Cogent Economics & Finance

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/oaef20

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To cite this article: Olugbenga Michael Adewumi, Chukwuemeka Echebiri & Andrew Adewale Alola (2024) Circular business activities and economic performance optimization in EU countries: towards consumption footprint management, Cogent Economics & Finance, 12:1, 2394491, DOI: 10.1080/23322039.2024.2394491

To link to this article: https://doi.org/10.1080/23322039.2024.2394491

COGENT ECONOMICS & FINANCE
2024, VOL. 12, NO. 1, 2394491
https://doi.org/10.1080/23322039.2024.2394491

ENVIRONMENTAL ECONOMICS & SUSTAINABILITY | RESEARCH ARTICLE OPEN ACCESS Check for updates

Circular business activities and economic performance optimization in EU countries: towards consumption footprint management

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ABSTRACT

As circular business activity is a pivotal component of the European Green Deal, this study examines its impact on economic prosperity by examining how the model influences income levels. The investigation spans a panel of 27 European Union (EU) member countries from 2014 to 2023, factoring in the income effect of consumption footprint and public trust in governing institutions. Based on the system Generalized Method of Moments (GMM) estimators of the dynamic panel model, the results reveal that circular business activities enhance economic well-being. However, the interaction effect of consumption footprint limits the full potential of this enhancing effect. Moreover, as public confidence in government institutions improves, so does economic well-being. This perspective underscores the pivotal role of trust in bolstering the economic benefits of circular business activities, leading to more robust societal conditions. Overall, the study suggests that while circular business activities can improve economic well-being, efficient management of the consumption footprint is crucial for optimization. Its policy implication emphasizes balancing economic aspects with social, institutional, and environmental elements to enhance individual well-being. Thus, the findings contribute to the literature and provide valuable policy insights into circular economy models, opening up avenues for future consideration.

IMPACT STATEMENT

This study highlights the significant role of circular business activities in enhancing economic prosperity within the framework of the European Green Deal. By analyzing data from 27 EU member countries between 2014 and 2023, the research demonstrates that while circular business practices positively impact economic well-being, their full potential is constrained by the interaction effect of consumption footprint. Additionally, it finds that increased public trust in government institutions further amplifies the economic benefits of circular activities. The study underscores the importance of managing consumption footprints and fostering institutional trust to optimize circular economy models' economic and societal advantages. These insights offer valuable policy implications, emphasizing the need to integrate various factors to improve overall well-being.

ARTICLE HISTORY
Received 27 May 2024
Revised 31 July 2024
Accepted 14 August 2024

KEYWORDS
Circular economy; economic well-being optimization; public confidence; consumption footprint; EU

SUBJECTS
Environment & Economics; Statistics for Business, Finance & Economics; Labour Economics; Development Economics

1. Introduction

The European Union's (EU's) introduction of environmental protection is one of the foremost principles, and this idea has been merged into its policies for achieving environmental sustainability. One of the drivers of this shift is the realization that the consumption patterns of goods and services negatively influence the global environment (European Commission, 2020). An attempt, among others, to achieve the EU's environmental objectives and targets is to mitigate the adverse environmental impacts of goods and services relative to consumption footprint (Sanyé-Mengual & Sala, 2023). In this regard, the EU has launched the European Green Deal (EGD), a strategic initiative to transform Europe into the first

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/23322039.2024.2394491.

climate-neutral continent. The EGD sets ambitious targets to tackle climate change, environmental degradation, and resource efficiency, all while ensuring economic competitiveness. This initiative is in line with the urgent need to address environmental crises (IPCC, 2023) to trigger a shift towards sustainable economic paradigms. In order to realize this, resource efficiency must be enhanced, and economic growth and societal well-being must be decoupled from environmental impacts (European Commission, 2011; Sala et al., 2014). In this connection, the Circular Economy (CE) model has been widely discussed and considered a potential solution (European Commission, 2020; Hopkinson et al., 2020).

The CE is a regenerative system that aims to eliminate waste and restore nature. It operates based on three design principles: the eradication of waste and pollution, the circulation of products and materials at their maximum utility, and the reinforcement of natural systems (Ellen MacArthur Foundation, 2020). The evolution of this concept has been significantly influenced by the escalating concerns about environmental degradation, resource scarcity, and climate change (Stahel, 2016). Specifically, the CE strongly emphasizes resource regeneration, waste reduction, and promoting sustainable consumption and production patterns, revolutionizing traditional linear economic processes (Ellen MacArthur Foundation, 2013, 2020). By optimizing resource use and minimizing waste, numerous authors have demonstrated that circular business practices can stimulate economic growth while addressing environmental challenges (Donaghy, 2022; Ellen MacArthur Foundation, 2020; Kirchherr et al., 2017a; Winans et al., 2017). However, the CE or circular business activities, as preferred in the current study, face the environmental repercussions of an average EU citizen's consumption habits (consumption footprint), which exceed the sustainable limits for human existence in several impact areas (Sanyé-Mengual & Sala, 2023).

The concept of the consumption footprint, a comprehensive framework of 16 indicators rooted in Life Cycle Assessment (LCA), was developed to quantify the environmental impacts associated with the consumption habits of an average EU citizen. The environmental impacts include those occurring within the EU territory and those embedded in the import and export activities (Sanyé-Mengual & Sala, 2023, p. 13). This framework encompasses five key areas: food, mobility, housing, household goods, and appliances (Sala & Sanyé Mengual, 2022). Daily activities such as eating and driving contribute significantly to the EU consumption footprint. In this context, food consumption is the most impactful, accounting for an 18% increase in the consumption footprint. Findings suggest that this increase is primarily driven by the environmental toll of agricultural production (Sanyé-Mengual & Sala, 2023, p. 20). Probing deeper into the impact of food consumption, it becomes evident that the rise in meat and dairy intake plays a significant role. Accordingly, there has been a marked increase in the consumption of certain foods like cheese, quinoa, tofu, and avocados, reflecting shifts in dietary preferences. Conversely, chickpeas, tuna, and olive oil consumption has significantly declined (Sanyé-Mengual & Sala, 2023, p. 31).

The increasing consumption footprint indicates increased municipal solid waste (MSW) generation, causing significant environmental concern. Consequently, effectively managing this escalating volume of waste presents a substantial challenge. In perspective, the global generation of MSW was 2.01×10^9 tons in 2016 and is projected to escalate to 3.40×10^9 tons by 2050 (Kaza et al., 2018). Despite these figures, there are concerns that the infrastructure for managing this MSW within the CE framework is insufficient, leading to environmental issues such as pollution and health risks. For instance, the United Kingdom faces a shortage of CE infrastructure, which is necessary for reducing resource use and enhancing recycling (Peake & Brandmayr, 2019). While a significant portion of the MSW in the EU is either recycled or recovered, the achievement of recycling and recovery targets varies (EU average $= \sim 47\%$). From this context, a substantial amount of waste ($>80\%$), which could potentially generate economic benefits, is still being disposed of in landfills in some EU countries (Eurostat, 2019). This situation calls for improved waste management strategies and policies to ensure environmental sustainability and public health. It also underscores the importance of promoting waste reduction practices and enhancing recycling and recovery efforts. Thus, addressing this issue is crucial in pursuing a more sustainable and waste-free society. In this regard, Marino and Pariso (2020) highlight that additional efforts are needed within the EU member states to surmount the challenges associated with the transition to the CE. This reasoning aligns with other studies showing that effective CE adoption can produce sustainable environmental performance (Dey et al., 2022; Fan et al., 2021; Mawutor et al., 2023) and economic gains (Sanyé-Mengual & Sala, 2023).

However, previous research indicates that while CE has economic significance (Donaghy, 2022; Ellen MacArthur Foundation, 2020; Kirchherr et al., 2017a; Sanyé-Mengual & Sala, 2023), its value addition is limited by the consumption footprint (Camacho-Otero et al., 2018; Kirchherr et al., 2017b). Therefore, a desirable trend regarding optimality is to separate the environmental impacts of consumption footprint from the corresponding economic output (Sanyé-Mengual et al., 2019). This view suggests a move towards more responsible consumption patterns that can mitigate the effects of increasing consumption footprint. In other words, it underscores the need to bolster robust circular business activities by implementing policies and programs encouraging more citizen participation within EU countries. The rationale is that improved CE practices can yield substantial global, national, and household economic benefits (Ferreira Gregorio et al., 2018; Lyeonov et al., 2019). Along these lines, the current study aims to investigate how the economic impact of circular business activities optimizes, reducing the environmental impact of the escalating consumption footprint across EU countries. The rationale for this direction hinges on numerous grounds, each contributing to a comprehensive understanding of CE and its implications. Firstly, the environmental impact of the EU's per capita consumption footprint is exceeding planetary boundaries. This upward trend suggests obstacles to diminishing the EU's consumption footprint in the forthcoming years (European Environmental Agency, 2024). Thus, this alarming trend necessitates a thorough understanding of managing and moderating the environmental impact of the EU's consumption footprint. Secondly, while the specific ways in which the consumption footprint hinders the CE are not fully understood (Geissdoerfer et al., 2017), there is a scarcity of studies demonstrating optimal models for assessing the influence of the CE on economic outcomes. Hence, we aim to fill a gap by empirically examining the impact of circular business activities on economic well-being to unveil a direction toward optimization.

In order to accomplish our objective, three research questions are articulated. First, is the economic performance of circular business activities optimal in the EU countries? Second, if not, how does the economic performance of circular business activities optimize across the EU? Third, what measures should the EU countries take to improve circular business participation? To answer these questions, we investigated a panel of 27 EU member countries between 2014 and 2023 based on Eurostat and World Bank databases. Then, we utilize the Generalized Method of Moments (GMM) system estimators of linear dynamic panel data models to facilitate the empirical analysis. The idea is to gain insights into the time-bound effects of circular business activities on economic well-being, exploring the pattern of EU citizens' participation for potential optimal outcomes. Along this line, we include the effect of public confidence in government institutions on economic well-being in the study. This aspect enables an understanding of why citizens' participation in circular business activities may improve or decrease across the EU countries. Following this path, the findings reveal a complex relationship between circular business activities and economic well-being. While circular business activities can improve income levels, there are potential downsides. From a policy perspective, we address these drawbacks by underscoring the importance of managing the consumption footprint for CE model improvement. Essentially, the study offers valuable insights that can assist policymakers in optimizing the economic benefit of circular business activities, leading to improved environmental conditions and economic well-being in EU countries.

Next, the paper progresses into Section 2 with the literature review and presents the research method in Section 3. Section 4 unveils the results, followed by a discussion in Section 5. Then, it wraps up with the conclusion in Section 6.

2. Literature review

2.1. Economic performance

In traditional economic theory, evaluating a country's economic performance is pivotal in informing decision-making processes across various contexts, from shaping governmental policies to formulating individual investment strategies. It stands as a basis for driving economic trajectories and nurturing sustainable progress. While GDP per capita frequently serves as a benchmark in such assessments, criticisms have arisen regarding its limitations as a singular indicator. Scholars such as Dědeček and Dudzich (2022) have highlighted concerns about the exclusion of factors like income inequality and

economic freedom, which may distort the accuracy of GDP per capita as a comprehensive metric. Nevertheless, proponents, including Brock and Rathburn (2009), Brown (2023), and Bright Hope International (2023), contend that GDP per capita retains efficiency, particularly in comparative analyses across nations with vastly disparate population sizes. They argue that this measure offers a more equitable basis for evaluating economic performance, accommodating the nuances inherent in cross-country comparisons.

2.2. Overview of economic performance in the EU context

As of 2024, the EU has a GDP estimated to be worth $19.35 trillion (nominal) or $26.64 trillion in purchasing power parity (PPP), thus accounting for one-sixth of the global economy. In nominal terms, it is the second biggest economy in the world, just behind the United States of America (USA), and the third largest in terms of PPP, with China and the US in front. Germany, France, and Italy are the bloc's three largest economies in terms of national GDP. The GDP per capita expressed in PPP was about $56,970 in 2023, but there were remarkable differences between member states that lay well above and those that blew the average. Figure 1, as indicated below, shows the GDP per capita index for EU member states in 2023. The Figure indicates that Luxembourg has the highest GDP level of 140% above the EU average, while Bulgaria recorded the lowest GDP per capita, 36% below the EU average (Eurostat, 2024).

2.3. Circular economy

The circular economy has gained significant attention due to recent global imperatives to adopt more sustainable practices to minimize waste, mitigate the rapid depletion of finite resources, and curb emissions. This attention comes from academics, policymakers, and practitioners across all levels, including private, public, and even voluntary organizations (European Parliament, 2023; Geissdoerfer et al., 2020; Kanda et al., 2021; Urbinati et al., 2017). For example, Brydges (2021) investigated the strategies for a more circular fashion industry in Sweden. Geissdoerfer et al. (2022) compared the drivers and barriers and identified 25 obstacles and 10 drivers. The broad focus ranges from sustainable consumption and production to industrial ecology, from startups to small and medium enterprises (eg Kirchherr et al., 2023; Maher et al., 2023; Van Opstal & Borms, 2023). This diversity of interest is also reflected in how CE is conceptualized. At the European Union level, the European Parliament defines the CE as 'a model of production and consumption that involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible' (European Parliament, 2023, p.115). In a nutshell, it is an economic business model that entails a combination of measures and approaches to minimize waste through the utilization of the least amount of resources but at the same time maximizing value

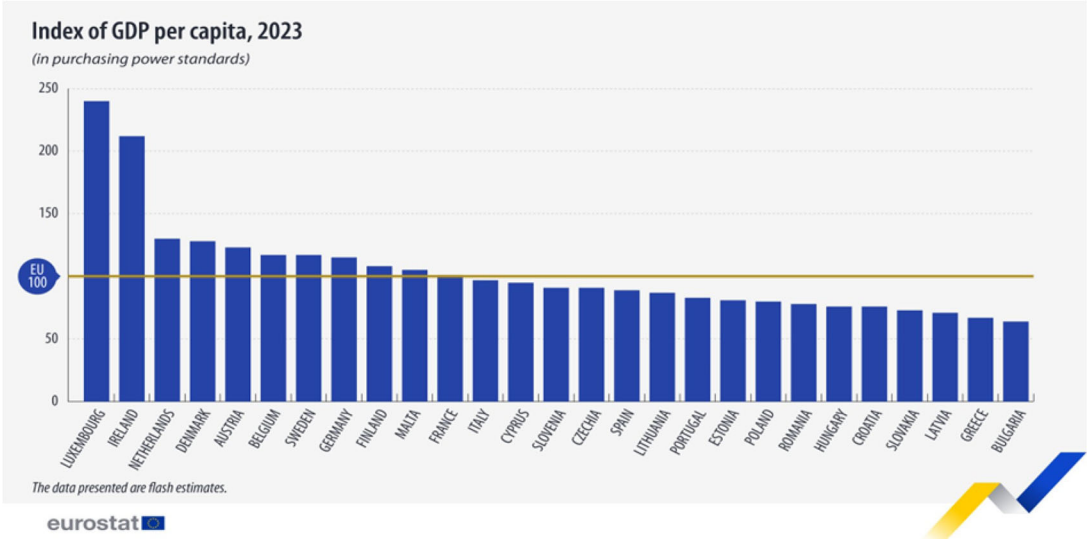

Figure 1. Index for GDP per capita, 2023 (in purchasing power standards) - adopted from Eurostat (2024).

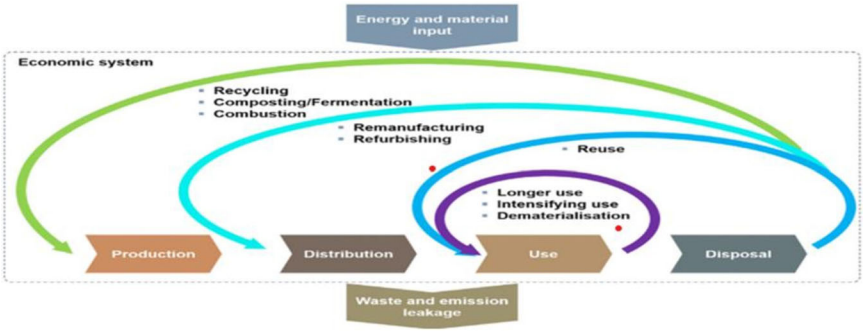

Figure 2. Circular economy model adopted from Geissdoerfer et al. (2020).

extraction in the process, thus elongating a product's end-of-life and ultimately moving away from the linear socio-economic Model (Geissdoerfer et al., 2020; Tura et al., 2019). The linear model has pushed excessive material consumption due to the use-and-dispose culture, a process often conceptualized as 'take, make, and waste' (European Parliament, 2023).

In contrast, CE models lean toward a more restorative and regenerative system (Brydges, 2021). Typically, this includes but is not limited to reusing, sharing, leasing, recycling, and recovering materials for production, redistribution, and consumption (Henry et al., 2020; Urbinati et al., 2017). This transition to circular business models, exemplified in the CE model in Figure 2, could be achieved in several ways but mainly through one or a combination of three strategies: retaining product ownership, product life extension, and design for recycling. In this context, organizations must chart a path that aligns with their capabilities and resources (Dumas & Van Wassenhove, 2021). The CE has surfaced as a fundamental element of the EU policy, particularly with the European Commission's endorsement of a circular economy action plan in March 2020, referred to as the European Green Deal. This plan aimed to use regulatory and non-regulatory measures to achieve the bloc's 2050 carbon neutrality. Adopting the circular economy principle is estimated to create about 700,000 new jobs with an addition of 0.5% to the bloc's GDP (European Commission, 2020). Furthermore, switching to CE will protect the environment by slowing down the utilization of natural resources and limiting biodiversity loss, reducing raw material dependence as the world's population continues to grow (European Parliament, 2023).

2.3.1 Circular economy and economic performance

Research suggests that adopting a CE model in the EU can positively impact economic growth and enhance an organization's sustainability performance (Dey et al., 2022). Busu (2019) and Vuta et al. (2018) found that resource productivity and real economic growth improve with higher recycling rates and increased investment in research and innovation. Busu (2019) elucidates by identifying critical economic factors driving the development of the circular economy in the EU, including resource productivity, labor employed in environmental protection, recycling rates, and renewable energy use. George et al. (2015) propose a theoretical model suggesting that environmental quality improvements are not directly linked to economic growth but to increases in the environmental self-renewal rate or recycling ratio. According to Horbach and Rammer (2019), firms with circular economy innovations experience growth in turnover and employment, indicating a better financial standing despite no significant impact on labor productivity. Hysa et al. (2020) further support this view, emphasizing the importance of sustainability, innovation, and investment in initiatives that produce no waste in promoting economic growth. From this perspective, Grdic et al. (2020) underscore the potential of the circular economy to ensure economic and GDP growth while reducing natural resource use and enhancing environmental protection. More recently, Dey et al. (2022) found that CE adoption can produce superior environmental performance through energy and resource efficiency and reduce waste in SMEs.

2.4. Consumption footprint

Transitioning to CE within the EU requires that all stakeholders reduce their consumption footprint. According to the European Environment Agency (2023), the consumption footprint refers to the overall

impact of the consumption of goods and services on the environment and climate of EU citizens, regardless of where these goods and services are produced. It is also an essential step towards the European Green Deal and, overall, the United Nations' sustainable development goals (SDGs), mainly responsible production and consumption (SDG12) (UN, 2024). The European Commission – Joint Research Centre (EC-JRC) devised the Consumption Footprint indicator to assess the effects of consumption within the EU. This indicator is a process-based Life Cycle Assessment that takes into account the supply chain of 150 representative products selected from five areas of consumption, which include housing, mobility, food, household appliances, and household goods (Castellani et al., 2021; Genta et al., 2022). The importance of monitoring consumption footprints was re-emphasized in the 2023 revised circular economy framework. The revised version includes new indicators on 'material footprint and resource productivity – to monitor material efficiency' and 'consumption footprint – to monitor if EU consumption fits within planetary boundaries' (European Commission, 2020).

In 2021, food consumption, housing, and mobility had an environmental impact in the EU, accounting for 48%, 19% and 15%, respectively. Studies show that the consumption footprints of EU citizens are high and most likely to increase further by 2030 based on the present trends, thus exceeding the EU's fair share of planetary boundaries (European Environment Agency, 2023). Notably, although the values remained higher in 2021 than in 2010, this was also amidst the Eighth Environment Action Programme's call for the EU to reduce its consumption footprint considerably (European Environmental Agency, 2024). Figure 3 below summarizes the consumption footprints of the 27 EU Member States in 2021 compared to 2010. As shown in the Figure, the difference between the highest and the lowest two States is about sixfold.

Overall, understanding the consumption footprints of EU residents provides valuable insights into the environmental and climate impact of consumption patterns and can shape policies to support them. This transition to CE is a shared responsibility at various levels of government and stakeholders (OECD, 2024a), each having different roles in the form of pressure exerted (Yu et al., 2022). For example, the national and local governments can collaborate as promoters and enablers of CE (OECD, 2024a), and consumers can adapt their consumption patterns to minimize their consumption footprint. Previous studies found that stakeholder pressure can catalyze a firm to become more environmentally friendly and produce resource-efficient products (Pinheiro et al., 2022). Rodríguez-Espíndola et al. (2022) argued that the customer, as a stakeholder, can pressure an organization to adopt CE principles. However, this requires citizens to have confidence in the government's policies.

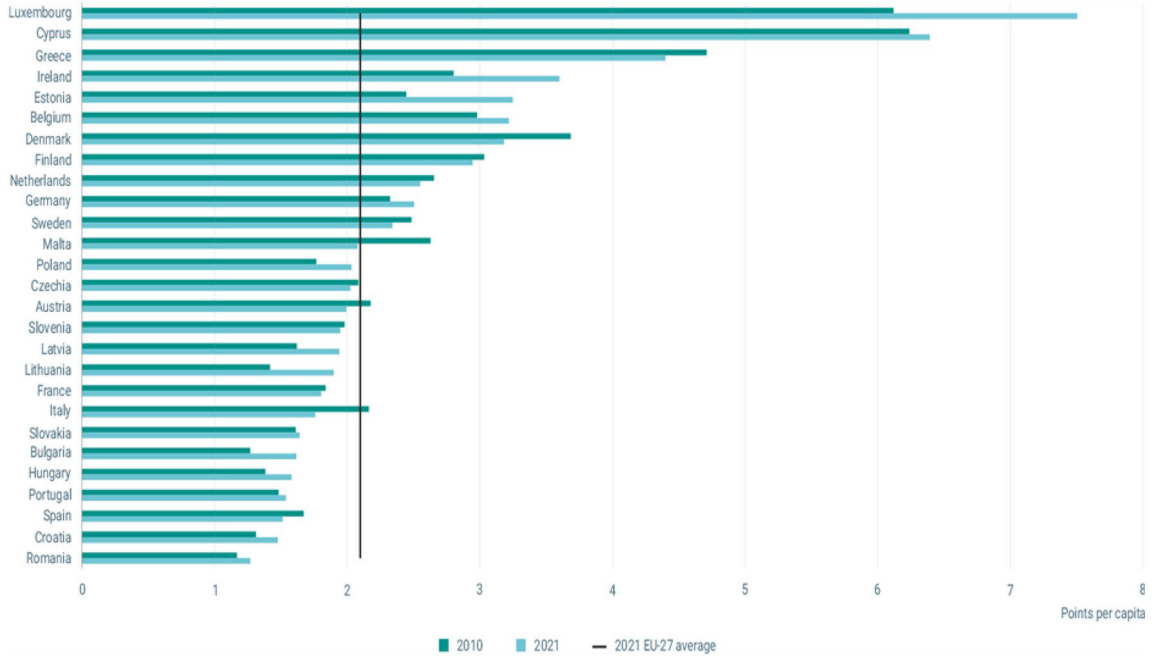

Figure 3. Consumption footprints for EU countries in 2010 and 2021 adopted from the European Environment Agency (2024).

2.5. Governance-induced confidence

According to the Organisation for Economic Cooperation, 'trust in government refers to the proportion of individuals who express trust in their national government' (OECD, 2024b)[1]. Trust is of two types: trust accorded to impersonal bodies like the government and trust given to people. The trust given to people is further categorized as a particularised trust to people we know and generalized or social trust to strangers (Muringani, 2022). Several empirical studies show that good governance practices impact the attitudes and citizens' behavior toward government policies (Mansoor, 2021; Muringani, 2022). This view is supported by Mawutor et al. (2023), who argue that the quality of governance can moderate the relationship between CE and carbon emission such that the emission rate reduces when governance is perceived to be efficient.

Conversely, declining trust in the government indicates fundamental dissatisfaction (Citrin, 1974), reducing the government's capacity to address public policy concerns (Chanley et al., 2000). To this effect, it is logical that the ability of the government to promote green practices requires reducing consumption footprints (Mawutor et al., 2023). In a panel data study (1996–2017), Baloch et al. (2019) demonstrated the negative association between governance and carbon emission in Brazil, Russia, China, and South Africa, commonly known as BRICS. In this fashion, Muringani (2022) argued that trust matters for regional economic growth and emphasized the need to develop interventions to generate trust. Transitioning to CE, which would reduce the consumption footprint, is a top-down policy driven by the EU-level and national governments. However, the success or failure of this policy depends on the extent to which citizens have confidence in their governments and institutions to make the right decisions. Previous studies show an association between trust in public institutions and outcomes (Price et al., 2023). Therefore, public trust can be essential for tackling long-term societal challenges such as reducing consumption footprints or transitioning to CE.

3. Research method

3.1. Data and sources

With the exemption of GDP per capita (per capita gross domestic product), this investigation employs a dataset from the European Commission online source, ie the Eurostat database for 27 European Union member states.[2] The panel's GDP per capita dataset was obtained from the World Bank database (The World Bank, 2024).[3] The unavailable values for GDP per capita in 2023 and consumption footprint for 2022 and 2023 were computed from the average values of the previous years to ensure balanced panel data covering 2014 to 2023. Supplementary Appendix Table A1 conveys other essential information about the dataset, such as description and metric information (see Supplementary Appendix).

3.2. Variables

Regarding economic performance indicators, several alternatives to GDP have been proposed in the literature, including the Human Development Index (HDI) (Costanza et al., 2009; van den Bergh, 2009). Nonetheless, Brock and Rathburn (2009), Brown (2023), and Bright Hope International (2023) recommend the relevance of GDP per capita, particularly for its efficacy in comparative analyses across nations with significantly divergent population sizes. Along this line, this study's primary independent variable influencing economic well-being is 'circular business activities.' Horbach and Rammer (2019) posit that firms implementing innovations in the circular economy witness an upswing in both turnover and employment, suggesting an improved financial status, albeit without a substantial effect on labor productivity. In this context, it indicates that circular business activities could potentially bolster economic and GDP growth while concurrently diminishing the utilization of natural resources and augmenting environmental protection (Donaghy, 2022; Sanyé-Mengual & Sala, 2023).

The 'Government's confidence' is another crucial variable influencing economic performance. The underlying premise is that public trust is critical in addressing lasting societal challenges, such as diminishing consumption footprints or transitioning towards the operations of a CE. Existing literature demonstrates a correlation between trust in public institutions and consequential outcomes (Price et al., 2023).

Table 1. Essential characteristics of variables for EU country sample (2014–2023).

Variable	Obs	Mean	Std. Dev	Min	Max
GDP per capita	243	32,835.88	22,328.44	7078.86	110,425.9
Circular Bus. Act.	243	142,722.6	200,125	1839	785,297
Government Conf.	243	48.687	11.270	19	83
Consumption F. print	243	105.207	8.264	84	141
Year effect	243	5	2.587	1	9

In this regard, Muringani (2022) posits that trust is vital for regional economic growth and underscores the necessity to devise strategies that foster trust. Specifically, Mawutor et al. (2023) found that implementing functions relating to circular business activities necessitates high-quality governance for a positive impact. Accordingly, an adequate level of governance elucidates why citizens may show an increased inclination to participate in circular business activities, leading to a favorable environmental outcome regarding reduced carbon emissions. Building on this view, we include governance–induced trust (Government's confidence) as a variable that improves economic prosperity (GDP per capita).

To effectively assess the economic implications of circular economic activities, evidence suggests employing the Decoupling Index (DI) to evaluate the dissociation of GDP from environmental impacts attributable to EU-28 consumption is pertinent (see detail in Sala et al., 2019). In this context, the environmental impacts were quantified utilizing the LCA-based consumption footprint set of indicators because of their comprehensive depth (Sala et al., 2016; Sala et al., 2019). Accordingly, this approach facilitates the evaluation of impacts along supply chains and a variety of potential environmental impacts. Also, it can explain potential trade-offs between distinct environmental impact categories and various stages of product life cycles (Sala et al., 2016). That said, how the variables included in our model are measured is presented in Supplementary Appendix Table A1.

3.3 Variable characteristics

The statistical classification of the variables included in our model is presented in Table 1. Expectedly, GDP per capita and circular business activity, ie represented by the number of people in circular business and economic activities, have the highest deviation from the mean value. This outcome arises because of the measurement unit and the peculiar changes associated with the variables over a given period. However, government confidence (measured by the percentage of the population's confidence in institutions) and consumption footprint also show reasonable changes over the examined period. The year variable shows that the observed influence of the variables occurs within nine years in our study.

3.4. Model specification

The description of economic performance vis-à-vis productivity evolved from the traditional economic models detailing the roles of exogenous factors. These factors include technological changes and entrepreneurship, which extend the labor and capital driver type of growth perspective (Acemoglu et al., 2005; Barro, 2000; Lucas, 1978; Solow, 1957). Given the prospects of economic expansion, society is expected to experience positive change in the household or per-head income level. In this direction, the present study follows the work of Acemoglu et al. (2008) and Fields et al. (2003) on income drivers. It focuses on the economic and econometric formulation of 243 observed circular business activities across 27 EU countries. These circular business activities are quantified based on the number of individuals employed in three sectors: repair and reuse, recycling, and rental and leasing. Employment is measured by the absolute number of individuals employed and as a proportion of total employment, expressed in full-time equivalent terms. The specifics of this formulation are presented in Equation (1).

$$\text{GDP per capita} = f(\text{Circular Bus. Act.},\ \text{Government Conf.},\ \text{Consumption F. print}) \tag{1}$$

3.4.1. GMM approach

In order to estimate Equation (1), we employ the linear dynamic panel data model. In a dynamic panel data model, the current value of the dependent variable is influenced by its past values. By adopting

this model, we can control for the unobserved individual country-level fixed or random effects and address the potential endogeneity of circular business activities concerning GDP per capita and temporal effects. Moreover, the dynamic panel data model is preferred in our study due to its robustness in accounting for omitted variables and sample selection bias that may be present. Precisely, including lagged dependent variables captures dynamic relationships and persistence over time, while fixed effects control for time-invariant unobserved heterogeneity (Wooldridge, 2010). Also, data transformations such as first differencing and the use of the GMM estimator further mitigate omitted variable bias by eliminating individual-specific effects and addressing endogeneity (Arellano & Bond, 1991; Arellano & Bover, 1995; Blundell & Bond, 1998). Besides, instrumental variables (IV) and GMM estimators correct for endogeneity arising from sample selection bias, as instruments correlated with endogenous regressors but uncorrelated with the selection process yield consistent estimates. GMM methods enhance this by utilizing lagged values as instruments, thus improving estimate robustness (Arellano & Bond, 1991; Blundell & Bond, 1998). These techniques collectively control for unobserved factors, correct bias at its source, and accommodate various regressors, thereby enhancing the model's efficiency and accuracy.

In that regard, assuming that in Equation (1), Y, C, G, K, and γ denote GDP per capita, circular business activities, government confidence, consumption footprints, and year effect, respectively, our model is presented in Equation (2) as:[4]

$$Y_{i,t} = \beta_1^* Y_{i,t-1} + \boldsymbol{\beta}_2 \sum_{j=0}^{2} C_{i,t-j} + \boldsymbol{\beta}_5 \sum_{j=0}^{1} G_{i,t-j} + \beta_7 K_{it} + \boldsymbol{\beta}_8 \gamma_{i,t} + \beta_9 Int_{i,t} + v_{i,t} + \ u_{i,t}, t = 4, 5 \ldots\ldots\ldots T \qquad (2)$$

Where β^* is the anticipated coefficient for the lagged GDP per capita, $\boldsymbol{\beta}_2$, $\boldsymbol{\beta}_5$ $\boldsymbol{\beta}_7$, and $\boldsymbol{\beta}_9$ are the expected coefficients that quantify the impact of circular business activities, government confidence, consumption footprints, and the interaction term, *Int.* (ie C*K) on GDP per capita, respectively. Also, $\boldsymbol{\beta}_8$ is the coefficient vector that quantifies the impact of the vectors of year effect γ. Specifically, γ illustrates how the ever-changing competitive landscape influences the impact of circular business activities on income levels across different countries over time. While ν_i is the unobserved individual country-level fixed or random effects ($i = 1, 2, \ldots, 27$) that may correlate with the dependent variables, u_i is the idiosyncratic error that captures the unobserved influences on the dependent variable that change over time ($t = 2014, 2015, \ldots, 2023$) and are not correlated with the explanatory variables. The GDP per capita and circular business activity are included in our model logarithmic as the remaining variables are not.

Based on Equation (2), we assume that the EU countries have previously invested in circular business activities (Circular Bus. Act.), which is expected to improve their economic prosperity (GDP per capita) later. Research suggests that in 2022, 42% of EU individuals aged 25–34 held a higher education, exceeding 50% in one-third of EU countries (Yanatma, 2024). This finding indicates that most people in developed EU economies are well-educated and must have acquired some applicable skills. Thus, employed citizens within the circular business activities are expected to understand the basic operations of CE to a reasonable extent. From this perspective, we assume that in our model, a crucial variable, education levels, which can also influence economic prosperity, is accounted for by the people participating in circular business activities across the EU. Also, we assume that circular business activity is endogenously determined in the model. The rationale is that these countries self-select into circular business activities, leading to selection bias that creates a self-selection-based endogeneity problem, which breaches the strict exogeneity assumption.

Furthermore, we expect that earlier realizations of GDP will improve investment in circular business participation in the current period. So, past GDP per capita values are included in our model. Moreover, GDP per capita is expected to account for size indicators, given that the effect of GDP per capita can vary significantly across countries of different sizes, reflecting the heterogeneous impact of country size on economic performance. Going forward, we assume that the EU countries are implementing enabling healthcare services, quality education systems, standard infrastructural facilities, and implementable policies that encourage citizens to trust their governing institutions. In this regard, we specify that government confidence is predetermined in our model as the participating citizens already trusted the governing institutions before the current period. Therefore, it is anticipated that reliable government

policies foster public engagement in circular business activities. As a result, such engagement would be characterized by responsible production and consumption practices that are mindful of the consumption footprint. Also, building on the insights presented in Section 3.2, our model incorporates the interaction between circular business activities and the consumption footprint to reflect this relationship. This inclusion enables us to gain insights into how the consequences of consumption footprint escalate relative to circular business activities. Nonetheless, we assume that several indicators outside our model determine the consumption footprint of each country and, therefore, would be treated as an exogenous variable. In this context, the equivalent linear dynamic panel model offered in Equation (2) above follows the number of lags suggested by the test statistics.

On that note, the transformed Equation that eliminates the endogeneity in Equation (2) is specified in Equation (3):

$$\Delta Y_{i,t} = \beta_1^* \Delta Y_{i,t-1} + \boldsymbol{\beta}_2 \sum_{j=0}^{2} \Delta C_{i,t-j} + \boldsymbol{\beta}_5 \sum_{j=0}^{1} \Delta G_{i,t-j} + \beta_7 \Delta K_{it} + \boldsymbol{\beta}_8 \Delta \gamma_{i,t} + \Delta \beta_9 Int_{i,t} + \Delta u_{i,t}, t = 4, 5 \ldots\ldots\ldots T \tag{3}$$

where the time-invariant unobserved heterogeneity $\nu_{i,t}$ has been eliminated, and $\Delta y_{i,t} = y_{i,t} - y_{i,t\text{-}1}$, $\Delta y_{i,t\text{-}j} = y_{i,t\text{-}j} - y_{i,t\text{-}j\text{-}1}$, as consistently applied to all other variables. Then, following Blundell and Bond (1998) system GMM estimation approach, we implemented Equation (3) with the dynamic panel data (dpd) and system (dpd) implementation commands. The modeling of Equation (3) started without the interaction term as the baseline model. After that, the interaction term *Int* – the interaction between circular business activities and consumption footprints was introduced in our preferred model.

4. Results

4.1. Empirical analysis and findings

We apply the system GMM estimators of the linear dynamic panel data model to investigate the impact of circular business activities on GDP per capita, as presented in Equation (2). This approach enables us to account for unobserved heterogeneity at the country level, the endogeneity of circular business activities concerning a country's economic growth, and temporal effects. Following the recommendation to incorporate valid lagged variables as instrumental variables in dynamic panel data models, ie GMM by Arellano and Bond, (1991), further modifications have been made. Specifically, there are recommendations to incorporate a particular category of independent variables in the form of either the lagged values of the dependent variables (ie autoregressive distributed lag-ARDL) or the lagged values of the independent variables (ie distributed lag-DL) (Arellano & Bover, 1995; Baltagi, 2008; Blundell & Bond, 1998).

The basis assumptions that justify the empirical approach are rigorously tested in this context. In the first attempt, the evidence of cross-sectional dependence was tested with the validation of the alternative hypothesis. The results from the Breusch and Pagan (1980) and Pesaran (2021) test approaches (Table A2, see Supplementary Appendix) imply that there is a clear possibility of transmission of country-specific effects such as social and economic changes across the entire panel. Also, the stationarity property of the variables (Table A3, see Supplementary Appendix) and cointegration of the Model (Table A4, see Supplementary Appendix) are respectively ascertained through the test approaches of Pesaran (2007) and Kao (1999). Following the required test, the lagged GDP per capita and Circular Bus. Act.'s values are deployed in Equations (2) and (3) as test results recommend. As such, the analyses' outcomes are presented in Tables 2–4. Specifically, Table 2 treats circular business activity as a predetermined variable while it is endogenous in Tables 3 and 4. In this fashion, while the Sargan test results support the system GMM estimator of our model from the dpd and system dpd implementation strategies, our interpretation is based on the latter.

Table 2. The system GMM estimator results when circular business activity is treated as a predetermined variable (The dependent variable = the GDP per capita in Log).

	(1)		(2)	
Variables	dpd	SE	System dpd	SE
Lag GDP per capita	0.970***	(0.005)	0.971***	(0.004)
Circular Bus. Act.	0.206***	(0.058)	0.056**	(0.021)
Ist Lag Circular Bus. Act	−0.210***	(0.058)	−0.067***	(0.019)
Government Conf.	0.001**	(0.001)	0.001**	(0.001)
Ist Lag Government Conf.	−0.001*	(0.001)	−0.001*	(0.002)
Consumption F. print	−0.001*	(0.001)	0.001	(0.001)
Year effect	−0.001	(0.001)	−0.002**	(0.001)
Number of countries	27	–	27	–
Constant	1.604	(1.336)	4.366***	(1.189)
Sargan value (Instr.)	64	–	49	–
Sargan *p*-value	1.000	–	0.966	–
AR(1)/*p*-value	−3.116***	–	−2.905***	–
AR(2)/*p*-value	−2.240***	–	−2.016***	–
Observations	216	–	216	–
Year dummies	Incl.	–	Incl.	–

Standard errors in parentheses, Significance levels: $^{+}p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. The dpd signifies the dynamic panel data estimation strategy, and Incl means included. Models 1 and 2 follow a two-step estimator.

Table 3. The baseline model for the system GMM estimator results when circular business activity is treated as an endogenous variable (The dependent variable = the GDP per capita in Log).

	(3)		(4)	
Variables	dpd	SE	System dpd	SE
Lag GDP per capita	0.986***	(0.007)	0.979***	(0.006)
Circular Bus. Act.	0.420***	(0.093)	0.175**	(0.032)
Ist Lag Circular Bus. Act	−0.343***	(0.056)	−0.155***	(0.024)
2nd. Lag Circular Bus. Act	0.162***	(0.033)	0.135***	(0.013)
3rd Lag Circular Bus. Act	0.047	(0.072)	−0.054***	(0.015)
4th Lag Circular Bus. Act	−0.198*	(0.088)	−0.108***	(0.021)
Government Conf.	0.002**	(0.001)	0.001***	(0.000)
Ist Lag Government Conf.	−0.001*	(0.001)	−0.001*	(0.000)
Consumption F. print	−0.001*	(0.001)	0.001	(0.001)
Number of countries	27	–	27	–
Constant	1.154	(1.121)	4.366***	(1.189)
Sargan value (Instr.)	53		49	–
Sargan *p*-value	1.000	–	0.966	–
AR(1)/*p*-value	−2.399***	–	−2.782***	–
AR(2)/*p*-value	−1.173	–	−1.775	–
Observations	135	–	216	–
Year dummies	Incl.	–	Incl.	–

Notes: Standard errors in parentheses, Significance levels: $^{+}p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. The dpd signifies the dynamic panel data estimation strategy, and Incl means included. Models 3 and 4 follow a two-step estimator.

4.2. Robustness and Granger causality

In our analysis, a new variable that offers an interactive effect was created from the interaction of circular business activity and consumption footprint, ie *Circular Bus. Act* * *Consumption F.print*. The interaction term was incorporated in the econometric model, ie in Equations (2) and (3), to improve our understanding of the economic performance effect of circular business activity. In essence, this offers an understanding of how the income effect of participating in circular business activity is moderated by consumption footprint, as presented in Table 4. This relationship is statistically significant and supported, as graphically illustrated in Figure 4. Additionally, following the recent work of Juodis et al. (2021), the Granger causality among the variables was conducted within the examined framework, as shown in Table A5 (see the Supplementary Appendix). The result further corroborates the estimated dynamic panel data model in Equation (3).

5. Discussion of the results

Table 3 presents the outcome of the system GMM estimators of our model as implemented with the dpd and dpd system strategies. The overall income level in the current year across the EU countries is

Table 4. The interaction model for the system GMM estimator results when circular business activity is treated as an endogenous variable, including the interaction between circular business activity and consumption footprint (The dependent variable = the GDP per capita in Log).

	(5)		(6)	
Variables	dpd	SE	System dpd	SE
Lag GDP per capita	0.981***	(0.008)	0.915***	(0.041)
Circular Bus. Act.	0.301***	(0.066)	0.148**	(0.062)
Ist Lag Circular Bus. Act	−0.264***	(0.055)	−0.164***	(0.072)
2nd. Lag Circular Bus. Act	0.163***	(0.041)	0.104^{+}	(0.058)
3rd Lag Circular Bus. Act	−0.109**	(0.042)	−0.054***	(0.027)
4th Lag Circular Bus. Act	−0.085*	(0.041)	−0.123***	(0.035)
Government Conf.	0.001**	(0.001)	0.001^{+}	(0.001)
Ist Lag Government Conf.	−0.001*	(0.001)	−0.001	(0.001)
Consumption F. print	−0.001	(0.001)	0.001	(0.001)
Interaction effect	−4.42e-10	(0.001)	5.99e-09*	(0.000)
Number of countries	27	–	27	–
Constant	1.195	(1.185)	1.800***	(1.579)
Sargan value (Instr.)	77		42	–
Sargan *p*-value	0.079	–	–	–
AR(1)/*p*-value	–	–	−2.722***	–
AR(2)/*p*-value	–	–	−1.867	–
Observations	135	–	135	–
Year dummies	Incl.	–	Incl.	–

Standard errors in parentheses, Significance levels: $^{+}p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. The dpd signifies the dynamic panel data estimation strategy, and Incl means included. Models 5 and 6 follow a one-step estimator.

positively spurred by the level of income a year before. This result suggests that a percentage increase in the previous income level is responsible for 0.915% of the current income level. It is plausible that this effect is justified by the rationality or economic intuition of the propensity to accrue future earnings from the savings, investments, or consumptions (for the future) arising from a rise in previous earnings. While this outcome is desirable, it supports the quality or high financial literacy level expected or demonstrated by the EU member states. For instance, according to the European Union (2023), out of a surveyed proportion of people across the EU, nine out of ten acknowledged that affordability is crucial to purchasing decisions. The same proportion believes in keeping records and monitoring personal expenses, while seven out of ten strive to achieve long-term financial goals.

Again, the result shows that circular business activity spurs income levels. Indicatively, from Table 3, a 1% increase in the number of people participating in circular economy sectors is causing the general income level to increase by 0.175%. The increase in the number of people in the circular economy sectors directly implies economic expansion and overall productivity of the affected sectors, thus yielding aggregate economic and income growth. This outcome is also expected by far, given that circular economy policy is central to the European Greal Deal, thus suggesting a surge in the implementation of circularity practices across EU member countries. The evidence in the current study aligns with the observations by the Ellen MacArthur Foundation (2020) and Hysa et al. (2020). Specifically, Hysa et al. (2020) found that circular economic activities (characterized by several aspects) are responsible for economic growth across the EU member countries. Of course, a contrary scenario was observed across the panel of 163 Chinese cities, as detailed in Chen et al. (2020). Although Chen et al. (2020) observed that circular economic activities improve economic growth only in the future, its immediate impact is noticeably significant and negative. Interestingly, the observation of Chen et al. (2020) might well explain the inconsistency in the impact of the lag values of circular business activity on income level in the current investigation (see Table 3).

Moreover, the result of the preferred model, ie the system GMM estimator implemented with the dpd system command, shows that income level does not respond significantly to consumption footprint. On the other hand, the other model implemented with the dpd command (Models 1 and 3) shows a negative association (Tables 2 and 3). However, a different scenario in the robustness model shows the response of income level to the interaction effect, ie the interaction between circular business activity and consumption footprint (see Table 4). Although the impact of the interaction term is statistically significant and small in magnitude (ie 5.99e-09), it primarily shows that the income level effect of circular business activity is somewhat dependent on consumption footprint. In Model 6 of Table 4, the direct

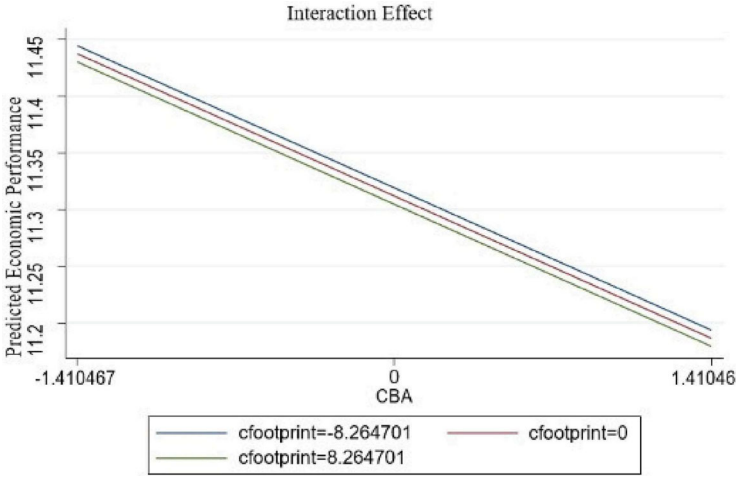

Figure 4. Interaction effect of circular business activity and consumption footprint on GDP per capita.

income level effect (0.148) associated with circular economic activities is quantifiably smaller than (0.175) obtained in Model 4 of Table 3. On this view, Figure 4 demonstrates that the EU countries with lower consumption footprint levels experience a slightly more significant decrease in economic performance with increasing circular business activities than those with average or higher consumption footprint levels. This outcome suggests that a higher consumption footprint has a less pronounced negative impact on the economic effect of circular business activities. In other words, the reduced negative economic impact due to a higher consumption footprint leads to diminished environmental consequences. This observation suggests that as consumption increases, the economic benefits of circular business activities grow faster than their environmental impact in the EU countries. This insight aligns with Sanyé-Mengual and Sala (2023), who reflect a decoupling of environmental impacts from economic growth. Based on their finding, a shift towards more sustainable practices in the EU is expected if circular business activities persist in bolstering economic growth as it simultaneously diminishes the environmental consequences of the consumption footprint. While this finding aligns with The World Bank (2022), Yu et al. (2022) further corroborate that a circular economy characterized by ecological design and investment recovery enhances the financial performance of 308 manufacturers across China. Accordingly, this enhancement occurs directly and indirectly through improvements in environmental and innovation performances (Yu et al., 2022).

From a trust perspective, the current study further reveals that, with a 1% increase in people's confidence in government institutions, the income level improves across the EU countries by 0.1%. One of the reasons this improvement is plausible can be traced to Mawutor et al. (2023) observation. From their finding, what is considered efficient and fair governance can motivate people to engage more in sustainable circular business practices, which helps reduce pollution and lower carbon emissions. This outcome reinforces Sala et al. (2019) and Sanyé-Mengual and Sala (2023) idea of decoupling environmental impacts from economic growth, leading to GDP growth. Contrarily, the result also reveals that the previous increase in peoples' confidence in governing institutions during the immediate past year negatively affects the current year's income level but by the same amount (ie decreases by 0.1%). All things being equal, these contrasting results indicate that implementing relevant policies can incentivize improvement in trust and confidence in governance. However, applying these policies is also challenging and may not always satisfy the needs of society. Thus, while governing institutions strive to implement what is perceived as the right policies, they are sometimes pushed back by society or a section of society. In this sense, to improve the well-being of the people, constructive opposition and confidence in institutions identified in Sustainable Development Goal 16 (SDG16 – Peace, Justice, and Strong Institutions) offer vital strength to governance. While it is unsurprising to associate high economic performance and income levels with societies with strong institutions, such as advanced economies, Muringani (2022) made an interesting finding. Accordingly, the economic impact of government decentralization is unaffected by public trust across 21 EU countries comprising 208 regions (Muringani, 2022). Similarly, Chanley et al. (2000) somewhat note the

negative impact of a decline in public trust in the United States of America. So, lacking public trust could hinder the promotion of critical domestic policies (Chanley et al., 2000).

6. Conclusions

6.1. Policy implications

This study suggests that managing the consumption footprint has significant implications for optimizing the economic growth impact of circular business activities in EU countries. However, the relationship between consumption footprint and economic growth optimization is nuanced. While circular business activities improve economic growth, increasing the consumption footprint reduces this growth effect slightly, decoupling environmental impacts from economic growth. Note that the consumption footprint has a reduced negative economic impact, leading to diminished environmental consequences. This scenario indicates that GDP is growing faster than the negative economic impact of consumption footprint, a notion of relative decoupling. The implication is that while circularity can enable economic growth, the relative growth impact associated with the environmental consequence of consumption footprint is suboptimal. Thus, improved consumption footprint management becomes imperative for achieving sustainable and optimal economic growth impact of circular business activities regarding absolute decoupling (see Sanyé-Mengual & Sala, 2023). In this context, policies promoting circular business activities should prioritize efficiently reducing the environmental consequences of consumption footprints further to ensure long-term sustainability and optimization. This could be achieved if policymakers implement more effective strategies regarding barriers and opportunities associated with circular business activities to foster efficient CE operations toward entirely decarbonizing the EU countries.

Besides, since circular economy activities incentivize improving peoples' economic well-being, relevant policy formulation of circular economy participation can be scaled up through (in) direct public and private investment instruments. These investment priorities can be piloted through entrepreneurship activities of startups, research and development activities across the sectors of the economy, and the adoption of innovative circular economy practices across households. Additionally, policy implications arising from these findings include the importance of implementing relevant policies to incentivize improvement in trust and confidence in governance. This view implies that the governments of the EU member states should further seek to improve public trust through a more consistent and transparent communication of government intentions and policies. Drawing on this insight, intentionally raising public awareness about the importance of responsible consumption patterns can be crucial. This effort highlights the environmental benefits and economic advantages of a CE. In light of this observation, if relevant and improved resources that promote circular economic activities are readily available, they can further encourage greater public participation in these sustainable business practices. This viewpoint underscores the necessity of complementing economic considerations with social, institutional, and environmental factors to optimize individual well-being. Meanwhile, the overall theoretical and practical implication and relevance of consumption footprint and recycled material cannot be overemphasized. Specifically, the result further outlines the relevance of a hybrid life-cycle assessment that offers detailed upstream and downstream environmental impacts of conventional and recycled materials.

6.2. Limitations and further research

This study institutes valuable insights that contribute to extant research on CE models. While so, it has some caveats. First, while the study looks into nine years of circularity effect on economic growth, other proxies for circular business and economic activities with extended time coverage could provide distinct insights and broader policy relevance. Second, the analysis perspective in the current study focuses on country-level effects, whereas the missing regional industry and sector-level impacts pose a limitation. This relationship could be investigated further by including regional and sector-level/industry heterogeneity perspectives to understand our study context better, thus providing additional topical information. Lastly, as the current study provides an understanding of circular economic growth effect optimization through consumption footprint management, the degree to which the effect optimizes is beyond our

analysis. To this end, future research investigating the efficiency effect of the consumption footprint from the context of the current study is relevant for improved understanding.

6.3. Concluding remarks

Given a new pathway for sustainable growth and a foremost component of the European Green Deal, this study further puts the EU's circular economy in the spotlight. Considering the panel of 27 EU member states, the study investigated the role of circular business activities, consumption footprint, and confidence in governing institutions on income level from 2014 to 2023. Insightful results were documented by implementing the dynamic panel model with system GMM estimators and other relevant empirical approaches. These results include that (i) peoples' participation in circular business and economic activities is a positive and direct driver of general income level, (ii) while income level is positively influenced by participation in circular economy activities, consumption footprint moderates the positive effect, and (iii) public confidence in governing institutions vis-à-vis SDG16 affect income level positively. Overall, the study emphasized that while circular business activities improve the economic well-being of EU countries, there is a need to manage the consumption footprint further for optimal economic growth. Then, it presents some implications and offers possible policy formulations.

Acknowledgment

Authors appreciate the selfless service of the Editor and anonymous referees.

Author contributions

Olugbenga Michael Adewumi is involved in conceptualization, data curation, formal analysis, methodology, the introduction section, the original draft, and editing.

Andrew Alola Adewale is engaged in conceptualization, data curation, methodology, discussion of results, writing – original draft, and editing.

Chukwuemeka Echebiri is involved in conceptualization, data curation, writing of the literature section, writing – the original draft, and editing.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Notes

1. General government – Trust in government – OECD Data.
2. Database – Eurostat (europa.eu).
3. World Development Indicators | DataBank (worldbank.org).
4. The endogeneity issue associated with Equation (2) is eliminated by transformation to remove the firm fixed effect using a first-differencing approach (detail in Arellano & Bond, 1991). Also, following Blundell and Bond (1998), the estimation of Equation (2) followed Equation (3) and was performed with a system GMM estimation strategy to eliminate significant finite sample biases and possible endogeneity issues (detail in Roodman, 2009).

Funding

No funding was received for this study.

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Data availability statement

Based on the Eurostat and World Bank databases, an analysis was conducted, and new data was generated. These datasets can be accessed freely and are publicly available at Database – Eurostat (europa. eu) and World Development Indicators | DataBank (worldbank.org). No data cannot be shared for ethical, privacy, or security concerns.

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