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The Impact of Environmental Performance on profitability

Evidence of European Construction Companies, from 2018 to 2024

Using generalized Method of Moment

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Abstract :
This study aims to evaluate the dynamic impact of environmental variables on profitability in eight European companies in the construction sector, over the period 2018–2024. A one-step difference Generalized Method of Moments (GMM) model with lagged effects is employed to capture both immediate and delayed impacts. The results show that emission intensity negatively affects net profit at lag 1 and becomes positive at lag 2. The impact of total intensity isimmediate and negative on operating margin but insignificant on net profit. Diverted waste reveals a delayed positive impact on both net profit and operating margin. Renewable energy has an immediate negative impact on operating margin, while its impact on net profit is delayed and initially negative. These findings confirm that the relationship between environmental variables and profitability in the European construction sector is dynamic over time; suggesting that AI represents the ultimate technological catalyst required to resolve temporal lags and translate immediate environmental costs into sustainable financial returns .

Keywords: Environmental Performance; net profit; operating margin; Construction; GMM

Jel Classification Codes :Q50 ; C32; C33;L74

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1. Introduction.

The relationship between humans and their natural and social surroundings is inherently interactive, as environmental quality influences individual behavior, values, and responsibility towards their resources. Individuals living in a clean, healthy, and organized environment, are more inclined to respect laws and contribute to sustainable development. Environmental preservation reflects a broader cultural and social responsibility that societies promote through education and awareness programs. In this context, the topic of environmental protection and the management of its natural resources including water, energy resources, agricultural land, and biodiversity is one of the most prominent challenges faced by countries in the twenty-first century, especially with the rising of pollution and climate change, along with increasing industrial and construction waste.

The construction sector is a major contributor to global carbon emissions, accounting for approximately 39% of worldwide energy-related CO_2 emissions. In response to this challenge, European construction companies have intensified their efforts to achieve carbon neutrality and zero-waste objectives by 2035 and 2040. These efforts primarily rely on the adoption of renewable energy technologies, improved waste management practices, recycling strategies, and enhanced resource efficiency within a circular economy framework. Environmental sustainability has thus become a fundamental organizational requirement driven by regulatory pressures and stakeholder expectations. Moreover, sustainable environmental practices contribute to strengthening corporate reputation, improving investor confidence, and enhancing competitive advantage. Such practices also support cost reduction associated with environmental fees and taxes.

Research Problem:

- **how do environmental performance variables impact profitability of European companies in construction sector *?***

Hypothesis:

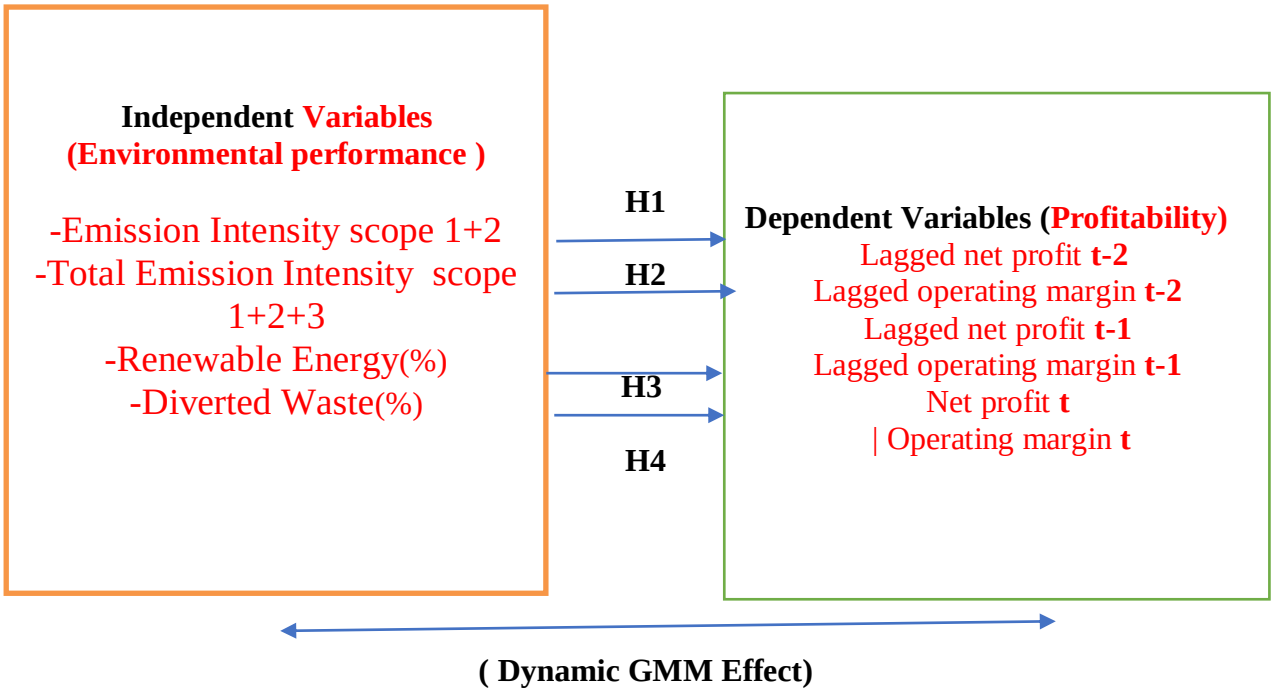
H1: Emission intensity has a statistically significant impact on profitability (operating margin and net profit) in the European construction sector.

H2: Total emission intensity has a statistically significant impact on profitability (operating margin and net profit) in the European construction sector.

H3: Renewable energy consumption has a statistically significant impact on profitability (operating margin and net profit) in the European construction sector.

H4: Diverted waste has a statistically significant impact on profitability (operating margin and net profit) in the European construction sector.

figure 1. Conceptual model of the relationships between environmental variables and profitability in in the European construction sector



***Source**: Prepared by the Author*

The importance of the study:

The subject is viewed as a contemporary issue aligned with the shift towards a circular economy, which is one of the sustainable development goals. The construction sector is considered one of the vital sectors that generate waste and carbon emission, especially due to urban growth and population increase. Research efforts and scientific studies examining the relationship between environmental performance and profitability remain limited; in particular, those highlighting the specific characteristics of the construction sector.

Research objectives :

1. Giving comprehensive understanding of the European construction sector and its specifications.
2. Emphasizing the importance of environmental performance to enhance profitability and achieve competitive advantage.
3. Studying the relationship between intensity emissions and profitability.
4. Assessing the economic impact of waste management strategies on profitability.
5. Assessing the economic impact of renewable energies strategies on profitability
6. Proposing suggestions to improve environmental performance and enhancing profitability.

2. Methods and Materials:

To address the problem raised, this study utilized two methods. The first is the descriptive method, which presents the facts and provides a clear picture about the subject through an analysis of previous studies. The second method is analytical, aimed at diagnosing and analyzing financial reports and statistical tables related to European construction companies using difference GMM,Generalized Method of Moments (Arellano & Bond, 1991) with panel data. The model employ one-step difference with lags to capture bothimmediate and delayed (lagged**)**effect .The model uses the second lag of the dependent variable (DNETPROFIT_{t-2}) as an instrument and analyzing data with EVIEWS program. The statistical significance level of the study is 05%.

3- Literature Review:

Carbon emissions are the primary cause of global warming and climate change. It results from various sources such as fossil fuel combustion, industrial processes, deforestation, and agriculture. As a key sustainability indicator, emissions are calculated via Scope 1, Scope 2, and Scope 3 by organizations and governments. Several countries plan to achive zero carbon in the next years.

Nadzirah Zainordin (Zainordin, 2020, p. 117) distinguishes two main types of Carbon Emission in the construction sector. Direct carbon emissions are those related directly and generated from on-site construction operations like construction, maintenance or demolition, indirect carbon emissions are emissions resulting from the supply of construction operations with products and services this include upstream activities like manufacture of bricks and cement.

Despite the growing policy relevance of greenhouse gas emissions, only a limited number of empirical studies have examined emissions as a key indicator of the green economy, particularly with regard to their economic impacts and mitigation strategies in the industrial and construction sectors. Iqbal et al. (2025) show that supply chain optimization, adaptive reuse of materials, and bio-based materials are among the most influential circular economy practices for reducing the the industry's carbon footprint.(Iqbal, 2025, p. 01)

Other empirical studies have analyzed the relation between emissions and profitability across different ratio ; Ki-Hoon Lee 2015 (Ki-Hoon Lee, 2015, pp. 1-11) , José L. Gallizo-Larraz (Gallizo-Larraz, 2024, p. 319), report a significant negative association between greenhouse gas emissions and firm performance indicators such as return on assets (ROA), indicating that higher emission levels are linked to lower financial performance .

Marcel Oestreich and Ilias Tsiakas (Tsiakas, 2024, p. 766) identify that there is a negative relation between carbon emissions and profitability due to the direct costs of high carbon emissions which include the costs of allocating resources for measuring, disclosing and reducing carbon emissions .The indirect costs are related to uncertainty about future environmental regulations, technological obsolescence leading to higher clean-up costs , research and development costs, potential litigation risk related to environmental issues, and higher reputational risk relating to environment .

Fortune Ganda and Khazamula Samson Milondzo (F Ganda, 2018, p. 20)report a negative relationship between carbon emissions and firm financial performance within the South African corporate setting.

Eva Horváthová (Horváthová, 2012,p.91) examines the intertemporal effect of environmental performance on financial performance the results suggest that while the effect of environmental

performance on financial performance is negative for environmental performance lagged by 1 year lag, it becomes positive for 2 years lag. As a consequence, Porter hypothesis holds in the long-run.

More recently, Zhehao Huang and all 2025 (Zhao, 2025, p. 1) demonstrate that, in the short run, carbon emissions reduction leads to a crowding-out effect (negative impact) on corporate profit; while in the long run, this effect shifts to a feed-backing loop (positive impact).

The circular economy and sustainability are also connected to the waste hierarchy which describes how waste should be prioritized. In a perfect circular economy, no waste exists, but instead is defined as usable material banks (SVENSSON, 2023,p16)

In the European Union, construction and demolition waste accounted for 38.4% of the total waste generated in 2022, representing the largest waste stream across economic sectors. At the national level, construction waste represented 70% of total waste generation in France, 77% in Austria, 64% in the Netherlands, 42% in Italy, and 33% in Spain(EUROSTAT, 2024, p. 3)

According to the definitions of the European Environment Agency and Directive 2008/98/EC, waste is defined as any substance or object that the holder disposes of, waste produced by construction Group includes inert materials, non-hazardous waste and hazardous waste, (vinci, 2024,p .276)

Hazardous waste originates from industrial processes, oil residues, contaminated soils, and medical activities. It exists in solid, semi-liquid, or liquid forms and contains high pollutant concentrations requiring specialized treatment processes that are not compatible with conventional municipal waste-to-energy facilities. (Vinci,2024, p277)Non-hazardous waste refers to waste that does not present toxic or dangerous characteristics that pose immediate risks to human health.

Construction waste can be also classified in to inert and non-inert waste, inert waste which consists of construction materials, stone fragments, soil, asphalt, and concrete, which can be used to adjust the constructarea; and non-inert construction waste, which accounted for 20% of all construction waste, and consists of bamboo, wood, plants, packaging, and other organic material (Chakkrit Luangcharoenrat, 2019, p. 3)

According to the Waste Framework Directive (2008/98/EC) by the European environment agency management construction waste follows hierarchical five stages in order to achieve economic and environment benefits ;(European Commission, 2021, p. 12) prevention , reuse ,recycling, other recovery and disposal to the landfill . This hierarchy is commonly referred to in the literature as the “3R” principle—Reduce, Reuse, and Recycle. Waste process prioritizes reducing waste use (if possible), sorting waste according to waste characteristics, reusing waste that is still feasible, and recycling waste so that it can have economic value (Mahartin, 2023, p. 3). Material recovery strategies contribute significantly to reducing pressure on natural resources. In particular, reuse avoids the need for energy-intensive recycling processes and limits additional resource consumption, there by improving the environmental performance of the construction sector. (eiffage,2024,p112)

Francisco Porles-Ochoa (Porles-Ochoa, 2024, p. 8) examines the impact of the corporate carbon footprint that had a very significant impact on corporate profits, The study also analyzes the role of clean energy and eco-innovation, particularly renewable energy , the results show that the changeover to renewable energy is a gradual process that requires considerable capital investment thus limited the effect of emissions reduction and decrease profitability . Hyunju Shin and all 2016 (Shin, 2016, p. 1123)report consistent positive associations between Renewable energy and financial performance across operating margin ROA and Tobin’s Q . However this study used a single output metric as an indicator for this construct. Which is renewable energy In contrast, the

present study extends the analysis by incorporating an additional environmental variable, diverted waste .

Daan Hulshof and Machiel mulder 2020 (Hulshof, 2020,p.1) find that renewable energy use has no effect on profit**,** in 2024 Hendrik Sitompul and all published interesting study (Sitompul, 2024,p.13) basing on27 selected articles and PRISMA models and found mixed results between no significant effect and positive and significant effects .

The majority of previous studies have examined the relationship between environmental variables and financial performance using multiple profitability indicators, such as ROA, EBITDA, operating margin, EBITDA margin, revenue growth, and net income. In contrast, the present study focuses specifically on two key indicators: net profit and operating margin. .

Many factors influence the impact of environmental performance on the profitability, such as the nature of the sector and the size of the company; therefore, our study focuses on one sector and companies that are similar in terms of sizeand in the same region.

4– study case

For this study, we selected eight major diversified European groups companies whose core business is construction; FERROVIAL ,VINCI, HOCHTIEF , SKANSKA, BELFOR BEATTY, EIFFAGE , WEBUILD, PORR AG,

This companies publicly disclose both financial indicators and environmental performance metrics. data used were obtained from the sustainability reports and annuals reports on its website. These firms provide a robust and diverse sample for analyzing the relationship between environmental and economic performance in the construction sector. Our econometric analyses uses a panel dataset from 2018 to 2024 to evaluate the statistical relationship between selected environmental indicators (emissions intensity, renewable energy use and diverted waste) with financial metrics (operating margin, net income) across these firms.

Dependent variables

- Net profit in m euro
- Operating margin % = operating profit / revenue

Independent variables

- Waste diverted share (%)Waste diversion including recovery, reuse, and recycling
- Emission Intensity **emissions co2** (scopes 1 and 2) per unit of revenueandcalculated by the formula (tons CO_2e / revenue million euro) total emission intensity (scopes 1 and 2 and scope 3)
- Renewable Energy Share (%) : Renewable Energy/ Total Energy consumation MWh

4 -1 Presentation of measurement variables

The table 1 present the descriptive statistics for the dependent and independent variables.

Table 1. descriptive statistics of variables

Million EURO and %

	RENEWABLE	WA	INTENSITY	INTENSITYTOT	NET_PROFIT	OPERATIN...
Mean	7.850232	75.98036	37.88648	347.5900	781.6336	5.052679
Median	4.640000	77.00000	33.31000	274.1950	401.0000	4.050000
Maximum	42.00000	98.15000	158.0000	1657.500	5274.000	12.26000
Minimum	0.010000	20.00000	9.000000	30.80000	-448.0000	-2.370000
Std. Dev.	9.361880	18.78053	29.41945	314.1601	1259.060	4.018932
Skewness	1.996751	-1.099779	2.204700	1.770706	2.270080	0.386782
Kurtosis	6.799895	4.103676	8.779296	6.994942	7.512486	1.898925
Jarque-Bera	70.90360	14.13104	123.3005	66.50271	95.60969	4.225124
Probability	0.000000	0.000854	0.000000	0.000000	0.000000	0.120928
Sum	439.6130	4254.900	2121.643	19465.04	43771.48	282.9500
Sum Sq. Dev.	4820.464	19398.96	47602.73	5428310.	87187808	888.3497
Observations	56	56	56	56	56	56

Source :EViews

Profitability: the mean of net profit for all the firms studied is 832 with maximum of 5274 and minimum of -424 , the operating MARGIN is in average equals 4,9 %, with a minimum of -2,3%and a maximum value of 12,26%

Waste Diverted Rate (%) recovered, reused and recycled:

The construction activity generate a large amount of waste. The most relevant waste streams come from construction and demolition activities: which is mainly composed of: Stone (concrete, asphalt and a mix of bituminous ; (Ferrovial, 2024, p. 74).

Hazardous construction waste includes paints and solvents, contaminated oil and oil filters, polluted soil or water, batteries, electrical and electronic equipment, as well as sprays and aerosols. In contrast, non-hazardous waste includes materials such as wood, sand, plastics, cardboard, metals, ceramics, packaging, paper, glass, and vegetal waste.

Waste diversion practices, including reuse and recycling, have a positive impact on biodiversity, as they reduce environmental pollution and minimize the need for primary raw materials, thereby lowering pressure on ecosystems(PORR GROUP ,2024, p98-99)For example, at Balfour Beatty, 96% of the Group's waste was diverted from landfill in 2021 (Beatty, 2022, p. 18).

Renewable energy share:

The renewable energy share represents the proportion of renewable energy in total energy consumption. This ratio shows a year-to-year increase for all sampled companies, indicating a growing commitment to sustainability. Renewable electricity constitutes the main source of renewable energy, while the use of renewable gas and fuel remains limited. This explains the relatively low overall renewable energy share observed across firms.

The mean value of the renewable energy share is approximately 8.44%, with a minimum of 0.033% and a maximum of 42%. Skanska, the Swedish company, records the highest share of renewable energy consumption within the sample.

Renewable energy indicators show strong country-specific characteristics. Sweden is among the countries with the highest share of renewable energy in both Europe and the world. In 2024, the share of renewable energy in Sweden reached 50.9%. Skanska, the Swedish construction company, records the highest share of renewable energy consumption within the sample. In 2022, 93% of the electricity consumed by the company came from renewable sources, including biofuels, biomass, biogas, solar, and wind energy. This share increased from 87% in the previous year. (skanska, 2022, p. 171)

Balfour Beatty has made substantial investments in the integration of renewable energy sources, particularly wind and solar power, alongside initiatives to enhance energy efficiency. The company estimates that approximately £60 billion in network infrastructure investment will be required by 2030. Its sustainability strategy targets a significant reduction in carbon emissions by 2030, including Scope 3 emissions, and sets an ambitious objective of going beyond net zero by 2040. (BALFOUR, 2024, pp. 12-24).

year	Green Tariff MWh	Solar	Hydrogen	Total Electricity	Renewable electricity Share (%)	total Energy	Renewable energy Share (%)
2020	12,536	27	–	47,821	26.3%	498,268	2.52%
2021	15,812	49	–	64,707	24.5%	558,703	2.84%
2022	16,096	161	413	63,093	26.4%	610,015	2.73%
2023	26,627	7	109	61,620	43.4%	624,367	4.28%
2024	34,474	231	138	70,000	50%	628,374	5,6%

Table n 02. Balfour Beatty's renewable Energy

Source: *Balfour Beatty's annual reports 2020 -2021- 2022- 2023- 2024*

For Balfour Beatty, renewable energy consumption is derived exclusively from renewable electricity. In 2024, the company's renewable electricity consumption consisted of 34,474 MWh sourced from green tariff electricity, 231 MWh generated from on-site solar renewable systems, and 138 MWh generated from green hydrogen. The company's total energy consumption for the same year amounted to 628,374 MWh.

Although renewable energy use has increased from year to year, this growth is driven mainly by the purchase of green electricity, while direct investment in renewable energy generation (such as solar and hydrogen) remains very limited.

Intensity emission: During 2018 Skanska started to report scope 3 data. Scopes are devised in three categories: (Francisco Porles-Ochoa, 2023, pp. 14-16)

Scope 1: direct emission gazoline emissions from sources owned or controlled by the company

Scope 2: indirect emission from electricity consumed by the company

Scope 3 represent theindirect GHG emissions, from the upstream and downstream supply chain, which are mainly related to the use of goods and services sold and waste landfilled .

This share is ranges between 80 % and 09 % and is decreasingslowly from year to year. The compagnies aims to reduce the emissions scope and achieve climate neutrality "net zero" by 2045 and Net zero Scope 1, 2 and 3 carbon emissions by 2050. Hochtief aim to be climate-neutral by as soon as 2038 and accordingly have specified short-term reduction scope 1 and 2 targets through 2025. (HOCHTIEF, 2022, pp. 48-54)

A noticeable decline in emissions occurred around 2019 and 2020 due to reduced activity during the COVID-19 pandemic, followed by a resumption of emissions levels in 2021.

4.2 Model estimation, panel data from 2018 to 2024

Stationary test is necessary to validate the model the table 3 shows four different panel unit root tests Levin, Lin, Chu, Person and Shin, Fisher ADF, Fisher PP

•**p-value < 0.05**, we reject the null hypothesis of a unit root and the variable is **stationary**.

•**p-value > 0.05**, we accept the null hypothesis of a unit root , suggesting the variable is **non-stationary**.

Table 3. stationary test

Variable	Levin, Lin, Chu	Person and Shin	Fisher ADF	Fisher PP	Result
Net profit	0,0000	0,0003	0,01	0,0003	I(0)
Operating margin	0,0000	0,000	0,0006	0,0002	I(0)
Intensity	0,000	0,5	0,7	0,1	I(1)
Waste divided	0,000	0,0064	0,05	0,04	I(0)
Renewable energy	0,05	0,88	0,9	0,9	I(1)

Source: Author calculations under Eviews

Dependents variables are stationery in level I**(0)** all tests are**< 0.05** for the net profit and the operating margin ,the independents variables intensity and renewable energy are not stationary in level but became stationary in the first difference **I(1)**, to test cointegration and the long term relation with FMLOS the panel variables need to be non-stationary at level and stationary after first differencing so we cannot used this model . Differenced GMM Generalized Method of Moments Arellano-Bond is the suitable method to overcome the problems dynamic panel bias and potential endogeneity of Variables (Istemi Berk, 2020, p. 4)GMM estimator consider only short-run dynamics because it is mostly used to short time-series in which the stationarity of the variables is less important (Modibbo, 2020, p. 7)

In our model we use the second lag of the dependent variable (DNETPROFIT_{t-2}) as an instrument,

- **In the short term effect (immediate)**

$$\Delta NETPROFIT_{it} = \alpha \Delta NETPROFIT_{it-1} + \beta 1 \Delta INTENSITY_{it} + \beta 2 \Delta WASTE_{it} + \beta 3 \Delta RENEWABLE_{it} + \varepsilon_{it}$$

- **In the delayed (lagged) short-term effect**

$$DNETPROFIT_t = \alpha 1 DNETPROFIT_{t-1} + \beta 0 DINTENSITY_{t-1} + \beta 1 DINTENSITY_{t-2} + \gamma 0 DWASTE_{t-1} + \gamma 1 DWASTE_{t-2} + \ldots\ldots + \epsilon_t$$

All variables are in **first differences**, and independent variables are lagged lag1 and lag2

The results of our estimate are illustrated in the following tables;

- ✓ **GMM(differenced, one-step) Immediate term**

Dependent Variable: DNETPROFIT
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 21:00
Sample (adjusted): 2021 2024
Periods included: 4
Cross-sections included: 8
Total panel (balanced) observations: 32
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DNETPROFIT,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNETPROFIT(-1)	-0.603824	0.136320	-4.429474	0.0030
D0INTENSITYTOT	-0.179660	1.993777	-0.090111	0.9307
D0WASTE	-32.54277	17.75268	-1.833119	0.1094
D0RENEWABLE	66.43612	72.18805	0.920320	0.3880

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	178.4816	S.D. dependent var	1111.408
S.E. of regression	1242.331	Sum squared resid	43214827
J-statistic	3.527930	Instrument rank	8
Prob(J-statistic)	0.473644		

Dependent Variable: DNETPROFIT
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 21:03
Sample (adjusted): 2021 2024
Periods included: 4
Cross-sections included: 8
Total panel (balanced) observations: 32
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DNETPROFIT,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNETPROFIT(-1)	-1.023188	0.322028	-3.177324	0.0155
D0WASTE	-94.96970	39.47152	-2.406031	0.0470
D0RENEWABLE	136.8483	64.54119	2.120324	0.0717
D0INTENSITY	125.8508	58.51015	2.150922	0.0685

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	178.4816	S.D. dependent var	1111.408
S.E. of regression	2452.573	Sum squared resid	1.68E+08
J-statistic	3.287420	Instrument rank	8
Prob(J-statistic)	0.510928		

Dependent Variable: DOPERATINGMARGIN
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 21:27
Sample (adjusted): 2021 2024
Periods included: 4
Cross-sections included: 8
Total panel (balanced) observations: 32
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DOPERATINGMARGIN,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOPERATINGMARGIN(-1)	-0.131461	0.106943	-1.229268	0.2587
D0INTENSITY	0.138328	0.050232	2.753750	0.0284
D0WASTE	0.055513	0.032954	1.684584	0.1359
D0RENEWABLE	-0.445405	0.089861	-4.956621	0.0016

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	0.576875	S.D. dependent var	3.839727
S.E. of regression	3.967902	Sum squared resid	440.8389
J-statistic	6.283763	Instrument rank	8
Prob(J-statistic)	0.178935		

Dependent Variable: DOPERATINGMARGIN
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 21:29
Sample (adjusted): 2021 2024
Periods included: 4
Cross-sections included: 8
Total panel (balanced) observations: 32
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DOPERATINGMARGIN,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOPERATINGMARGIN(-1)	-0.193813	0.140716	-1.377334	0.2108
D0INTENSITYTOT	-0.011270	0.001953	-5.771664	0.0007
D0WASTE	-0.001856	0.032064	-0.057896	0.9554
D0RENEWABLE	-0.453783	0.095496	-4.751856	0.0021

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	0.576875	S.D. dependent var	3.839727
S.E. of regression	5.595550	Sum squared resid	876.6849
J-statistic	1.946788	Instrument rank	8
Prob(J-statistic)	0.745546		

In the immediate term, for the first dependent variable (net profit), waste diversion shows a weak and negative effect, while renewable energy, emissions intensity, and total emissions intensity are not statistically significant. In other words, the explanatory variables—total intensity and renewable energy—do not have a significant impact on net profit in the short run.

For the operating margin variable , emissions intensity has a positive and statistically significant effect, whereas both total emissions intensity and renewable energy exert significant negative effects on the margin. Specifically, a one-unit increase in emissions intensity is associated with a 0.1383 increase in the operating margin in the same period.

In the short term the effect of intensity and total intensity is opposite intensity has a positive effect while total intensity has negative effect on both net profit and operating margin. Waste diversion has no immediate impact.
Since the impact of sustainability variables may not be immediate, and takes time to materialize, therefore the short term analysis should include lagged variables to capture delayed effects .

- GMM **delayed (lagged) short-term**

Net profit Delayed effect over a period (1 YEAR)

Dependent Variable: DNETPROFIT
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 17:49
Sample (adjusted): 2021 2024
Periods included: 4
Cross-sections included: 8
Total panel (balanced) observations: 32
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DNETPROFIT,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNETPROFIT(-1)	-0.850085	0.162408	-5.234266	0.0012
DRENEWABLE	339.5449	222.7909	1.524052	0.1713
DWASTE	92.93380	14.16451	6.561034	0.0003
DINTENSITY	-93.09289	21.62655	-4.304565	0.0035

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	178.4816	S.D. dependent var	1111.408
S.E. of regression	2826.016	Sum squared resid	2.24E+08
J-statistic	3.392548	Instrument rank	8
Prob(J-statistic)	0.494404		

Dependent Variable: DNETPROFIT
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 17:55
Sample (adjusted): 2021 2024
Periods included: 4
Cross-sections included: 8
Total panel (balanced) observations: 32
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DNETPROFIT,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNETPROFIT(-1)	-0.571227	0.055255	-10.33792	0.0000
DINTENSITYTOT	-0.455241	3.263462	-0.139496	0.8930
DRENEWABLE	89.83165	141.7953	0.633531	0.5465
DWASTE	60.47926	13.94294	4.337627	0.0034

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	178.4816	S.D. dependent var	1111.408
S.E. of regression	1749.791	Sum squared resid	85729539
J-statistic	6.207698	Instrument rank	8
Prob(J-statistic)	0.184165		

Source: Author calculations under Eviews

In the first difference and delayed effect of 1 year, intensity became significant and strong negative on net profit. The value of the intensity coefficient shows a value of -93 explaining that if the intensity increases by 1%, then the net profit decreases by 93 %.

Waste diversified variables is statistically significant, meaning it impact positively and measurably the net profit in the model used

Waste recycling helps mitigate the short-term losses caused by emissions intensity, as reflected by the nearly symmetric coefficients of +0.92 for waste diversion and −0.93 for emissions intensity. This suggests that the negative impact of emissions on profitability becomes less severe in the presence of effective recycling practices.

The Renewable Energy variable is not statistically significant, indicating that it does not have a measurable or reliable impact on net profit in the model used . In contrast the lagged value of net profit has a negative and significant influence on current net profit.

Net profit Delayed effect over a period (2YEARS)

Dependent Variable: DNETPROFIT
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 17:59
Sample (adjusted): 2022 2024
Periods included: 3
Cross-sections included: 8
Total panel (balanced) observations: 24
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DNETPROFIT,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNETPROFIT(-1)	-0.104093	0.101997	-1.020548	0.3414
D2INTENSITY	51.31661	9.561683	5.366902	0.0010
D2WASTE	-7.517795	12.01745	-0.625573	0.5514
D2RENEWABLE	-265.7061	111.9322	-2.373814	0.0493

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	6.295833	S.D. dependent var	870.1436
S.E. of regression	1364.066	Sum squared resid	37213542
J-statistic	2.547243	Instrument rank	8
Prob(J-statistic)	0.636197		

Dependent Variable: DNETPROFIT
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 18:04
Sample (adjusted): 2022 2024
Periods included: 3
Cross-sections included: 8
Total panel (balanced) observations: 24
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DNETPROFIT,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNETPROFIT(-1)	-0.252568	0.076348	-3.308095	0.0130
D2INTENSITYTOT	-0.298882	0.405989	-0.736183	0.4856
D2WASTE	-13.44583	6.864949	-1.958620	0.0910
D2RENEWABLE	-232.3246	132.7309	-1.750343	0.1235

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	6.295833	S.D. dependent var	870.1436
S.E. of regression	1337.218	Sum squared resid	35763040
J-statistic	3.856695	Instrument rank	8
Prob(J-statistic)	0.425747		

Total intensity remain negative and non-significant contrary to intensity which is significant and became positive at lag2 , the impact of diverted waste is significant and negative , renewable energy is not significant in the first model but has a delayed initially negative effect on profit in the second one .

Table 04. Hansen test and Arellano Bond serial correlation test AR1 AR2 for net profit variable

J statistic	3,39	6,20	2,54	3,85
probability	0,49	0,18	0,63	0,42
Pro AR1	0,048	0,11	0,069	0,9
Pro AR2	0,5	0,9	0,47	0,5

Source: Author calculations under Eviews

Since the Probability of j statics is significant >0,05 and AR 2>0,05 for all the models the instrument are reliable and the model is valid.

Operating margin Delayed effect over a period (1 YEAR)

Dependent Variable: DOPERATINGMARGIN
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 18:07
Sample (adjusted): 2021 2024
Periods included: 4
Cross-sections included: 8
Total panel (balanced) observations: 32
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DOPERATINGMARGIN,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOPERATINGMARGIN(-1)	-0.183707	0.156045	-1.177269	0.2776
DWASTE	0.077608	0.021395	3.627422	0.0084
DINTENSITY	-0.143086	0.069906	-2.046826	0.0799
DRENEWABLE	0.276259	0.084721	3.260817	0.0138

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	0.576875	S.D. dependent var	3.839727
S.E. of regression	3.711276	Sum squared resid	385.6599
J-statistic	3.455283	Instrument rank	8
Prob(J-statistic)	0.484710		

Dependent Variable: DOPERATINGMARGIN
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 18:11
Sample (adjusted): 2021 2024
Periods included: 4
Cross-sections included: 8
Total panel (balanced) observations: 32
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DOPERATINGMARGIN,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOPERATINGMARGIN(-1)	-0.432646	0.129586	-3.338672	0.0124
DINTENSITYTOT	7.56E-06	0.002498	0.003028	0.9977
DWASTE	0.132727	0.028471	4.661896	0.0023
DRENEWABLE	0.199398	0.039622	5.032508	0.0015

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	0.576875	S.D. dependent var	3.839727
S.E. of regression	3.733415	Sum squared resid	390.2749
J-statistic	5.915660	Instrument rank	8
Prob(J-statistic)	0.205536		

Source: Author calculations under Eviews

In this model ;intensity and total intensity do not have significant impact on the operating margin, whereas waste diversion and renewable energy impact positively the operating margin .

Operating margin delayed effect over a period (2 YEARS)

Dependent Variable: DOPERATINGMARGIN
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 18:13
Sample (adjusted): 2022 2024
Periods included: 3
Cross-sections included: 8
Total panel (balanced) observations: 24
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DOPERATINGMARGIN,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOPERATINGMARGIN(-1)	-0.200122	0.060057	-3.332224	0.0126
D2INTENSITY	0.031155	0.065494	0.475698	0.6488
D2RENEWABLE	-0.176096	0.164262	-1.072040	0.3193
D2WASTE	-0.056035	0.018314	-3.059668	0.0183

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	0.115417	S.D. dependent var	2.585464
S.E. of regression	2.291284	Sum squared resid	104.9996
J-statistic	3.327859	Instrument rank	8
Prob(J-statistic)	0.504530		

Dependent Variable: DOPERATINGMARGIN
Method: Panel Generalized Method of Moments
Transformation: First Differences
Date: 09/12/25 Time: 18:09
Sample (adjusted): 2022 2024
Periods included: 3
Cross-sections included: 8
Total panel (balanced) observations: 24
White period (period correlation) instrument weighting matrix
White period (cross-section cluster) standard errors & covariance (d.f. corrected)
Standard error and t-statistic probabilities adjusted for clustering
Instrument specification: @DYN(DOPERATINGMARGIN,-2)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DOPERATINGMARGIN(-1)	-0.169335	0.078353	-2.161180	0.0675
D2INTENSITYTOT	-0.001699	0.002930	-0.580087	0.5800
D2RENEWABLE	-0.253570	0.133248	-1.902997	0.0988
D2WASTE	-0.072172	0.019586	-3.684926	0.0078

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	0.115417	S.D. dependent var	2.585464
S.E. of regression	2.783585	Sum squared resid	154.9670
J-statistic	1.691114	Instrument rank	8
Prob(J-statistic)	0.792331		

The dynamic term operating margin (-1) is significant in the first model and is closer to being significant in the second model , renewable energy and both intensity and total intensity do not impact operating margin, the coefficient of diversified waste is negative which mean that is inversely related to operating margin.

In both models, the variable D2waste is statistically significant and has a negative effect on operating Margin.

Table 05. Hansen test and Arellano Bond serial correlation test AR1 AR2 for operating margin

J statistic	3,45	5,91	3,32	1,69
probability	0,48	0,20	0,50	0,79
AR1	0,53	0,34	0,97	0,97
AR2	0,33	0,33	0,960	0,9

Source: Author calculations under Eviews

J-statistic and its p-value are all >0,05, the AR 2>0,05 suggest the instruments are valid.

5.RESULTS

- In the immediate and short term, variables do not impact net profit, however the operating margin is impacted immediately and positively by the intensity, contrary total intensity and renewable energy decreases margin significantly. the intensity and total intensity do not impact operating margin in delayed term.
- The increase in emissions has a negative effect on net profit in lag1 and a delayed positive effect in lag2 that emerges as an implicit dynamic response fromcompanies. They dynamically adapt implicitly to the rise in emissions and attempt to reduce the impact.
- After a 2-year delay, intensity positively affects net profit. This may suggest that increased energy use enhance productive capacity over time. Based on these results **H1** is accepted confirming that intensity has a significant delayed impact on profitability.
- Although Scope 3 emissions represent the largest share of total emissions in the construction sector, their inclusion in the total emissions intensity indicator (Total Intensity) did not identify a significant impact on profitability. Total intensity has no significant impact on net profit and show negative impact on operating margin only in immediate term. This confirms the study of Salvatore Perdichizzi and all 2024 (Salvatore Perdichizzi, 2024) that show that emissions reduce the relevance of earnings, and this reduction is driven only by Scope 1 and direct emission and , not the indirect ones .the reasons of non-signification can be explained by the difference in the methods of calculation of scope 3 between the firms in the industry this methods are not standardized , and the complexity of measurement due to the difficulty and the lack to find the components included in it . Or because its effect may be visible in the long term. Based on these results we reject **H2** becausethere is no statistically significant impact of total intensity emission on the net profit in construction

sector in Europe but there is statistically significant impact of total intensity emission on the operating margin just in the immediate term .

- Renewable energy has an immediate negative effect on operating margin (cost effect), and a delayed initially negative effect on profit. after a two-year delay. This means that renewable energy does not contribute immediately to improving profitability; on the contrary, it has negative effects. This not only reflects the nature of investment and operating costs but also reflects the limited use of renewable energy, as the reliance on renewable energy is minimal in most companies and depends only on green electricity from external providers, without actual investment in renewable energy production systems or integration into project infrastructure. Therefore, Therefore, **H3** is accepted, confirming that renewable energy has a statistically significant delayed impact on profitability.
- Waste management shows a delayed positive impact on both net profit and operating margin after one year; however, this impact declines and becomes negative on operating margin only in the second year due to the ongoing costs of environmental management.
- The effect of diverted waste on operating margin is robust across both lags and models. Other sustainability variables (Intensity and renewable energy) appear to have shorter-term effects, or their impact may be less direct. Based on these results **H4** is accepted confirming that diverted waste has a significant delayed impact on profitability.
- waste diverted represents a real opportunity to offset the negative impact of emissions and achieve sustainable profitability in the short term. Renewable energies take longer to show their effects Therefore, it requires external support to reduce costs or expanding the activity by establishing energy projects or acquiring energy Companies. the integration of artificial intelligence helps in reduce emissions and costs and improve profitability.
- Concerning the adoption of artificial intelligence and due to data limitations, the empirical analysis does not directly measure artificial intelligence adoption. However, the increasing role of digital technologies and smart systems in emission monitoring, energy optimization, and waste management suggests that AI could play a critical role in enhancing the effectiveness of environmental strategies and improving firms' financial performance. Future research is therefore encouraged to explicitly integrate AI indicators into dynamic profitability

- The model reveals a robust and statistically significant delayed positive impact of diverted waste on both net profit and operating margin after a one-year lag .In the context of the European construction sector, achieving such high rates of waste recovery and recycling without incurring prohibitive operating overheads is heavily dependent on smart automation. The integration of AI-driven sorting platforms and digital tracking systems optimizes the circular economy framework, directly lowering transaction costs, minimizing administrative penalties, and driving this robust delayed financial return.
- The findings indicate that total emission intensity (including Scope 3) fails to yield a significant positive impact, while renewable energy exerts immediate negative cost effects on operating margins. This emphasizes that green structural transitions and value-chain tracking are highly complex and financially demanding. Here, advanced digital technologies and predictive AI algorithms serve as an essential operational bridge. AI tools provide the capacity needed to standardize and model unpredictable Scope 3 indirect data while optimizing real-time smart energy monitoring to reduce the capital-intensive pressures of alternative energy transitions.
- This synthesis demonstrates that while AI adoption operates as an unmeasured catalyst in the current empirical timeline (2018–2024), it represents the ultimate technological catalyst required to resolve temporal lags and translate immediate environmental regulatory costs into sustainable financial returns.

6. Recommendations

To improve profitability by environmental performance in construction sector, we propose the following recommendations,

- Accelerate the integration of digital technologies such as artificial intelligence, waste management platforms, and smart energy monitoring tools. These innovations reduce emissions and costs of transparency, control….. , and improve profitability
- It is recommendedthat construction companies adopt effective environmental management strategies, especially in the area of waste recycling, not only to reduce environmental impact but also to compensate for financial losses resulting from high emission levels in the short term. The results indicate that waste recycling has a nearly equivalent positive impact to the negative impact of emissions, making it a strategic tool for protecting profitability.
- The transition to alternative and renewable energy sources cannot be managed by firms alone; rather, it constitutes a national strategic priority. Governments play a leading role in driving this transition and ensuring its implementation in a coordinated and integrated manner across all sectors. Harmonizing regulatory and legislative frameworks related to renewable energy and sustainable construction among European countries. Strengthening international cooperation and establishing common policies that address disparities between countries in terms of technical and financial capacities.
- Construction Firms can better manage the cost of renewable energy by investing in the renewable energy. Considering the integration between the construction sector and the renewable energy sector, construction companies can improve profitability by diversifying their sources of activity and investing in new project of renewable energy or acquiring other renewable energy companies, while at the same time taking advantage of the lower-cost renewable energy benefits.

- A dedicated strategy for Scope 3 emissions, completely separate from Scopes 1 and 2, is essential for achieving long-term sustainability in the construction industry this strategy requires standardization of Scope 3 calculation methods and modeling indirect emissions by artificial intelligence tools.

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