Walkowiak, 2019; Fitch-Roy et al., 2021; Hartley et al., 2020; Lindström et al., 2020). The criteria for evaluation are comprehensive, considering the reduction of waste and pollution, the optimization of resource utilization, the fair distribution of economic impacts, and the adaptability of policies to different operational scales and contexts.

The culmination of the research process is the synthesis of all findings from the literature review, case study analysis, and policy instrument evaluation (Geng et al., 2019; Govindan and Hasanagic, 2018; Rosa et al., 2020). This synthesis is instrumental in crafting a cohesive policy framework that champions the circular economy. The framework is

designed to be actionable, offering clear guidance for stakeholders at various governance levels and proposing strategies to surmount barriers while capitalizing on enablers.

The research is conducted with an awareness of its inherent limitations, such as the possibility of selection bias in the case studies, the challenge of extrapolating findings across different contexts, and the dynamic nature of circular economy policies. These limitations are acknowledged to ensure a balanced and transparent discourse.

5 Results

5.1 Policies to promote the circular economy

As discussed in the previous section, the linear economic model of producing and consuming goods and services has resulted in economic, environmental, and social challenges. To address the previous challenges, it is essential to shift to a more sustainable model of production and consumption, such as the circular economy (Zhu et al., 2018). The circular economy concept aspires to eliminate waste and pollution, circulate products and materials at their highest values, and regenerate natural systems (Hartley et al., 2020). It requires a systemic approach that involves designing products for durability, reuse, and recyclability; managing resources efficiently; creating incentives for circular practices; investing in innovation, infrastructure, and skills; collaborating across sectors and stakeholders (Ellen MacArthur Foundation, nd). This section examines the role of regulatory policies in fostering the circular economy transition, focusing on four types of policies: extended producer responsibility, product design and labeling standards, bans and restrictions, and deposit schemes.

5.1.1 Regulatory policies

Regulatory policies are crucial for promoting the circular economy (Ellen MacArthur Foundation, 2013). They can encourage more sustainable practices and technologies, re-

duce waste and pollution, and promote the circular use of resources (Ellen MacArthur Foundation, 2015a). Regulatory policies can be divided into three broad categories: command and control, economic instruments, and voluntary measures (Fitch-Roy et al., 2021). Command-and-control policies typically involve imposing rules and standards that businesses must follow (Abad-Segura et al., 2020). For example, economic instruments such as taxes on carbon emissions or landfill usage can make unsustainable practices more costly, thereby encouraging companies to find greener alternatives. Conversely, subsidies or tax breaks can be offered to support businesses that invest in circular economy processes, such as recycling or renewable energy usage. Market-based mechanisms like cap-and-trade systems for emissions can also drive companies to innovate in order to stay within legal limits. Voluntary measures include programs such as certification, labeling, and eco-design initiatives that encourage businesses to adopt more sustainable practices voluntarily (Ma et al., 2022). For instance, a company may receive a tax reduction for achieving and maintaining a recognized environmental management standard, or a product may carry a premium price if it is certified as sustainably sourced.

a) Extended producer responsibility

Extended producer responsibility (EPR) is a regulatory policy that holds producers accountable for the environmental impacts of their products throughout the product life cycle, including post-consumer stages. By mandating producers to manage the disposal or recycling of their products, EPR shifts the waste management cost and physical responsibility from local governments and consumers back to producers (WRAP, 2023). This policy mechanism incentivizes producers to design for recyclability, reduce material usage, and create more durable goods. For example, in the electronics industry, EPR can lead to the design of devices that are easier to disassemble for repair or recycling, potentially reducing e-waste. In packaging, EPR schemes can result in producers choosing materials that have a lower environmental impact or are more readily recyclable (Kunz et al., 2018).

Economic examples of EPR include the use of deposit-refund systems for beverage containers, where producers fund the collection and recycling process, thereby ensuring high recovery rates (Leal Filho et al., 2019). Another example is the tire industry, where fees are charged at the point of sale to fund the collection and processing of tires at the end of their useful life. These fees are then used to subsidize recycling plants that turn old tires into rubber mulch for playgrounds or asphalt for roads, thus closing the loop on tire materials (Eunomia, 2023).

EPR policies have been instrumental in driving innovation in product design and waste management. They encourage companies to consider the end-of-life phase during the design process, leading to products that are easier to reuse, repair, or recycle. Additionally, EPR can lead to the development of new business models, such as take-back programs, where companies offer discounts on new products when old ones are returned. This not only reduces waste but also fosters customer loyalty and brand reputation. By internalizing the environmental costs, EPR policies ensure that producers contribute to the overall sustainability of the products they introduce to the market.

b) Product design and labeling

Product design and labeling policies are key to fostering a circular economy by guiding businesses to create products with sustainability in mind. These policies can mandate that companies disclose environmental information, such as the use of materials, energy consumption, and emissions during production, enabling consumers to make environmentally conscious choices (European Commission, 2022; Gåvertsson et al., 2020; Meis-Harris et al., 2021). For example, a furniture company might use sustainably sourced wood and non-toxic finishes, then highlight these features through eco-labeling, which can influence consumer preference and market value.

Energy labeling on appliances, another economic example, informs consumers about the product’s energy efficiency, encouraging manufacturers to innovate in energy-saving technologies. This not only helps consumers save on electricity bills but also stimulates

competition among producers to improve product efficiency (Bovea et al., 2018; Boyer et al., 2021).

In the automotive industry, labeling that indicates a vehicle’s fuel efficiency and carbon emissions can steer consumers towards more efficient, lower-emission vehicles. This demand shift can lead to a market where sustainable design is a competitive advantage, pushing the industry towards greener alternatives. Similarly, in the electronics sector, labels indicating a product’s recyclability can prompt companies to design products that are easier to disassemble and recycle, reducing electronic waste and conserving resources (European Commission, 2023d).

By providing transparency and fostering accountability, product design and labeling policies not only promote sustainable consumption but also drive innovation in product development, aligning business goals with environmental stewardship.

c) Bans and restrictions

Bans and restrictions serve as a direct regulatory approach to curtail the use of environmentally harmful materials and products, thereby mitigating waste and pollution (Qu et al., 2019). Economic examples of this include the prohibition of single-use plastic bags, which has led to increased use of reusable bags, reducing plastic waste. This policy has economic implications as it shifts consumer behavior and opens markets for alternative products (Alberich et al., 2023).

Another example is the restriction on microbeads, which has spurred the personal care industry to develop biodegradable alternatives, affecting product formulation and market offerings (Deutsche Bank, 2021). The ban on hazardous substances like lead in electronics and mercury in thermometers has not only improved public health and safety but also driven innovation in the production of safer, more sustainable electronics and medical devices. These restrictions often lead to the development of new materials and technologies, which can create economic opportunities in research and development, as well as in the manufacturing of alternative products (World Economic Forum, 2020).

Such regulatory measures can also have broader economic benefits by reducing the long-term costs associated with waste management and environmental cleanup, and by fostering a market for green technologies and sustainable materials.

d) Deposit return schemes

Deposit return schemes serve as a critical mechanism to incentivize recycling among consumers, with a refundable deposit charged at the time of purchase and returned upon recycling of the product or packaging (Organization for Economic Cooperation and Development, 2023; O'Dwyer et al., 2022). The success of these schemes, however, is not uniform across regions. For example, British Columbia's pioneering legal mandate for single-use drink containers in 1970 has led to a significant uptick in recycling rates. In contrast, Lithuania's more recent program, initiated in 2016, achieved a 90% recovery rate by its second year (GS1 UK, 2021; Hossain et al., 2022). Similarly, established programs in Germany, Norway, and Sweden have seen sustained success and have expanded to include a broader array of packaging (Velis et al., 2022). These variations highlight the complexities of consumer behavior as a critical determinant in the varied success of these initiatives (Chioatto and Sospiro, 2023). A thorough investigation into these behavioral dynamics is essential (Gavrilescu et al., 2023), as understanding these factors is key to overcoming the challenges and leveraging the successes of deposit return schemes in fostering circular economies, a topic well-explored in existing literature (Charles et al., 2019; Euractiv, 2023).

e) Reuse

In the pursuit of a circular economy, a reuse policy is paramount, aiming to diminish waste and optimize the utilization of resources. The ethos of the circular economy is not only to reclaim and repurpose materials but also to establish a closed-loop system where materials are continuously cycled back into the economy, thereby prolonging their utility and curtailing the impetus for fresh production (Geissdoerfer et al., 2017). This closed-loop approach is exemplified by adaptive reuse, particularly within the realm of

cultural heritage, which contributes to the circular economy’s objectives. It involves the transformation of existing edifices and locales, thus obviating the demand for new constructions and safeguarding cultural patrimony (Chioatto and Sospiro, 2023; Prendeville et al., 2018; Velis et al., 2022).

Illustrative of this closed-loop approach are several examples (Rosa et al., 2020; Zhu et al., 2018). The High Line in New York City, an innovative public park crafted atop a historic freight rail line, has been lauded for its integration of green spaces and public art, embodying the circular economy’s principle of material recovery and reuse. London’s Tate Modern, a modern art museum within a repurposed power station, and Toronto’s Distillery District, which has transitioned from a historic distillery to a cultural hub, both exemplify the fusion of cultural rejuvenation and architectural conservation. Glasgow’s Lighthouse and Vienna’s Gasometer have similarly been transformed, showcasing how adaptive reuse can contribute to a sustainable, closed-loop system by minimizing the need for new resources and reducing waste (Kjær et al., 2019; O’Dwyer et al., 2022). These cases highlight the potential for a circular economy to extend beyond recycling, creating systems where materials and products are reused in a manner that maintains their value and utility over time.

f) Other elements

Without being exhaustive, we may emphasize the importance of other elements, such as very short supply chains with a focus on reuse policies, and the increasing emphasis on corporate social responsibility (CSR) and environmental, social, and governance (ESG) commitments.

One important aspect of promoting the circular economy is the consideration of very short supply chains (Geissdoerfer et al., 2018). These supply chains involve a limited number of intermediaries and propose to minimize the distance between producers and consumers. By reducing transportation and logistics requirements, very short supply chains can help to lower carbon emissions and energy consumption. Additionally, when

these supply chains are coupled with a reuse policy, such as the case of milk in glass bottles that are returned for reuse, they can further contribute to waste reduction and resource conservation (Govindan and Hasanagic, 2018).

The use of glass bottles for milk packaging, which can be returned and reused, offers several advantages (Cappiello et al., 2022; World Economic Forum, 2014). Firstly, glass is a highly durable material that can be reused multiple times before recycling. This reduces the need for new packaging materials and decreases the overall environmental impact associated with the production and disposal of single-use containers. Secondly, the return and reuse of glass bottles in a closed-loop system can help to minimize waste generation and promote resource efficiency. By implementing appropriate collection and cleaning processes, the bottles can be reintroduced into the supply chain, reducing the demand for new packaging and minimizing the associated environmental footprint.

Furthermore, the emphasis on CSR and ESG commitments is gaining traction in the context of promoting the circular economy (Avramov et al., 2022; Fatima and Elbanna, 2023). CSR refers to the voluntary actions taken by companies to address social and environmental issues beyond legal requirements (Investopedia, 2022). On the other hand, ESG refers to the integration of environmental, social, and governance factors into business practices (Halbritter and Dorfleitner, 2015). Customers are increasingly demanding that suppliers comply with their ESG commitments, reflecting a growing awareness of the need for sustainable and responsible business practices. This shift in customer expectations is driving companies to adopt more comprehensive sustainability strategies and align their operations with the principles of the circular economy.

Regulatory policy framework overview

The described regulatory measures operate synergistically within a circular economic model. EPR provides the overarching structure, under which Product Design and Labeling Standards ensure products are born circular. Bans and Restrictions eliminate

non-conforming items from the production cycle, and Deposit Return Schemes serve to close the loop, ensuring products come back for reuse or recycling. This integrated policy framework requires constant dialogue between stakeholders and adaptive governance to manage the complex interplays within these mechanisms . Figure 1 below visualizes this structured framework.

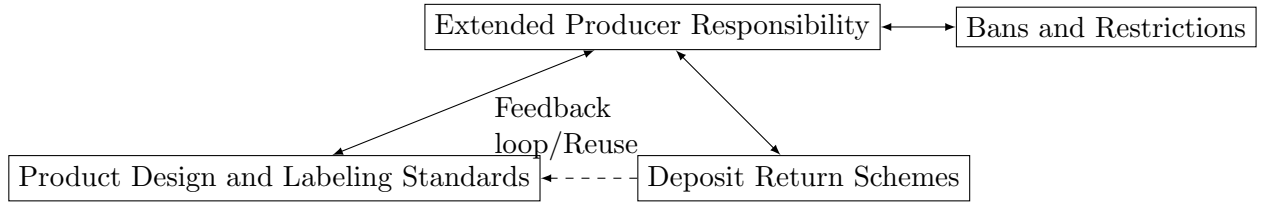


Figure 1: Integrated Regulatory Framework for a Circular Economy

In summary, regulatory policies can play a crucial role in promoting the circular economy. Extended producer responsibility, product design and labeling, bans and restrictions, deposit schemes, and reuse are examples of regulatory policies that can promote resource efficiency, waste reduction, and circular use of resources. Note that the list of policies that we provide is not exhaustive and can be further extended. Policymakers must design and implement policies to address a linear economy environmental, economic, and social challenges. Regulatory policies are vital tools in this effort.

5.1.2 Economic incentives

Economic incentives are essential to policy measures for promoting a circular economy (Domenech and Bahn-Walkowiak, 2019). They attempt to stimulate the adoption of sustainable practices by providing financial rewards for activities that reduce waste and pollution or promote resource efficiency. Economic incentives include environmental taxes and charges, subsidies, grants, and green procurement.

a) Environmental taxes and charges

Environmental taxes and charges are the financial penalties imposed on activities that

generate pollution, waste, or other environmental harm (Bellver-Domingo and Hernández-Sancho, 2022). Their design discourages such activities and encourages sustainable alternatives. For example, governments may tax waste disposal in landfills to encourage recycling and composting (European Environment Agency, 2023). Similarly, taxes on carbon emissions can encourage companies to reduce their greenhouse gas emissions and shift to cleaner energy sources.

The effectiveness of environmental taxes and charges depends on their design and implementation. To be effective, they need to be at a high enough level to discourage harmful activities, but not so high that it creates significant economic distortions (Vence and López Pérez, 2021). It is also vital to ensure that the revenue generated from these taxes supports sustainable development activities and does not finance general government spending (European Commission, 2023b).

b) Subsidies and grants

Subsidies and grants are economic incentives that should promote the circular economy (Ngan et al., 2019). They support businesses and individuals who adopt sustainable practices or invest in resource-efficient technologies (Marinina et al., 2021). For example, governments may offer subsidies for renewable energy projects or grants to businesses that invest in waste reduction or recycling technologies (Euro-Funding, 2023).

The effectiveness of subsidies and grants depends on their design and implementation. To be effective, they must target activities promoting sustainable development and avoid creating economic distortions. Governments must ensure that subsidies and grants should not prop up unsustainable practices or support activities that would have occurred anyway (Circular City Funding Guide, 2023).

c) Green procurement

Green procurement is an economic incentive that encourages adopting sustainable practices by public- and private-sector organizations (Shadrina et al., 2022). These practices involve procurement policies that prefer goods and services meeting specific envi-

ronmental and social criteria (Fuertes Giné et al., 2022; Wijayasundara et al., 2022). For example, a government may require that all the paper products it purchases be certified sustainably sourced. Similarly, a business may require all its suppliers to adhere to specific environmental standards (European Commission, 2023a).

Green procurement can promote a circular economy by creating a market for sustainable goods and services (Bohnenberger, 2022). However, this requires the cooperation of both buyers and suppliers, and it can be challenging to ensure that suppliers comply with the required standards (Lindström et al., 2020). To be effective, green procurement policies require careful design and implementation to avoid creating market distortions or unfairly favoring certain suppliers (EU-Japan Centre for Industrial Cooperation, 2023).

In summary, economic incentives such as environmental taxes and charges, subsidies, grants, and green procurement can be effective policy measures for promoting a circular economy. However, their effectiveness depends on their design and implementation, and they must be carefully targeted and monitored to avoid creating unintended consequences or market distortions (European Commission, 2023c; Papadopoulos and Evangelinos, 2022).

5.1.3 Voluntary measures

In addition to regulatory policies and economic incentives, voluntary measures can promote a circular economy (Milios, 2021). These measures are not legally enforced, but are taken up voluntarily by companies or individuals. These include eco-labeling and certification, corporate social responsibility, and circular economy networks.

a) Ecolabeling and certification

Ecolabeling and certification are voluntary measures that enable consumers to identify environment-friendly products. An ecolabel is a label or mark placed on a product that indicates that it meets specific environmental criteria. On the other hand, certification verifies whether a product or process meets specific environmental standards (Global

Ecolabelling Network, 2023).

Ecolabeling and certification provide incentives for companies to design and produce environment-friendly products. By meeting the environmental standards set by ecolabels or certifications, companies can differentiate themselves from their competitors and attract environmentally conscious consumers (Federal Trade Commission, 2023). However, companies can also misuse ecolabels and certifications to greenwash their products and processes. In greenwashing, companies make false or exaggerated environmental claims about their products or processes to mislead consumers (Federal Trade Commission, 2023).

b) Corporate social responsibility

Corporate social responsibility is a voluntary measure that involves companies taking responsibility for their social and environmental impact (Fortunati et al., 2020; Morea et al., 2021). Corporate social responsibility can include various activities, such as reducing energy and water use, reducing waste, and promoting sustainable sourcing. Corporate social responsibility can be driven by the company values or by external pressures, such as consumer demands or regulatory requirements (Geissdoerfer et al., 2018; Investopedia, 2022).

Corporate social responsibility can be a powerful tool for promoting the circular economy, as it encourages companies to consider their environmental impacts and take steps to reduce them. However, corporate social responsibility is also criticized for being a voluntary measure that allows companies to select the environmental and social issues they address rather than being legally required to address them all (Investopedia, 2022).

c) Circular economy networks

Circular economy networks are voluntary groups of organizations that work together to promote a circular economy (Geng et al., 2019). These networks can include companies, government agencies, and non-governmental organizations. Circular economy networks can share knowledge and best practices, collaborate in circular economy projects, and

promote a circular economy to a broader audience (Harvard Business Review, 2021).

Circular economy networks can be a powerful tool for promoting the circular economy because they allow organizations to collaborate and learn from each other (Ngan et al., 2019; Rosa et al., 2020). However, one can criticize circular economy networks for being exclusive and favoring larger companies over smaller ones (European Commission, nd).

Overall, voluntary measures such as eco-labeling and certification, corporate social responsibility, and circular economy networks can be effective in promoting a circular economy. However, they should be used with regulatory policies and economic incentives to create a comprehensive policy framework for promoting a circular economy.

5.2 The challenges to implementing the circular economy

Despite the benefits of the circular economy, its implementation has challenges. This section discusses cultural and behavioral barriers, economic and regulatory barriers, technical and logistical barriers to implementing the circular economy.

5.2.1 Cultural and behavioral barriers

Cultural and behavioral barriers to the implementation of the circular economy stem from the current linear economy way of thinking, where products are designed for one-time use and then disposed of. Therefore, a significant cultural shift is required to support a circular economy, in which products are designed for multiple uses and material recovery (Korhonen et al., 2018). The traditional business model of the linear economy encourages consumers to purchase new products frequently, even if the products they currently own are still functional. The circular economy success relies on consumers' willingness to adopt a more sustainable lifestyle, prioritizing durability and repairability over constant consumption (Rizos et al., 2016).

Furthermore, a lack of awareness and knowledge of the circular economy concept and benefits can also be a significant cultural barrier. Many individuals and organizations are

unaware of the circular economy principles, its benefits, and its impact on the environment and economy (Koszewska, 2018). Therefore, education and awareness-raising campaigns are crucial for breaking cultural barriers and promoting a circular economy (Gustavsson et al., 2016).

5.2.2 Economic and regulatory barriers

Economic and regulatory barriers to the circular economy come from the current economy being built on a linear model, where resources are extracted, transformed, and disposed of. This linear model operates at a lower cost than the circular model, making it difficult for circular businesses to compete in the market. The current economic model does not account for the environmental and social costs of resource depletion, pollution, or waste (Gustavsson et al., 2016). Therefore, there is a need for economic policies that incentivize business models to level the playing field (Chenavaz et al., 2022).

Regulatory policies play a crucial role in implementing the circular economy. Many regulations favor a linear economy, making it difficult for circular businesses to operate (Hopkinson et al., 2018). For instance, regulations prohibiting using recycled materials in certain products or waste disposal regulations that do not prioritize recycling can hinder the transition to a circular economy (Korhonen et al., 2018). Therefore, policy-makers must enact regulations supporting circular business models and penalize those not adhering to circular principles.

5.2.3 Technical and logistical barriers

Technical and logistical barriers to the circular economy stem from current infrastructure and technology not being designed to fully support a circular economy (European Commission, 2018; Govindan and Hasanagic, 2018). The current waste management infrastructure is built around a linear model, where materials are discarded rather than reused. The infrastructure for collecting, sorting, and processing waste must be reconfig-

ured to support a circular economy. Furthermore, there is a need for new technologies that support circular business models, such as innovative recycling technologies that can recover valuable materials from waste streams (Gustavsson et al., 2016).

Moreover, implementing a circular economy can be challenging. For example, designing products for multiple uses and returning them to the manufacturer for refurbishment requires a more sophisticated supply chain management system (Pla-Julián and Guevara, 2019; Upadhyay et al., 2021). Similarly, it can be challenging to coordinate the collection, sorting, and processing of waste streams in a manner that supports circular business models (Korhonen et al., 2018). Therefore, there is a need for investment in R&D to address the technical and logistical barriers to implementing a circular economy.

6 Policy framework and research agenda

This section sets the stage for a detailed exploration of both the structured policy framework and the future research directions, emphasizing their relevance and interdependence in advancing the circular economy.

6.1 Structured policy framework

The advancement of the circular economy necessitates a multifaceted policy approach, integrating insights from various sectors and disciplines. This section outlines the essential policy interventions and their respective roles in nurturing a circular economy, informed by the comprehensive literature reviewed in previous sections.

Effective regulatory policies are paramount for guiding and enforcing circular economy practices. As Geissdoerfer et al. (2018) illustrate, policies like extended producer responsibility (EPR) influence production and consumption patterns. Similarly, Rizos et al. (2016) emphasize the role of environmental regulations in driving sustainable business models.

Technological innovation is a cornerstone of the circular economy. Govindan and Hasanagic (2018) highlight the critical role of emerging technologies in waste management and resource optimization. The study by Hopkinson et al. (2018) further underscores the importance of technological advancements in enhancing circular economy practices.

The success of circular economy initiatives heavily relies on active stakeholder engagement. Koszewska (2018) discuss the necessity of collaborative efforts among various stakeholders, including businesses, governments, and communities. Ngan et al. (2019) further argue for the inclusion of diverse perspectives in policy-making processes.

Raising awareness and education are critical for fostering a culture of sustainability. The impact of educational programs on consumer behavior, as demonstrated by Abad-Segura et al. (2020), is pivotal for the circular economy transition. Brito et al. (2022) also stress the importance of public campaigns in promoting recycling and sustainable consumption.

Monitoring and evaluating circular economy policies is essential for their success and scalability. Upadhyay et al. (2021) emphasize the need for effective indicators to assess the impact of circular economy initiatives. Similarly, Zhu et al. (2018) advocate for data-driven approaches to policy evaluation.

The circular economy's global nature necessitates international cooperation. Ellen MacArthur Foundation (2021) highlight the importance of cross-border collaboration in resource management. The work of Eunomia (2023) further supports the need for harmonizing policies to facilitate international trade in sustainable goods.

Financial support is crucial for implementing circular economy initiatives. 1GNITE (2021) discuss the relevance of sustainable finance in aligning investments with environmental goals. Chen et al. (2020) also explore the potential of green bonds in funding circular projects.

Integrating social equity into circular economy policies is vital. Halbritter and Dorfleitner (2015) examine the relationship between circular practices and social justice, ad-

vocating for inclusive policies. Fatima and Elbanna (2023) explore how circular economy strategies can contribute to job creation and poverty reduction.

Local and regional policies play a significant role in supporting the circular economy. Domenech and Bahn-Walkowiak (2019) emphasize the effectiveness of localized policy approaches. The integration of circular principles into urban planning is further supported by Lindström et al. (2020).

6.2 Future research agenda

The transition to a circular economy presents a paradigm shift in how societies manage resources, produce, and consume goods. While this article has explored the current state of policies that support this transition, several areas warrant further investigation to enhance the efficacy and reach of these policies. This section outlines a future research agenda to address these gaps and propel the understanding and implementation of the circular economy forward.

Digital technologies such as blockchain, Internet of Things, and artificial intelligence have shown potential in enhancing transparency, traceability, and efficiency in supply chains. However, research on their integration into circular economy practices remains nascent. Future studies could focus on developing frameworks for incorporating these technologies into circular models. Understanding the barriers to their adoption and the implications for data security and privacy is also crucial. Studies could explore case examples where digital solutions have been successfully implemented, providing insights and best practices for broader application.

The success of circular economy policies hinges on consumer behavior and cultural shifts. While some studies have touched upon this aspect, comprehensive research focusing on how to induce behavioral change towards more sustainable consumption patterns is needed. This includes understanding the psychological and sociocultural factors that drive or impede circular practices among consumers and businesses. Research could also

delve into how education and awareness campaigns can be designed to maximize their impact on changing mindsets and habits.

The interplay between circular economy policies and other economic and environmental policies (e.g., climate change, biodiversity conservation) is complex and underexplored. Future research should propose to identify synergies and potential conflicts between these policy domains. This will aid in developing integrated policy frameworks that address multiple sustainability goals simultaneously. Researchers could also explore how circular economy policies can be aligned with broader socio-economic objectives, such as job creation, poverty alleviation, and social equity.

There is a clear need for more robust and standardized metrics to measure the impact of circular economy policies. Future studies should focus on developing and validating quantitative indicators that can assess the environmental, economic, and social outcomes of circular practices. Longitudinal studies tracking these metrics over time would be particularly valuable in understanding the long-term impacts of circular economy policies. Additionally, comparative studies across different geographical and industrial contexts can provide insights into the effectiveness of various policy instruments.

Much of the current research on circular economy is centered around developed countries. However, the applicability and implications of circular economy policies in developing and transition economies remain relatively unexplored. Future research should focus on understanding the unique challenges and opportunities that these economies face in transitioning to a circular model. This includes examining the role of informal sectors, the availability of technological and financial resources, and the capacity for policy enforcement. Comparative studies between developed and developing contexts can yield valuable lessons and strategies that are contextually relevant.

Research is needed to understand the factors that influence the scalability and transferability of successful circular models. This includes identifying the key drivers and barriers to scaling up pilot projects and understanding how circular solutions can be

adapted to different contexts and scales. Studies should also explore the role of public-private partnerships and collaborative networks in facilitating the diffusion of circular models.

In conclusion, a future research agenda in the field of circular economy should encompass a multi-disciplinary approach, integrating insights from technology, psychology, economics, policy studies, and environmental science. Such comprehensive research efforts are crucial for unlocking the full potential of circular economy policies and practices, ultimately contributing to a more sustainable and resilient future.

7 Conclusion

In addressing the urgent global challenge of waste and pollution, this policy article has provided a critical examination of the circular economy as a transformative approach to sustainable development. By systematically categorizing and analyzing policies that underpin the circular economy, this study contributes to the existing body of literature by offering a structured policy framework that integrates regulatory, economic, and voluntary measures. Our findings resonate with and extend previous research by demonstrating the multifaceted nature of policy instruments and the complex interplay of barriers that can impede their effectiveness.

The significance of our results lies in their practical implications for a broad spectrum of stakeholders. For policymakers, the research underscores the necessity of crafting regulations and economic policies that not only incentivize circular business models but also address the cultural and behavioral shifts required for a sustainable transition. For businesses, the findings highlight the importance of integrating circular principles into core operations and value chains. For consumers, the study reinforces the need to embrace consumption patterns that prioritize product longevity and resource conservation.

Comparatively, our research situates itself within the scholarly discourse by providing

empirical evidence on the practicality and impact of circular economy policies, thereby offering a more nuanced understanding of their operationalization. The article also identifies fertile ground for future research, particularly in exploring the scalability of circular economy practices and their long-term socio-economic and environmental outcomes.

The limitations of this research, including the potential for selection bias in case studies and the generalizability of findings, are acknowledged as areas for further investigation. These limitations, however, do not detract from the study's contribution to ecological economics theory and the concept of the circular economy. Instead, they provide a roadmap for subsequent empirical work that can refine and expand upon the policy recommendations offered herein.

Finally, this article contributes to the theoretical underpinnings of the circular economy by reinforcing the notion that sustainable development is not merely an environmental or economic issue but a comprehensive one that encompasses cultural and social dimensions. By highlighting the interconnectedness of policy, practice, and behavioral change, this study offers a valuable perspective for readers and practitioners in the field, advocating for a concerted effort to realize the potential of the circular economy. In doing so, it lays the groundwork for a paradigm shift towards a more resilient and equitable global economy.

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