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The opening circle: four moves to rethink the circular economy

Il cerchio da aprire: quattro mosse per ripensare l'economia circolare

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ABSTRACT AND KEYWORDS

The opening circle
The 'closing of the circle' has been advocated since the early environmental movements as a way to reconcile man and woman with nature by mitigating the destructive effects of modern technology, which threaten the very survival of humanity on the planet. More recently, the concept has been integrated into public policies and programs, leveraging the narrative of a circular economy capable of decoupling growth from resource consumption and pollution. In light of the practical and conceptual difficulties of closing the circle, this article investigates four moves to "open" rather than "close" the circle of the circular economy. The openness it proposes encourages new constructive encounters between critical theory and experimental practice, and between technical and social disciplines, in order to advance toward an epistemologically diverse understanding of circularity.

Keywords: circular economy, public policy, closed vs. open modelling, interdisciplinarity

Il cerchio da aprire
La "chiusura del cerchio" è stata invocata fin dai primi movimenti ambientalisti come un modo per riconciliare l'uomo e la donna con la natura mitigando gli effetti distruttivi della tecnologia moderna, che minacciano la sopravvivenza stessa dell'umanità sul pianeta. Più recentemente, il concetto è stato integrato nelle politiche e nei programmi pubblici, facendo leva sulla narrativa di un'economia circolare in grado di disaccoppiare la crescita dal consumo di risorse e dall'inquinamento. Alla luce delle difficoltà pratiche e concettuali di chiudere il cerchio, questo articolo indaga quattro mosse per "aprire" piuttosto che "chiudere" il cerchio dell'economia circolare. L'apertura che propone incoraggia nuovi incontri costruttivi tra teoria critica e pratica sperimentale, e tra discipline tecniche e sociali, per avanzare verso una comprensione epistemologicamente diversa della circolarità.

Parole chiave: economia circolare, politica pubblica, modellazione chiusa vs. aperta, interdisciplinarità

1. Introduction

In Europe, as elsewhere in the world, the concept of circular economy (CE) has recently been incorporated into many public policies as a strategy to boost the economy amidst economic, social, and ecological crises. Public funding and programs have created opportunities for research and development, primarily in the fields of chemical and industrial engineering, but also digital and social innovation.[1] At the same time, national and city governments have adopted the concept within strategic development plans and programs (Petit-Boix and Leipold, 2018). The dominant narrative promotes the idea of considering "waste as a resource" within closed circles of resource production and consumption to decouple economic growth from global resource depletion and environmental pollution. This evocative and normative discourse presupposes a win-win scenario, with positive outcomes for the economy, society, and the environment alike. (Ellen Mac Arthur Foundation and McKinsey Center for Business and Environment, 2015). However, criticisms of the theoretical, heuristic, and methodological limitations of this interpretation of CE have been widely discussed. These criticisms highlight the tension between CE and a neoliberal economic system, which is inherently linear in its organization and design (Kovacic et al., 2019; Völker et al., 2020). Additionally, they contract CE with the economy of natural ecosystems, which operate in open and dissipative terms rather than closed and fully regenerative cycles (Skene, 2017).

This paper aims to contribute to this critical debate by fostering an interdisciplinary dialogue around the concept of CE.[2] In particular, it builds upon a recent strand of research that advocates "hybridising", "contaminating", and complexifying the metaphor of the circle with counter-discourses (Barrie et al., 2022; Genovese and Pansera, 2021; Nylén et al., 2023). In doing so, and as others before, this paper acknowledges the transformative potential embedded in the current political and normative momentum surrounding EC. Rather than rejecting the metaphor outright, it seeks to transform it from within to avoid generating further confusion by proposing new metaphors and concepts. The underlying assumption is that the abstract formalisation of circularity–as proposed by normative and managerial interpretations–is ineffective. Analytically, it is limited by its inherent conceptual rigidity, and politically, it reinforces the links between production and consumption through an economic valorisation logic, albeit rhetorically associated with circular processes. In contrast, contextual and situated experiences of CE demonstrate adaptive and differentiated trajectories that require greater epistemological flexibility.

The paper is structured as follow: the next section outlines some of the main criticisms of CE and advocates for greater openness in defining circularity challenges and their solutions. Section 3 introduces four theoretical "moves" that expand (or open) the circle of CE to incorporate more conceptual frameworks and foster a critical awareness of the limits and potential of circularity. Building on this reflection, Section 4 emphasises the need for an epistemological shift in the political ecology of the CE. It calls for alternative ways of imagining and practicing circularity that are better aligned with territorialised specificities and potentials. The conclusion highlights the importance of creating spaces for experimentation but also developing tools (and fostering political will) to recognize and legitimise alternative approaches to circularity. These alternatives, though often marginalised and overlooked, exit outside the confines of the closed-circle framework of CE.

2. Opening the circle: critiques of the Circular Economy

Over the past decade, numerous criticisms have emerged regarding the notion of CE as "an essentially contested concept" with multiple and slippery interpretations (Corvellec et al., 2021; Korhonen et a., 2018). There is indeed a widespread lack of consensus among scholars and stakeholders on CE definitions and objectives, which are predominantly skewed toward economic prosperity, occasionally toward environmental conservation, and rarely toward social justice (Homrich et al., 2018; Kirchherr et al., 2017; Petit-Boix and Leipold, 2018; Prendeville et al., 2018). In terms of content, the concept can paradoxically prove counterproductive. The rhetorical move to turn waste into a resource risks normalizing wasteful practices by commodifying waste for the expanding global market (Greer et al., 2021; Corvellec et al., 2020; Corvellec and Hultman, 2012). This perspective often neglects the materiality and toxicity of waste, as well as the length and complexity of global product chains, which make it almost impossible for companies to build closed material loops (Corvellec et al., 2020; Johansson et al., 2020; Liboiron, 2009). Most importantly, the CE model contradicts the law of entropy, which dictates that all transformations result in energy loss (Andersen, 2007). While materials can be recirculated, doing so requires significant energy inputs, particularly in industrial recycling processes.

Social issues such as those related to territorial inequalities, uneven distribution of resources and benefits, environmental hazard, and labour exploitation are insufficiently addressed within the CE framework (Gregson et al., 2015, 2016; Moreau et al., 2017; Schröder et al., 2019). The metaphor of the circle appears little permeable to contamination with more complex modelling necessary to include the collective contradictions and the dynamics of social transitions, except in the often-ambiguous terms of its "social desirability" (Murray et al., 2017). Ultimately, the strong focus on post-consumer waste, coupled with an emphasis on consumption behaviour as a result of choices made by autonomous, rational actors, reflects a reductive modelling approach. This perspective overlooks that social practices follow patterns extending beyond individual rationality (Völker et al., 2020) and are deeply influenced by cultural and territorial contexts (Hobson, 2020). This critique is perhaps the most distinctly sociological objection to CE and is reinforced by post-structuralist perspectives, which highlight socio-material nexuses (meanings, routines, infrastructures, skills, etc.) as critical elements for understanding forms of collective regulation.

In light of these criticalities, this paper emphasises the need to reformulate the concept of CE by thinking in terms of "open" rather than "closed" modelling and adopting an epistemologically diverse understanding of circularity. This reformulation is particularly urgent given the growing political support for circularity as part of regional development strategies and local carbon neutrality ambitions, which has driven demand for further research into the territorial agendas and the tangible effects of community initiatives on cities, culture and sustainability (Marin and De Meulder, 2018). As mentioned above, one of the main flaws of the current metaphor of circularity is that, while it challenges the traditional linearity of modern industrial society, it reinforces a singular, normalised solution to the problem of unsustainability. This approach identifies the circular form as a type of logical-organisational essentialism, promoting a generalised dynamic that fails to account for situated processes and ecological relationships, which by inherently contextual, dynamic, heterogeneous, and diverse.

To counter the recursiveness and finiteness of the metaphor of the circle, a "reopening" of its conceptual formulation is proposed that i) questions its

epistemological foundations, e.g., the link between moral values and scientific modelling, which informs global discourses but also shapes the situational applications of circularity; ii) promotes the adoption of a more comprehensive approach that incorporates the social dimension within strategies of ecological transition. Drawing on literature about epistemological (and ontological) plurality (Mol, 1999), this approach recognizes the many ways of putting the common world "in form" and "in action" (Boehnert, 2018). It seeks to challenge and reopen the closed and normalised metaphor of circularity. An epistemology of diversity enables the emergence of alternative, co-existing ways of activating reality, encompassing theoretical, methodological and cultural production, the practices of individual and collective actors, the cognitive sphere, as well as social coordination and regulation. In the following sections, four "moves" are presented that aim to "start from" and "tend towards" an epistemological diversity to reopen the closed circle of CE: *#1 Move the circle upstream!* emphasises the importance of addressing the upstream impacts of consumption choices, rather than focusing solely on disposal. While waste and pollution are often framed as a post-consumer problem, this perspective overlooks the root causes and broader systemic issues. *#2 Measuring the circle (differently)* highlights the need to redefine how circularity is measured, ensuring metrics are meaningful and relevant for end-users, including citizens and workers–whether formal, informal, or precarious–who are on the frontline of material recovery and recirculation. *#3 Slowing down circularity* suggests thinking in terms of different temporalities of decay, generation and destruction of value. Ultimately, *#4 Caring circularity* brings attention to the informal and often invisible labour that underpins circularity but remains excluded from its mainstream narratives and accounting practices. Together, these movements aim to rethink the implementation of circularity through local policies that reshape the relationship between production and consumption. By doing so, they seek to address and balance often divergent economic, social, and environmental priorities.

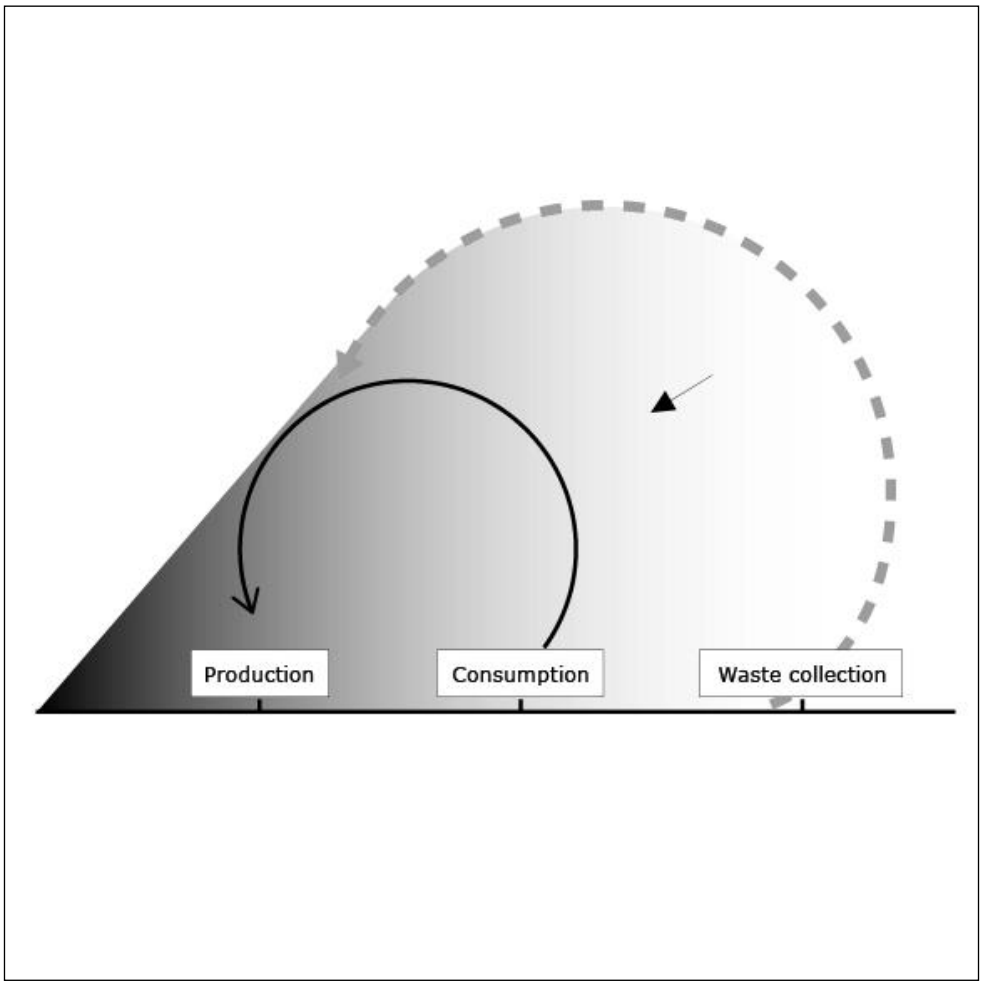
3. Four schematic moves to open the circle

3.1 Move the circle upstream!

At present, CE is largely skewed towards the end of the linear economy, emphasising waste recycling, treatment, and management, rather than addressing production and consumption. As a result, the CE has essentially been reduced to the recycling industry. Over the years, this sector has been consolidated through legislative and regulatory interventions, the stabilisation of public-private partnerships, and the widespread adoption of consumer recycling practices. While recycling may reduce the use of primary resources in specific sectors, such as metal production, it addresses only the symptoms of waste production rather than its causes. It does not drive a fundamental transformation of the production system, which remains structured around linear logic. Paradoxically, the CE's extractivist model–designed to extract economic value and generate profit from waste–often demands significant energy and technological resources, in stark contrast to the broader goal of reducing resource use. The model perpetuates the notion that post-consumer waste can sustain new production cycles while concealing the fact these cycles can be as energy intensive and polluting as conventional production (Liboiron, 2009; MacBride, 2011; McDonough and Braungart, 2008; Rogers, 2006). Furthermore, for many products, the environmental impact of production is greater than that of disposal. Yet public policies focus almost exclusively on the last stage of consumption (Deutz et

al., 2010).

Figure 1. ***Move the circle upstream!*** **shifts the challenge from closing the circle between waste generation and production to reducing the gap between production and consumption. This approach also involves shrinking the circle by shortening the value chain and striving to retain material use and value at the local level (elaboration: A. Bortolotti).**



To address these shortcomings, moving the circle upstream is crucial. This would involve prioritizing practices such as repair, dismantling, and, most importantly, waste reduction. Globally, "zero-waste" movements have combined social and environmental justice goals by opposing the construction of new waste treatment infrastructure and advocating for local jobs in repair, building deconstruction, and remanufacturing using recycled materials. Intuitively, locally closed loops–based on small-scale, decentralized waste management systems–are preferable to the current reliance on large-scale material recovery facilities and long-distance transportation (MacBride, 2011). However, the quantity and quality of post-consumer waste pose obvious limitations to small-scale treatment processes. It is difficult to imagine that waste management can be organised in large cities around networks of small or medium-sized diversion companies, as unsorted waste products that dominate consumption are of little use to buyers other than industrial recyclers (MacBride, 2022).

A key challenge lies in regulating the use of heterogeneous materials in non-durable objects that are difficult to repair and recycle. Addressing this requires a shift in

policy focus from restorative measures to preventive interventions that promote regenerative and conservative practices. Such policies should be grounded in a deeper understanding of the individual and collective customs, norms, and practices associated with (re)production.

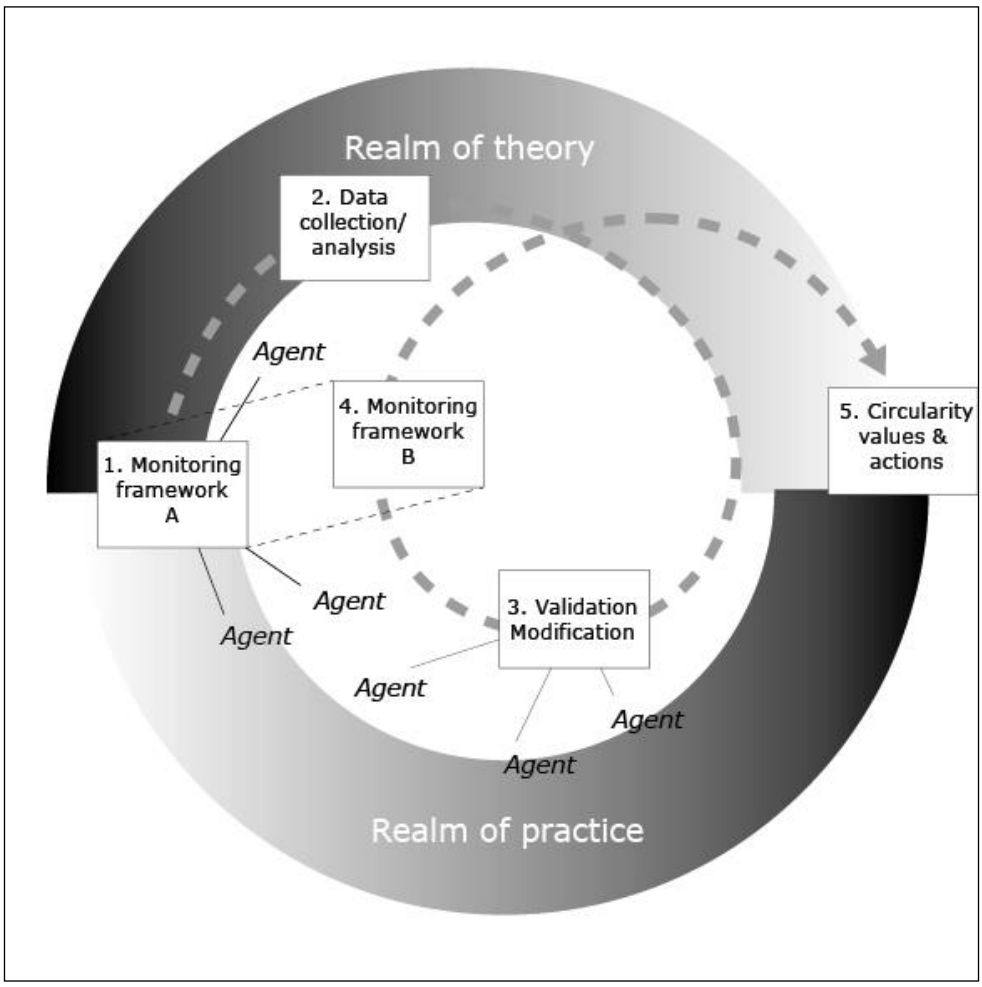
3.2 Measuring the circle (differently)

The widespread adoption of CE concept among policymakers and businesses has come along with the demand for circularity measurements and appropriate indicators to monitor progress toward a CE (Domenech and Borrion, 2022; Sileryte et al., 2023). This is particularly the case with projects and initiatives funded by public policies and programs. However, current CE endeavours lack systematic data collection and monitoring frameworks, in a way circularity's benefits are often taken for granted, even in the absence empirical proof (De Man and Friege, 2016; Harris et al., 2021). For example, the recycling performance of municipal solid waste is typically measured in terms of waste diversion rates and mass, leaving out critical environmental aspects such as embodied energy and toxicity (MacBride 2012). Mass balance indicators, often employed to assess circularity, are also contested because they exclude energy flows–which cannot be made "circular", as energy inherently degrades with use (Völker et al., 2020).

Moreover, existing metrics do not adequately address complex and nuanced factors, such as variations in consumer daily practices or changes in how products are used over time (Hobson, 2020). Similarly, small and medium-sized enterprises that play crucial roles in circular supply chains, such as reconditioning and remanufacturing, are often overlooked or omitted from national reporting frameworks (Harris et al., 2021). A further limitation of current frameworks lies in their limitations in identifying burden shifting. For example, reducing the mass of materials in a product does not necessarily equate to a reduced environmental impact if the materials used as substitutes are more toxic or harmful over the product's lifecycle. These limitations underscore the need for more sophisticated accounting models that can better capture the intricate socio-material, political and economic entanglements that underpin the material economy (from product to supply chain) as well as the relationships between producer choices, consumer practices, and the physical properties of goods and services.

This consideration becomes even more pertinent when we acknowledge that metrics function as active actants–in Latourian terms–in the process of implementing circularity. From this perspective, metrics are not merely descriptive tools; they play a performative role (Law, 2004) in shaping the implementation of circularity. In other words, indicators do not just describe reality but actively contribute to its formation through the assemblages of human and non-human entities that are part of it. Pondering circularity, therefore, entails both visualizing and concretely shaping the CE (Völker et al., 2020). Metrics are instrumental in driving choices towards particular organisational forms. For example, the predominant focus of official waste statistics on separate collection rates reflects and reinforces a commercial declination of circularity: higher rates correspond to cost-efficient operations and the realisation of profitable secondary markets (MacBride, 2022). Consequently, it is essential to critically re-examine the logic underpinning CE indicators to realign value judgements with the desired type of circularity–whether market-driven circularity, aimed at profit maximisation, or community-oriented, prioritizing local well-being of communities managing everyday resources and their environmental costs.

Figure 2. ***Measuring the circle*** **requires incorporating diverse perspectives and levels of understanding. Conceptualized as an open learning circle, the evaluation of circular strategies should integrate the insights of circularity agents from the initial definition of circularity metrics (monitoring framework A). These metrics should then be tested for validation by the agents themselves (monitoring framework B) to align data collection and analysis with specific circularity goals, values and actions (elaboration: A. Bortolotti).**



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Scholars have recently focused on improving monitoring frameworks by either expanding circularity metrics or integrating them with environmental assessments (Alaerts et al., 2019; Harris et al., 2021; Sileryte et al., 2023). For instance, Harris and colleagues (2020) suggest combining circularity with the concept of annual thresholds aligned with "planetary boundaries" (Steffen et al., 2015), to identify the sectors or social functions exerting the greatest systemic impact. This approach involves integrating the Planetary Boundaries framework with a comprehensive life cycle assessment (LCA) approach–a challenging endeavor given the inherent complexity of the issues. Other researchers emphasize the need for greater alignment between monitoring frameworks and governance tools and structures. Sileryte and colleagues (2023) advocate for a "bottom-up approach to build a shared terminology as a starting point for monitoring development" in consultation with the data providers, tool developers, and city representatives. Similarly, Alaerts et al. (2019) propose a framework to measure the outcomes and societal impacts of the circular economy–addressing needs such as housing, food, mobility, consumer goods, services, health care, and communication. This framework draws on existing literature on CE and sustainability, as well as insights from consultation with academics, policy makers and stakeholders.

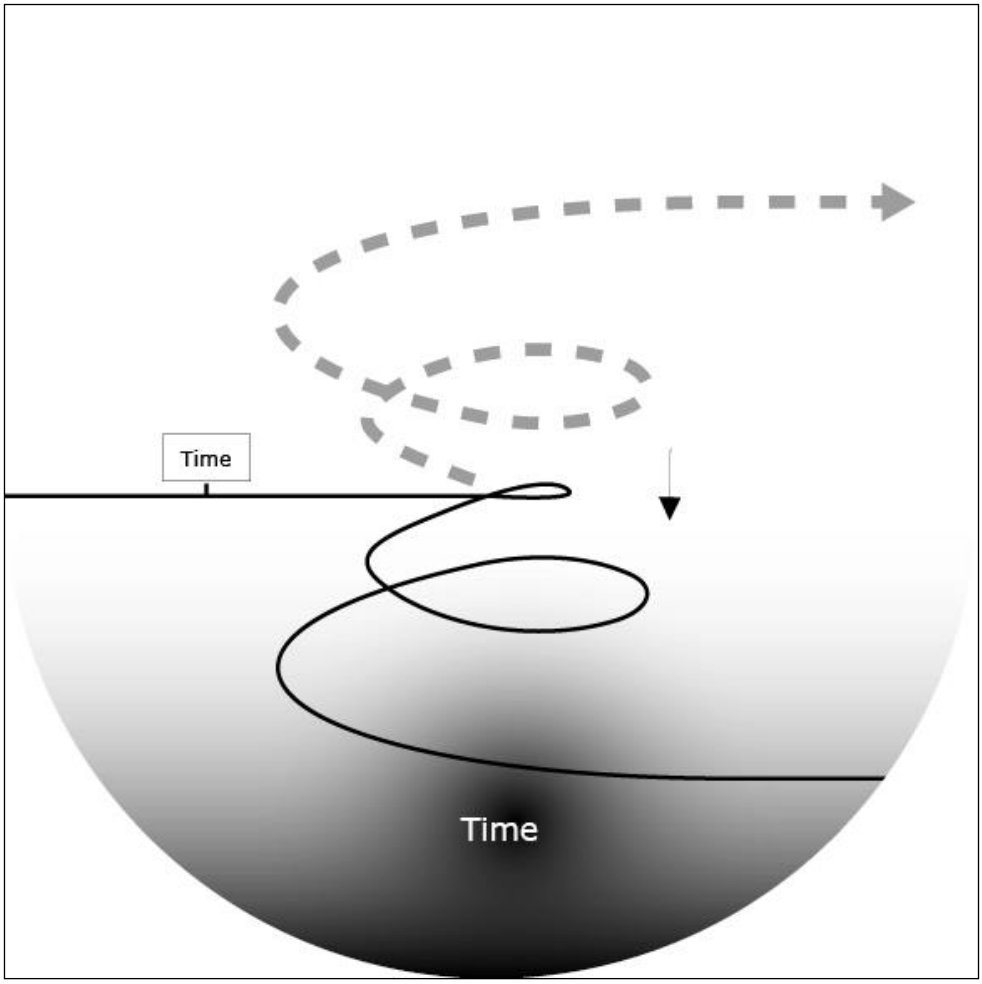
The consequences of changing strategies for evaluating circularity extend to the the legitimacy of political choices. Deliberative approaches can certainly widen the spaces of inclusion of those who are directly or indirectly involved and affected by circularity. Innovators, companies, grassroots organizations, and consumers form a broad and diverse audience capable of contributing to a democratic definition of CE objectives and the tools used to measure them [fig. 2]. In this context, the theme of epistemological diversity emphasizes integrating various way of knowing and valuing aspects of circularity, including the practical, concrete, and measurable utility often prioritized in evaluation frameworks The multiplication of epistemological perspectives in weighing circularity requires significant cultural and political effort to connect research and citizens' world. This shift requires moving beyond rhetoric to practicing true transdisciplinary dialogue. However, this is no easy task. It necessitates additional effort from research and a well-informed citizenry willing to engage and communicate effectively. Examples include campaigns where citizens monitor air quality (Da Schio, 2022) or participate in the co-design of green urban infrastructures for water management (Ranzato and Bortolotti, 2015).

3.3 Slowing down circularity

The faster the circle turns, the more the technological, material and energy efficiency margins are undermined, as they clash with the laws of thermodynamics, according to which every transformation involves a loss of energy (Skene, 2018). An excessive rapid transition could accelerate material consumption, inducing, for example, the replacement of one functional technical stock with another (e.g., the replacement of fossil fuel cars by electric veichles). Consequently, CE interventions may not only prove ineffective in reducing resource consumption, but could generate new dynamics and opportunities that accelerate–rather than slow down–the environmental impacts of human activities (Hobson, 2021). This calls for considering different temporalities–namely, cycles of "creation and destruction of value" (Thompson, 1979)–in theorising how waste is defined, perceived, produced, and treated (Weber, 2022). Temporal processes of material transformation, such as decay, ageing and disintegration, challenge the notion of recycling as a perfectly closed material cycle. At the same time, they help to conceive material obsolescence

as produced by social conventions and norms embedded in the design, production, and consumption of products and goods.

Figure 3. *Slowing down circularity* highlights strategies aimed at shifting away from the paradigm of accelerated and infinite economic growth. This approach emphasises embracing alternative trajectories and temporalities, prioritizing sustainability, resource stewardship, and the integration of slower cycles of production and consumption (elaboration: A. Bortolotti).



Within this framework, the question remains how to challenge business-as-usual practices to make them work more consistently with ecological planetary boundaries (Schröder et al., 2019). Integrating the time perspective prompts the critical examination of the unprecedented and seemingly limitless growth enabled by fossil energy use. This critique can be traced back to urban and rural practices of "permaculture" (Arnsperger and Bourg, 2016), "steady-state economy", "social and solidarity economy" (Moreau et al., 2018), and "degrowth" (Martinez-Alier, 2012). These forms of knowledge generally prioritise the social sphere, including politics, economics, work-life balance, and social structures, implying a cultural critique of the market system. As such, they contrast with how governments typically frame the CE as an engine for economic growth (Gregson et al., 2015). Slowing down circularity is closely linked to the degrowth discourse, which advocates for a fair and sustainable reduction in production and consumption. This approach calls for decolonising the collective imaginary from the epistemology of economic valorisation, creating a temporal space to redefine collective well-being, eco-social

connections, relations between local action and global processes, and the coordination between short- and long-term dynamics (Georgescu-Roegen cited in Kerschner, 2010, p. 544). Accelerated form of circularity, on the other hand, often fail to question the mechanism of progressive accumulation, which frequently redistributes the costs and benefits of transition unfairly. They overlook power asymmetries and perpetuate the destructive exploitation of both human and non-human resources and labour.

3.4 Caring circularity

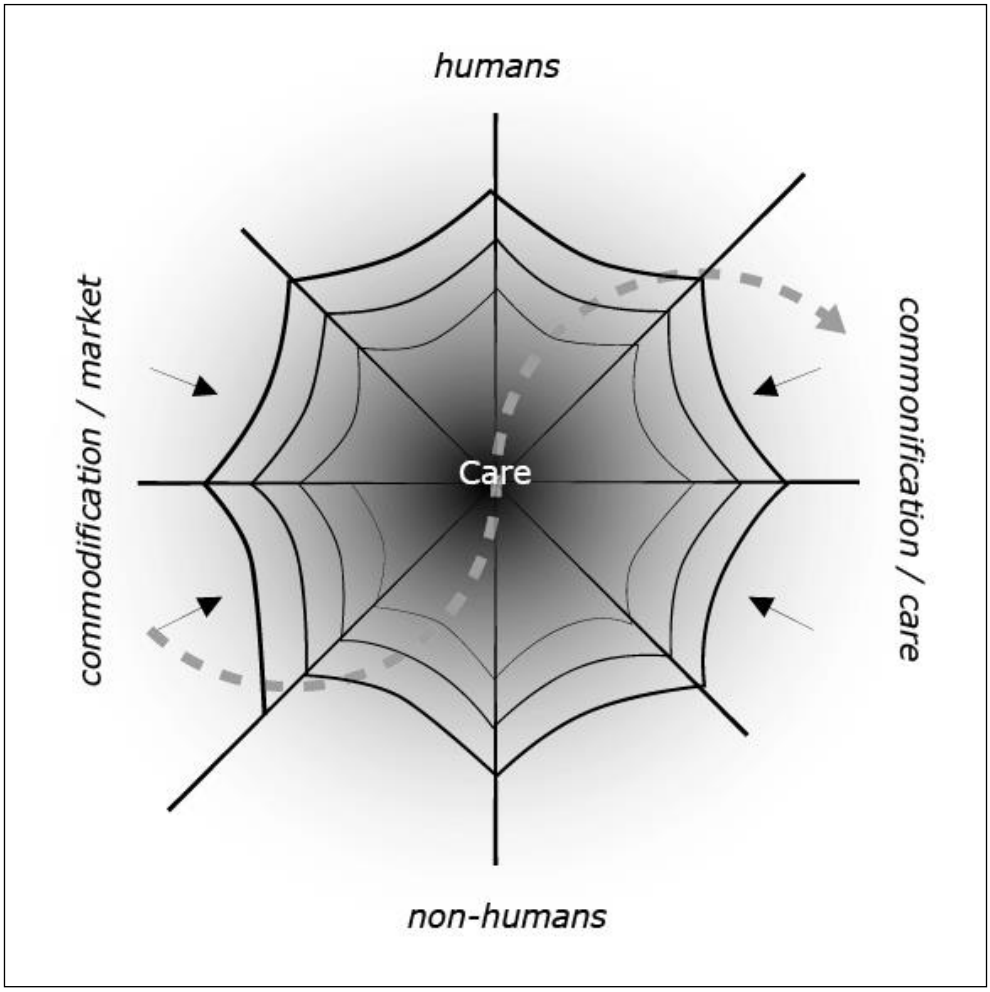
As mentioned, the metaphor of circularity mainly refers to the economic and technological optimisation of the material flows underlying production and, to some extent, consumption. Managing these flows implies that someone must "take care" of circularity, although this aspect is often underestimated in existing models. Who is then responsible for this task? The debate around the creation of new green jobs often shows the emergence of highly skilled profiles that combine traditional expertise (such as environmental protection) with skills in mediating between conflicting issues and values (Giannini et al., 2012). In other words, the politics of the circular transition appear to hinge on the capacity to mediate different tensions. This somewhat reflects the modernist process of translating heterogeneity (of interests, values, goals, priorities) into a "purified" (closed) programme of action that shapes post-carbon management policies and strategies (Latour, 1991; 2004). Rather than constituting a revolution, the management of the CE seems to augment existing linear production and consumption flows by adding mediation, facilitation, and so-called networking skills.

This association between caring for circularity and managerial skills employed in caring for the transition to eco-efficiency obviously excludes forms of care that resist the epistemology of economic valorisation. Caring, intended as the adaptive maintenance and constant fixing of the ecological failures within the production/consumption nexus, often operates invisibly in the space of informality. The most explicit example of those dwelling in the shadows of the excited claims of circularity can be identified in the waste-pikers, especially in the Global South. Global and national value chains frequently intertwine with this hidden, heterotopic space of action (Zapata Campos and Hall 2013). However, the epistemology of a closed circularity based on the logic of waste commodification, while benefiting from informal labour, does not necessarily recognises it since it is not measured according to ordinary metrics (and therefore cannot be accounted for). In contrast to the commodification of waste, the "care" of waste appears to be more consistent with a process of commoning, viewing waste as a common resource or common good (Zapata Campos and Zapata, 2013; Armiero, 2021). This distinction underscores one of the most recurrent criticisms of the CE: its failure to address issues of environmental justice. Specifically, it neglects to acknowledge those left outside the circle of formalized circularity (Walker, 2009; Schlosberg, 2007).

Care is also at the core of the feminist debate. While the metaphor of circularity appears inadequate to problematise the relationship between production and reproduction, feminist critics have challenged the traditional way of conceiving reproductive and care work, which has commonly been seen as subordinate to and supportive of productive work. Scholars have overturned this unbalanced residuality between production and reproduction by questioning what could be a circular recursiveness between care and value, (social) reproduction and (economic) production. Reproduction is posited as a core element of creation/enactment rather than merely a "soft" auxiliary function. The ecofeminist thought addresses the basic

assumption of the patriarchal/modernist rationality that emphasizes productive labour over what is considered non-labour and value-free practices, reframing it into a new global theory of labour and value (Barca, 2020). Indeed, the metabolic value of caring is directly linked to the eco-social thermodynamic functioning of life on Earth (Salleh, 2010). Thus, there is no reason to suppose that the metaphor of circularity is less prone to gender essentialism in reproductive dynamics than the linear model.

Figure 4. *Caring circularity* is represented by a net-like figure, a spider web as a light yet resilient structure that connects entities and replaces the finiteness and perfection of the circle. It symbolises the ability to co-produce adaptive, complex and dynamic ecosystems (elaboration: A. Bortolotti).



As mentioned, the opening of the circle can be approached from the conceptualisation of care elaborated by critical feminism, but also from the work of scholars who have spoken of intersectionality in a non-essentialist and non-dualist epistemological framework. From this perspective, mainstream CE theory remains overly focused on material dimensions, failing to incorporate the complexity social structuring–such as gender, race, class and religion–but is not material enough to extend the ethics of care beyond humans and recognize the active involvement of non-humans in the reproduction and restoration of ecosystems (Clare, 2016; Puig de la Bellacasa, 2017). When women's labour and non-human contributions are included in circular discussions, they are often framed in economic or financial terms, reducing these entities to components of a closed system. Here again, the eco-

social practices that shape the commons clash with the normalisation of commodification that tends to conceal the generative and restorative function of care. It is precisely through care we might reopen the closed circle of the economicist epistemology, incorporating eco-social responsibility into cooperative relational systems that resist purely utilitarian frameworks. These systems also challenge the dominance of value orders that underpin the "new spirit of capitalism" (Boltanski and Chiapello, 1999). In the diverse practices of reusing, reimagining, and revaluing discarded objects and goods, care emerges as situated, meaningful, and generative work between human and non-human beings (Isenhour and Reno, 2019).

4. Politicizing circularity

The challenges of sustainability are complex and deeply entrenched in cultural norms and assumptions, requiring a fundamental re-examination of established beliefs and behaviours to address them effectively. The critical approach adopted in this article draws on sociology, anthropology, and human geography to advance ecological and relational thinking, radically reframing the ontological and epistemological separation between humans and nature. This re-examination of circularity has led to the identification of four conceptual "movements" that could guide diversified CE innovations and translate into the programmatic actions summarised as follow:

- Prioritizing prevention and reduction over efficiency. A shift in strategic planning towards prevention and reduction objectives, rather than on greater efficiency in the use of materials and production cycles, could represent a first element of discontinuity with the status quo. For example, tax incentives could promote the reuse of secondary raw materials in key economic sectors such as construction, product design, and fashion.
- Redefining monitoring strategies. A redefinition of monitoring strategies seems fundamental to build indicators of CE that take into account the experimentation, conflicts, and social practices that shape territories. This could involve employing action-research and design activism methods (Faud-Luke, 2009). Plans and projects should address both the digital and technological innovations as well as the social innovations and tactics that arise daily in public squares, schools, workplaces, etc., to better understand, support, and scale these efforts.
- Revisiting the growth paradigm through the Bio-economy. The third action involves rethinking the growth paradigm by regulating global extractive practices, reducing material flows, and managing and enhancing locally existing resources and material stocks. Local governance and regulation play a crucial role in reshaping urban planning practices within a bio-regionalist perspective sensitive to territorial metabolisms.
- Combining local valorization with fair exchange systems. Finally, the rhetoric of local valorisation–often restricted to territorial marketing strategy and the promotion of identity and typicality (of products, landscapes, and experiences)–should be expanded to support fair and solidarity-based exchange systems. Such systems would foster social cohesion and strengthen local networks that convey relational goods.

These actions underscore the need for place-based policies that recognize territorial specificities and promote inclusive, participatory approaches (Tapia et al., 2021). This shift exposes the "perfect circle" of circularity to the complexities of practice and politics. Reopening the circle thus entails reopening the possibility of implementing alternatives–including different epistemologies–and accepting that a trans-disciplinary and post-normal dialogue between sciences, practitioners and

laypeople (Funtowicz and Ravetz 1993) can prefigure a plurality of models in which socio-material flows are articulated. From this point of view, incommensurable values are not reduced to the formalisation of the value of so-called "ecosystem services" but remain in the realm of the plurality of values that are experienced in terms of what is worth more. Only in this scenario can "degrowth" strategies, which are not circular in financial terms, be considered, adopted, and implemented.

Epistemological diversity thus reopens the circle of CE by acknowledging heterogeneous and divergent perspectives, including those traditionally excluded or marginalized by both circular and linear models. Inclusiveness, in this sense, takes on a dual epistemological and political dimension: it concerns eco-social justice and opens up the possibility of forms of governance and coordination otherwise considered residual and ineffective. By intersecting circularity with epistemological plurality it is possible to develop an operational critique that politicizes and territorializes CE, while also opening pathways to inclusive and equitable transitions.

5. Conclusions

This paper presented a critical reading of the concept of CE, proposing four "moves" to disarticulate the rigidity of the closed circle and its normalising, post-political discourse. By advocating for epistemological diversity, it emphasised the need to incorporate a plurality of perspectives and actions in both theorising and practicing circularity. Conventional CE modelling, such as the butterfly diagram promoted by the Ellen MacArthur Foundation, prefigures dynamics of socio-material flows that fail to accommodate the divergent and pluralistic paths characteristic of contemporary contexts. Circular reductionism–and above all, its emphasis on closure and optimisation–results in a framework in which the green economy's logic appears effective only when issues like social inequalities are excluded from the organised, accounted flows. Accountability, metrics, and evaluation methodologies are at the core of this problematisation, as they are part of the political ontology of CE (Mol, 1999; Law and Hassard, 1999). In other words, circularity, as it has been developed within the techno-economic discourse, participates in the activation of a closed circular ontology, which is thus recursive and confirmatory.

In conclusion, politicizing circularity emerges as a crucial theoretical and practical exercise to avoid perpetuating legitimizing frameworks that, much like the modern industrial linear model, fail to progress beyond a rhetoric of green sustainability. However, theorizing and practicing an epistemological pluralism that reshapes the relationship between production and consumption from an eco-social perspective is a twofold challenge, as it requires space for experimentation but also the tools (and the political will) to recognise and make visible the alternatives that are already in place, even if they are disregarded and placed on the margins of the closed circle. Certainly, the proposed approach leads to limitations and complications. For example, broadening the perspectives requires new arrangements of collective regulation with the establishment of recognition procedures towards the plurality of values at stake, including the non-predominant ones. The urgency of such institutional innovation clashes with times of renewed nationalism and the weakening of international ecological cooperation.

Notes

1. See for instance the European Union's Horizon 2020 funded DUT call 2023 supporting transnational research and/or innovation projects addressing urban challenges to help

cities in their transition towards Circular Urban Economies https://dutpartnership.eu/funding-opportunities/dut_call_2023/.

2. This article stems from the discussion initiated by the authors as part of the organization of an international workshop held at Politecnico di Milano, Italy, in 2022 entitled "Re-opening the Circle". The workshop was attended by practitioners and scholars from different fields with the aim of crossing disciplinary perspectives and at the same time discussing experimental orientations from bottom-up as well as more structured, top-down experiences. Circularity as metaphor, conceptual framework and situated experience was placed at the centre of an open discussion between scholars from the hard and applied sciences, the critical and social sciences and the life sciences.

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Conflicts of Interest

The authors declare no conflict of interest.

Originality

The authors declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere, in English or any other language. The manuscript has been read and approved by all named authors and there are no other persons who satisfied the criteria for authorship but are not listed. The authors also declare to have obtained the permission to reproduce in this manuscript any text, illustrations, charts, tables, photographs, or other material from previously published sources (journals, books, websites, etc).

Use of generative AI and AI-assisted technologies

The authors declare that they did not use AI and AI-assisted technologies in the writing of the manuscript; this declaration only refers to the writing process, and not to the use of AI tools to analyse and draw insights from data as part of the research process. They also did not use AI or AI-assisted tools to create or alter images and this may include enhancing, obscuring, moving, removing, or introducing a specific feature within an image or figure, or eliminating any information present in the original.

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