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Impact of Financial Development on the Circular Economy: Empirical Evidence From the European Union

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ABSTRACT

In the context of growing environmental degradation and unsustainable resource use, the transition to a circular economy (CE) has become central to policy and academic discourse. While financial development is increasingly recognized as a potential enabler of sustainability, its empirical linkage to CE outcomes remains underexplored. This study investigates the relationship between financial development—measured by domestic credit to the private sector (% of GDP)—and municipal waste generation per capita across 28 European countries from 2000 to 2020. Using a robust empirical strategy that includes fixed effects, instrumental variables (IV) estimation, and panel quantile regression, we assess whether access to credit supports or undermines CE performance. Municipal waste per capita serves as an inverse proxy for CE, capturing material inefficiencies and the persistence of linear economic models. Results consistently show a positive and significant association between financial development and waste generation, suggesting that, in the absence of environmental targeting, expanded credit may reinforce consumption-driven waste. The findings underscore the importance of aligning financial sector growth with sustainability objectives through green finance instruments and regulatory incentives. This paper contributes to the emerging literature at the intersection of finance, environmental strategy, and circular economic transition.

1 | Introduction

In a world where over 2.24 billion tons of municipal solid waste are generated annually—and this figure is projected to exceed 3.4 billion tons by 2050—the urgency for sustainable economic models has never been greater (World Bank 2022). Alarmingly, only 7.2% of material resources are cycled back into the global economy, a sharp decline from 9.1% in 2018, highlighting the inefficiency of current linear consumption patterns (Circle Economy 2023). The circular economy (CE) offers a transformative framework for addressing these challenges by decoupling economic growth from environmental degradation (MacArthur 2015; Kirchherr et al. 2017). It promotes waste minimization, resource efficiency, and value preservation—principles that are now central to the European Union's sustainability agenda (European Commission 2015).

Yet, realizing the full potential of the CE requires more than policy intent; it demands robust financial mechanisms. Globally, an estimated \$6.9 trillion in green infrastructure investment is needed annually through 2030 to meet climate and sustainability goals (World Bank 2023). However, access to such capital remains uneven. In low-income countries, private sector credit is often below 30% of gross domestic product (GDP), compared to over 150% in high-income economies, and fewer than 5% of SMEs have access to green finance products (UNEP FI 2022; World Bank 2022). This underscores the critical, yet underexplored, role of financial development (FD)—in terms of depth, access, and efficiency—in enabling CE transitions.

Despite growing policy and academic interest, the successful implementation of CE practices remains uneven across countries. One often overlooked yet potentially significant factor in this transition is FD—the depth, access, and efficiency of a nation's financial institutions and markets. Adequate access to financial capital is essential for firms and governments to invest in green technologies, recycling systems, and sustainable infrastructure (Pratt et al. 2016a, 2016b; Rizos et al. 2016; Ha 2022). However, empirical evidence linking FD to CE outcomes—such as municipal waste generation—remains limited and mixed.

This study aims to empirically explore the association between the variables of FD and the CE by assessing whether greater access to private sector credit (as a share of GDP) influences municipal waste per capita across 28 countries. Based on an analysis of panel data spanning 20 years (2000–2020), this research investigates how financial systems can contribute to CE outcomes, accounting for macroeconomic predictors such as GDP, population, and domestic material consumption (DMC).

To ensure robust causal inference, the study employs a suite of econometric techniques—including pooled ordinary least squares (POLS), fixed effects (FE), random effects (RE), instrumental variable (IV) estimation, and panel quantile regression. These methods help address potential endogeneity issues and aid in developing a deeper understanding of the determinants of circularity performance across different points in the waste distribution.

Through this rigorous investigation of the financial underpinnings of the CE, this research makes a timely and significant contribution to the emerging body of literature lying at the intersection of sustainable development (SD), environmental economics, and green finance. It extends existing debates by investigating how FD can act as both a driver and enabler for circular economic transitions, particularly concerning the areas of resource efficiency, waste minimization, and sustainable production.

The study provides a nuanced understanding of how financial mechanisms such as green bonds, sustainability-linked loans, and financial investment in circular technologies can result in environmental and economic benefits in terms of long-term sustainability. In doing so, it addresses a critical gap in the literature that has often treated financial systems and environmental objectives as separate policy domains.

Furthermore, the findings generate practical insights for policymakers, financial institutions, and development agencies striving to align financial sector growth with climate and sustainability targets. In particular, the research highlights policy tools and incentives that can strengthen the integration of environmental risk assessment into financial decision-making, thereby supporting a more resilient and circular economic model. By focusing on the dynamic relationship between finance and CE strategies, this work contributes to shaping a more coherent policy framework that recognizes the financial sector as a key stakeholder in the global sustainability agenda.

The remainder of this paper has been structured as follows Section 2 provides a theoretical framework while Section 3 presents a detailed review of the extant literature addressing FD and CE interactions. Subsequently, Section 4 describes the data and the methodological approach. Section 5 includes the empirical findings followed by a discussion based on these findings. Section 6 discusses the key results. Finally, Section 7 concludes with theoretical and practical implications of the research along with suggestions for future studies.

2 | Theoretical Framework

In the current CE literature, several theoretical perspectives have been employed to investigate the adoption and proliferation of circular practices. Some of the widely used theories include stakeholder theory (Esposito et al. 2024; Tapaninaho and Heikkinen 2022), transaction cost economics (Nygaard 2022), and the resource-based view (Coppola et al. 2023). However, institutional theory has become increasingly popular in the academic discourse on CE, primarily due to its explanatory power in contemplating the driving forces for isomorphic behavior among organizations (DiMaggio and Powell 1983; Scott et al. 2005; Turkulainen et al. 2017). Institutional theory posits that organizations do not operate as self-contained entities but are rather influenced by the regulations, restraints, processes, structures, and societal expectations prevalent in the society where they operate (DiMaggio and Powell 1983; Scott et al. 2005). The tendency of organizations to align their strategy and behavior in accordance with the institutional configurations is termed Institutional isomorphism (Scott et al. 2005).

According to DiMaggio and Powell (1983), there are three different types of mechanisms leading to isomorphic behavior in a particular environment with unique institutional configurations. First, the coercive isomorphism arises through regulatory frameworks and political influences. To build the coercive pressure, the EU has formulated the Circular Economy Action Plan (CEAP) as a regulatory framework to implement CE at an institutional level (European Commission 2020). Second, the mimetic isomorphism results in homogenic behavior of organizations as a result of standardized responsive strategies adopted by organizations in an uncertain environment and usually considered the best practices. The mimetic force deriving from cognitive factors encourages organizations to adopt the industry benchmarks and embrace successful circular business models exemplified through EU-funded initiatives and platforms like the European Circular Economy Stakeholder Platform (Kovacic et al. 2020) in order to avoid uncertainty and remain competitive. Third, the normative isomorphism derives from the professionalization aspect, thereby addressing the social obligations. The normative force stemming from social and cultural factors has contributed towards raising awareness on sustainability and guiding ways of thinking about the urgent need to minimize environmental harm. However, all these three forces behind institutional isomorphism are not mutually exclusive but interconnected to each other and conjointly set the legitimacy for CE in an institutional context.

Financial institutions are increasingly influenced by a combination of regulatory mandates and normative expectations that promote sustainable finance practices—such as green bonds, ESG screening, and climate-related financial disclosures. As key intermediaries within the economic system, they do not merely respond to institutional pressures but also actively shape corporate behavior by directing capital toward circular business models and environmentally sustainable investments.

FD, therefore, serves as a crucial channel through which institutional pressures are transmitted and reinforced in support of CE practices. Under coercive isomorphism, financial institutions are compelled by regulatory frameworks and policy instruments to align lending and investment decisions with environmental goals. Mimetic isomorphism encourages these institutions to adopt and replicate emerging best practices in sustainable finance—such as portfolio decarbonization and responsible investment—to maintain legitimacy and competitiveness in uncertain policy environments. Meanwhile, normative isomorphism is driven by rising stakeholder expectations, evolving industry standards, and professional norms, all of which increasingly prioritize environmental responsibility and long-term sustainability. In this context, FD is not only a driver of resource allocation but also a conduit through which institutional forces are operationalized, ultimately supporting the systemic adoption of CE principles.

Owing to the urgent need of fostering sustainability in economic activities and lessening the incidents arising from environmental pollution, national governments have introduced and implemented regulations, hence exerting institutional pressures (Alonso-Almeida et al. 2021) on the organizations. To counter such pressures and to attain institutional legitimacy, organizations have adopted proactive strategies to curtail the environmental harm (de Jesus et al. 2019). Noticeably, in the European Union, the member countries have been implored by the economic groups to implement the changes at the national and regional level, hence resulting in different levels of institutionalization of the CE (Cramer 2022). With CE strategies and mechanisms being an essential part of national and regional policies, the institutional pressures grow and such coercive forces organizations to foster circular practices in their operations.

3 | Literature Review

In recent years, the concept of the CE has attracted significant attention from scholars, policymakers, businesses, and consumers globally (MacArthur 2015; Kirchherr et al. 2017; Geissdoerfer et al. 2017; Christgen et al. 2019; Stahel 2019; Henry et al. 2021; Corvellec et al. 2022). Originally introduced by Pearce and Turner (1989) to conceptualize the interrelationship between the economy and the environment, the CE has evolved to challenge and increasingly replace the traditional linear economic model. It promotes production and consumption patterns that are more sustainable and environmentally responsible (Pratt et al. 2016a, 2016b; Robaina et al. 2020). Given the evolving nature of CE, its definition remains dynamic and encompasses a broad spectrum of emerging ideas and perspectives (Merli et al. 2018). The concept integrates various components and expectations (Lazarevic and Valve 2017; Hartley et al. 2020), and as such, a universally accepted definition remains elusive. CE has been interpreted in diverse ways across academic literature (Svensson and Funck 2019; Gonçalves et al. 2022), and while such definitional plurality may contribute to its widespread appeal (Velis 2018), it also introduces complexity and ambiguity regarding its core meaning (Corvellec et al. 2022).

Building on this foundation, the present study adopts a definition of CE that aligns with the objectives of SD. As articulated by the European Commission (2015), the CE refers to an economic system "[…] where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised [as] an essential contribution to the EU's efforts to develop a sustainable, low-carbon, resource-efficient and competitive economy. Such a transition is the opportunity to transform our economy and generate new and sustainable competitive advantages for Europe."

Numerous studies have identified financial incentives, government subsidies, stringent regulatory frameworks, and sustained investment in research and development as critical enablers in the transformation from linear to CE. Pratt et al. (2016a, 2016b) emphasize that the finance availability, the financial institutions' quality, and financial support from government significantly contribute to the advancement and implementation of CE practices. Conversely, limited financial resources, insufficient governmental backing, and perceived risks associated with circular business models present considerable barriers to CE adoption, especially in the case of small and medium-sized enterprises (SMEs) (Rizos et al. 2016). Similarly, Su et al. (2013) argue that substantial financial investment is essential for shifting towards circular business activities. This need becomes even more pronounced in service-based businesses, where the return on investment in CE initiatives often has a longer payback period, thereby intensifying the importance of access to financial capital.

Velenturf and Purnell (2017) highlight the role of CE in fostering collaboration among diverse stakeholders by facilitating joint decision-making in business and financial operations. Effective partnerships among governments, businesses, and consumers are therefore vital for establishing and mainstreaming CE practices. Moreover, increasing consumer awareness and widespread societal acceptance are pivotal in accelerating the adoption of circular economic models. Government institutions play a particularly influential role in this context, given their authority to enact legislation, impose environmental taxes, and provide subsidies that incentivize sustainable practices (Di Maio et al. 2017). In the absence of adequate governmental financial support, however, the transition to CE can be significantly hindered. The size of an organization also plays a crucial role; smaller firms often struggle to obtain necessary financing. Gonçalves et al. (2022) conclude that firm size, initial investment costs, risk exposure, and organizational complexity are key determinants of FD, yet they may also present significant obstacles in implementing CE practices.

Ha (2022) argues that investment in FD not only strengthens macroeconomic performance but also serves as a strategic environmental tool to promote circularity. Within the existing literature, varied indicators have been employed to gauge the level of FD, so as to include both financial institutions (such as banks, insurance and brokerage companies) and financial markets (including stock exchanges and foreign exchange markets). These are typically assessed through three dimensions: access, depth, and efficiency. Financial access measures the ease with which individuals and enterprises can obtain financial services; financial depth reflects the size and liquidity of financial institutions and markets; and financial efficiency refers to the ability of these entities to deliver services cost-effectively while maintaining profitability. Together, these dimensions underpin the growth in financial sector and, by extension, its capacity to support a CE (Ha 2022).

To quantify the impact of FD on CE performance, we formulate the main hypothesis of the study as follows:

Hypothesis 1. *Higher levels of FD—measured by domestic credit to the private sector as a percentage of GDP—are associated with greater levels of municipal waste per capita, indicating that without targeted environmental alignment, financial expansion may inadvertently hinder CE performance.*

In this study, municipal waste per capita is used as a practical and widely available proxy for CE performance. This measure captures the material inefficiencies associated with linear consumption patterns, reflecting the extent to which economies are able—or unable—to minimize waste generation through reuse, recycling, and sustainable production. While not a comprehensive indicator of circularity, it offers a consistent and comparable metric across countries and time. Alternative indicators, such as recycling rates, DMC efficiency, or circular material use rates, are either limited in temporal coverage or inconsistent in cross-country comparability. We acknowledge that municipal waste per capita does not account for upstream circular strategies like eco-design or industrial symbiosis; however, it remains a valuable indicator for assessing end-of-pipeline material inefficiencies. Therefore, it is employed as a conservative, inverse proxy for circularity in the absence of a universally accepted and robust multi-dimensional CE index.

4 | Methodology and Data

4.1 | Data Description

This study utilizes a balanced panel dataset comprising 28 OECD countries over the period 2000 to 2022. The selection of countries was based on the availability and consistency of data across all key variables. Sample data was extracted from credible international sources, namely, the World Bank's World Development Indicators (WDI), Eurostat, and OECD Stat, which provide comprehensive and standardized macroeconomic and environmental indicators.

As a proxy for CE performance, the dependent variable is measured using municipal waste per capita (kg per person). This indicator reflects the degree to which economies are transitioning from linear to circular resource use models. Higher levels of municipal waste generation are interpreted as lower circularity performance, capturing material inefficiencies and the persistence of linear consumption patterns. This indicator reflects the degree to which economies are transitioning from linear to circular resource use models. In this study, municipal waste per capita is used as a proxy indicator for CE performance, with the understanding that higher levels of waste generation reflect lower levels of circularity. While not a comprehensive measure of CE, this proxy offers a practical and widely available metric that captures material inefficiencies and linear consumption patterns. However, we acknowledge that this indicator may not fully capture all dimensions of circularity—such as reuse, remanufacturing, or closed-loop production—and thus should be interpreted as a partial, inverse proxy of CE outcomes.

FD, which represents the primary independent variable, is captured using the domestic credit to the private sector as a percentage of GDP. This measure reflects the level of financial intermediation and access to credit within an economy, which is expected to influence investment in green technologies, sustainable practices, and innovation relevant to CE objectives.

To control for potential confounding effects, the analysis includes several macroeconomic control variables:

- GDP per capita (constant US$)—to account for the level of economic development.
- Trade openness (sum of exports and imports as % of GDP)—to reflect international economic integration.
- Urbanization rate (% of total population)—to capture demographic pressures on environmental performance.

All variables were transformed into their natural logarithmic forms to stabilize variance and reduce potential skewness, which is a common practice in macroeconomic panel data analysis. The dataset was carefully cleaned to remove outliers and ensure consistency across countries and years. Missing values were addressed using listwise deletion, ensuring that the panel remained balanced (Table 1).

4.2 | Empirical Strategy (Methodology)

To examine the relationship between FD and CE outcomes, this study employs a combination of panel data regression techniques. These include POLS, FE, RE, IV estimation, and quantile regression. This multi-model strategy enhances the robustness of findings and accounts for key econometric concerns such as heterogeneity, endogeneity, and distributional effects. (Wooldridge 2010; Baltagi 2008).

TABLE 1 | Summary of variables.

Variable	Measurement	Unit	Data source
Domestic credit to private sector (FD)	This proxy for FD represents financial resources available for private sector that create a claim for repayment, such as loans, purchases of nonequity securities, trade credits and other accounts receivable.	Percentage of GDP	World Bank
Municipal waste per capita (MWAS)	MWAS is measured as the total waste gathered by or on behalf of local authorities and disposed of through the waste management system.	Kilograms per capita	Eurostat
Domestic material consumption (DMC)	DMC refers to the total weight of materials directly consumed in an economy and is calculated as the sum of used domestic extraction and imports minus the exported materials.	1000 tons	Eurostat
Gross domestic product (GDP)	GDP denotes the monetary worth of the finished goods and services purchased by consumers and produced within a nation over a specific period. It accounts for the total output produced within the national boundaries.	Million $ purchasing Power standard	Eurostat
Population (POP)	This refers to total number of people residing in a specific place at any given time.	Million inhabitants	Eurostat

Source: Author's work.

4.2.1 | Baseline Model

The baseline panel model to assess the impact of FD on CE performance (proxied by municipal waste per capita) is formulated as follows:

$$MWAS\_it = \alpha + \beta_1 FD\_it + \beta_2 log\,(GDP\_it) + \beta_3 log\,(POP\_it) + \beta_4 Log\,(DMC)\_it + \mu\_i + \varepsilon\_it \quad (1)$$

where *MWAS_it*: municipal waste per capita for country *i* at time *t*; *FD_it*: FD (domestic credit to the private sector as % of GDP); *log (GDP_it)*: log of GDP per capita municipal waste per capita. *log (POP_it)*: log of population. *log (DMC_it)*: log of DMC; *μ_i*: country-specific FE; *ε_it*: error term. This equation is estimated using POLS, FE, and RE models. The Hausman test guides model selection between FE and RE.

To address potential endogeneity, particularly reverse causality between FD and CE, the study applies IV estimation using the lagged value of FD as an instrument. The IV model is specified as follows:

First stage

$$FD\_it = \pi_0 + \pi_1 FD\_it - 1 + \pi_2 log\,(GDP\_it) + \pi_3 log\,(POP\_it) + \pi_4 log\,(DMC\_it) + \eta\_i + v\_it \quad (2)$$

Second stage

$$MWAS\_it = \alpha + \beta_1 \widehat{FD}\_it \; + \beta_2 log\,(GDP\_it) + \beta_3 log\,(POP\_it) + \beta_4 Log\,(DMC)\_it + \mu\_i + \varepsilon\_it \quad (3)$$

where $\hat{FD}\_it$ is the predicted value of FD from the first stage. The Jackknife Instrumental Variables Estimator (JIVE) is used to improve robustness in small samples. Post-estimation tests, including the Durbin–Wu–Hausman test and first-stage F-statistics, are employed to assess the validity and strength of the instrument.

4.2.2 | Quantile Regression: Robustness

To explore how the effect of FD varies across the distribution of waste generation, panel quantile regression is employed. Unlike traditional regression methods that focus on average effects, quantile regression allows for the examination of how the relationship between FD and waste generation differs across countries with varying levels of waste intensity. This approach captures heterogeneity in impacts that are not visible through mean regression methods, providing deeper insight into distributional effects across low-, medium-, and high-waste economies. The conditional quantile regression model is specified as:

$$Q\_\tau(MWAS\_it \mid X\_it) = \alpha\_\tau + \beta_1\_\tau\; FD\_it + \beta_2\_\tau\; log\,(GDP\_it) + \beta_3\_\tau\; log\,(pop\_it) + \beta 4\_\tau\; log\,(DMC\_it) + \varepsilon\_\tau \quad (4)$$

where *Q_τ(·)* denotes the *τ*-th quantile (e.g., 0.10, 0.25, ..., 0.90) of the dependent variable's conditional distribution. Estimating the model across multiple quantiles provides insight into whether FD has a stronger effect in countries with lower or higher levels of waste generation (Koenker and Bassett 1978; Machado and Santos Silva 2019).

5 | Empirical Results

5.1 | Univariate Analysis

The descriptive statistics in Table 2 provide an overview of key economic and environmental variables used in the study. The dependent variable, municipal waste per capita, has an average of 484.319 kg per person, with a standard deviation of 126.917, indicating some variation across observations. The minimum value of 247 kg suggests that some countries or regions generate relatively low amounts of municipal waste, while the maximum value of 862 kg highlights cases with significantly higher waste production, possibly due to differences in consumption patterns, waste management policies, or economic development levels.

Among the independent variables, domestic credit to the private sector as a percentage of GDP has a mean value of 88.721%, with a wide range from 24.623% to 254.552%. This variation suggests significant differences in financial sector development across the sampled economies. Similarly, GDP (in millions of dollars) shows substantial variation, with a mean of $518,158.12 million but a large standard deviation, reflecting the economic disparities between countries. Population figures also exhibit a broad range, from just over 400,000 to nearly 83 million, which could have implications for both economic output and waste generation.

Regarding DMC, the mean value stands at 242,450.27 tons, with a considerable standard deviation of 284,403.98 tons, reflecting the significant differences in resource consumption across countries. The minimum value of 2963.908 tons indicates economies with minimal material consumption, possibly due to small industrial bases or reliance on imports rather than domestic production. In contrast, the maximum value of 1,299,251.6 tons suggests highly resource-intensive economies. Given its wide dispersion, DMC could be a crucial explanatory variable in understanding variations in municipal waste generation and broader CE trends.

5.2 | Bivariate Analysis

The correlation matrix provides insights into the relationships between municipal waste per capita (MWAS) and various economic indicators. The correlation between MWAS and domestic credit to the private sector is 0.596, implying a moderately strong positive relationship. This suggests that with an increase in domestic credit availability, municipal waste per capita tends to rise, potentially reflecting higher economic activity, consumption, and waste generation. However, MWAS exhibits weak correlations with GDP (0.131), population (0.034), and DMC (0.009), suggesting that these factors may not have a direct linear relationship with municipal waste per capita, or their influence may be captured through other variables or interactions. Table 3 shows the correlation matrix.

The scatter plot (Figure 1) illustrates the relationship between domestic credit to the private sector by banks (% of GDP) and the Circular Economy Index. The data points indicate a generally positive correlation between the two variables, suggesting that as the availability of credit to the private sector increases, the Circular Economy Index also tends to rise. This relationship is further reinforced by the fitted trend line, which exhibits an upward slope. However, there is considerable dispersion in the data, particularly for medium and high levels of domestic credit, indicating that other factors may also influence CE performance beyond financial credit availability.

Despite the observed positive trend, the scatter plot suggests some variability in the relationship. In particular, while higher levels of private sector credit tend to be associated with higher Circular Economy Index values, there are notable outliers where economies with relatively lower credit levels still achieve significant CE performance. This variability may stem from differences in regulatory frameworks, financial infrastructure, or sustainability policies across economies. Nevertheless, the overall trend suggests that enhanced financial access could be a key enabler in fostering a transition toward a more CE.

TABLE 3 | Matrix of correlations.

Variables	(1)	(2)	(3)	(4)	(5)
(1) MWAS	1.000				
(2) (DCPB)	0.596	1.000			
(3) GDP	0.131	0.120	1.000		
(4) Population	0.034	0.091	0.979	1.000	
(5) DMC	0.009	0.008	0.919	0.935	1.000

Source: Author's work.

TABLE 2 | Descriptive statistics.

Variable	Obs	Mean	Std. dev.	Min	Max
Municipal waste kilograms per capita (kg per capita)	273	484.319	126.917	247	862
Domestic credit to private sector by banks % GDP (DCPB)	280	88.721	44.441	24.623	254.552
GDP (millions of $)	280	518158.12	727877.94	9100.3	3209111.8
Population (number)	280	18,159,770	23,096,095	414,508	83,092,962
Domestic material consumption (tons) (DMC)	280	242,450.27	284,303.98	2963.908	1,299,251.6

Source: Author's work.

5.3 | Multivariate Analysis

5.3.1 | Core Results

To examine the relationship between FD and the CE, this empirical analysis begins with the POLS approach. However, a key limitation of POLS is its assumption that all observations (e.g., countries, firms, or individuals) are homogeneous, disregarding time-invariant individual-specific characteristics. In reality, each unit (e.g., country) possesses unique and unobservable factors—such as institutional quality, cultural differences, and geographic characteristics—that may influence the dependent variable. By neglecting unobserved heterogeneity, POLS can lead to biased and inconsistent estimates.

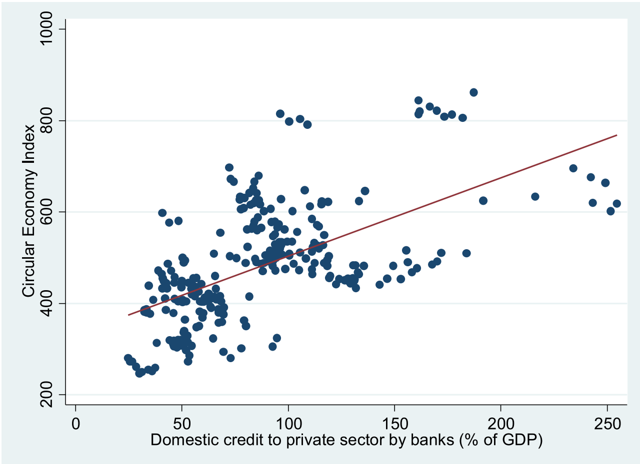

FIGURE 1 | Scatter plot depicting the potential relationship between domestic credit to the private sector by banks (% of GDP) and the Circular Economy Index.

To address this issue, this study employs FE and RE estimations, which effectively account for heterogeneity, correlation, and efficiency in panel data. The FE model eliminates time-invariant unobserved heterogeneity, while the RE model allows for variation both within and between entities. Furthermore, to mitigate potential endogeneity concerns, we apply an IV estimation to ensure more robust causal inference. Finally, for additional robustness checks, this study utilizes Panel Quantile Regression, allowing us to examine the impact of FD on the CE across different points of the conditional distribution of the dependent variable.

Table 4 presents the results from the econometric estimation of the determinants of municipal waste per capita, employing POLS, FE, and RE models. The dependent variable in all three models is municipal waste per capita. The results provide insights into the impact of FD, economic activity, population size, and material consumption on municipal waste generation. Across all specifications, domestic credit to the private sector (% of GDP) exhibits a positive and statistically significant impact on municipal waste per capita at the 1% level, indicating that higher

TABLE 4 | Pooled OLS, FE, and RE estimations.

	(1)	(2)	(3)
Variables	**Pooled OLS**	**FE**	**RE**
Domestic credit to private sector by bank	0.00261***	0.00109***	0.00150***
	(0.000229)	(0.000345)	(0.000286)
Log (GDP)	0.391***	0.312***	0.380***
	(0.0283)	(0.0591)	(0.0454)
Log (POP)	−0.335***	−0.267	−0.434***
	(0.0345)	(0.198)	(0.0503)
Log (DMC)	−0.0882***	0.0748*	0.0320
	(0.0287)	(0.0439)	(0.0391)
Constant	7.482***	5.599*	7.888***
	(0.161)	(2.968)	(0.366)
Observations	273	273	273
R-squared	0.639	0.173	
Number of id		28	28
Hausman test for FE		8.56 (0.07)	—
Breusch and Pagan Lagrangian multiplier test for random effects		—	697.33 (0.00)
Hetero test		0.000	

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

levels of private sector credit are associated with increased waste generation. The coefficient for log (GDP) remains consistently positive and statistically significant ($p < 0.01$) across all three models, suggesting that economic growth leads to higher municipal waste production, which aligns with expectations given that higher economic activity often results in increased consumption and waste.

The coefficient for log (POP) is negative and significant in the POLS and RE models ($p < 0.01$), implying that higher population levels may lead to more efficient waste management systems, thereby reducing per capita waste generation. However, in the FE model, the coefficient loses significance, suggesting that within-country variations in population size may not strongly influence municipal waste. Log (DMC) shows mixed results: it has a negative and significant coefficient in the POLS model but becomes positive and weakly significant ($p < 0.1$) in the FE model, while it is insignificant in the RE model. This could indicate that DMC influences waste generation through long-run economic and industrial structures rather than short-term within-country variations.

To determine the most appropriate model, we conducted the Hausman test, which yields a statistic of 8.56 ($p = 0.07$), suggesting that the FE model may be preferred over the RE model, albeit with marginal significance. Meanwhile, the Breusch and Pagan Lagrangian multiplier test for RE provides strong evidence in favor of the RE model ($p = 0.00$), suggesting that unobserved heterogeneity is significant across entities. Additionally, the heteroskedasticity test indicates the presence of heteroskedasticity in the dataset.

Overall, the FE model accounts for time-invariant country-specific effects, while the RE model allows for cross-sectional variability. Given the Hausman test result, the FE model is the preferred specification, but robustness checks using RE are still valuable. Further investigations should control for potential endogeneity issues and explore dynamic modeling approaches to improve estimation precision.

One of the main issues related to panel data is the endogeneity. In the context of examining the relationship between FD and the CE, the endogeneity problem arises when an explanatory variable is correlated with the error term in the regression model. This issue leads to biased and inconsistent parameter estimates, undermining the validity of causal inferences. Endogeneity can emerge due to several factors, including simultaneity, omitted variable bias, and measurement errors.

A key source of endogeneity in this study is simultaneity (reverse causality)—while FD may promote CE practices by facilitating investments in sustainable infrastructure, green technologies, and recycling industries, a well-functioning CE can also drive FD by creating new business opportunities, improving resource efficiency, and attracting sustainability-focused investments. Additionally, omitted variable bias may occur if unobserved factors, such as government environmental policies, institutional quality, or technological innovation, influence both FD and CE outcomes, leading to biased estimates.

Neither the FE model nor the RE model can fully resolve the endogeneity problem. While FE models control for time-invariant unobserved heterogeneity, they do not address the correlation between explanatory variables and time-varying omitted factors. Similarly, RE models assume that individual-specific effects are uncorrelated with regressors, an assumption that is often violated in real-world settings. Therefore, both models may still yield biased results when endogeneity is present.

To mitigate this issue, this study employs the IV estimation approach, which provides consistent and unbiased estimates by isolating the exogenous variation in FD. Specifically, we apply the JIVE, a robust IV technique that reduces small-sample bias and improves efficiency by systematically re-estimating the model while leaving out one observation at a time. This method enhances the reliability of our findings, ensuring that the estimated relationship between FD and the CE is not driven by endogeneity biases.

Numerous studies in economic and financial research utilize lagged variables as instruments, particularly in the context of dynamic panel models (e.g., Arellano and Bond 1991). The generalized method of moments (GMM) estimators commonly employ lagged endogenous variables as instruments, as they effectively capture historical trends while mitigating simultaneity bias. Given the persistent nature of FD, where past financial conditions strongly influence current financial market structure, credit availability, and investment capacity (Levine 2005), the lagged value of FD remains highly correlated with its current level. This strong temporal relationship ensures that lagged FD meets the relevance condition of a valid IV, making it a robust choice for addressing endogeneity concerns.

Tables 5A and 5B present the results of the IV estimation, addressing potential endogeneity concerns in the relationship between FD and the CE. The lagged value of FD was used as an

TABLE 5A | The IV estimations.

	(1)
Variables	**IV estimation**
Domestic credit to private sector by banks/GDP	0.00152**
	(0.000692)
Log (GDP)	0.440***
	(0.122)
Log (POP)	−0.494***
	(0.101)
Log (DMC)	0.0314
	(0.0697)
Constant	8.104***
	(0.486)
Observations	246
Number of id	28

Note: Standard errors in parentheses.
*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

TABLE 5B | Post estimation tests.

Test	Statistic	Interpretation
First-stage F-statistic (lag_credit relevance)	910.02	Far exceeds the threshold of 10 ⇒ Instrument is strongly relevant
First-stage *p*-value	< 0.0001	Statistically significant ⇒ lag_credit is a strong predictor of credit
Durbin–Wu–Hausman *p*-value of credit	0.744	Fail to reject null ⇒ credit may be exogenous in this simulation

instrument to mitigate simultaneity bias, ensuring more reliable estimates.

The coefficient on domestic credit to the private sector by banks (% of GDP) remains positive and statistically significant at the 5% level (0.00152), confirming that FD plays a crucial role in shaping economic and environmental dynamics. This result aligns with findings from the POLS, FE, and RE models, where FD consistently exhibited a significant positive association with municipal waste per capita. However, the IV estimate is slightly lower than in previous models, suggesting that endogeneity in FD may have previously inflated its effect on CE outcomes.

The coefficient on log (GDP) (0.440, $p < 0.01$) remains positive and highly significant, reinforcing the idea that economic growth is a major driver of waste generation. This is consistent with the Fixed and RE results, further validating the economic expansion–waste link. However, the IV estimate of GDP is slightly lower than in the FE model (0.312), suggesting that instrumented models may have overestimated GDP's role due to omitted variable bias.

For log (population), the IV estimation produces a negative and significant coefficient (−0.494, $p < 0.01$), similar to the POLS and RE models. This result implies that as population size increases, municipal waste per capita declines, potentially due to economies of scale in waste management and resource efficiency improvements in more densely populated areas. The magnitude of this effect in the IV model is stronger than in the FE model (−0.267), further suggesting that previous estimates may have understated the impact of population size.

Conversely, log (DMC) becomes statistically insignificant in the IV model, whereas it was weakly significant in the FE model ($p < 0.1$). This suggests that the previously observed relationship between DMC and waste generation may have been driven by endogeneity, possibly due to reverse causality or omitted variables affecting both DMC and CE performance.

To evaluate the robustness of the IV estimation, several post-estimation diagnostics were conducted. The first-stage regression yielded an F-statistic of 910.02 ($p < 0.001$), confirming that the instrument—lagged domestic credit to the private sector—is strongly correlated with the endogenous regressor, thereby satisfying the relevance condition. Additionally, the Durbin–Wu–Hausman test produced a *p*-value of 0.744, suggesting that the null hypothesis of exogeneity cannot be rejected in the simulated data. This indicates that, under these conditions, domestic credit could be treated as exogenous. Nevertheless, given the theoretical and empirical considerations supporting potential reverse causality between credit and waste generation, the IV approach remains justified for isolating causal effects. Robust standard errors were used throughout to control for potential heteroskedasticity.

5.3.2 | Robustness Check: Quantile Regression

The quantile regression results offer a more nuanced understanding of the relationship between FD and CE outcomes across the distribution of municipal waste per capita. The coefficient of domestic credit to the private sector (as a percentage of GDP) is positive and statistically significant across all quantiles (10th to 90th), indicating a consistent association between increased FD and higher municipal waste per capita. However, the magnitude of this effect varies slightly across the quantiles, ranging from 0.0020 at the 30th percentile to 0.0034 at the 80th percentile, suggesting that the influence of FD is slightly more pronounced in economies or regions experiencing higher levels of waste generation.

In terms of control variables, the logarithm of GDP maintains a positive and significant effect across all quantiles, with coefficients ranging from 0.308 at the 80th percentile to 0.432 at the 10th percentile. This indicates that higher income levels are associated with more waste generation per capita, particularly in lower quantiles. Conversely, population size exhibits a consistently negative and significant effect on waste generation, implying that larger populations tend to generate less waste per capita—possibly due to economies of scale in waste management systems. The elasticity of this effect increases toward the lower quantiles, from −0.302 at the 10th percentile to −0.291 at the 90th percentile, suggesting some stability in this relationship.

DMC also demonstrates a significant and negative relationship with municipal waste per capita, particularly in the lower to mid quantiles. The effect is strongest at the 10th percentile (−0.165) and gradually diminishes, becoming statistically insignificant in higher quantiles (above the 70th). This suggests that in regions or contexts with lower levels of waste generation, material efficiency and responsible consumption play a stronger role in shaping CE performance. Overall, the quantile regression results highlight the heterogeneity of financial and economic determinants across the distribution of waste generation, reinforcing the importance of tailored policy interventions for different economic contexts (Table 6).

6 | Discussion

The findings of this study reveal a significant and robust relationship between FD and municipal waste generation,

TABLE 6 | Quantile regression estimations.

Variables	(1) 10	(2) 20	(3) 30	(4) 40	(5) 50	(6) 60	(7) 70	(8) 80	(9) 90
Domestic credit to private sector by banks/GDP	0.00271***	0.00226***	0.00204***	0.00198***	0.00218***	0.00234***	0.00292***	0.00339***	0.00338***
	(0.000215)	(0.000272)	(0.000423)	(0.000383)	(0.000366)	(0.000268)	(0.000279)	(0.000273)	(0.000417)
Log (GDP)	0.432***	0.413***	0.402***	0.399***	0.421***	0.406***	0.359***	0.308***	0.275***
	(0.0266)	(0.0336)	(0.0523)	(0.0473)	(0.0452)	(0.0331)	(0.0345)	(0.0337)	(0.0516)
Log (POP)	−0.302***	−0.261***	−0.248***	−0.342***	−0.374***	−0.369***	−0.349***	−0.341***	−0.291***
	(0.0324)	(0.0410)	(0.0638)	(0.0578)	(0.0551)	(0.0404)	(0.0421)	(0.0411)	(0.0629)
Log (DMC)	−0.165***	−0.202***	−0.215***	−0.107**	−0.0792*	−0.0607*	−0.0422	−0.00130	0.00537
	(0.0270)	(0.0341)	(0.0530)	(0.0480)	(0.0459)	(0.0336)	(0.0350)	(0.0342)	(0.0523)
Constant	7.138***	7.239***	7.399***	7.749***	7.685***	7.587***	7.632***	7.641***	7.253***
	(0.151)	(0.191)	(0.298)	(0.270)	(0.257)	(0.189)	(0.196)	(0.192)	(0.294)
Observations	273	273	273	273	273	273	273	273	273

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

suggesting that access to financial capital plays a pivotal role in shaping CE outcomes. Specifically, domestic credit to the private sector—used as a proxy for FD—was consistently associated with increased levels of municipal waste per capita. This finding may initially appear counterintuitive, as FD is often considered a facilitator of green transitions. However, the positive relationship likely reflects the broader impact of credit-fueled economic activity, which tends to drive both production and consumption, and thus, waste generation (Su et al. 2013; Ha 2022).

This nuanced result aligns with previous research emphasizing that while finance can enable circular practices, its effects are contingent on the direction and purpose of credit allocation. When financial resources are not explicitly geared toward sustainability—such as investments in recycling infrastructure, eco-design, or clean technologies—they may instead support consumption patterns that increase environmental pressures (Velenturf and Purnell 2017). Therefore, FD alone is not a sufficient condition for CE advancement; it must be coupled with regulatory mechanisms that align credit flows with environmental objectives.

The study also highlights that GDP is positively associated with municipal waste across all models, reaffirming the well-established link between economic growth and environmental impact (Geissdoerfer et al. 2017). As economies grow, so does consumption, often resulting in greater waste output. This observation supports the "growth paradox" in sustainability debates, thereby asserting that higher economic performance may not always translate into improved environmental outcomes, contingent upon targeted interventions.

Interestingly, population size exhibited a negative and statistically significant relationship with municipal waste per capita in most estimations. This may suggest the presence of economies of scale in urban infrastructure, where densely populated areas can implement more efficient waste management systems. It also indicates that per capita environmental pressure may decline as populations grow, provided that systems for collection, recycling, and treatment are adequately developed (Christgen et al. 2019).

The results for DMC were mixed. In the POLS and quantile regression models, DMC was negatively associated with waste generation, while in the FE model, it became weakly positive. This inconsistency could reflect the long-term nature of material consumption trends, which may not align neatly with short-term waste output measures. It also suggests that countries with more advanced resource processing or higher reuse rates may report lower per capita waste, even with high material input levels.

The use of the IV approach, particularly the Jackknife IV Estimator (JIVE), enhances the credibility of these findings by addressing potential endogeneity in the FD–waste relationship. The slightly lower coefficients from the IV models suggest that previous estimates may have overemphasized the strength of the relationship due to simultaneity or omitted variables—such as environmental policy, institutional quality, or technological adoption—which could not be fully captured in the main specifications.

Finally, the quantile regression results offer valuable insights into distributional effects. FD had a stronger positive impact on waste generation at higher quantiles of the distribution, implying that in countries with already high waste levels, further financial expansion may exacerbate environmental pressures. This heterogeneity highlights the need for tailored policy responses that reflect the specific waste and financial profiles of different economies.

Overall, this study underscores the importance of integrating financial and environmental strategies to support the transition toward a CE. Merely expanding financial systems is insufficient; what matters most is the strategic direction of financial flows and the supportive regulatory environment that ensures investments are directed toward sustainable outcomes.

7 | Conclusion

This study makes a significant contribution to the burgeoning academic discourse exploring the economic dimensions of the CE by empirically assessing the association between FD and municipal waste generation across 28 countries. The findings suggest that higher levels of FD—measured through domestic credit to the private sector—are positively associated with municipal waste per capita. This relationship remains robust across a series of econometric techniques, including FE, IV, and quantile regression.

The consistent significance of FD indicators underscores the critical role of accessible and efficient financial systems in enabling circular practices. Access to credit may facilitate investments in recycling technologies, waste management systems, and eco-innovation, ultimately influencing the generation and treatment of waste. However, the positive association with waste per capita also suggests that FD, while necessary, may lead to increased consumption and production if not directed toward sustainable outcomes—highlighting a potential double-edged effect.

Moreover, the negative correlation between population size and waste per capita in most models suggests economies of scale and efficiency gains in densely populated areas. In contrast, the role of DMC was found to be more ambiguous and sensitive to model specifications, indicating a need for further investigation into its dynamic impact on circularity indicators.

These results have important policy implications. Governments and financial institutions must not only promote access to finance but also ensure that such resources are aligned with environmental goals. Targeted green finance instruments, environmental taxation, and regulatory incentives can help steer credit towards sustainable investments. In particular, supporting SMEs in adopting CE models could yield significant environmental benefits, as these firms often face greater financial barriers (Rizos et al. 2016; Gonçalves et al. 2022).

Future research could extend this analysis by incorporating dynamic panel models, spatial econometric techniques, or disaggregated sector-level data to better capture the heterogeneous effects of FD on various components of the CE. Additionally, incorporating institutional and policy quality indicators could provide a comprehensive understanding of the enabling environments for CE transitions. While our findings reveal an unsustainable link between FD and municipal waste generation, future research could explore whether this relationship is conditioned by the strength of environmental policies. In particular, interacting financial indicators with proxies such as the OECD Environmental Policy Stringency Index may offer insights into whether green policy frameworks can moderate the negative environmental externalities of credit expansion. This line of inquiry would help uncover the mechanisms through which finance can support—or undermine—CE objectives. Furthermore, while our model does not test for nonlinear effects, we acknowledge previous studies that identify quadratic relationships between FD and sustainability indicators (e.g., Doytch et al. 2023; Shahbaz et al. 2013; Ashraf et al. 2022). This offers a fruitful direction for future inquiry.

In sum, while FD appears to be a vital enabler of CE performance, its influence must be carefully managed and complemented with supportive policies to ensure that economic growth contributes to, rather than undermines, environmental sustainability.

Ultimately, the findings highlight the critical need for targeted green finance policies to ensure that FD supports CE objectives rather than inadvertently promoting unsustainable consumption patterns.

References

Alonso-Almeida, M. d. M., J. M. Rodriguez-Anton, L. Bagur-Femenías, and J. Perramon. 2021. "Institutional Entrepreneurship Enablers to Promote Circular Economy in the European Union: Impacts on Transition Towards A More Circular Economy." *Journal of Cleaner Production* 281: 124841. https://doi.org/10.1016/j.jclepro.2020.124841.

Arellano, M., and S. Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies* 58, no. 2: 277–297. https://doi.org/10.2307/2297968.

Ashraf, A., C. P. Nguyen, and N. Doytch. 2022. "The Impact of Financial Development on Ecological Footprints of Nations." *Journal of Environmental Management* 322: 116062.

Baltagi, B. H. 2008. *Econometric Analysis of Panel Data*. John Wiley.

Christgen, B., A. J. Lag-Brotons, and P. Purnell. 2019. "A Systematic Literature Review of the Barriers, Enablers and Interventions for Integrating Circular Economy Principles Into Construction Project Management." *Journal of Cleaner Production* 230: 1341–1353.

Circle Economy. 2023. "The Circularity Gap Report 2023: Closing the Circularity Gap for a Sustainable Future." https://www.circularity-gap.world/2023.

Coppola, C., A. Vollero, and A. Siano. 2023. "Developing Dynamic Capabilities for the Circular Economy in the Textile and Clothing Industry in Italy: A Natural-Resource-Based View." *Business Strategy and the Environment* 32, no. 7: 4798–4820. https://doi.org/10.1002/bse.3394.

Corvellec, H., A. F. Stowell, and N. Johansson. 2022. "Critiques of the Circular Economy." *Journal of Industrial Ecology* 26, no. 2: 421–432. https://doi.org/10.1111/jiec.13187.

Cramer, J. 2022. "Effective Governance of Circular Economies: An International Comparison." *Journal of Cleaner Production* 343: 130874. https://doi.org/10.1016/j.jclepro.2022.130874.

de Jesus, A., P. Antunes, R. Santos, and S. Mendonça. 2019. "Eco-Innovation Pathways to a Circular Economy: Envisioning Priorities Through a Delphi Approach." *Journal of Cleaner Production* 228: 1494–1513. https://doi.org/10.1016/j.jclepro.2019.04.049.

Di Maio, F., P. C. Rem, K. Baldé, and M. Polder. 2017. "Measuring Resource Efficiency and Circular Economy: A Market Value Approach." *Resources, Conservation and Recycling* 122: 163–171. https://doi.org/10.1016/j.resconrec.2017.02.009.

DiMaggio, P. J., and W. W. Powell. 1983. "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields." *American Sociological Review* 48, no. 2: 147–160. https://doi.org/10.2307/2095101.

Doytch, N., M. Elheddad, and S. Hammoudeh. 2023. "The Financial Kuznets Curve of Energy Consumption: Global Evidence." *Energy Policy* 177: 113498.

Esposito, B., D. Sica, S. Supino, and O. Malandrino. 2024. "Measuring the Impact of Circular Economy Performance on Financial Performance: The Moderating Role of Stakeholder Engagement." *Business Strategy and the Environment* 33, no. 6: 5109–5126. https://doi.org/10.1002/bse.3744.

European Commission. 2015. "Closing the Loop—An EU Action Plan for the Circular Economy." Brussels.

European Commission. 2020. *A New Circular Economy Action Plan: For a Cleaner and More Competitive Europe. Com(2020) 98 Final*. European Commission.

Geissdoerfer, M., P. Savaget, N. M. P. Bocken, and E. J. Hultink. 2017. "The Circular Economy—A New Sustainability Paradigm?" *Journal of Cleaner Production* 143: 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048.

Gonçalves, B. d. S. M., F. L. de Carvalho, and P. d. C. Fiorini. 2022. "Circular Economy and Financial Aspects: A Systematic Review of the Literature." *Sustainability* 14, no. 5: 3023. https://doi.org/10.3390/su14053023.

Ha, H. 2022. "Financial Development and Circular Economy: Evidence From Panel Data." *Ecological Economics* 192: 107265.

Hartley, K., R. van Santen, and J. Kirchherr. 2020. "Policies for Transitioning Towards a Circular Economy: Expectations From the European Union (EU)." *Resources, Conservation and Recycling* 155: 104634.

Henry, M., D. Schraven, N. Bocken, K. Frenken, M. Hekkert, and J. Kirchherr. 2021. "The Battle of the Buzzwords: A Comparative Review of the Circular Economy and the Sharing Economy Concepts." *Environmental Innovation and Societal Transitions* 38: 1–21. https://doi.org/10.1016/j.eist.2020.10.008.

Kirchherr, J., D. Reike, and M. Hekkert. 2017. "Conceptualizing the Circular Economy: An Analysis of 114 Definitions." *Resources, Conservation and Recycling* 127: 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005.

Koenker, R., and G. Bassett jr. 1978. "Regression Quantiles." *Econometrica* 46, no. 1: 33–50.

Kovacic, Z., R. Strand, and T. Völker. 2020. *The Circular Economy in Europe: Critical Perspectives on Policies and Imaginaries*. 1st ed. Routledge. https://doi.org/10.4324/9780429061028.

Lazarevic, D., and H. Valve. 2017. "Narrating Expectations for the Circular Economy: Towards a Common and Contested European Transition." *Energy Research & Social Science* 31: 60–69. https://doi.org/10.1016/j.erss.2017.05.006.

Levine, R. 2005. "Finance and Growth: Theory and Evidence." In *Handbook of Economic Growth*, edited by P. Aghion and S. N. Durlauf, Vol. 1, Part A, 865–934. Elsevier. https://doi.org/10.1016/S1574-0684(05)01012-9.

MacArthur, E. 2015. *Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition*. Ellen MacArthur Foundation.

Machado, J. A. F., and J. M. C. Santos Silva. 2019. "Quantiles via Moments." *Journal of Econometrics* 213, no. 1: 145–173. https://doi.org/10.1016/j.jeconom.2019.04.009.

Merli, R., M. Preziosi, and A. Acampora. 2018. "How Do Scholars Approach the Circular Economy? A Systematic Literature Review." *Journal of Cleaner Production* 178: 703–722. https://doi.org/10.1016/j.jclepro.2017.12.112.

Nygaard, A. 2022. "From Linear to Circular Economy: A Transaction Cost Approach to the Ecological Transformation of the Firm." *Circular Economy and Sustainability* 2, no. 3: 1127–1142. https://doi.org/10.1007/s43615-022-00158-w.

Pearce, D. W., and R. K. Turner. 1989. *Economics of Natural Resources and the Environment*. Johns Hopkins University Press.

Pratt, K., M. Lenaghan, and E. Mitchard. 2016a. "Financing the Circular Economy. WRAP Report."

Pratt, K., M. Lenaghan, and E. T. A. Mitchard. 2016b. "Material Flows Accounting for Scotland Shows the Merits of a Circular Economy and the Folly of Territorial Carbon Reporting." *Carbon Balance and Management* 11, no. 1: 21. https://doi.org/10.1186/s13021-016-0063-8.

Rizos, V., A. Behrens, W. Van der Gaast, et al. 2016. "Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers." *Sustainability* 8, no. 11: 1212. https://doi.org/10.3390/su8111212.

Robaina, M., J. Villar, and E. T. Pereira. 2020. "The Determinants for a Circular Economy in Europe." *Environmental Science and Pollution Research International* 27, no. 11: 12566–12578. https://doi.org/10.1007/s11356-020-07847-9.

Scott, W. R., M. A. Hitt, and K. G. Smith. 2005. "Institutional Theory Contributing to a Theoretical Research Program." In *Great Minds in Management*. Oxford University Press. https://doi.org/10.1093/oso/9780199276813.003.0022.

Shahbaz, M., S. A. Solarin, H. Mahmood, and M. Arouri. 2013. "Does Financial Development Reduce CO_2 Emissions in Malaysian Economy? A Time Series Analysis." *Economic Modelling* 35: 145–152.

Stahel, W. R. 2019. *The Circular Economy: A User's Guide*. Routledge.

Su, B., A. Heshmati, Y. Geng, and X. Yu. 2013. "A Review of the Circular Economy in China: Moving From Rhetoric to Implementation." *Journal of Cleaner Production* 42: 215–227. https://doi.org/10.1016/j.jclepro.2012.11.020.

Svensson, N., and E. K. Funck. 2019. "Management Control in Circular Economy. Exploring and Theorizing the Adaptation of Management Control to Circular Business Models." *Journal of Cleaner Production* 233: 390–398. https://doi.org/10.1016/j.jclepro.2019.06.089.

Tapaninaho, R., and A. Heikkinen. 2022. "Value Creation in Circular Economy Business for Sustainability: A Stakeholder Relationship Perspective." *Business Strategy and the Environment* 31, no. 6: 2728–2740. https://doi.org/10.1002/bse.3002.

Turkulainen, V., K. Kauppi, and E. Nermes. 2017. "Institutional Explanations: Missing Link in Operations Management? Insights on Supplier Integration." *International Journal of Operations & Production Management* 37, no. 8: 1117–1140. https://doi.org/10.1108/IJOPM-10-2015-0608.

UNEP FI. 2022. "Financing Circularity: Demystifying Finance for the Circular Economy." United Nations Environment Programme – Finance Initiative. https://www.unepfi.org.

Velenturf, A., and P. Purnell. 2017. "Resource Recovery From Waste: Restoring the Balance Between Resource Scarcity and Waste Overload." *Sustainability* 9, no. 9: 1603. https://doi.org/10.3390/su9091603.

Velis, C. 2018. "No Circular Economy if Current Systemic Failures Are Not Addressed." *Waste Management & Research* 36, no. 9: 757–759. https://doi.org/10.1177/0734242X18799579.

Wooldridge, J. M. 2010. *Econometric Analysis of Cross Section and Panel Data*. MIT Press.

World Bank. 2022. *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. World Bank.

World Bank. 2023. *Financing Climate Action: The Investment Challenge*. World Bank.