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Reconciling Circularity and Growth: The Model of Qualitative Economic Growth

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ABSTRACT

In response to the twin environmental crises of climate change and resource depletion, the circular economy has emerged as a key strategy to reduce waste, minimize the extraction of virgin materials, and promote reuse, repair, and recycling. However, the circular economy, as currently conceived, does not inherently support continuous economic growth in the conventional sense. At the same time, modern societies — grounded in ideals of progress, innovation, and rising living standards — rely on economic growth to sustain social stability, employment, and investment. In this paper, Focardi and Fabozzi argue that integrating qualitative economic growth with circularity offers a viable pathway to decoupling economic progress from the depletion of natural resources. Qualitative growth refers to economic progress driven by increased quality, functionality, and complexity of products, services, infrastructure, and institutions rather than the sheer output volume. To illustrate how qualitative growth and circularity can complement each other in practice, the paper highlights initiatives in Ljubljana, Slovenia, Vitoria-Gasteiz, Spain, and Amsterdam, Netherlands, where circular economy strategies have been combined with urban greening, infrastructure regeneration, and resource-efficient policies to enhance both environmental sustainability and quality of life.

KEYWORDS

Circular Economy; Qualitative Growth; Economic Complexity; Sustainability; Decoupling of Economic Growth from the Use of Natural Resources

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1. Introduction

The combined pressures of climate change, environmental degradation, and resource depletion have forced policymakers, businesses, and researchers to reconsider the foundations of modern economic growth models. In particular, the traditional focus on quantitative economic expansion — measured by ever-increasing production and consumption volumes — is fundamentally at odds with the reality of finite planetary resources and the need to reduce environmental impact. These tensions have fueled interest in the circular economy, which seeks to close material loops by promoting reuse, repair, remanufacturing, and recycling, thereby minimizing waste and reducing the demand for virgin materials.

However, the circular economy, as currently conceived, does not inherently support continuous economic growth in the conventional sense. Modern economies rely heavily on economic growth not just as a measure of prosperity but as a stabilizing force essential for employment, investment, technological innovation, and social welfare programs. This raises a critical question: Can economic growth and the circular economy be reconciled? `

This paper explains how qualitative growth offers a potential pathway to reconciling economic progress with circularity. In contrast to quantitative growth, which focuses on increasing the sheer volume of goods and services, qualitative growth emphasizes quality, functionality, and complexity improvements. This includes higher-quality products and services, more efficient infrastructure, more resilient institutions, and greater integration of sustainability principles into economic processes. Qualitative growth decouples economic progress from resource depletion by shifting the focus from volume to value, aligning economic development with environmental sustainability.

The paper first introduces the concept of qualitative growth. It explains why conventional economic metrics, such as Gross Domestic Product (GDP) and inflation-adjusted real GDP, fail to capture qualitative improvements. The argument builds on the work of Focardi and Fabozzi (2022), who proposed modeling the economy in terms of both observable monetary variables and hidden variables representing quality, quantity, and generalized inflation. This modeling approach offers a more nuanced understanding of how qualitative improvements contribute to economic progress.

The discussion then turns to the role of qualitative growth within the framework of a circular economy. The paper emphasizes that circularity cannot be retrofitted onto existing economic models — it must be designed into policies, industrial processes, and cultural norms from the outset. Moreover, not all forms of qualitative growth are compatible with circularity. For example, some qualitative improvements in medicine or high-technology products may depend on innovations and scarce materials that are difficult to recover through recycling, creating tensions between innovation and resource conservation. Thus, qualitative growth and circularity compatibility depend heavily on sectoral context, technological capabilities, and societal values.

The paper also highlights the need for a cultural transformation to support qualitative growth within planetary boundaries. In place of a culture that equates well-being with material abundance, societies must embrace a cultural shift toward valuing creativity, intellectual life, aesthetic quality, and environmental stewardship. This reorientation can reinforce qualitative growth while reducing pressure on finite natural resources.

Finally, to illustrate how these principles are already being applied in practice, the paper presents case studies of three European cities — Ljubljana, Vitoria-Gasteiz, and Amsterdam — that have integrated circular economy principles into urban planning and development strategies. These cities demonstrate how qualitative improvements in urban design, infrastructure, and governance can enhance environmental sustainability and quality of life, showing that qualitative growth and circularity are not only compatible but mutually reinforcing when appropriately designed and implemented.

2. Early Warnings and Their Critics

Praise for a frugal life respectful of nature has been a constant theme of poets and philosophers since antiquity. In practice, however, most people prefer consumption to frugality. Already in the second half of the 1300s, the Italian poet Francesco Petrarca in the Canzone IX of his Rime describes how the poor peasant goes back home in the evening and puts on the table poor food, *like those acorns, that the whole world praises though fleeing them* (…la mensa ingombra di povere vivande, simili a quelle ghiande, le qua' fuggendo tutto il mondo honora).

After World War II, the School of Frankfurt was particularly inluential in criticizing a consumption-based lifestyle. The initial development of the School of Frankfurt is especially associated with Walter Benjamin, Max Horkheimer, Theodor W. Adorno, Herbert Marcuse and Erich Fromm. With the rise to power of Hitler these philosophers and sociologists had to leave Germany. In his attempt to go to the United States, Benjamin was stopped in Spain by the police of the Spanish dictator Franco. Fearing deportation back to Germany, Benjamin committed suicide with an overdose of morphine. Horkheimer, Adorno, Marcuse and Fromm went to the United States and became very influential.

Horkheimer and Adorno returned to Germany after World War II but Marcuse and Fromm remained in the United States. Marcuse, who served during the war for the Office of Strategic Services (the government organization that later became the CIA) was the main philosopher behind the youth movement of 1968. His books, *Eros and Civilization* and *The One Dimensional Man,* proposed a new vision of life not centered on material possession and consumption and proposed a new idea of freedom. Fromm, a professional psychoanalist, proposed similar ideas in his books *The Art of Loving* and *To Have or to Be*.

Rejection of a lifestyle based on consumption and ownership was an intellectual movement that for a while captured the imagination of large masses of young people but ultimately had little influence on economics. On the other hand, the new vision of freedom proposed by the critical theory had a lasting influence on Western civilization.

The main preoccupation of governments after World War II was economic growth. In the first post-war period, the need to reconstruct Europe and, in the United States, the fear that the end of the war effort could result in secular stagnation were powerful drivers of growth. Economic growth was perceived as the main engine for economic well-being in Europe and the United States. Governments and the general public shared the view that economic growth creates opportunities that are beneficial not only to businesses but to everybody. Critics of growth were perceived as marginal intellectual movements.

It is true, however, that there was an increasing awareness of the danger of pollution. Events such as the Cuyahoga River catching fire in Cleveland, Ohio in 1969 due to decades of waste dumped in the river raised concerns about pollution and became a symbol of environmental degradation. This led to a change of attitude regarding environmental issues and provided support for the creation in the United States of the Environmental Protection Agency (EPA) in 1970 and the passage of a series of federal acts to protect the environment – National Environmental Policy Act of 1969, the Clean Water Act of 1972, the Clean Air Act of 1977, and the Endangered Species Act of 1973, In Europe, many countries created similar agencies and laws for environmental protection.

These actions were local actions intended to solve local environmental problems. For several decades, neither the government nor the public were seriously afraid that growth in itself could be a problem. However, an intellectual debate on growth started with the publication of the 1972 report *Limits to Growth* and the 1971 book *The Entropy Law and the Economic Process*.

The report *Limits to Growth*, written by three MIT scientists – Donella Meadows, Jorgen Randers, and Dennis Meadows – describes the results of simulations performed at MIT with World3, a global model that uses the system dynamics, a modelling methodology created by MIT professor Jay Forrester. The conclusion of the report was very clear: a world with finite resources cannot sustain unlimited exponential material growth.

The Entropy Law and the Economic Process written by the Bulgarian-American mathematician Nicholas Georgescu-Roegen in 1971, introduced the notion that economies are physical systems subject to physical laws, in particular the entropy law that describes how an isolated system can only perform a finite amount of work because all temperature differences progressively disappear. (The next section will discuss thermodynamic concepts, including the entropy law.) The energy stored in an isolated system remains constant, but its ability to produce work progressively degrades. This is not true for an open system that receives energy from the outside. The earth is an open system that receives energy from the sun either directly or through the energy stored in fossil fuels.

But Georgescu-Roegen objected that not only energy but also matter degrades. After producing work, matter degrades and cannot produce additional work. For example, after burning fossil fuels, it is impossible to recover energy from the ashes. Even if the earth receives a continuous flow of energy from the sun, matter will degrade and become unable to perform useful work. Therefore, there are physical limits to the ability of economies to grow and, ultimately, to exist for very long periods.

Both *Limits to Growth* and *The Entropy Law and the Economic Process* concluded that the earth, a finite system endowed with finite resources, cannot support endless exponential growth. While this academic conclusion had no bearing on political decision-making and public perceptions of growth, it stirred an intellectual debate between those who believed that endless growth was impossible and those who believed the contrary. Farley (2008) discusses the debate on growth. He reminds us that in writings and debates, those who believed that there were limits to growth were referred to as "doomsdayers," while those who believed in the possibility of endless growth were labeled "cornucopian." To simplify, we will adopt this terminology.

Prima facie, the conclusion that a finite system cannot sustain endless material growth seems quite robust. How could cornucopians avoid the conclusion that there are limits to growth? Below, we explore the proposed strategies to solve the problem of supposedly finite resources.

Julian Lincoln Simon was an enthusiastic cornucopian. Simon (1996) claimed that there is no resource crisis as human ingenuity and creativity will always find a way to replace exhausted resources with substitutes. Simon argued that when a resource becomes scarce, its price increases, thus creating opportunities for recycling and finally developing substitutes. For Simon, the answer to doomsdayers is that recycling, improving efficiency, and developing substitutes will ultimately solve any problem of scarcity of resources. Simon had an almost unlimited faith in the human ability to invent new technologies.

Robert Solow, an American economist awarded the 1987 Nobel Memorial Prize in Economic Sciences, was also a cornucopian. Solow (1974) accepts that recycling materials and resources is a viable strategy but admits that recycling cannot be perfect because there is some material loss or degradation at every re-cycle. However, the lost resource will be progressively replaced by a substitute resource. Describing in detail the market mechanism that leads to substituting a resource with a man-made resource, Solow (1974) concludes that: "As you would expect, the degree of substitutability is also a key factor. If it is very easy to substitute other factors for natural resources, then there is, in principle, no problem. The world can, in effect, get along without natural resources, so exhaustion is just an event, not a catastrophe." According to Solow, economic growth can be completely dematerialized. In 2003, Eric Neumayer, a professor of Environment and Development at the London School of Economics and Political Science, introduced the distinction between weak and strong sustainability in his book *Weak versus Strong Sustainability*. An economy is weakly sustainable if human-made capital can be substituted for natural capital.

In his 1974 book *In Defence of Economic Growth*, Wilfred Beckerman considered the problem of growth from a different perspective. Claiming that growth is an essential feature of modern democratic societies, he wrote, "If growth were to be abandoned as an objective of policy, democracy too would have to be abandoned." Beckerman accused the authors of *Limits to Growth* of underestimating the potential of technology improvement.

Doomsdayers disagreed on the possibility of the unlimited substitution of natural capital with man-made capital. Georgescu-Roegen forcefully defended the idea that the economic process entails matter degradation, mainly due to dispersion, so recycling cannot be perfect, and substitution cannot work indefinitely. Daly (1977) partially agreed with Georgescu-Roegen but admitted the possibility of a steady-state economy based on recycling. Population growth was a significant point of discussion. Doomsdayers, such as Paul Ehrlich, predicted that population growth would lead to an environmental catastrophe within a few decades (Ehrlich, 1968).

In summary, cornucopians claimed that unlimited growth is possible due to recycling resources, substituting natural resources with man-made resources, and technological progress. The notion was that dematerialization of growth could also be achieved by replacing products with services. However, no general theoretical argument was offered to justify the thesis that natural resources can always be substituted. In contrast, doomsdayers claimed that resource degradation is inevitable and substitution cannot continue indefinitely. The exponential growth of population and degradation of natural resources would lead to economic catastrophe.

The debate on the possibility of economic growth continues today but on different terms. This conversation has expanded beyond academic circles and now influences the economic policy decisions of governments and the strategies of the industrial sector. Most governments and international organizations have espoused the notion of a circular economy. The key topic of this paper is the need and opportunity to integrate circularity with qualitative growth. Many environmental activists, however, reject the notion of growth and espouse the notion of de-growth. De-growth has been formulated in many different ways. A widely shared notion of de-growth replaces the notion of growth with the idea of well-being. We will discuss concepts of growth in Section 4. In the next section, we will discuss entropy and the second law of thermodynamics. The critical question is whether thermodynamics effectively limits growth.

3. Entropy and the Entropy Law

Entropy is a concept that originated in physics, but it is now widely used — and sometimes misused — across many scientific fields and business sectors. The thermodynamic concept of entropy was developed through the contributions of Rudolf Clausius, Sadi Carnot, and Lord Kelvin. Later, Ludwig Boltzmann extended the concept into statistical mechanics, and Claude Shannon introduced the information-theoretic concept of entropy, which measures the uncertainty in a system.

To explain entropy in simpler terms rooted in everyday experience, consider the following: If you drop ink into a glass of water, within minutes the ink disperses, leaving the water uniformly light blue. The ink never spontaneously reassembles into a drop. If you open the window of a warm room on a cold winter day, the heat flows out into the cold air. You would never expect the reverse — the room warming up from the cold outside air after opening the window.

We observe similar behavior in mechanical and thermal processes. When air is pumped into a bicycle tire, the tire gets warmer — the mechanical work from the pump increases the air pressure, converting work into heat. Conversely, when using a spray can, the expanding gas cools down. Air conditioners rely on the same principle: by expanding gas, they extract heat from the indoor air and transfer it outside. However, this process requires electricity — energy input is necessary to move heat from a cooler space to a warmer one. This is the same principle that applies to refrigerators. In communication, if you try talking to someone in another room, the message often becomes garbled rather than clearer — another example of how processes tend toward disorder.

The second law of thermodynamics formalizes these everyday observations. It states that heat flows spontaneously from a hotter body to a cooler one, and reversing this flow requires external energy. Systems with temperature differences can perform useful work, but without an inflow of energy, they will eventually reach thermal equilibrium, at which point no further work can be extracted.

Entropy, denoted by S, represents the amount of heat in a system that cannot perform useful work, divided by the system's temperature. The second law of thermodynamics states that in an isolated system, entropy cannot decrease. This principle explains why heat flows from hot to cold, why work cannot be extracted from systems with uniform temperatures, and why there are fundamental efficiency limits for thermal engines. Specifically, any thermal engine requires at least two heat sources at different temperatures to function.

Ludwig Boltzmann provided a deeper interpretation of the second law through statistical mechanics. Boltzmann showed that the second law can be understood as a statistical principle: a system evolves toward its most likely configuration. This statistical perspective frames entropy as a measure of disorder. In an isolated system, internal structures gradually break down, and the system evolves toward a more disordered state.

Economist Nicholas Georgescu-Roegen was the first to emphasize the importance of entropy in economics. He argued that economic processes should incorporate the physical constraints imposed by the entropy law. While he recognized that the second law of thermodynamics technically applies only to isolated systems — and Earth, as an open system, continually receives energy from the Sun — Georgescu-Roegen introduced a distinct concept: material entropy. He also proposed a new theoretical principle, which he called the fourth law of thermodynamics.

Material entropy, unlike thermodynamic entropy, lacks a precise mathematical definition. It refers to the energy and value stored in the internal structure of materials. Georgescu-Roegen's fourth law states that matter produces work at the expense of its internal structure, increasing material entropy irreversibly in the process. This principle highlights the inherent material degradation involved in economic activity. For example, when coal burns, its internal energy is released as heat, and the coal itself is transformed into ash — a form of matter that can no longer be used to produce work. According to Georgescu-Roegen, this degradation is irreversible and ultimately limits the economy's ability to rely on recycling alone.

Georgescu-Roegen's work is foundational for introducing thermodynamics into economic thought. He sharply criticized classical economic models for neglecting the physical constraints and irreversibility inherent in economic processes. At the same time, he acknowledged that in open systems like Earth, the second law of thermodynamics does not by itself imply the inevitable collapse of economic systems — because energy inflows from the Sun sustain life and activity. However, he argued that material entropy — the progressive degradation of matter itself — is the real limiting factor for long-term economic sustainability. The fourth law was intended to capture this overlooked process.

In Section 2, we discussed the wide-ranging reactions to the 1972 report The Limits to Growth, which warned that exponential economic growth is incompatible with finite planetary resources. In response, technological optimists — often called cornucopians — offered several counterarguments:

- Resources can be recycled, albeit imperfectly.
- Exhausted resources can be endlessly substituted with new materials, including synthetic materials.
- Growth can be dematerialized — meaning economic value can grow without proportional increases in material consumption.
- Technological progress, driven by human ingenuity, will always find solutions to emerging resource constraints.

Cornucopians accepted the premise that recycling is inherently imperfect (a topic further discussed in Section 4), but they placed great faith in substitution, believing that whenever one resource is depleted, another will be found. However, this idea of infinite substitution is vague and fundamentally flawed in a finite system. The notion implicitly assumes that Earth contains an infinite set of potential materials — a premise that is false.

A modern variation of substitutionism argues that advanced technologies will allow humanity to synthesize any material it needs. While significant research efforts are devoted to developing synthetic materials, we are still far from being able to create arbitrary materials at scale, and there is no guarantee this will ever be feasible. For now, the belief in unlimited substitution rests more on optimism than on empirical or theoretical support.

Even if unlimited substitution is ruled out, recycling is constrained not by the second law of thermodynamics — because Earth is an open system — but by the growth of material entropy as defined by Georgescu-Roegen.

Despite its intuitive appeal, the fourth law of thermodynamics was never widely accepted by the scientific community for two key reasons: (1) it was not rigorously formulated, and (2) it lacked both empirical validation and theoretical robustness.

Critics such as Robert Ayres (1999) argued that resources could, in theory, be recycled indefinitely, though Ayres himself did not offer a solid theoretical foundation for this claim.

Nature offers an example of a circular system: the biological ecosystem, which has sustained itself over billions of years through complex cycles of recycling organic materials. However, biological systems operate under numerous constraints — particularly regarding what materials are used and how they are processed. As we will discuss, achieving a fully circular industrial economy would likely require similarly strict constraints on the products we make and the processes we use to make them.

4. The Limits of a Circular Economy

In this section, we will discuss the limits of a circular economy from both a theoretical and a practical point of view. It's important to clarify from the outset that, in the context where the circular economy is suggested as a redesign of industrial production and societal structures, the focus shifts from the theoretical constraints of circularity to its real-world implications. Stated differently, we should not ask if circularity is possible because we plan to design circular products and services. Instead, we should ask if the constraints of a circular economy are compatible with the values and motivations of modern advanced societies. This will be the true test of circularity.

It isn't easy to believe that societies and economies can be peacefully engineered by decree. Societies are self-organizing systems that evolve under endogenous forces. Regulations can steer the path of economic and social evolution but cannot completely change it. Historically, abrupt changes happened in situations of great social stress. In particular, we believe that a democratic capitalistic system requires some form of growth.

As we have seen, after the publication of *The Limits to Growth* and Georgescu-Roegen's *The Entropy Law and the Economic Process*, economists were divided between cornucopians, who believed in the possibility of limitless growth, and doomsdayers, who believed the contrary due to resource degradation and exponential population growth.

Cornucopians thought that circularity, substitution, and still-to-come technology progress would allow continuous growth. The key issue was circularity. Georgescu-Roegen believed that many economic processes are irreversible because of matter dispersion. Therefore, he believed circularity can only be partial. Ayres (1999) claimed the opposite, arguing that the second law of thermodynamics does not forbid recycling if sufficient energy is available.

Today, proponents of circularity, such as the Ellen MacArthur Foundation, seem to espouse the thesis that full circularity is possible, provided products that products and services are appropriately designed to be circular. There are perhaps three main questions related to circularity:

1. Can chemical reactions always be reversed?
2. Can materials be separated even if massively dispersed?
3. Can we produce sufficient energy to perform the above?

First, manufacturing products implies creating material structures, such as a plane or a bridge, made of materials often resulting from complex chemical reactions. The general notion of full circularity means that any chemical reaction can be reversed and that any assembly of materials, such as an alloy, can be separated.

The second law does not forbid that chemical or nuclear reactions can be reversed if enough energy is available. However, this fact does not imply that we have a technology that reverses chemical or nuclear reactions. For example, many chemical scientists are currently working on the problem of creating new materials. Szczypinski et al. (2021) discuss using computers to predict what new materials will have useful properties and, given that a possible new material is useful, indicate if it can be realistically synthesized. Therefore, circularity is not guaranteed in practice because we do not have the technology to reverse any possible reaction. However, we can constrain the economy to use materials that can be recycled.

Georgescu-Roegen's main argument against circularity was the impossibility of separating or recovering dispersed materials. Although it is probably tough to give a general theoretical answer, a full theoretical answer is also not very useful because, in practice, recycling every possible situation of dispersion would require too much energy.

This leads to the third question: can we generate enough low-entropy energy to provide full circularity? Again, the theoretical answer is probably negative if we want to cover every possible situation. However, the current notion of circularity differs from the framework of the early discussions on the possibility of circularity. The current notion of circularity requires that products and services be designed with this in mind circularity. If products and services are designed with circularity in mind, it seems clear that full circularity can be achieved.

The Ellen MacArthur Foundation is evident on this point: we must change how we design and manufacture things. Circularity implies a profound rethinking of economies and societies. But how? This question cannot have a complete theoretical answer because economies will self-organize in largely unpredictable ways. Of course, we can list the requirements for full circularity, for example, that all chemical reactions be practically reversible with the energy provided by the sun. However, it would be challenging to state what actual limitations are implied by the requirement of circularity.

Modern economies are complex systems subject to emergent properties and self-organization. Both are difficult, perhaps impossible, to predict. Therefore, describing a complete characterization of future circular economies is impossible. We can only enunciate general principles, but the fine details remain unknown.

To summarize, the real issue is not if an arbitrary economic system can be made circular, but what systems are fully circular? The critical question is whether a fully circular economy can grow. Beckermann (1974) claimed that growth is so crucial that planning an economy without growth would destroy democracy. This statement is probably not exaggerated. Growth allows people to have objectives, improve, and compete to arrive at a superior social standing. In a situation of no growth, competition becomes a true fight because a person's success is the failure of another. When there is economic growth, there is room for everyone to grow.

This is the current cultural situation of capitalistic economies. In the future, cultures may change, and people will learn how to enjoy life without competing. But for the moment, we are very far from that situation. We must deal with excessive competition that leads to extreme, unsustainable inequalities and precarity. It is, therefore, critical to understand if circularity allows growth.

There are many different concepts of growth, and each concept is problematic. In fact, growth in the value of economic output is subject to the problem of inflation, while material growth cannot be realistically defined because of heterogeneity and the evolution of products and services. Qualitative growth is conceptually difficult to define, and growth in well-being is subject to cultural relativism.

Today, in practice, material growth is measured by real GDP growth, that is, nominal GDP divided by cumulated inflation. However, given the evolutionary nature of modern economies and how we measure inflation, price changes due to qualitative changes are computed as inflation-depressing growth.

Recycling cannot increase an economy's material quantities. However, we could create new materials and new production techniques that allow economies to grow, in some sense, the quantity of output. But with the circular economy, we must admit that growth will come primarily from qualitative improvement of economic output. The following section is devoted to qualitative growth.

5. Literature Review of Heterodox Economies and Sustainability

Mainstream economics does not solve the problem of sustainable growth. In this section, we discuss how alternative economic theories, particularly institutional economic theory and evolutionary economic theory, offer solutions to the problem of decoupling economic growth from the use of natural resources. We draw extensively on Waller (2023).

William Kapp, a self-declared institutionalist, was highly influential in establishing the economic theory of social costs. In his book *The Social Cost of Business Enterprises,* he thoroughly examines how private enterprises operating in an environment of unregulated competition often generate social costs that are not reflected in their operational expenses. Instead, they are transferred to individuals and the community at large. Therefore, his analysis concurrently addresses a particular question of economic theory while also exploring wider matters related to social philosophy and our understanding of economics.

Kenneth Boulding is considered the founder of environmental economics. In his 1966 paper "The Economics of the Coming Spaceship Earth," Boulding anticipated virtually all main themes of environmental economics, including an early description of the circular economy. Boulding (1966) distinguishes between an open economy, where unlimited growth is a legitimate endeavor, and a constrained closed economy. The concept of an open economy, Boulding writes, can be likened to what one might term the "cowboy economy," drawing parallels with the boundless expanses historically available and the often reckless, exploitative, and adventurous behaviors seen in open societies. In contrast, he writes that envisioning the closed economy of the future brings to mind the analogy of a "spaceman economy." Here, Earth is viewed as a singular spacecraft with finite resources for extraction and waste disposal, compelling humanity to adapt to a sustainable ecological cycle that supports the ongoing regeneration of materials, albeit with the necessity of energy inputs.

He remarks further about these two economies. In the cowboy economy, consumption and production are valued positively, with economic success gauged by the volume of resources processed from inputs, such as raw materials, to outputs, including pollutants. However, the perspective shifts dramatically in what he labels the spaceship economy. Here, the goal is not to maximize throughput but to minimize it, emphasizing that economic success should not hinge on production and consumption rates. Instead, it focuses on the overall quality, diversity, and richness of the collective capital, which encompasses both the physical and mental well-being of individuals within the system. In Boulding's work, we find the themes currently at the center of the debate on the circular economy: growth is not the growth of the quantities produced but the growth of the quality and complexity of what is produced. If we recycle trains, planes, cars the quantity of recycled materials cannot grow but the complexity of recycled products can indeed grow.

Until recently, institutionalists have not paid much attention to environmental economics under the assumption that technology will solve the problems of pollution and exhaustion of natural resources. Several authors took the opposite approach, saying that we now live in a world of abundance and that the key problems are the distribution of abundant resources. James Galbraith and David Hamilton effectively discussed how to apportion real abundance. The 2009 book *Economic Abundance: An Introduction,* written by Dugger, William M. and James T. Peach discusses how economics should deal with abundance.

However, there are different strains in the literature. The 2010 book *The Economics of Abundance: A Political Economy of Freedom, Equity, and Sustainability* written by Wolfgang Hoeschele claims that scarcity is an artifact in the sense that capitalist institutions push people to desire scarce goods. The author claims that we could live a pleasant life by adapting our desires to critical resources. Actually, this is an ancient theme. Ancient Stoics believed that one can be happy under any material circumstance by adapting desires to reality.

Published in 1979, *The Discretionary Economy: A Normative Theory of Political Economy* by Marc Tool argues that communities can and should determine their own optimal institutions. The integration of original institutionalism and sustainability follows three main lines: Circular Economy, downsizing, and de-growth.

Katherine Whalen and Charles Whalen discuss the circular economy in the global institutionalism framework. They conclude that institutionalism and circularity are compatible and complementary. Following the original insight of Boulding, they distill three main principles. First, human well being should be a critical part of the metrics of economic performance. Second, maintenance of the stock of resources should be a primary concern. Third, production and consumption should be minimized, not maximized. In addition, the production of waste should not exceed the ability of the Earth to assimilate waste. The authors observe that sustainability is a systemic process. Therefore, private firms' individual actions are insufficient but should be seen in the context of government actions.

Lin (2020) claims that the circular economy can grow because in the circular economy, waste has value. Understanding the reasoning behind the paper is difficult, however. Waste has value for the economy itself. The sale of waste cannot be considered a final transaction as it is similar to the sale of intermediate goods, so it is difficult to understand how the sale of garbage makes GDP grow. Bauwens (2021) discusses the growth potential of a circular economy and concludes that a circular economy grows if we account for the environmental benefits of circularity.

In 2001, the institutional economist David Brown wrote the book *Insatiable is Not Sustainable*, arguing that humans have always been insatiable since ancient times. Brown argues that an insatiable culture cannot be sustainable. Sustainability requires a significant change of culture.

6. The Circular Economy

Current economic systems are called “linear systems” based on the “linear” principle of extracting→manufacturing→using→waste. In opposition to linear systems, the concept of circular economy has gained traction in the last two decades. The United States, Europe, and China have all adopted some form of circular economy. Many definitions of a circular economy imply different degrees of circularity. The ultimate objective of the circular economy concept is to transform economies into self-sustained systems that do not exhaust natural resources. The basic principle of the circular economy is designing products that have long operational lives, can be repaired and eventually refurbished, and can be recycled at the end of their lives. Production should use renewable resources as much as possible. A broader concept of circular economy includes social objectives of well-being that are supposed to replace the objective of economic growth.

The report *Jobs For Tomorrow: The Potential For Substituting Manpower For Energy* by Stahel and Reday-Mulvey (1977) prepared for the Commission of the European Communities can be considered the first organic statement of the principles of circular thinking. However, the idea of recycling products appears in Solow (1974) and, earlier, in the concept of the Spaceship Earth in Boulding (1966).

The Policy Brief N3 Industry 5.0 issued by ESIR, a consulting group of the European Commission comprised of high-level experts, agrees with the above definition and implies that the future European circular economy should achieve the objective of decoupling growth from the use of natural resources (European Commission’s Directorate-General Research and Innovation, 2022). However, Industry 5.0 states that growth should not be intended in the classical sense of GDP growth but should be measured by several new yet-to-be-defined measures and indicators. Industry 5.0 broadly discusses the social changes the transition to a truly circular economy implies. Bauwens (2021) introduced the concept of post-growth circularity, claiming that the circular economy should strive to maximize well-being.

The circular economy is one of the key strategies proposed to achieve the goals set by the European Union Green Deal and the equivalent New Green Deals in the United States, Australia, and Canada. The Ellen MacArthur Foundation has done much to promote the concept of a circular economy.

As we can see from the above statements, the circular economy is a set of recommendations and, eventually, policies to achieve circularity. However, the concept of circular economy leaves many technological questions open.

The "green growth" concept is more global and might include circularity as a strategy. Green growth is based on the belief that technology will solve all environmental problems without major disruptions of consumption habits. It might or might not use circularity. For example, replacing fossil fuels with clean energy sources is part of green growth as a technology change. Circularity might mitigate the energy problem but, per se, does not supply new energy sources. We might also develop a technology to synthesize needed materials from abundant sources. Such technology would reduce the importance and role of circularity.

Currently, the rate of circularity – defined as the ratio of the quantity of recycled materials and the quantity of material inputs – is low. According to the 2023 Circularity Gap Report prepared and published by the Circle Economy, the global circularity rate is 7.2%, down from the 9.1% for the prior five years. Europe is doing better. According to a Eurostat report,[1] In 2021, Europe's circularity rate was 11.7%, slightly down from the peak of 12% reached in 2019. The total consumption of materials in 2022 surpassed 100 billion tons, equivalent to 12 tons per person, while it was 28.6 billion tons, equivalent to 7.4 tons per person, in 1972, when the report *The Limits of Growth* was first published.

There are different levels of circularity. The simplest level of circularity includes recycling waste. A higher level of circularity includes reusing product components. The full implementation of a circular economy is described in the European Union Parliament Article (2023) as follows:

"The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible thanks to recycling. These can be productively used again and again, thereby creating further value."

The Ellen MacArthur Foundation Circular Economy Introduction gives a similar definition of the Circular Economy. They claim that the circular economy is a global framework. According to the Ellen MacArthur Foundation, the circular economy is based on three principles. These principles are driven by (1) the elimination of waste and pollution, (2) the circulation of products and materials (at their highest value), and (3) the regeneration of nature. Moreover, "the circular economy is based on renewable energy and materials. A circular economy decouples economic growth from the exhaustion of non-renewable resources.

Korhonen et al. (2018) observe that the current definitions of the circular economy have been proposed by practitioners and consultants, not by academics. The authors propose a scientific notion of a circular economy that uses cyclical materials flows, renewable energy sources, and cascading-type energy flows. A successful circular economy contributes to all aspects of sustainable development. The circular economy has a tolerable impact on nature and utilizes ecosystem cycles, respecting their natural reproduction rates.

There are several points to note. First, circular economies are designed economies. Products should be designed to last longer and to be repaired. Products should be constructed with renewable materials that can be recycled and that do not harm the environment. A circular economy's design rules and objectives differ from the design objectives of the current industrial system. Second, the relationship with the biological ecosystem should change. Today, many industrial processes are very harmful to the biological environment. This must be changed because the biological environment is the basic frame of human activities and needs protection. Finally, all the above implies changes in human behavior and culture. The circular economy is not a technology for recycling waste; it is the main reason for rethinking our societies.

As discussed in Focardi and Fabozzi (2022), Fabozzi et al. (2022), and Fabozzi et al. (2021), economies are complex evolutionary systems. The concept of growth is problematic. We cannot measure physical growth because there is no possibility of aggregating the quantities of evolving heterogeneous products and services. We can

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Circular_economy_-_material_flows

measure the monetary value of economic output, but to model its evolution, we have to take an abstract view of the physical economy and introduce a concept of inflation. Economies exhibit emerging behavior and self-organization, which makes them systems that are very difficult to predict. The supposedly linear systems have an intricate web of interactions and non-linear, complex feedback loops. In addition, humans develop cultures whose evolution interacts with the evolution of economies in complicated ways.

There are different levels of engineering in a circular economy. It is relatively easy to reach a small rate of circularity by imposing rules to recycle wastes and by imposing rules that require some materials, such as plastic and textiles, to be recyclable. However, modern economies produce innovative products and services that are difficult to recycle. Modern high-tech products evolve rapidly and rapidly become obsolete, contradicting the principle that we should prolong the life of products through design for long life, reparability, and the possibility of recycling.

Circularity seems to imply a return to a simpler, slower-moving lifestyle. But changing lifestyles is not easy—it can be impossible. Planning a circular industry, with the additional constraints of provisioning materials from politically difficult areas, might prove to be an extremely difficult task.

The project of circularity is also based on social justice. The *2023 Circularity Gap Report*, on page 9 of the Executive Summary states that: “There is currently enough wealth and materials in the world to provide a good quality of life to every single human being on this planet.” This is probably true, but it implies social changes of an unprecedented magnitude. And it does not consider that “good quality of life” is not a concept all humans share. What is good life for one individual is sinful for another.

Circularity implies redesigning products, which implies, in turn, that consumer habits should change. For circularity to work, not only products but society at large must be redesigned. In fact, circularity affects not only products but also work, transport and mobility, finance, and leisure. Assuming it is possible to implement these changes, circularity is a long-term process. It will require a long time to produce the needed social changes.

It also affects the financial system. Discussing the unsustainability of inequality, Galbraith (2019) concludes that: “…. economic inequality is tied to the most unstable and unsustainable element of the world system, which is global finance. Achieving anything sustainably….. requires a financial order that is broadly reformed ….” Sustainability, which is the objective of economic circularity, is not only a question of industrial strategy, technology, and culture but also of finance. It is a truly global phenomenon.

7. Qualitative Growth

Qualitative growth refers to economic growth driven by improvements in the quality of products, services, and infrastructure rather than increases in the quantity of goods produced and consumed. This concept has been discussed in depth by Focardi and Fabozzi (2022), Fabozzi et al. (2022), and Fabozzi et al. (2021). Their work highlights several key ideas: modern economies function as evolutionary complex systems characterized by continuous innovation. Products and services are highly heterogeneous and cannot be aggregated into a single quantity metric. As a result, it is impossible to compute an economy's overall output quantity. The only feasible metric is the value of the output, i.e., GDP. However, GDP is subject to inflation, which must be accounted for when analyzing economic dynamics.

Reviewing how output is estimated is essential to understanding why current methods for measuring economic growth fail to capture qualitative growth. Today, the standard measure of output is GDP (for this discussion, GDP and Gross National Product (GNP) can be treated as equivalent). Nominal GDP measures the total dollar value of all final transactions in a year.

Figure 1 represents the evolution of GDP and Real GDP in the USA from 1947 to 2024. Real GDP is based on dollars chained in 2017; therefore, the two graphs have the same value in 2017. For this reason, Real GDP was higher than GDP from 1947 to 2017. At the end of 2024, U.S. GDP was 29,720 billion dollars, compared to 243 billion dollars at the start of 1947. Over these 77 years (1947-2024), nominal GDP grew by a factor of 122, implying an average annual growth rate of 6.44%.

However, because prices are relative, nominal GDP alone does not reveal much about real economic progress. Inflation-adjusted GDP (real GDP) is used to make meaningful comparisons across time. Real GDP reflects nominal GDP adjusted for inflation, removing the effects of rising prices. Between 1947 and 2024, real GDP in the U.S. increased from 2,182 billion dollars to 23,536 billion dollars, a growth factor of 10.78, with an average real growth rate of 3.1% per year. Over the same period, average inflation was 3.2% per year. These data come from Federal Reserve Economic Data (FRED), with real GDP chained to 2017 dollars.

The problem lies in how inflation is measured. Inflation is calculated by tracking a fixed basket of goods and services price changes. This method assumes that the goods and services themselves do not change qualitatively over time, which is fundamentally flawed. In reality, products and services continuously evolve—with new features, greater functionality, and improved performance. These qualitative improvements disappear from official inflation calculations, meaning that quality-driven price increases are mistakenly classified as inflation rather than real economic growth.

The bottom line is that current methods of measuring inflation—and thus real GDP—fail to account for qualitative improvements. As a result, qualitative growth is systematically misclassified as inflation, leaving official statistics blind to a significant source of real economic progress. In a modern economy, a continuous stream of new, more sophisticated products and services exist. Yet, real GDP calculations do not capture the qualitative improvements embodied in these products.

This has profound implications for sustainability. If economies want to grow without exhausting natural resources, they must increasingly focus on qualitative growth rather than quantitative expansion. This requires an economic theory capable of distinguishing the contribution of quality versus quantity to growth. Currently, both terms—quality and quantity—are imprecisely defined, leaving plenty of room for interpretation.

The current method of computing inflation, which relies on price indices built from fixed baskets of goods, cannot detect qualitative changes. As a result, qualitative improvements are misclassified as inflation, distorting both inflation rates and real GDP growth.

To address this problem, Focardi and Fabozzi (2023) proposed a new modeling framework inspired by modern scientific modeling approaches. Their framework includes both directly observable variables, such as monetary values, and hidden variables, such as quantity, quality, and generalized inflation. These hidden variables are estimated within a complete model, meaning they derive meaning from their interactions with the observable data. This leads to a fundamental new relationship:[2]

Nominal GDP = Quality × Quantity × Generalized Inflation.

This formulation explicitly separates qualitative growth from quantitative growth, giving a more accurate view of how modern economies evolve.

The emergence of qualitative growth as a defining economic feature can be traced back to the 19th century, but qualitative change was relatively slow until World War II. After the war, Europe faced the urgent need for physical reconstruction—rebuilding roads, bridges, rail networks, and housing.[3] Demand was dominated by basic needs such as shelter, home appliances, education, and transportation. In the United States, post-war economic policy was shaped by fears of a return to secular stagnation, prompting government stimulus programs to sustain demand.

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[2] Economics does use abstract, hidden variables such as states of Markov-switching models.
[3] Historically, several periods in selected places exhibited an extraordinary progress of artistic achievement. However, there was no precise notion of the economic contribution of the arts.

The character of growth changed fundamentally in the 1970s, driven by technological innovation and shifting social trends. The electronics revolution enabled entirely new categories of products, and automation began to reshape manufacturing and design processes. At the same time, social changes introduced new symbolic and cultural dimensions to consumption. Products increasingly served as cultural markers, not just practical tools.

Economic growth has combined quantitative and qualitative elements over the past 50 years. Consumers have gained access to an ever-expanding menu of products and services, many featuring innovative qualities designed to appeal to changing preferences and social identities. Product prices increasingly reflect not just production costs but also the costs of marketing, branding, and the cultivation of symbolic value.

In Focardi and Fabozzi (2023), quality is identified with complexity. Over time, products, services, and the economy have become more complex, thanks to the emergence of interconnected networks such as the World Wide Web (WWW) and social media platforms. While quality and complexity are not identical, complexity offers a useful proxy for modeling qualitative change.

There are two broad types of qualitative improvements. The first concerns products and services—for example, global positioning systems (GPS) represent a significant qualitative enhancement for vehicles and mobility. In recent decades, a continuous stream of product and service innovations has enhanced quality. The second type concerns services and amenities that are nearly dematerialized. Cultural events, digital content, and the greening of urban spaces are qualitative improvements with minimal material footprint.

However, it is important to recognize that even apparently dematerialized services, such as the Internet, require significant physical infrastructure, including data centers, fiber networks, and energy consumption.

Looking forward, achieving the goals of green deals and sustainability programs will require focusing on dematerialized qualitative growth and qualitative improvements that rely on regenerative resources. This shift is closely related to circular economy principles, a topic discussed in the next section.

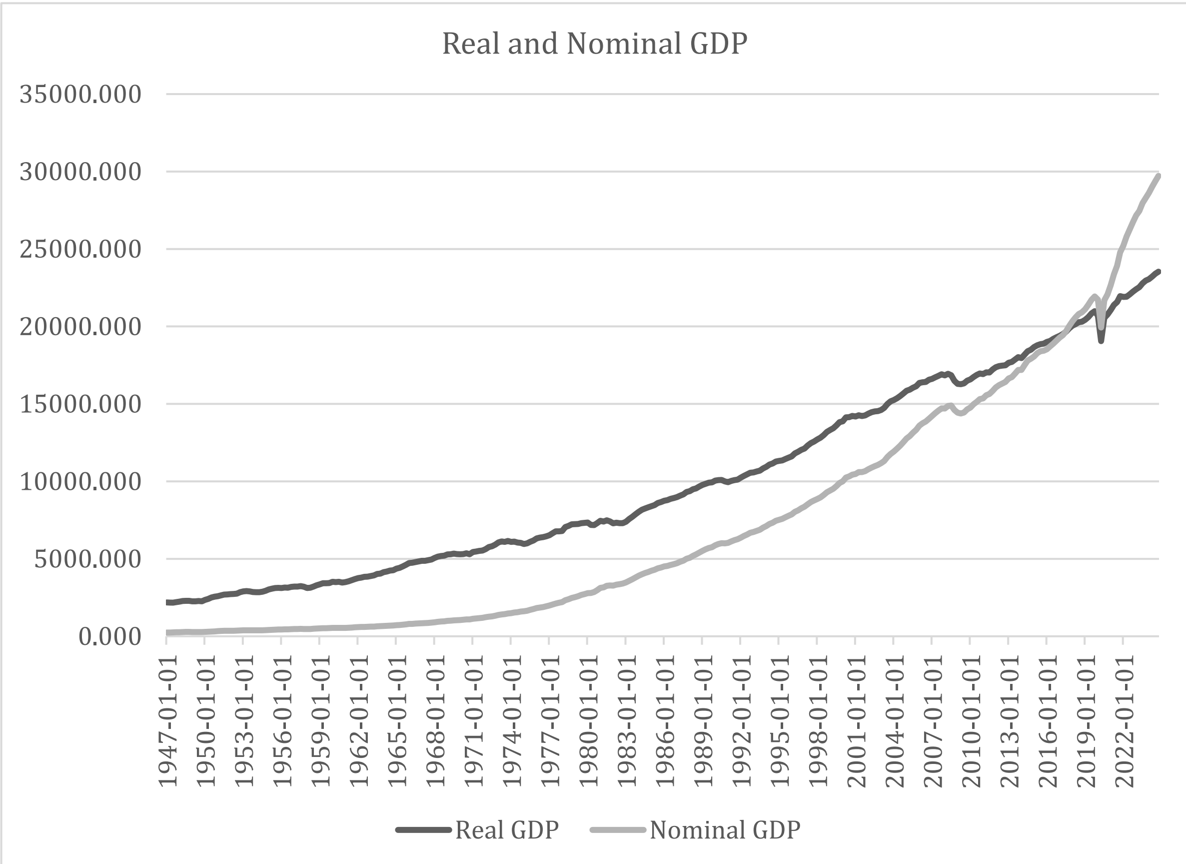

Figure 1. Real and Nominal GDP.

Figure 1 compares real (black) and nominal (grey) GDP growth. Real GDP is chained to 2017 dollars. That is, the graphs assume that real and nominal GDP were identical in 2017.

8. Integrating Qualitative Growth with the Circular Economy

If we had a perfect recycling technology plus sufficient clean energy, the circular economy would have little impact on consumption. We would reduce the extraction of minerals, metals, and materials by extracting only what would be needed for growth or what was not included in past products and services. Unfortunately, though green growth places great faith on technology, we are still very far from the objective of perfect recycling.

All definitions of circular economy suggest profound changes in consumption patterns. Perhaps the most serious issue is innovation. We have seen an accelerating trend toward innovations to satisfy consumers' needs in the last three decades. Not only this, but aggressive marketing actions have created needs that people did not know they had. Every available innovation and every aspect of human behavior, even the most questionable, have been exploited to sell products. Innovations have allowed the selling of more products or more expensive products.

This is in stark contrast to the objective of building products that have a long operational life and can be repaired and recycled. Unless there are unforeseeable technology changes, circularity requires that the design of many products and services follow the opposite of current trends. It seems that circularity points backward to less innovation.

Still, we need to conserve the possibility of growth. The studies by Focardi and Fabozzi cited earlier proposed qualitative growth. This means that an economy must become more complex, still reducing its material footprint. Stated differently, consumption must be pushed towards complexity, preferably dematerialized complexity. Is this compatible with circularity?

Many aspects of circularity are perfectly compatible with qualitative improvement. It is fair to say that products with long operational life must be good quality. We can even say that qualitative improvement is built in circularity. In practice, there are many aspects of quality. The requirement of a longer operational life of products implies designing and building products of better quality. It will not be easy to push people to consume a smaller number of products of better quality, but probably it can be done. For example, purchasing second-hand products, from furniture to apparel, has become fashionable in several countries. The essential requirement of circularity to reduce the turnover of products is perfectly compatible with quality improvement.

However, we need more dynamic elements of qualitative growth compatible with circularity. Innovation due to complexity is the most critical issue, especially for highly sophisticated electronics-based products. It will be necessary to reach some compromise in the function of the "weight" of each product category on the material footprint and the technology involved. For example, sectors such as textiles have a natural path to increasing quality by sacrificing quantity. The construction sector is also a sector where quality can replace quantity. However, many sectors, such as medical equipment, need innovation. We have to make an important consideration. We should not judge changes in function of their economic justification. If material resources were available, many changes could not be justified economically. But material resources are being depleted. Many changes will be costly but inevitable. The increased cost will generate increased revenues for manufacturers. Consumers will buy less of higher quality. The relative attractiveness of products and services will change. Market forces will have to work with unprecedented constraints.

The aesthetic dimension of life can become a source of qualitative growth. From infrastructure projects to the recovery of urban areas, aesthetics can play a significant role. The recovery of green spaces in cities is undoubtedly a primary target of qualitative growth. Of course, it requires a change of attitude. Traditionally, aesthetics played a significant role in transforming cities and nations. For example, the Renaissance was a vast movement that reshaped Europe.

It is very difficult to predict what will happen, but it seems clear that if economies want to grow, reducing the impact on natural resources consumption must become increasingly dematerialized. The three main areas of dematerialized growth might be aesthetics, culture, and humans' relationship with nature. Qualitative growth can place a structure of complexity on top of products and services that are becoming simpler at the level of their material implementation.

9. Is Qualitative Growth Compatible with the Circular Economy?

In the previous sections, we clarified that circularity is not an optional add-on that can simply be bolted onto any existing economic system. Instead, circularity must be intentionally designed into economic policies, industrial processes, and ultimately, societal cultures. Therefore, the appropriate question is not simply whether qualitative growth is compatible with the circular economy but rather: Can qualitative growth and a circular economy be deliberately designed to be compatible?

Circularity requires designing products with long operational lifespans and ensuring they can be repaired, refurbished, and recycled into raw materials. In principle, several industrial sectors are well-suited to these requirements. For example, textiles and construction are sectors where qualitative growth can coexist with circular practices. In these sectors, improvements in engineering and manufacturing that enhance product quality can also enable global resource savings by extending product lifespans and improving reparability.

However, qualitative improvements are much harder to reconcile in other sectors with circularity and resource conservation. Consider the medical sector, where qualitative improvements in treatments and devices may inherently require natural resources and may be difficult, if not impossible, to make fully circular. Similarly, product quality is closely tied to increasing design complexity in the electronics sector, making recycling highly complex devices exceedingly difficult—both technologically and economically.

The need to reconcile qualitative growth and circularity is an intellectual exercise and a pressing reality. Natural resource scarcity will become a critical constraint if humanity does not develop technologies that allow the synthesis of essential materials from abundant sources—perhaps through industrial molecular engineering. Learning to optimize available resources will become increasingly critical as we approach that point. To avoid the devastating social and economic consequences of pure degrowth, we must re-engineer human societies to pursue reasonable growth paths that emphasize well-being and sustainable prosperity rather than relentless material expansion.

In this context, qualitative improvements in products and services emerge as a critical strategy. However, there will inevitably be constraints on the types of feasible qualitative improvements. Specifically, we must avoid qualitative enhancements that impose excessive demands on scarce resources. Not all qualitative improvements will be compatible with sustainability goals, and some will become unaffordable.

More importantly, qualitative growth must be accompanied by profound cultural change. Ultimately, societies must learn to value intellectual life, culture, beauty, nature, and the enjoyment of creativity and knowledge more than accumulating and possessing physical objects. This shift in values will be essential for sustainability in a resource-constrained world.

However, affluent societies still operate as if material resources were unlimited. The only visible sign of environmental constraints is the growing share of energy generated from renewable sources. In 2023, the global share of renewable energy surpassed 30%; in the United States, renewables accounted for 20% of energy production, and in Europe, renewables reached 25%. Much of this renewable generation comes from hydropower, though solar and wind energy are expanding rapidly.

Despite this shift, there are no apparent limits on the sheer volume of material goods produced—from ever-larger automobiles to enormous cruise ships to skyscrapers pushing toward one-kilometer heights. Daily life is saturated with many physical objects, and even recreational “toys” have become increasingly extravagant. For example, the Formula Rossa rollercoaster in Abu Dhabi reaches speeds of 240 km per hour, while the Falcon Flight rollercoaster in Riyadh towers 195 meters high.

It seems reasonable to predict that this trajectory is unsustainable. Although the Earth’s materials supply may seem vast, their extraction is becoming progressively more difficult, dangerous, expensive, and environmentally damaging. Extraction processes for many critical materials are either too polluting or too destructive to ecosystems to continue indefinitely.

Unless technological breakthroughs enable the low-impact engineering of essential materials, societies will be forced to reduce the rate of raw material extraction and cultivate a new cultural paradigm. In this paradigm, satisfaction and well-being would be derived from the qualitative aspects of sustainable products, services, and experiences rather than from the endless accumulation of physical goods.

10. Illustrations of Circular Economy in Practice

This section presents three illustrative examples of qualitative changes implemented in urban projects to promote circular economy principles. These examples are drawn from the report *Building Prosperity: Unlocking the Potential of a Nature-Positive, Circular Economy for Europe* by the Ellen MacArthur Foundation, which is available online.[4]

10.1. Ljubljana, Slovenia

Ljubljana, Slovenia, experienced significant environmental degradation due to rapid urbanization. In response, in 2007, the city introduced Ljubljana 2025, a comprehensive, interdisciplinary urban plan designed to improve environmental quality and promote green-blue infrastructure.

A central element of the plan was the expansion of green spaces across the city. Since 2010, more than 40,000 trees have been planted, and 120 hectares of new green park areas have been created. One of the key features is a 34 km tree-lined avenue that encircles the city, complemented by a public orchard garden, significantly enhancing urban liveability.

Ljubljana also focused on restoring the ecosystem of the Ljubljanica River, improving biodiversity, and developing pedestrian and cycling infrastructure along the riverbanks. These measures have delivered multiple benefits, including (1) improved air quality, (2) reduced urban heat, and (3) enhanced citizen health and well-being.

Ljubljana's success in implementing this qualitative transformation was recognized when it received the European Green Capital Award in 2016. Ljubljana is a leading example of how a well-defined urban plan can improve environmental sustainability and quality of life through qualitative growth.

10.2. Vitoria-Gasteiz, Spain

The city of Vitoria-Gasteiz, located in northern Spain, exemplifies the transformative potential of urban greening initiatives. Named the European Green Capital in 2012, Vitoria-Gasteiz has systematically integrated green infrastructure into its urban planning and development processes.

A hallmark of this effort is the creation of a 30 kilometer “green ring” encircling the city. This regenerative project aims to restore degraded areas along the urban perimeter and plays a crucial role in improving urban biodiversity, enhancing recreational opportunities, and connecting fragmented green spaces.

[4] The Ellen MacArthur Foundation is a not-for-profit organization that collaborates with governments across the world to advance the circular economy agenda.

The Green Urban Infrastructure Strategy, launched by the Vitoria-Gasteiz City Council in 2012, provided the policy framework for these initiatives. The strategy focuses on (1) regenerating degraded areas, (2) enhancing biodiversity, and (3) improving connectivity and functionality of green spaces.

Since the strategy's inception, over 165,000 trees have been planted, surpassing half of the city's initial goal of 250,000 trees. As a result, Vitoria-Gasteiz now boasts the highest density of green spaces per capita among Spain's provincial capitals.

Vitoria-Gasteiz demonstrates how qualitative improvements in urban green infrastructure can enhance environmental quality, social cohesion, and long-term resilience.

10.3. Amsterdam, Netherlands

In 2020, Amsterdam became the first city in the world to formally commit to becoming a fully circular economy by 2050, with an intermediate goal of halving the city's consumption of virgin materials by 2030. Amsterdam's Circular Economy Strategy focuses on three key sectors: food and organic waste streams, consumer goods, and the built environment.

Food and Organic Waste Streams

- Develop a robust regional food system that reduces waste and supports local producers.
- Promote healthy, sustainable food consumption patterns.
- Improve organic waste collection and processing to maximize nutrient recovery and minimize landfill contributions.

Consumer Goods

Use the city's purchasing power to reduce the municipality's consumption by 20% by 2030.

- Support citizens with infrastructure and education campaigns to promote circular consumption habits.
- Improve product design to ensure products are easily reusable, repairable, and recyclable while extracting maximum value from products at end-of-life.

Built Environment

- Engage the entire construction value chain, from developers to contractors and suppliers, to embed circular practices into all phases of development.
- The city applies circular procurement criteria to stimulate innovation and encourage the use of recycled and sustainable materials.

Amsterdam's approach exemplifies system-level planning for circularity, showing how a city can align public procurement, infrastructure investment, and consumer behavior campaigns to promote circular, qualitative growth.

11. Summary and Conclusion

Integrating qualitative growth with the circular economy represents a necessary rethinking of the relationship between economic development and environmental sustainability. For too long, economic growth has been equated with increases in the volume of production and consumption, with little regard for the physical limits imposed by finite natural resources and the environmental consequences of excessive extraction and waste generation. The circular economy offers a framework for reducing these pressures by closing material loops, minimizing waste, and designing products and systems to maximize reuse, repair, and recycling. However, the circular economy alone does not provide a clear pathway for achieving the economic growth that modern societies rely upon to maintain stability, innovation, and rising living standards.

This paper has argued that qualitative growth, focused on improving the quality, functionality, and complexity of products, services, and infrastructure, can reconcile economic development with environmental limits. Qualitative growth shifts the emphasis from producing more to producing better, decoupling economic progress from resource depletion. This shift requires new financial models, capable of capturing qualitative improvements that are currently overlooked by conventional GDP-based measures of economic output. The proposed approach — treating the economy as a system characterized not only by observable monetary variables but also by hidden variables such as quality, quantity, and generalized inflation — provides a more realistic framework for understanding modern economic dynamics in a resource-constrained world.

Achieving qualitative growth within the context of a circular economy will not be automatic. Circularity cannot be retrofitted onto existing systems; it must be designed into products, processes, policies, and cultural expectations from the outset. While some sectors, such as construction and textiles, are well suited to circular principles, others — particularly sectors reliant on complex technologies and scarce materials — face more substantial challenges. In these cases, innovation must focus on modularity, repairability, and improved material recovery technologies while also reconsidering the necessity of certain products and processes.

Ultimately, the success of integrating qualitative growth and circularity depends on more than just technical innovations or policy interventions. It requires a cultural transformation — fundamentally rethinking what societies value and how well-being and prosperity are defined. In place of a culture that equates progress with material abundance, modern societies must learn to derive satisfaction from the intrinsic quality of products and services, aesthetic and intellectual enrichment, and a deeper connection with nature and community. This cultural shift is essential to ensure that qualitative growth enhances human well-being while respecting planetary boundaries.

The urban case studies presented in this paper — Ljubljana, Vitoria-Gasteiz, and Amsterdam — demonstrate that elements of this integration are already underway. These cities show how thoughtfully designed urban systems can simultaneously improve environmental performance, enhance the quality of life, and foster social resilience. By embedding circular principles into urban planning and emphasizing qualitative improvements in public spaces, infrastructure, and governance, these cities exemplify the potential for qualitative growth and circularity to reinforce each other.

The path forward requires sustained policy innovation, scientific research, technological development, and cultural adaptation. Aligning economic processes, cultural values, and environmental realities can help societies navigate the transition toward a sustainable, prosperous future. When fully integrated, qualitative growth and circularity offer the potential to redefine progress in the 21st century, preserving economic dynamism while ensuring that the ecological foundation for future generations remains intact.

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