

# **The Circular Competitiveness Index**

*Measuring Sustainability for Economic  
Transformation*

By

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The Circular Competitiveness Index: Measuring Sustainability for  
Economic Transformation

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## Chapter 1

# Measuring Economic Circularity

### *Conceptual Foundations and Analytical Challenges*

This book situates the circular economy within the broader debate on competitiveness, economic growth, and sustainable transformation. It critically examines its economic foundations, the main theoretical debates that surround it, and the ways in which circularity has been integrated into corporate, sectoral, and national strategies. Beyond tracing the evolution of the concept, the book analyses how the circular economy relates to productive structure, innovation dynamics, and patterns of specialisation in contemporary economies, within the context of national competitiveness.

Throughout the book, the analysis of economic circularity is structured around three interrelated axes: productive structure, the dynamics of innovation and competitiveness, and the external positioning of economies within global markets. These axes reappear in the definition of the dimensions of the national circularity index, explicitly linking the initial theoretical framework to the methodological choices underpinning the empirical part of the study.

This opening chapter introduces the concept of the circular economy and highlights the significant role of measurement and circularity indices as instruments of economic analysis and decision-making support. It identifies the limitations of existing approaches and justifies the need for more integrated and dynamic frameworks capable of articulating circularity, competitiveness,

and the structural transformation of economies. This conceptual foundation underpins the book and prepares the ground for the analysis of circularity at distinct levels of aggregation, developed in the subsequent chapters.

Despite the growing diffusion of the concept of the circular economy across academic, political, and business discourses, its use often assumes a normative and insufficiently problematised character, presenting circularity as a consensual and intrinsically desirable objective. While such an approach may be useful for institutional mobilisation and strategic communication, it tends to obscure the underlying economic tensions associated with the circular transition, particularly the trade-offs related to productivity, cost structures, international competitiveness, and long-term growth trajectories. When treated as a technical or moral imperative, the circular economy risks becoming detached from the concrete economic conditions that shape its feasibility and real impacts.

From this standpoint, the book proceeds from the premise that the circular economy should primarily be analysed as a systemic economic phenomenon, embedded within broader processes of long-term economic reorganisation, innovation, and the reconfiguration of value chains. Circularity should not be understood as a homogeneous set of best practices, but rather as an uneven and contextually conditioned process, whose effects vary according to productive structure, levels of technological development, institutional frameworks, and the position of economies in international markets. This perspective makes it possible to move beyond simplistic interpretations that automatically associate circularity with economic gains, recognising that the circular transition involves adjustment costs, sectoral asymmetries, and potential conflicts between economic and environmental objectives.

In this context, the measurement of circularity assumes a central role (not merely as a technical exercise in quantification, but as an instrument of economic interpretation and governance). Circularity indicators and indices influence how performance is assessed, compared, and communicated, thereby shaping investment priorities, public policy design, and corporate strategies. By selecting certain dimensions of circularity over others, measurement instruments incorporate conceptual and normative choices that affect how the circular transition is interpreted and how associated economic decisions are made. Understanding these choices and their implications therefore constitutes an essential step towards a rigorous analysis of the circular economy as a contemporary economic phenomenon.

Throughout this chapter, the circular economy is examined from an explicitly economic perspective, prioritising an understanding of its structural mechanisms, its conceptual ambiguities, and the implications associated with its measurement. This approach frames circularity not as a closed or normatively consensual concept, but as an evolving field of analysis in which different theoretical interpretations and methodological options yield distinct evaluations of economic performance. This initial framework is fundamental for understanding the analytical and methodological choices developed throughout the book.

## **1.1 The Emergence of the Circular Economy in Economic Debate**

The emergence of the circular economy should also be situated within a broader intellectual movement that challenges the traditional view that economic growth is structurally detached from the

planet's biophysical and environmental limits. Debates surrounding resource scarcity, dependence on critical raw materials, and the vulnerability of global value chains have highlighted the need to reconsider the material foundations of competitiveness, bringing environmental concerns closer to the core of economic analysis. In this context, circularity emerges as a proposal for the structural reorganisation of productive systems, rather than merely as a set of marginal environmental management practices.

Beyond its environmental origins, the circular economy must also be interpreted in light of recent economic transformations that have exposed the structural fragilities of the linear model of production and consumption. Increasing volatility in raw material prices, external dependence on critical resources, and instability in global value chains have made more visible the economic vulnerability associated with productive models heavily reliant on the continuous extraction of virgin natural resources. Within this context, circularity appears not only as a strategy for mitigating environmental impacts, but also as a mechanism for preserving productive value and reducing systemic risks.

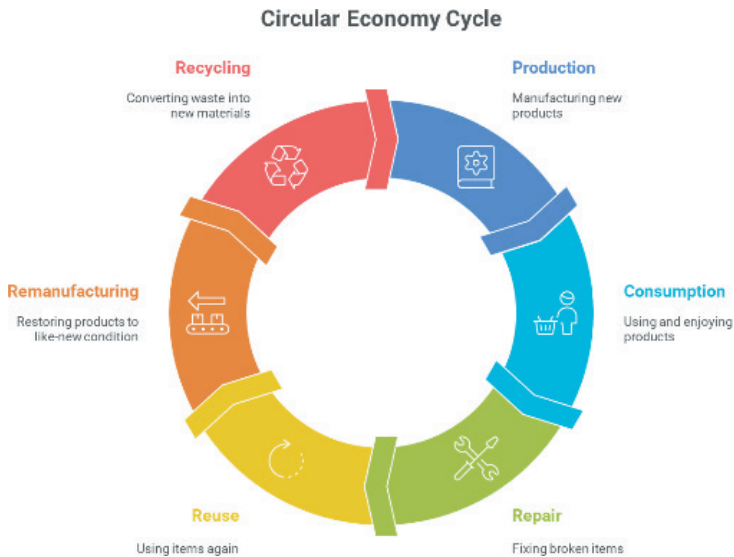
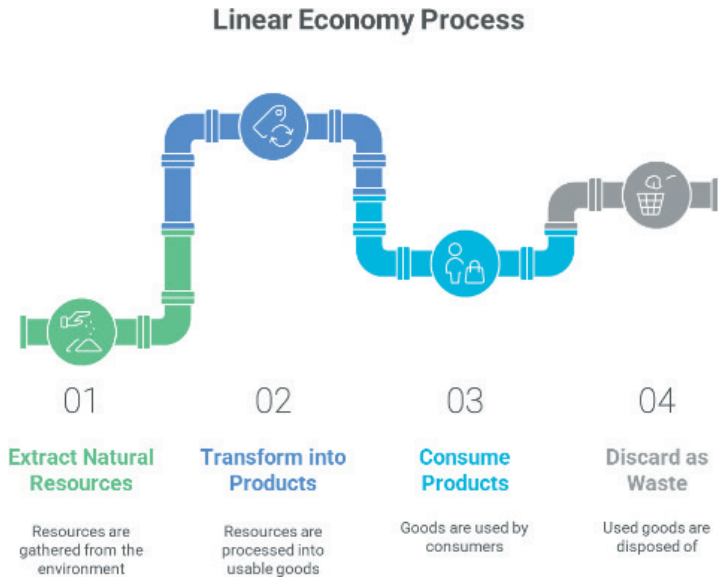
The intensification of productive globalisation over recent decades has contributed to the fragmentation of value chains and the outsourcing of resource- and energy-intensive stages of production. Although this process has enabled short-term efficiency gains and cost reductions, it has also heightened economies' exposure to external shocks, logistical disruptions, and geopolitical tensions. Recent episodes of supply chain disruption have demonstrated that competitiveness based exclusively on cost optimisation and the exploitation of static comparative advantages may prove fragile in contexts characterised by high uncertainty. The circular economy thus forms part of a broader reassessment of the economic

foundations of competitiveness, in which productive resilience and adaptive capacity assume increasing importance.

From this perspective, circularity may be understood as a mechanism of economic reorganisation oriented towards reducing dependence on primary raw materials, enhancing the valorisation of secondary flows, and extending the useful life of productive assets. By promoting a more efficient and strategic use of available resources, circular approaches contribute to mitigating risks associated with material scarcity, volatility in international markets, and increasingly stringent regulatory constraints. This economic analysis of circularity helps to explain why the concept has gained prominence not only within environmental agendas, but also in competitiveness strategies, industrial policy frameworks, and economic security considerations adopted by firms and governments alike.

The circular economy thus entails a reassessment of the mechanisms through which economies create, preserve, and destroy value over time. By introducing new modes of asset utilisation (such as sharing models, remanufacturing, and the systematic reuse of materials), circularity reconfigures incentives for innovation, the organisation of value chains, and patterns of productive specialisation. This framework opens the way for an economic interpretation of circularity that emphasises its potential effects on resource productivity, resilience to external shocks, and long-term growth trajectories.

**Figure 1.1** *From the Linear Model to the Circular Model*



Source: Author's own elaboration.

## **1.2 Circularity, Sustainability, and Economic Transformation**

The relationship between the circular economy, competitiveness, and economic growth has become an increasingly prominent topic in contemporary economic literature. For decades, sustainability was often regarded as a constraint on competitiveness, particularly in resource-intensive industrial economies. This perspective was grounded in the assumption that incorporating environmental concerns would entail additional costs for firms and reduce their competitive capacity in global markets characterised by intense cost pressures. However, this view has been progressively challenged by approaches that recognise circularity as a potential source of dynamic competitive advantage in increasingly demanding markets and among more informed consumers.

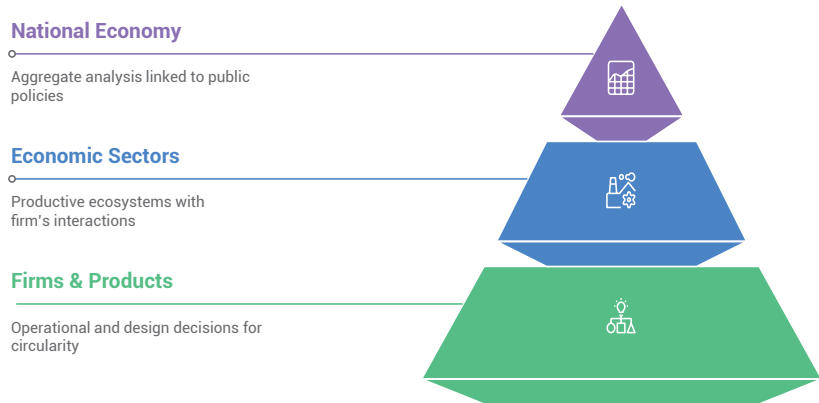
Within the context of the circular economy, competitiveness is no longer associated exclusively with short-term cost minimisation or the intensive exploitation of natural resources. Instead, it becomes linked to the capacity to preserve economic value throughout the life cycle of products and productive systems. Circular strategies enable firms and economies to reduce their exposure to external raw material price shocks, mitigate risks associated with global supply chains, and create opportunities for innovation in products, services, and business models.

At the macroeconomic level, circularity may contribute to more resilient growth trajectories by reducing dependence on imports of critical resources and strengthening the strategic autonomy of economies. Countries (or firms) that successfully integrate circular practices into their productive structures tend to exhibit greater adaptive capacity in the face of external shocks, such as energy

crises or disruptions in global value chains. Accordingly, the circular economy can be interpreted as a vital component of a sustainable competitiveness strategy, rather than merely as an environmental policy instrument.

Nevertheless, the relationship between circularity and economic growth is neither linear nor automatic. The transition to circular models requires substantial investment, structural change, and, in certain cases, short-term adjustment costs. The economic impacts of circularity depend heavily on institutional frameworks, levels of technological development, and the capacity for coordination among economic agents. Understanding how circularity influences competitiveness and growth therefore requires analytical instruments capable of capturing these complex and evolving dynamics, reinforcing the importance of measurement and circularity indices.

From an economic perspective, the circular economy should be understood as a question of intertemporal resource allocation, productive efficiency, and structural transformation, rather than solely as an environmental mitigation strategy. This economic interpretation of circularity raises specific challenges for its empirical assessment. If circularity affects competitiveness and economic growth through dynamic and structurally conditioned mechanisms, its measurement cannot be confined to static or exclusively material indicators. It becomes necessary to develop instruments capable of capturing these economic interactions over time, thereby reinforcing the relevance of circularity indices as central analytical tools.

**Figure 1.2** *Levels of Circularity Analysis*

*Source:* Author's own elaboration.

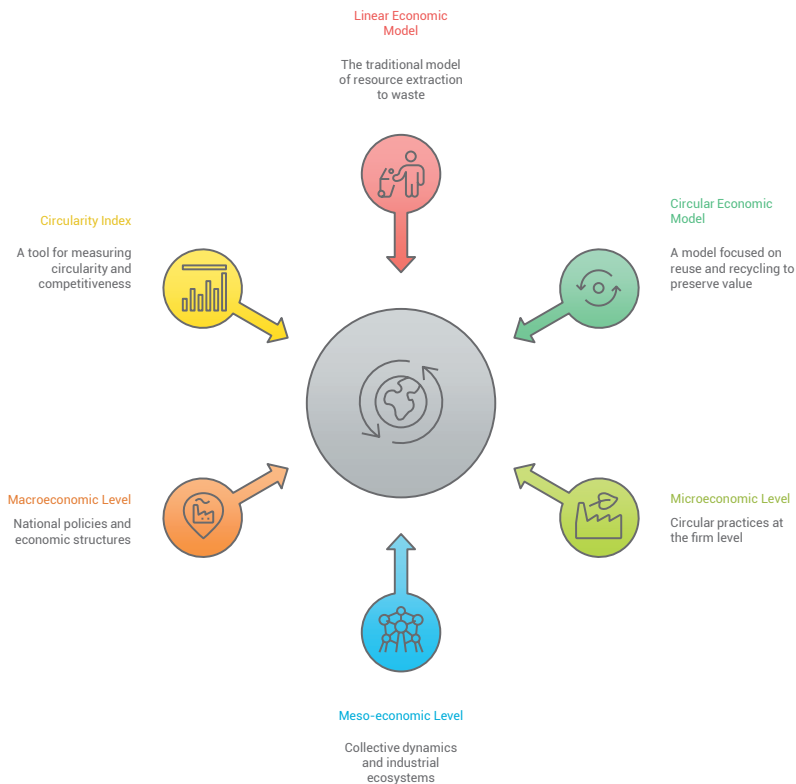
Figure 1.2 provides a concise overview of the analytical framework underpinning this book. The framework positions economic circularity as a multidimensional and multilevel process, connecting production systems, economic performance, and structural transformation. The perspective adopted centres on the transition from the traditional linear economic model (based on resource extraction, production, consumption, and disposal) to a circular economic model focused on value preservation through reuse, recycling, and regenerative processes. This transition is not interpreted merely as an environmental shift, but as a structural economic transformation with direct implications for competitiveness and long-term growth.

The figure explicitly distinguishes three complementary levels of analysis. At the micro level, circularity is explained through firm-level practices related to production processes, product design, and resource efficiency. At the meso-economic level, the concept emerges from collective dynamics within sectors and industrial ecosystems, including cooperation, industrial symbiosis, and shared infrastruc-

ture. At the macroeconomic level, national economic structures, institutions, and public policies shape the overall capacity of economies to adopt and sustain circular trajectories.

These three levels are interconnected and mutually reinforcing. Firm-level practices influence sectoral dynamics, which in turn affect national performance, while macroeconomic institutions and policy frameworks condition incentives and constraints at the lower levels of analysis.

**Figure 1.3** Analytical Framework for Understanding Economic Circularity across Levels



Source: Author's own elaboration.

The circularity index occupies a transversal position within the analysis, functioning as a measurement tool designed to capture the interaction between circularity and economic competitiveness at all levels (firm, sectoral, and national). By integrating material efficiency, economic performance, and structural characteristics, the index provides an analytical basis for comparing trajectories, identifying structural patterns, and supporting economic decision-making. This figure encapsulates the central argument of the book: economic circularity must be understood as a dynamic and multilevel process that extends beyond environmental considerations, requiring integrated measurement approaches capable of linking circular practices to competitiveness and economic transformation.

This reinterpretation of circularity as a vector of sustainable competitiveness nevertheless raises demanding analytical questions. Beyond identifying circular practices, it becomes necessary to understand the extent to which these practices effectively translate into productivity gains, risk reduction, and new opportunities for competitive differentiation. The measurement of circularity therefore assumes a leading role, enabling an assessment of whether and how circular strategies are reflected in economic performance and in the structural transformation capacity of economies.

Despite its potential as a framework for more sustainable development trajectories, the circular economy does not in itself guarantee positive economic outcomes or stable growth paths. The transition to circular models entails profound changes in the organisation of production, cost structures, and investment patterns, and may involve short-term efficiency losses, adjustment costs, and significant sectoral reallocations. In particular, economies and sectors heavily dependent on resource-intensive activities may

face substantial constraints during the transition process, underscoring that the relationship between circularity and economic growth is contingent, non-linear, and strongly conditioned by structural context.

These trade-offs become especially visible when the temporal dimension of economic transformation is considered. While the costs associated with adopting circular practices tend to materialise quickly (through investment in modern technologies, the reorganisation of production processes, or the adaptation of supply chains), economic benefits often emerge more gradually, as learning effects, economies of scale, and incremental innovation consolidate over time. This temporal asymmetry helps explain why empirical findings on the economic impact of circularity are frequently heterogeneous, or even contradictory.

Within this context, the circular economy should be interpreted less as a direct driver of economic growth and more as a process of structural transformation that shapes the conditions under which long-term growth can occur. By reconfiguring the relationship between production, resource use, and value creation, circularity affects factor productivity, exposure to external risks, and the capacity of economies to adapt to mounting environmental and geopolitical constraints. This assessment reinforces the need for analytical instruments capable of capturing not only static levels of performance, but also trajectories of structural change, thereby underscoring the vital role of measurement in the economic analysis of circularity.

### **1.3 Schools of Economic Thought and the Circular Economy**

The circular economy does not emerge in a theoretical vacuum, nor does it constitute an autonomous body of thought detached from the evolution of economic theory. On the contrary, its development reflects the convergence of different theoretical traditions which, over time, have questioned the assumptions of the dominant linear economic model and sought to integrate more explicitly the material and environmental dimensions into processes of economic growth and development.

One important intellectual tradition is environmental economics, which formally introduced environmental issues into the domain of economic analysis, particularly through the concept of externalities. From this perspective, environmental problems associated with the linear model of production and consumption are interpreted as market failures resulting from the absence of prices for environmental goods and the unregulated use of natural resources. The classical economic response consists in the internalisation of these externalities through policy instruments such as environmental taxes, tradable permits, or regulatory standards. Although this approach has significantly contributed to framing the relationship between economy and environment, its focus remains corrective, implicitly assuming the persistence of a linear productive structure, albeit moderated by regulatory mechanisms.

In contrast, ecological economics adopts a more radical perspective by placing biophysical limits at the centre of economic analysis. Drawing on insights from thermodynamics and ecology, this tradition questions the viability of continuous economic growth within a finite planetary system, emphasising the structural

dependence of the economy on flows of energy and materials. The circular economy converges with this tradition in so far as it recognises the need to reorganise productive systems in order to reduce primary resource extraction and minimise waste generation. However, it diverges in that, in most of its formulations, it does not advance a direct critique of economic growth. Instead, it seeks to reconcile material efficiency, technological innovation, and economic value creation.

A third key theoretical reference lies in endogenous growth theory. These approaches highlight the role of innovation, knowledge, and investment in human capital as drivers of long-term economic growth. Within this framework, the circular economy may be interpreted as a new domain of endogenous innovation, in which the development of reuse technologies, advanced recycling, remanufacturing, and circular design generates productivity gains and opens new market opportunities. By shifting the focus from resource extraction to the preservation and valorisation of existing materials and assets, circularity reconfigures incentives for innovation and knowledge accumulation, aligning closely with the central logic of endogenous growth.

Institutional economics provides another particularly relevant perspective for understanding the circular economy. Investment decisions in circular models are strongly conditioned by institutional frameworks, including property rights regimes, regulatory systems, fiscal structures, and social norms. Circularity often involves long-term investments, uncertain returns, and significant coordination costs among economic agents, rendering the role of institutions crucial in reducing uncertainty and aligning incentives. In this regard, the transition to a circular economy may be understood as an institutionally mediated process in which the quality

of economic governance decisively influences both the speed and the depth of productive transformation.

Finally, approaches rooted in structural change and economic structuralism offer a particularly useful lens for analysing the circular economy at the macroeconomic level. These traditions emphasise that economic development results from persistent changes in sectoral composition, productive specialisation, and the allocation of resources across activities. The circular economy may be interpreted as a specific vector of structural change, promoting the reconfiguration of resource-intensive sectors, the emergence of new economic activities linked to material valorisation, and the transformation of existing value chains. This discussion allows circularity to be understood not merely as a set of environmental practices, but as a profound reorganisation of productive structures, with direct implications for competitiveness and long-term growth.

In sum, the circular economy constitutes a transversal concept that engages with multiple strands of economic thought without being fully subsumed by any single one of them. Its originality lies precisely in its capacity to articulate environmental concerns, economic efficiency, and structural transformation within an action-oriented and policy-relevant framework. Recognising these theoretical roots is essential in order to avoid simplistic evaluations of circularity and to ground the construction of measurement instruments that reflect its economic, institutional, and dynamic dimensions.

Taken together, these different traditions of economic thought provide valuable contributions to the understanding of the circular economy, yet they also reveal significant limitations when consid-

ered in isolation. Environmental economics offers useful instruments for correcting market failures, but tends to assume implicitly the continuation of a linear productive structure. Ecological economics introduces a fundamental critique centred on biophysical limits yet provides less precise guidance regarding the mechanisms of economic transformation compatible with value creation and competitiveness. Endogenous growth and structural change theories highlight the importance of innovation and productive reconfiguration but often underestimate the material and institutional constraints that shape the circular transition.

This assessment reinforces the need for an integrated analytical approach capable of articulating material efficiency, economic dynamics, and institutional frameworks within a coherent perspective. The circular economy thus emerges not as a linear extension of a single school of economic thought, but as a transversal domain requiring the combination of diverse theoretical insights. It is precisely this articulation that underpins the framework adopted in this book, in which circularity is analysed as a structural economic process conditioned by historical trajectories of specialisation, technological capabilities, and institutional choices, and whose understanding demands measurement instruments sensitive to the complexity and dynamic nature of the transformation under way.

This systematisation illustrates that none of these strands, when considered in isolation, is sufficiently comprehensive to frame the circular economy adequately, thereby reinforcing the need for an integrated approach that combines elements from each of them.

**Table 1.1** *School of Economic Thought and Contributions to the Circular Economy*

<b>Economic thinking</b>	<b>Contributions to the circular economy</b>	<b>Limitations to circularity</b>
<b>Environmental economics</b>	Focus on externalities, instruments for correcting market failures, and the integration of pollution into welfare analysis.	Assumes the maintenance of the linear productive structure and tends to favour marginal and corrective solutions.
<b>Ecological economics</b>	Focuses on biophysical limits, highlighting the economy's dependence on energy and material flows.	Offers less clear guidance on concrete mechanisms for productive transformation and competitiveness.
<b>Endogenous growth theories</b>	Emphasise the role of innovation, knowledge, and human capital as drivers of growth and technological change.	Often underestimate material and environmental constraints, treating resources as largely substitutable inputs.
<b>Institutional economics</b>	Highlights the role of rules, incentives, and coordination in enabling long-term investments.	Does not always specify how different institutional combinations translate into concrete circularity outcomes.
<b>Structural change / Structuralism</b>	Emphasises sectoral reconfiguration, productive specialisation, and patterns of external integration.	May treat the environmental dimension in a residual manner if not explicitly linked to material flows.

*Source:* Author's own elaboration.

## 1.4 Economic Circularity: Concepts, Dimensions, and Ambiguities

Despite the growing diffusion of the concept of the circular economy in academic literature, political discourse, and business practice, considerable conceptual divergence persists regarding its meaning, scope, and objectives. This ambiguity is not merely terminological; it reflects deeper divergences concerning the nature

of the intended transition, the underlying economic mechanisms, and the role attributed to circularity in processes of economic growth and development.

One of the principal sources of divergence lies in the coexistence of multiple definitions of the circular economy, often used interchangeably yet grounded in distinct assumptions. Several definitions emphasise primarily the physical dimension of circularity, focusing on reducing the extraction of natural resources, increasing material recycling, and minimising waste. Other approaches assign greater relevance to the preservation of economic value embedded in products, components, and materials throughout their life cycle, highlighting mechanisms such as reuse, remanufacturing, and asset life extension. These conceptual differences directly influence how circularity is operationalised and measured.

A second source of ambiguity concerns the relationship between the circular economy and adjacent concepts such as the green economy, the bioeconomy, or degrowth approaches. Although these frameworks share common concerns regarding environmental sustainability and efficient resource use, they diverge with respect to the role attributed to economic growth, technological innovation, and market functioning. As predominantly formulated in institutional strategies, the circular economy seeks to reconcile material efficiency, innovation, and economic growth, thereby distinguishing itself from approaches that explicitly question the viability of continuous growth. This attempt at reconciliation contributes to its political and business appeal, yet also introduces conceptual tensions reflected in the diversity of existing interpretations.

From an analytical standpoint, the circular economy also presents ambiguities concerning the dimensions that constitute it. Some

approaches privilege an environmental perspective, assessing circularity through indicators of material and energy flows. Others insist on integrating economic dimensions, such as resource productivity, value added, and systemic efficiency. In addition, there is an institutional dimension (often underemphasised) which conditions the capacity of economies to coordinate agents, align incentives, and sustain long-term transition trajectories. The absence of consolidated consensus regarding the relative importance of these dimensions complicates comparisons across studies and the interpretation of empirical findings.

These conceptual ambiguities have direct implications for the measurement of economic circularity. The selection of variables to be included in a circularity index depends on the adopted definition and the dimensions considered relevant. Indices centred exclusively on physical flows may provide a detailed picture of material circularity, yet reveal little about its economic and competitive effects. Conversely, indices incorporating economic variables may better capture the relationship between circularity and performance, but risk diluting the material dimension that lies at the core of the concept. This tension between conceptual rigour and empirical operationalisation constitutes one of the central challenges in this field.

Another element of ambiguity concerns the definition of system boundaries. Circularity may be analysed at the level of products, firms, sectors, or national economies, each level emphasising different mechanisms and outcomes. The absence of clear criteria for articulating these levels contributes to fragmentation in the literature and to the proliferation of metrics that are difficult to compare. For example, significant improvements in circularity at firm level may not translate into aggregate gains at national

scale if offset by sectoral composition effects or unsustainable consumption patterns.

From an economic perspective, these ambiguities are not merely academic. The manner in which circularity is defined and measured influences investment decisions, public policy design, and corporate strategies. Metrics that emphasise certain aspects of circularity may incentivise specific behaviours, thereby shaping the trajectory of the transition in unintended ways. Conceptual clarification therefore plays a leading role in the construction of measurement instruments that are both analytically robust and relevant for economic decision-making.

In sum, the circular economy should be understood as a multi-dimensional and contested concept whose operationalisation requires explicit and transparent choices. Recognising existing conceptual ambiguities does not constitute a weakness of the approach, but rather a necessary condition for the development of more rigorous analytical frameworks. This perspective justifies the need for circularity indices that make underlying conceptual options explicit and that coherently articulate the material, economic, and institutional dimensions of circularity.

A useful way to systematise these ambiguities is to distinguish explicitly the different dimensions that coexist within the concept of the circular economy and that are often combined implicitly, or without sufficient transparency. Circularity is not a unidimensional attribute, but a composite concept integrating, in varying proportions, material, economic, institutional, and political dimensions. The absence of explicit clarification regarding the relative importance of these dimensions constitutes a major source of heterogeneity in the literature and largely explains the diversity of metrics and indices currently in use.

The material dimension of circularity focuses on the physical flows of resources, including extraction, use, reuse, recycling, and disposal of materials and energy. This perspective privileges indicators such as material intensity, recycling rates, or the share of secondary inputs, providing a direct assessment of the pressure exerted by productive systems on natural resources. While fundamental for evaluating the biophysical sustainability of economies, this approach tends to abstract from economic value creation and qualitative differences between materials, potentially leading to interpretations that penalise high value-added activities or business models that are less material-intensive yet economically significant.

The economic dimension of circularity emphasises the capacity of productive systems to preserve and generate economic value throughout the life cycle of products, components, and materials. In this perspective, circularity is associated with gains in resource productivity, systemic efficiency, cost reduction, and the mitigation of economic risks, including exposure to raw material price volatility. Although this approach enables the articulation of circularity and competitiveness, it risks diluting the material core of the concept, particularly when privileging aggregated economic performance indicators that do not directly reflect changes in underlying physical flows.

The institutional dimension of circularity refers to the set of formal and informal rules shaping incentives for the adoption of circular practices, including regulatory regimes, fiscal systems, property rights, and coordination mechanisms among economic agents. The transition to a circular economy frequently involves long-term investments, uncertain returns, and substantial coordination costs, rendering the institutional framework decisive for its economic

viability. Underestimating this dimension may lead to metrics that implicitly assume homogeneous institutional conditions, thereby overlooking relevant structural differences across countries, sectors, or stages of development.

Finally, the political dimension of circularity reflects the fact that the concept is mobilised within broader public strategies associated with industrial policy, competitiveness, economic security, or technological leadership. The circular economy is not merely a market-driven phenomenon but also an object of deliberate public intervention, entailing normative choices concerning priorities, transition pace, and the distribution of costs and benefits. Ignoring this dimension may result in technocratic analyses of circularity detached from the political processes that shape its effective implementation.

For analytical purposes, this book explicitly assumes that the measurement of circularity should coherently articulate these four dimensions. Nevertheless, different components of the index assign differentiated weights to each of them, reflecting the objective of capturing simultaneously material pressure, value creation, institutional conditioning, and the strategic policy framework underpinning the circular transition.

Recognising these distinct dimensions does not fragment the concept of the circular economy; rather, it clarifies the analytical choices underlying its operationalisation. Different definitions and metrics of circularity reflect different combinations of these dimensions and are therefore suited to distinct analytical purposes. This recognition reinforces the importance of transparent measurement approaches that make conceptual assumptions explicit and avoid overly simplistic interpretations of empirical results.