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Investigating the Impact of Circular Economy on Stock Market Performance: European Union Countries

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Abstract: Nowadays, circular economy (CE) has a substantial impact on stock market performance (SMP) especially in European Union (EU) countries that promote sustainable practices and encourage large companies to implement those practices in their business operations, this research investigates the impact of CE on SMP through examining the mediating role of the sustainable development goals (SDG) in the EU countries over the period 2000-2021. The variables used to measure CE are, annual freshwater withdrawal (AFWW), generation of municipal waste per capita (GMW), resource productivity (RP), recycling rate (RR), and recovery rate of recycling (RRR), further the SMP is measured by stock market indices return using panel least square regression analysis. Findings revealed that CE practices have a positive significant impact on SMP. However, the SDGs have insignificant mediation among CE practices and SMP. Accordingly, it's highly recommended that other researchers study this nexus in the context of emerging countries especially in Egypt, as in our research we focused on EU countries because EU countries are considered highly innovative and apply CE practices comprehensively.

Keywords- *Circular Economy, Sustainable Development Goals, Stock Market Performance.*
JEL Classification : *Q56, H54, N24*

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1. Introduction

CE refers to the efficient use of resources to decrease the consumption of raw materials as inputs and wastes as outputs. This idea extends beyond waste reduction as it can also influence the economic strategies of firms' operations and achieve sustainable growth (Murali & Kaya, 2023). Furthermore, the CE concept is based on the principles of the six R's (reuse, recycle, redesign, remanufacture, reduce, recover).

The EU has designated CE as an integral part of its industrial innovation strategy. The European Commission declared in December 2019 that the climate challenge would be transformed into an opportunity for a new development model (CE model) aiming for carbon neutrality by 2050. This will be implemented through an ecological transition path and an industrial strategy focused on sustainable production. In March 2020, the Next Generation EU introduced a new CE action plan focusing on sustainable product design, circularity in manufacturing, and specific resource-intensive industries with significant environmental impact (European Union, 2022; European Commission, 2022). A cluster analysis by Rodríguez et al. (2022) examined the relationship between CE and SDGs within the framework of the 2030 Agenda and the European CE plan (Figure 1). Cluster 1 (Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, and the United Kingdom) shows above-average CE performance in per capita municipal waste generation, recycling rates (municipal, packaging, e-waste, and biowaste), and has achieved SDGs 1, 3, 4, 5, 6, 8, 9, 10, 11, 14, 15, 16, and 17. Cluster 2 (Bulgaria, Czech Republic, Estonia, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovenia) performs above average in recycling rates (municipal waste, e-waste, construction/demolition waste), circular material use rate, investment in tangible goods, and employability, achieving SDGs 4, 12, and 14. Cluster 3 (Croatia, Cyprus, Finland, Greece, Slovak Republic, Spain, Sweden) has above-average circular material use rate and employability, achieving SDGs 2, 3, 5, 7, 9, 10, 13, and 15.

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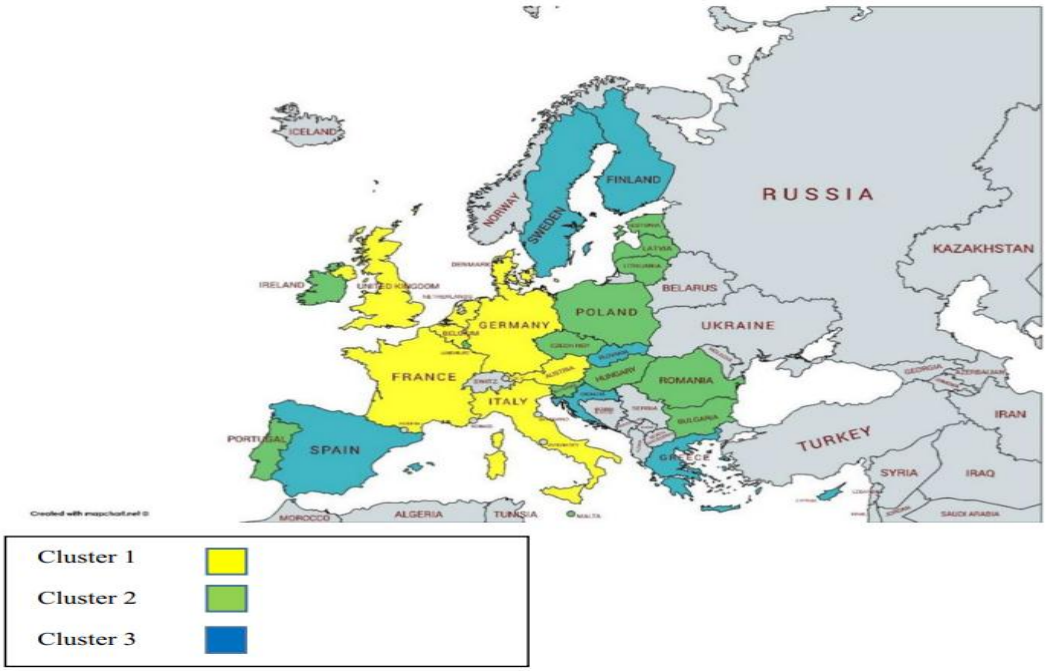

Figure 1: EU clusters by CE result (Rodríguez et al., 2022)

Today, numerous companies worldwide are increasingly adopting a CE strategy to achieve sustainable growth, taking into account its impact on stock performance in terms of returns and volatility. The SMP is influenced by demand and economic growth, reflected in stock prices, returns, risk mitigation, and investors' perception of market volatility. CE programs such as reusing, remanufacturing, recycling, and no waste attract venture capital investors and potential investors to the financial sector, resulting in financial returns with reduced linearity risks and lower resource dependence (Dewick et al., 2020). Moreover, SMP demonstrates a positive response to the disclosure of companies' new environmental projects, as investors believe that these companies demonstrate ecological awareness in their investment choices (Flammer 2013; Schmidt, 2022; Torre et al., 2020). However, Murali et al., (2023) argued that investors' focus on these stocks is cyclical and inconsistent. Certain stocks may gain popularity within a short span of time but then rapidly lose their appeal. Typically exhibiting cyclical patterns, this particular company offers investors several prospects to generate profits inside the short to medium timeframe.

Wierzbicka (2021) stated that the adoption of a CE will lead to the establishment of a system that effectively manages the achievement of sustainable development objectives in three key domains: the environment, society, and

economy. CE adaptions engage firms in prioritizing the development of sustainable business models that are socially creative, environmentally friendly, and efficient in using economic resources. The SDG implementation enhances the strategic value and market competitiveness of firms, leading to a positive impact on SMP (Goncalves et al., 2022; Kirchherr et al., 2017; Korhonen et al., 2018; Ma et al., 2014; Muhamad & Muhamad, 2020; Park et al., 2010; Wierzbicka 2021; Xue et al., 2010). Nevertheless, other scholars argue that circularity is not a prerequisite for sustainability. The use of certain CE practices, such as eco-design and the use of new materials, can have rebound adverse effects that diminish or even eliminate the positive environmental implications required (Helander et al., 2019; Salvador et al., 2020; Zink & Geyer, 2017). Furthermore, recycling, which often aims to prevent material losses and the extraction of new materials, may, under certain circumstances, be more energy-intensive than the original process Geissdoerfer et al., 2017; Harris et al., 2021; Lamba et al., 2023; Momete, 2020).

A number of theories have been developed to understand the influence of CE on SMP and to help scholars in establishing stronger connections and foundations for their research. A widely used socio-political theory is the stakeholder theory which posits that the economic dimension of an organization cannot be studied without taking into account the social, environmental, institutional, and political context in which the organization operates (Grey et al., 1995, Deegan & Blomquist, 2006). Particularly, the stakeholder theory centers on analyzing the current interactions between companies and the different individuals or groups who have a stake in the business activity, referred to as stakeholders. (Gray et al., 1995; Freeman 1984; Nicolò et al., 2021). Additional prominent theory encompasses transaction cost suggesting that initial transaction cost surge because of the need for complex and costly activities by large interdisciplinary teams in striving to overcome barriers in interconnected exchange and supply loops (Werning & Spinler, 2020). Moreover, Legitimacy theory posits that the political, social, and institutional environment significantly influences the economic activities of corporations. Hence, the choice of the company to adopt an alternative business model, such as a CE, should be evaluated considering the political environment encompassing regulations, the internal and external social dynamics, and the institutional structures in which the firm functions (Kwarteng et al., 2022).

Prior research explored diverse perspectives related to the effect of CE on SMP. Previous studies (Mazzuchelli et al., 2023; Balcilar & Toren, 2021; Figgie et al., 2021; Palea et al., 2023; Zara et al., 2023; Ha, 2022) found a positive relationship between CE and SMP. The positive relationship is attributed to the company's proactive implementation of a circular transition, which results in positive economic outcomes. Companies are inclined to adopt the new economic paradigm if it complements their efforts to enhance their economic and financial

standing. Capital providers regard the concept of CE as a viable strategy or a less hazardous approach in comparison to a linear modelling approach. The stock market rewards firms with superior CE results with increased share prices. On the contrary (Horak et al., 2023; Morea et al., 2022; Safraz, 2022) revealed a negative relationship between CE and SMP. This can be ascribed to the epidemic triggered by covid-19, which directly impacts the implementation of CE in numerous nations. Accordingly, this research intends to answer this question: How does CE affect SMP through sustainable performance mediating effect?

The current research has made substantial contributions to the growing literature of finance. Based on our current understanding, this is the first attempt to investigate the mediating influence of sustainable performance on the relationship between CE and SMP. Most current research focuses on CE and stock return nexus without considering the mediation effect of attaining SDGs (Morea et al., 2022; Zara et al., 2022). Furthermore, we expand upon previous research on stock returns (Moe & Oversveen, 2022; Ghosh et al., 2020) by including EU indices. Our contribution to the literature is based on our consideration of them as a sample. The selection of European markets is because Europe, as a group, constitutes the second largest portion of the green economy in terms of green revenue exposure (FTSE Russell, 2018). This characteristic makes Europe the fitting market for studying the current topic. Moreover, we outweighed the theoretical debate on the potential benefits or costs of CE activities, especially among EU countries. The results of our study indicate a positive relationship between CE and SMP.

The following sections of this research have been organized as follows: The review of existing literature and the formulation of hypotheses are addressed in Section 2, while Section 3 outlines the sample and statistical technique employed. Section 4 provides an in-depth description of the empirical results and a thorough discussion. Section 5 presents the conclusion, practical implications, limitations, and recommendations for future research.

2. Literature Review

2.1. Circular Economy

Since the linear model of resource consumption destroys the environment and depletes natural capital, it does not seem to be sustainable, further, resources are being wasted and ending up in landfills due to this unsustainable path of production and consumption, making the need for more sustainable systems critical. Hence, the concept of CE has arisen and has become of great importance in the last decade. The CE is a modern model of the economy, in which its focus on creating a new consumption and production model, which uses fewer resources and less amount of waste, in addition, to minimizing pollution. The CE aims to improve the living standards of the population, moreover, protect the environment, in addition

to being a tool for achieving and promoting sustainable development at the national and global levels (Popović & Radivojević, 2022). Further, the CE, according to the European Economic Forum, would cut carbon emissions by roughly 45 tons annually. CE is thought to be a potential solution for issues like the rising worldwide resource demand, unstable prices for raw materials, as well as global population growth and consumption (Anton et. al, 2019).

Moreover, the economy we are living in is primarily linear, the linear production model implies that the product ends up in a landfill. On the other hand, the CE is continuous of the linear economy, and is based on using waste as a main resource to create new goods with the least amount of energy consumption and resource extraction from the environment, unlike the linear economy model, so the main idea of the concept of CE is to replace the linear model in the economy, however, in today's business context, this becomes unfeasible because of scarce resources, waste buildup, and, insufficient waste management (Popović & Radivojević, 2022).

2.2. Stock Market Performance

One of the core functions of an investment is to buy stocks and start to trade in the stock market either individually or in companies through the assistance of brokerage firms to allocate the stocks efficiently. Almost every country should have an index that clarifies the performance of companies' stocks listed in the market that reflects the investment situation in this country. The main determinants and key players in the stock market are stock prices and returns. In addition, there are certain investment styles in the stock market including growth and value stocks which contribute to high returns and efficiency in the financial market. Stock market index clarifies the performance of the stock market in each country to show the movements in stock cycles through certain indices. Previous studies (Neves, et al., 2021; Iglesias, 2015) analyzed how the stocks respond to changes in the market which is stock index cycles which are mainly the fluctuations or movement in returns either growing or declining. When the stock market is efficient the co-movements no longer exist between stock market indexes. Further, stock market synchronization is critical in assessing the performance of investment in any country. Synchronization is when the index returns that represent the stock markets are correlated and highly dynamic. Zhou (2016) indicated that the correlation of stock indexes can be relatively small when they're perfectly integrated and the global stock market synchronization is like a made locking which is mainly synchronizing market fluctuations between stock market systems. Indeed, governments perceive the CE as an essential mechanism for mitigating climate change and enhancing economic resilience (Khanna et al., 2022; Domenech & Bahn-Walkowiak, 2019). In 2000, Japan became the pioneering nation to

implement legislation specifically addressing CE (Ministry of the Environment, 2000). In 2015, the EU implemented its initial "Circular Economy Action Plan" (European Commission, 2015). China is also advocating for the CE, however mostly focused on efficiency (People's Republic of China, 2008). In contrast, the United States of America (USA) has not yet undertaken any endeavor in this domain (Palea et al., 2023)

2.3. Sustainable Performance:

According to the United Nations Agenda 2030, 17 sustainable development goals, are a plan of action for prosperity, the environment, and people. The goal of it is to promote world peace and mainly aim to protect the environment, reduce poverty, and create socio-economic inclusion. To promote sustainable development, there are three priorities which are environment, social, and economy driving the country's growth. First, economic development mainly involves the potential of the economy and limits sensitivity. Second, social development is the role of social institutions in change, development, and resolution of differences. Finally, environmental development is about greener resources and must be aware of its importance through controlling and reducing waste, and water usage, and increasing the recycling of materials (Isa et al., 2021). The sustainability development is achieved and supported through implementing circularity in the country which mainly is zero waste and encouraging better use of resources.

CE is an economic system including business models that seek to promote sustainable development by replacing the notion of "end-of-life" with the reduction, alternative reuse, recycling, and recovery of materials in production, distribution, and consumption processes. The CE is explicitly mentioned in that spot as a direct contributor to the achievement of SDGs 6, 8, 9, 11, 12, 13, 14, and 15. Additionally, the EU has established a reform agenda that has significant growth potential, generated new employment opportunities, and promoted environmentally friendly production and consumption models. The objective is to enhance resource efficiency and reduce waste.

2.4. Theoretical Framework:

2.4.1. Stakeholders Theory

So far, research investigating the relationship between CE and SMP has shown inconclusive results, prompting additional studies to get a more comprehensive understanding of this paradox. Different theories have emerged supporting that the CE can improve SMP. The conceptual relation between CE and stakeholder theory arises from certain common beliefs, including the following: (1) the need for businesses to focus on purposes other than maximizing short-term shareholder gain; (2) the relationship between moral and business concerns; and (3)

considering a long-term viewpoint that permits the stakeholder value generation now, without sacrificing the capacity to produce long-term value. Furthermore, stakeholder relationships, as proposed by Vildasen & Havenvid (2018), influence business sustainability via (1) relationships on a particular technological project; (2) the accomplishment and growth of mutual sustainability long-term objectives; and (3) networking, which is the systematic relationship-building between a business and the stakeholders in cooperative sustainability projects (Attanasio et al., 2021). In other words, upholding an appropriate relationship with an organization's stakeholders is essential to integrate the three main aspects of sustainability—economic, social, and environmental—and striking an optimal balance between them. Lastly, the proposed theory of stakeholders influences the positive relationship between CE and the stock market by influencing stakeholders involved as investors, employees in the company, market, and government in adopting CE practices in their strategies and aligning stakeholders' interests with stock market growth.

2.4.2. Transaction Cost Theory

Transaction cost theory can aid in the understanding of how businesses might effectively close material loops and establish close partnerships. The transaction cost theory has emerged as a framework for comprehending CE and SMP nexus. This is because the uncertainty surrounding CE results in firms facing the risk of incurring substantial unexpected costs related to contracting. This uncertainty arises from their inability to find partners, their incompetence in droughting contracts that effectively safeguard their interests, or their decision to enter contracts with excessive complexity due to their inability to anticipate the challenges they may face during the transition (Lahiti et al., 2018).

Considering transaction cost theory, a negative association between CE and SMP is proposed. This is because the higher costs and significant expenses associated with circular products impact the market value of companies. Significant upfront expenses required to adopt CE practices resulted in fewer circular enterprises and impacted the stock market indices negatively.

2.5. Empirical Review

2.5.1. CE & Stock Market Performance Nexus

Murali et al., (2023) assessed how CE practices can influence investment in the stock market. The sample was extracted from fifteen global companies from different countries such as the USA, UK, Canada, and India covering the time 2010 to 2021. The CE was assessed through the BSE ESG index while daily close prices of stocks and VR ratio (excess volatility to market efficiency) were used for measuring the SMP. The results showed that CE positively affects the SMP and

creates additional cash flow prospects for investors in the short and medium term. However, the study's relatively small and geographically diverse sample may limit the generalisability of its findings to the EU context, where policy frameworks and investor behaviour differ significantly. Furthermore, Palea et al., (2023) investigated the influence of CE strategies on business profitability measures; debt financing, and stock market valuation in the European Union (EU) between 2010 and 2019. CE was assessed by considering waste reduction efforts, e-waste reduction efforts, recycling efforts, eco-design goods, resource reduction improvement, renewable energy use, policy water efficiency, and policy energy efficiency. On the other hand, corporate profitability and debt financing were measured through ROA, ROE, ROIC, ROS, asset turnover, capital intensity, leverage, and working capital. The results indicated that the stock market rewards the application of CE techniques inspiring businesses and capital providers to allocate resources towards the adoption of CE. Nevertheless, as their measures focused primarily on operational and resource efficiency indicators, the study may not fully capture the broader strategic or reputational dimensions of CE adoption. In addition, Mazzuchelli et al., (2023) examined the association among CE practices and financial performance by considering well-known firms in the manufacturing sector located in Italy as a sample to be studied. CE was measured by recycling rate & waste treatment, whereas financial performance was assessed by ROA and the increase in market share. Results showed that engaging in CE practices improved firm performance as circularity helps organizations improve their reputation by positively shaping stakeholders' perceptions. Yet, by concentrating on manufacturing firms in a single country, the findings may not be directly transferable to sectors with lower material intensity or to countries with different regulatory pressures. Furthermore, Horak et al., (2022) investigated if CE principles adoption impacted firms' stock return. CE was measured by DJSI World Sustainability Index, and the stock return fluctuations were assessed by the market capitalization and weekly and daily stock prices for selected companies such as Microsoft, Google, and United Health Companies from 1990 to 2021. Results showed a positive shift in firms' stock prices and market capitalization within the ten years following the application of CE principles promoting sustainability into corporate cultures. However, the inclusion of global tech giants raises questions about whether the observed effects stem from CE initiatives specifically, or from broader innovation-driven growth trends in these companies. Lastly, Zara et al., (2021) examined the impact of CE practices on risk-adjusted performance of 222 EU circular shares from 2013-2018. CE score was employed as a proxy for CE adaption, whereas the sharp ratio, Treynor ratio, and closing stock prices were used as proxies for the stock returns. The results showed a positive relation between CE and stock returns since circularity can be considered as a motive for a high-yield

investment strategy. Nonetheless, their short observation period might not fully capture long-term market adjustments to CE adoption.

In contrast, Sarfraz et al., (2022) illustrated the association between CE performance indicator and the financial performance of 411 corporations in the G7 between the period 2014 and 2020 using multivariate econometric estimations. The sample was extracted from the EU since its compliance with the European Green Deal. Results revealed that companies struggled to incorporate CE practices since certain eco-innovations are more expensive and have no immediate impact on profitability. This highlights the potential trade-off between environmental ambition and short-term financial performance, especially in capital-intensive industries. In the same vein, Morea et al., (2022) examined the association among corporate CE strategy and market performance. ESG scores were utilized as a substitute for CE, while daily returns from the ESG Euro Stoxx 50 and Euro Stoxx 50-ESG index were used as indicators for SMP. Empirical evidence revealed that the financial sector is more aware of environmental, social, and governance (ESG) concerns. Nevertheless, there is little evidence to suggest that CE activities can impact stock returns. One possible limitation is the use of ESG scores as a CE proxy, which may dilute the specific contribution of circularity-related actions compared to other ESG dimensions. Thus, the first hypothesis is formulated as follows:

H1: There is a significant positive nexus between CE and the SMP in EU context.

2.5.2. CE, SDGS, and Stock Market Performance Nexus:

An analysis conducted by Su (2023) examined the influence of green innovation (GI) on the financial performance of 526 non-financial firms listed in the EU between 2012 and 2022. The investigation considered both accounting and market-based techniques. The objective of the investigation was to examine the possible moderating influence of research and development (R&D) investments and ESG disclosure on the association between GI and financial performance. Analysis revealed an adverse relationship between GI and accounting-based financial performance, and a positive relationship with market-based financial performance. Furthermore, the results revealed that GI influences accounting-based financial performance by means of R&D investments and market-based financial performance by means of ESG disclosure. Although GI is conceptually related to CE, the study's focus on innovation rather than comprehensive circularity indicators means its implications for CE–SMP pathways should be interpreted with caution. This helps managers to be better equipped to tackle the difficulties of implementing CE by using sustainability disclosure. Therefore, the second and third hypotheses are formulated as follows:

H2: There is a significant positive nexus between CE and the SDG in EU context.

H3: There is a significant positive nexus between SDG and the SMP in EU context.

3. Methodology

3.1. Data Description

In this research, the data type used is panel data, since panel data is extremely beneficial in this case because it captures and explains the dynamic shifts and enhances the number of observations, particularly because the sample selected from ten EU countries including Austria, Denmark, France, Hungary, Ireland, Netherlands, Poland, Slovenia, Spain, and Sweden from the EU representing 220 observations based on the availability of data and CE adaption. Moreover, this research focuses on the time frame from 2000- 2021, the rationale for choosing this time frame is that CE is a recent concept and has recently emerged and was not well known to the countries and people before this. However, it should be noted that potential biases may arise from data availability constraints, as the sample is limited to countries with complete CE-related indicators, which may not fully capture the heterogeneity across all EU member states. In addition, the relatively short historical availability of some CE indicators could introduce measurement bias, particularly in earlier years.

3.2. Description and Measurement of Variables

The dependent variable which is SMP is expressed in the model as stock market indices namely including the Vienna stock index, OMX Copenhagen stock index, CAC 40, BUX index, ISEQ index, AEX index, WIG30, SBITOP index, IBEX35 index, OMX Stockholm 30 index. The index shows the average daily return or percentage change of each country's stock market. Then the percentage change was collected yearly to reflect the changes in return from a year to a year in each country.

While the independent variable is CE, it was measured through five dimensions. First, annual freshwater withdrawal (AFWW) that considered a crucial part of CE, it is the volume of freshwater used annually. Second, the generation of municipal waste per capita (GMW), shows the waste collected on behalf of municipal authorities and waste management disposal, mainly household, office, and commerce institutions waste. Third, resource productivity (RP) which is mainly GDP divided by domestic material consumption (DMC). It measures the total raw materials directly extracted from the local economy. Fourth, the recycling rate (RR) explains the CE by identifying the number of recycled materials. Fifth, recovery of recycling rate (RRR) which is the percentage of collected recyclable materials. These CE dimensions were collected from OECD (Organization for Economic Co-operation and Development) and EUROSTAT. These particular proxies were

chosen because they collectively represent key stages of the CE cycle — resource input (AFWW, RP), waste generation (GMW), and material recovery (RR, RRR). Other potential proxies, such as circular public procurement or eco-innovation indices, were excluded due to inconsistent data coverage across the selected time frame and countries.

SDGs score is an indicator for sustainable development implementation in each country (SDGs) and act as the mediator between CE and SMP. The score measures the SDG achievement; the higher the better. Finally, the first control variable is the Gross Domestic Product (GDP) which reflects the value of a country's production, measured in current international dollars, adjusted by the purchasing power parity (PPP) conversion. GDP is the total value added by all domestic producers in a country, calculated by adding any product taxes and subtracting any subsidies not included in the product value. PPP conversion factor is a geographical price deflator and currency converter derived from the World Bank database that effectively removes the impact of price level disparities among nations. Long-term interest rates, which relate to government bonds with a maturity of 10 years, serve as the second control variable. Interest rates are mostly influenced by the lender's fees, the borrower's level of risk, and the decline in the capital value. In general, long-term interest rates are calculated as the average of daily rates, expressed as a percentage, and obtained from the Organization for Economic Co-operation and Development (OECD).

3.3. Econometric Model

The empirical analysis of the impact of the CE aspects on SMP is conducted using a panel least-squares regression model with control variables, including the mediating effect of SDGs. The choice of this approach is based on the specific attributes of the dataset and the intended research objective. The use of control factors serves to mitigate the effects of omitted variables and endogeneity bias (Black et al., 2014). The data were subjected to statistical analysis using STATA 14 at significance levels of 1% and 99%. Winsorizing was implemented on all variables to mitigate the impact of potentially irrelevant outliers.

The model equation is:

The functional model for this research is specified as follows:

$$SMP_{it} = \alpha_0 + \beta_1 AFWW_{it} + \beta_2 GMW_{it} + \beta_3 RP_{it} + \beta_4 RR_{it} + \beta_5 RRR_{it} + \beta_6 SDGs_{it} + \beta_7 GDP_{it} + \beta_8 LTIR_{it} + \varepsilon_{it} \quad (1)$$

Where:

SMP_{it} is the country (i)the yearly stock market performance in the year (t),
$AFWW_{it}$ is the country (i) the yearly Annual freshwater withdrawal in the year (t),
GMW_{it} is the country (i) the yearly Generation of municipal waste per capita in the year (t),

RP_{it} is the country (i) the yearly Resource productivity in the year (t),
RR_{it}, is the country (i) the yearly Recycling rate in the year (t),
RRR_{it} is the country (i) the yearly Recovery rate of recycling in the year (t),
SDG_{it} is the country (i) the yearly score of sustainable development goals in the year (t),
GDP_{it} is the country (i) the yearly gross domestic product, in the year (t),
$LTIR_{it}$ is the country (i) the yearly efficiency ratio in the year (t),
$\mathcal{E}_{it}$ is the random error.

4. Empirical Findings and Discussion of Results

4.1. Descriptive Statistics

Based on the given descriptive data (Table 1), the average SMP for all countries is 0.016 while the minimum value is -.019 in France in 2015 which infers that at that time France's stock exchange was not affected by green practices or sustainability at all. While the maximum was also in France about 1.86 in 2008 which means that this is the highest return from all indices with a normal standard deviation. The average recycling rate in the given EU countries in the model is 1989.45 which is high compared to other variables in the model like the AFWW, GMW, RP, and RRR that has an average of 18.12, 36.829, 1.887, 40.855, thus it indicated that the RR in those EU countries is higher and used more than the other variables. Further, RR has the highest standard deviation with 1957.22, which reflects a huge gap between the minimum and maximum of the values with a minimum of 13 and a maximum of 9626, the deviation between the values results that Poland had the lowest RR in 2000 compared with the other countries, and France has the highest RR in 2021. The deviation between countries is extremely large, this is because implementing the circularity was challenging especially in Poland due to the transition phase from a central economy to a market-based economy that requires high investment and infrastructure to implement CE which is not the case in Poland at that time while most of the countries achieved high rates of recycling so most of them are large numbers. The AFWW has a mean of 18.12723 with a minimum value of .8145445 in the Netherlands 2019 reflecting sustainable water use, where less water is being taken from freshwater sources to balance water needs for human activities with the conservation of water resources for future generations and the maintenance of environmental well-being. While the maximum value was 105.7 in Hungary in 2009 inferring water scarcity, depletion of water sources, and negative impacts on ecosystems and biodiversity. Further, the GMW has a mean of 36.8, while the minimum value of GMW was 1.6 in Hungary in the year 2000 since the legal basis for preparing national waste management plans was first introduced in Hungarian legislation in the early 2000s. Therefore, waste management in Hungary was at the beginning level depending on landfilling to recycle different types of waste generated. While for maximum GMW was in Austria with 64.3 in 2001. Even though GMW was growing at that time, the overall

performance was stable in Austria at high levels and the deviation is relatively small between the minimum and maximum which makes sense throughout the years for all countries.

The RP has a mean of 1.8 with a minimum value of 0.4 in Poland 2002 reflecting low efficiency in resource usage, while the maximum value is 4.6 in the Netherlands 2021 as the more recent the years are the better the awareness and knowledge about resource usage and productivity.

The mean of RRR is 40.8, while the minimum value was 2.1 in the early years in Poland specifically in the year 2000. Poland RRR was relatively low in comparison with other countries because of limited recycling infrastructure as recycling facilities and economic priorities weren't about sustainability at that time. While the maximum value in Slovenia in the year 2021 which is had a superior recycling effort at that time; it exceeds the target which is 55% for the year 2025 with a normal deviation between them.

The SDG score has a mean of 79.09191 with a minimum value of 73.15in Poland in 2000 due to social exclusion because of poverty as one of the main problems faced by Poland, making a challenge to achieve economic growth and high standard of living, while the maximum value was 86.26in Sweden in 2020 through the comprehensive investment in hydropower and biomass, reducing their reliance on fossil fuels.

The control variables which are the GDP and LTIR are statistically normal and the minimum and maximum numbers considered with the standard deviation and mean numbers are in the range and relative to each other.

Table 1. Descriptive Statistics

Variables	Mean	Standard deviation	Min	Max	Robust Standard Error
Panel A: dependent variable					
SMP	.0167199	.01373384	-.19	1.8623	0.009259353
Panel B: independent & mediator variables					
RR	1989.465	1957.227	13	9626	4.61e-06
AFWW	18.12723	24.78212	.8145445	105.7	.0002011
GMW	36.82993	15.652	1.6	64.3	.0009657
RP	1.88722	.9238572	.4388	4.6592	.0121468
RRR	40.85563	14.05293	2.135	76.594	.0006634
SDGs	79.09191	3.291228	73.15	86.26	.0032782
Panel C: control variables					
GDP	29508.55	13316.24	6450	72110	9.41e-07
LTIR	3.372469	2.247339	-.3768333	10.68167	.0052478

Source: authors' calculations

4.2. Pearson Coefficient Correlation Matrix

According to (table 2), the findings showed that there is a weak positive correlation between the SMP and the RR at 0.2047 which infers that companies involved in recycling often attract investment from venture capital, private equity, and public markets, especially when there is a positive SMP. Investors are increasingly looking for opportunities in sustainable and green technologies, which include recycling and waste management solutions.

However, there's a negative moderate significant correlation of -0.6040 between GDP and AFWW, as the GDP increases, the AFWW decreases, this is because the sample is based on EU countries that possess technological advancements, shift to less water-intensive industries, improved water management and infrastructure, compliance to environmental regulations, and increased awareness and conservation efforts.

While GDP and GMW are highly correlated with a moderate positive correlation of 0.6230, since in EU countries, the service sector which includes hotels, restaurants, and other businesses, expands. These services generate significant amounts of waste, particularly food waste and disposable items like napkins, containers, and plastic utensils.

GDP and RP showed a 0.6833 moderate positive correlation, since EU countries have an increased allocation of resources towards research and development (R&D), leading to innovations that improve resource efficiency. Additionally, EU countries have large economies of scale, which allow them to produce goods and services more efficiently.

While GDP and SDGs score with a correlation of 0.5414 moderately positive, indicating that EU countries have more robust institutions and governance structures, which are essential for implementing and monitoring SDG-related policies effectively.

Also, GDP with RRR is positively moderately correlated with 0.5146, indicating that higher GDP allows for the development of more sophisticated waste management systems. These systems often include integrated approaches that combine recycling with other waste recovery methods, such as composting and energy recovery, leading to higher overall recovery rates. Further, RRR and GMW indicate 0.1291 weak positive correlations indicating that as GMW increases, there is a greater volume of waste that needs to be managed. This often leads to enhanced efforts to improve recycling rates to handle the larger amount of waste more effectively.

On the contrary, the GMW with AFWW shows a moderate negative correlation by -0.4890 inferring that the increased waste generation is often a result of higher consumption and economic activity, which also drives up the demand for

freshwater for production, sanitation, and waste management.

Moreover, the RP indicated negative moderate correlation with AFWW -0.4583, since EU countries represents developed economies, they often transit from resource-intensive industries (such as agriculture and heavy manufacturing) to less water-intensive sectors like services and technology. This shift reduces the overall demand for freshwater relative to economic output, improving resource productivity.

Lastly, RP is correlated positively with RR 0.4248, inferring those innovations in sorting and processing technologies help to increase the efficiency of recycling operations. This means that more materials can be recovered and reused, contributing to higher resource productivity. %. Moreover, the examination of the variance inflation factor (VIF) for all independent variables indicates values below 10, therefore suggesting the absence of multicollinearity issues in our models.

Table 2. Pearson coefficient correlation matrix

Variables	SMP	RR	AFWW	GMW	RP	RRR	SDGs	GDP	LTIR
SMP	1								
RR	0.2047**	1							
AFWW	-0.0215	0.0708	1						
GMW	0.0458	0.1291*	-0.4890***	1					
RP	0.0939	0.4248 ***	-0.4583***	0.6091***	1				
RRR	0.0377 -	0.0438	-0.5085***	0.8194 ***	0.4897***	1			
SDGs	-0.0026	-0.0171	-0.2984***	0.6214***	0.2320***	0.4286***	1		
GDP	0.0700	0.0688	-0.6040***	0.6230***	0.6833***	0.5146***	0.5414***	1	
LTIR	-0.0384	-0.2831***	0.4384***	-0.6183***	-0.5318***	-0.5272***	-0.5595***	-0.5200***	1

Multicollinearity diagnostics									
VIF	–	1.61	1.79	5.46	3.60	3.75	2.65	3.49	2.20

Note: *Significant at level 10%, **Significant at level 5%, ***Significant at level 1%

Source: authors' calculations

4.3. Empirical Analysis

Based on the conducted statistical model in (table 3), which is the random effect GLS using the robust estimate to obtain accurate and reliable results, the variables that have a significant positive impact on SMP are RR, RRR, and GDP. This means that when recycling increases by 1 unit then SMP increases by 0.0000191, inferring that when companies listed in the stock exchange encourage recycling or sustainable practices, it will be an attractive investment as it's a new sector that generates high returns in the long run.

Additionally, when RRR increases by 1 unit, the SMP increases by 0.0012889. this is because EU countries typically have stringent environmental regulations and policies that promote recycling and waste management, along with the incentives and subsidies available for companies that achieve high recycling rates, which can improve their profitability and attractiveness to investors.

And lastly, when GDP increases by 1 the SMP increases by 1.86. Because GDP is one of the most influential economic factors that surely affect the SMP; since when GDP grows, it typically means higher consumer spending and stronger demand for goods and services. Companies often witness increased sales and revenue during periods of economic growth, which can boost their profitability and, consequently, their stock prices. Moreover, a growing GDP generally reflects a strong and expanding economy, which boosts investor confidence. When investors are optimistic about the economic prospects, they are more likely to invest in the stock market, driving up stock prices.

According to the random effect results, the hypothesis is accepted as CE has a positive impact on SMP which is elaborated through the two significant dimensions of CE. Further, the overall R squared which is 0.0573 approximately reveals that 5% of the variability observed in the SMP is explained by the CE in the regression model. CE practices focus on maximizing the value of resources by reducing waste and reusing materials. This can lead to significant cost savings for companies through more efficient use of raw materials and lower waste disposal costs, which can boost profitability and, consequently, stock prices. Additionally, companies that implement CE practices often benefit from enhanced brand reputation and consumer loyalty. Positive public perception and strong brand value can lead to increased sales and higher SMP. Moreover, companies that lead in CE

practices can differentiate themselves from competitors, capturing market share and driving growth. This competitive edge can result in higher stock valuations.

Table 3. Panel Least Square Model

Variables	Coef.	z-statistic	Robust standard error
Constant	0.0430737	0.19	0.2322366
RR	.0000191***	4.14	4.61e-06
AFWW	.0003295	1.64	.0002011
GMW	-.0004149	-0.43	.0009657
RRR	.0012889**	1.94	.0006634
SDGs	-.0018351	-0.56	.0032782
GDP	1.86e-06**	1.98	9.41e-07
No. of Observations.	220		

Note: *Significant at level 10%, **Significant at level 5%, ***Significant at level 1%.

4.4 Discussion

According to the statistical findings of the data from using the random effect model using robust estimate, it was concluded that there's a positive significant association between CE and SMP at a significant level of 1% according to the RR, and at 5 % significant level based on the measure RRR, in addition, it was concluded that the control variable GDP is significant at level 5%. Further, these results are supported by previous studies as (Horak et al., 2022) demonstrated that stock prices are positively affected by CE principles implementation that resulted in a shift in companies' market capitalization. The investor encouraged to invest in this sector therefore stock prices increased. While (Thanh Ha, 2022) stated that financialization is affected by circularity in the EU through the increasing number of materials recycled that statistically significantly impact the growth of financial institutions. In addition, there's a positive impact of circularity on SMP as the stock market rewards CE application techniques which leads to more profitability (Palea et al., 2023). In addition, (Figgie, 2021) has highlighted that CE has an impact on efficient portfolios through mitigating risk and desirable return, by studying two assets (A, B) in the portfolio aiming to examine how CE implementation affects this portfolio. Moreover, (Murali, 2023) highlighted that the company achieving disposal practices implementation will develop its contribution to the environment, in which the results expressed that CE positively affects the SMP due to circular stocks performance in the market as it generates money opportunities in a short and medium run for investors.

Moreover, Balcilar & Toren, (2021) have highlighted that the relationship is positive between CE and the stock market based on their research as a positive shock to the prices of stocks may result in influencing sustainable consumption greatly, especially in Turkey, and encourage consumers to perform circularly. Another study demonstrated that the CE affects risk-adjusted performance and financial returns as examined by Zara et al., (2021). In which the result of finding

a positive relation is that circularity is a motivation for investment strategy innovation.

Thus, the overall and most of the research have supported the results that were tested in this research which additionally supports the stakeholder theory which states that there are common values that can be focused on more than the shareholders' value. For instance, building circular business models that can lead to high gains for different stakeholders in the long run. Additionally, based on the legitimacy theory the reputation of the companies can be enhanced by being legitimate which is reflected in investor decision-making in the stock market.

On the contrary, this study results contradicts with some other studies, in which some researchers (Morea et al., 2022; Sarfraz, 2022) have proved that there is no relation between the CE and SMP. These different results can be attributed to many reasons, as the researchers conducted their sample from different periods or used different measures, it can also be from conducting a sample from different country regions. For instance, (Sarfraz, 2022) determined that there is no association among corporate financial performance and the performance measures of the CE, in addition, (Morea et al., 2022) found that there is no relationship between CE strategies and SMP. Lastly, our study results contradict the transaction cost theory which posits that CE can have a negative effect on the stock market as there are high expenses and costs to shift from linear to circular business models thus, making contracts can be expensive which affects the investment negatively.

According to the statistical result regarding the mediation impact of SDG on the association between CE and SMP, it was found that the SDG score does not affect SMP (P-value of SDGs is 0.5576), thus the CE does not affect the mediator SDGs. This can be attributed to the fact that financing sustainable development is not easy and requires large funds to be circular, limited awareness from different stakeholders about its importance and practices, and finally can lead to ineffective implementation that mainly can negatively affect the relation between the CE and SDGs. In the EU context, this non-significant mediation could also be linked to the uneven progress of SDG implementation across member states, where economic priorities, regulatory enforcement, and public awareness of sustainability vary substantially. For example, while northern and western EU countries generally score higher on SDG performance, some eastern and southern EU economies face structural challenges, such as limited access to green finance or slower adoption of circular business models, which may weaken the pathway from CE initiatives to broader sustainable development outcomes. Additionally, the time horizon for achieving measurable SDG improvements may be longer than the short-to-medium-term financial impacts captured in stock market performance, thereby reducing the observed mediating effect.

5. Conclusion, Implications, Limitations, and Recommendations for Future

Research

Implementing a CE in the EU will reduce the pressure on natural resources and foster sustainable economic development and employment opportunities. Therefore, it will successfully attain the European Union's objective of achieving climate neutrality by 2050 and limit the decline of ecological diversity. The objective of the research is to investigate how SDG scores mediate the relationship between CE and the SMP in the European context. The current research employed a random effect Generalised Least Squares (GLS) model with robust estimation to assess the data's robustness and address any issues in the standard errors. The sample consisted of 10 European Union (EU) countries within the time frame of 2000-2021. The indicators employed to quantify CE are AFWW, GMW, RP, and RRR. The findings of our study indicate that RR has a statistically significant and positive effect on SMP at a significance level of 1%. Additionally, both RR and GDP have a statistically significant and positive effect on SMP at a significance level of 5%.

This study has various implications for different stakeholders, companies' managers, investors, and government authorities. First, companies' managers should prioritize how to integrate circularity in their business models to enhance their profitability level and gain a competitive advantage edge. By optimizing resource efficiency, reducing waste, and embracing recycling, companies can enhance profitability, reduce costs, and improve their appeal to investors, thereby driving up their SMP. Second, investors should prioritize companies that are leaders in adopting CE practices as part of their ESG investment strategies. These companies are likely to experience better long-term financial performance and stability, making them attractive investment options with the potential for positive stock market returns. Lastly, governments should continue to develop and enforce policies that promote the CE, such as subsidies for sustainable practices, tax incentives for recycling and waste reduction, and stringent regulations on waste management. These policies can create an environment where businesses are incentivized to adopt circular practices, leading to overall economic growth and positive SMP.

This study has some limitations. First, this study specifically examined a subset of the CE proxies, rather than all of them. Therefore, future studies could investigate the influence of CE on SMP using alternative CE indicators such as the Industrial Circular Economy Questionnaire (ICEQ). Furthermore, our approach exclusively relies on market indices as a proxy for SMP. Therefore, future study should investigate the relationship between CE and SMP using alternative indicators of SMP such Volatility Index. Moreover, future researchers could examine the influence of CE on economic growth, as CE focusses on optimizing resource utilization, minimum waste generation, and maximizing material value.

Consequently, enterprises derive substantial financial benefits by reducing their expenditures on raw materials and waste management. The accumulated savings can be allocated to other sectors of the firm, therefore promoting economic activity and making a positive contribution to the growth of GDP. Furthermore, the study sample was restricted to 10 nations inside the European Union, resulting in a small sample size. Future research in this area can investigate other countries, such as the MENA region, as CE interventions are equally relevant to these regions. Future studies could also adopt advanced econometric techniques such as dynamic panel models (e.g., Generalized Method of Moments – GMM) to better account for endogeneity issues, or Structural Equation Modeling (SEM) to simultaneously test multiple direct and indirect relationships, including mediation effects. In addition, mixed-method approaches combining quantitative analysis with qualitative case studies could provide richer insights into country-specific policy impacts and stakeholder perspectives on CE implementation.

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