

Does ESG Improve Short-Term Efficiency? Evidence from Turkish Manufacturing Firms

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Abstract

This paper investigates whether Environmental, Social, and Governance (ESG) performance enhances firm-level efficiency in the short term, focusing on Turkish manufacturing firms. Using panel data from 16 firms listed on Borsa Istanbul over the period 2019-2023, the analysis employs fixed-effects models with robust estimators to account for heterogeneity and potential dependence structures. The findings indicate that ESG performance is not statistically significant in explaining operational efficiency, innovation, or firm growth in the short run. While the contemporaneous effect on production efficiency is weak and sensitive to estimation methods, the evidence for lagged ESG effects remains limited and sensitive to estimation methods. These results suggest that ESG does not generate robust short-term performance gains but may operate through longer-term and context-dependent mechanisms. Overall, the study highlights the importance of time horizon and methodological choices in evaluating ESG-performance relations.

Key words: ESG, Operational Efficiency, Capacity Utilization, Short-Term Effects, Turkish Manufacturing Sector

JEL Code: D24, G32, M14

1. Introduction

ESG-performance has become a major focus in both academic research and corporate practice (Kweh et al., 2025). It is widely regarded as an important factor shaping firm performance and long-term value creation. The ESG-performance literature has expanded significantly in recent years, with evidence pointing to a generally positive but heterogeneous relation (Marchan, 2024; Singhania and Gupta, 2024). Prior research largely reports a positive relation between ESG engagement and firm outcomes. Sustainability practices are linked to improved resource allocation, stronger stakeholder relations, and enhanced operational efficiency (Friede et al., 2015; Atz et al., 2023).

Despite this general view, empirical results remain inconclusive, with recent studies emphasizing the need to reconsider the ESG-performance relation (Agnese

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et al., 2025). While some studies identify positive effects (Kalyani and Mondal, 2024; Khamis et al., 2025), others report limited or even negative impacts, particularly in the short term. One explanation relates to the nature of ESG implementation, which often involves organizational restructuring, compliance investments, and adjustments to production processes. These changes may impose short-term costs and disrupt operations, delaying the realization of potential benefits. Empirical studies support this argument. For example, Krüger (2015) finds that investors react weakly negatively even to positive CSR announcements, suggesting that markets do not unconditionally reward ESG engagement. Similarly, Bhandari and Javakhadze (2017) show that CSR activities can distort firm-level capital allocation efficiency, indicating a potential cost channel through which ESG may constrain short-term performance. As a result, ESG benefits may not appear immediately and may depend on firm-specific characteristics and institutional conditions (Tang et al., 2023; Narula et al., 2024).

Recent research further suggests that the ESG-performance relation is more complex than traditionally assumed. ESG effects may be nonlinear and vary across different levels of engagement (Kweh et al., 2025; Omri and Guenichi, 2026). In addition, ESG outcomes may depend on the interaction among its pillars rather than their individual effects (Nguyen and Nguyen, 2025). In emerging market contexts, ESG practices may also serve as signaling mechanisms shaped by institutional pressures, which can weaken their direct impact on firm performance (Ioannou and Serafeim, 2012; Singh, 2024). Moreover, ESG effects often operate through indirect channels, such as stakeholder relations, innovation, and reputational dynamics (Blach et al., 2025).

These considerations are particularly relevant in emerging market settings such as Türkiye. Compared to developed economies, differences in institutional quality and regulatory frameworks may create additional challenges for firms adopting ESG practices (Ioannou and Serafeim, 2012; Gürsoy and Erbuğa, 2024). These constraints can influence both the effectiveness of ESG strategies and the timing of their impact on firm performance. Another important issue concerns how firm performance is measured. Much of the existing literature relies on aggregate indicators, which may obscure variation across different dimensions of efficiency. In practice, ESG may affect operational efficiency, production efficiency, innovation, and firm growth through different channels (Popescu et al., 2023; Li et al., 2024).

The dynamic dimension also remains underexplored. Although ESG is typically viewed as a long-term strategic investment, most empirical studies focus on contemporaneous relations. This approach overlooks potential lagged effects and the role of short-term adjustment costs (Tang et al., 2023; Narula et al., 2024). In addition, empirical results may be sensitive to methodological choices, with findings varying across model specifications and estimation techniques (Tang et al., 2023).

Against this background, this study examines the short-term impact of ESG-performance on firm-level outcomes. The analysis focuses on Turkish manufacturing firms listed on Borsa Istanbul over the period 2019-2023. It adopts a multidimensional approach by considering operational efficiency, production efficiency, innovation, and firm growth. Lagged ESG variables are included to capture potential dynamic effects, and alternative estimation methods are used to assess methodological sensitivity. The findings provide a more refined interpretation of ESG-performance. ESG does not have a statistically significant effect on firm-level outcomes in the short term. While the contemporaneous effect on production efficiency remains weak, the evidence for lagged ESG effects is limited and sensitive to the estimation method. These results suggest that ESG should be viewed as a gradual and context-dependent investment process rather than an immediate driver of performance.

This study contributes to literature in several ways. First, it shows that ESG-performance does not significantly improve firm-level outcomes in the short term across multiple performance dimensions. Second, it highlights the importance of dynamic effects by demonstrating that ESG effects are not observable even when lagged structures are considered. Third, it shows that empirical findings are sensitive to methodological choices. The study also extends the literature and offers relevant implications for policymakers and practitioners.

2. Literature Review

The linkage between ESG-performance and firm outcomes has been extensively analyzed in prior research. Although a substantial body of work highlights the performance-enhancing role of ESG, the overall evidence remains inconclusive. Early contributions largely emphasize positive effects, whereas more recent studies underline the importance of temporal, contextual, and methodological factors in shaping empirical results.

A considerable number of studies report a positive link between ESG engagement and firm performance. Meta-analyses by Friede et al. (2015) and Atz et al. (2023) indicate that sustainability practices are generally linked to improved financial and operational outcomes. Consistent with this view, Eccles et al. (2014) show that firms adopting strong sustainability practices tend to outperform their peers over longer periods. Additional evidence suggests that ESG engagement may enhance investment efficiency, alleviate financing constraints, and reduce downside risk (Cheng et al., 2014; Albuquerque et al., 2020).

From a theoretical standpoint, the ESG-performance nexus is commonly interpreted through stakeholder theory and the resource-based view. ESG initiatives can foster trust among stakeholders, lower transaction costs, and facilitate access to valuable resources. These mechanisms strengthen firm capabilities and support competitive advantage (Fatemi et al., 2018; Li et al., 2024). Furthermore, ESG

practices may reduce information asymmetry and improve financing conditions, thereby contributing to more efficient investment decisions (Cheng et al., 2014).

When attention shifts specifically to efficiency-related outcomes, the empirical evidence becomes less clear-cut. ESG investments can enhance resource utilization through mechanisms such as energy savings, waste reduction, and process optimization (Popescu et al., 2023; Arsenopoulou et al., 2025). In manufacturing contexts, these improvements may directly influence production and operational performance. However, efficiency is inherently multidimensional. Indicators such as asset utilization, production intensity, and innovation capacity may respond differently to ESG initiatives, and in some cases, the effects may even diverge. This heterogeneity contributes to the variation observed across empirical findings.

The timing of ESG effects represents another important dimension. The implementation of ESG practices often entails substantial organizational adjustments, including restructuring, compliance investments, and process redesign. These changes may disrupt existing operations and generate short-term inefficiencies. Empirical studies support this argument. For example, Krüger (2015) documents that stock markets react weakly negatively to positive CSR announcements, suggesting that short-term investor sentiment does not consistently reward ESG engagement. Similarly, Bhandari and Javakhadze (2017) show that CSR activities can distort investment sensitivity to growth opportunities and reduce capital allocation efficiency, reinforcing the view that ESG implementation may impose short-term resource costs. Consistent with this perspective, Tang et al. (2023) and Narula et al. (2024) emphasize that ESG-related benefits are unlikely to materialize immediately and may involve transitional inefficiencies.

The impact of ESG also varies across institutional and industry contexts. Differences in regulatory quality, market structures, and firm characteristics influence how ESG practices translate into performance outcomes (Ioannou and Serafeim, 2012). In emerging economies, limited institutional support and weaker regulatory frameworks may constrain the effectiveness of ESG initiatives and delay their benefits. In such settings, ESG practices may also function as signaling mechanisms rather than reflecting substantive operational changes (Singh, 2024).

Recent research emphasizes the importance of moderation and contextual factors. Mendonça et al. (2025) demonstrate that sustained ESG engagement can enhance firm performance, particularly through improvements in energy efficiency. Similarly, Narula et al. (2024) highlights the evolving contribution of ESG to productivity over time. In manufacturing contexts, Popescu et al. (2023) report a positive relation between ESG ratings and resource efficiency. In addition, emerging evidence suggests that ESG effects may not be linear. For example, Omri and Guenichi (2026), Kweh et al. (2025), and Singhania and Gupta (2024) provide evidence of nonlinear ESG-performance relations, indicating that the impact of ESG varies across different levels of engagement. These findings further underscore the relevance of contextual and moderating factors, as ESG-

performance relations are shaped by firm, industry, and country-level characteristics (Prashar, 2021).

Beyond linear and contextual explanations, recent studies also emphasize the configurational and multidimensional nature of ESG. Nguyen and Nguyen (2025) show that different combinations of ESG dimensions are associated with firm performance, indicating that ESG effects depend on how its pillars interact. In a broader perspective, ESG outcomes may also operate through indirect and stakeholder-driven mechanisms. Blach et al. (2025) suggest that ESG research is structured around themes such as stakeholder engagement, innovation, and reputational risk, suggesting that ESG effects are often mediated rather than direct. Another critical issue concerns methodological sensitivity. Variations in model specification, variable measurement, and estimation techniques can lead to different empirical conclusions (Tang et al., 2023). Studies employing alternative estimators or accounting for cross-sectional dependence often report changes in statistical significance, suggesting that empirical outcomes may partly reflect methodological choices.

The literature presents a complex picture. While ESG is frequently associated with improved firm performance, its effects are neither immediate nor uniform. Instead, ESG appears to operate through dynamic processes shaped by temporal, contextual, and methodological factors. Prior research suggests that ESG effects may involve adjustment costs, nonlinearities, and configurational dynamics, although the empirical evidence remains mixed. In this context, the study explores the short-term impact of ESG-performance on firm-level efficiency by incorporating multidimensional performance indicators, temporal dynamics, and methodological robustness.

3. Methodology

3.1. Hypothesis Development

ESG-performance is increasingly treated as a strategic factor in shaping firm-level efficiency. Within the resource-based view, ESG practices can strengthen firm capabilities through more efficient resource allocation, improved operational discipline, and stronger stakeholder relations. These mechanisms allow firms to use their assets more effectively and improve operational processes (Arsenopoulou et al., 2025). Existing studies also indicate that ESG investments are associated with efficiency gains through better resource management and process improvements. In manufacturing settings, ESG adoption may contribute to more efficient operational structures and asset utilization (Gürsoy and Erbuğa, 2024). Based on this reasoning, ESG-performance is expected to increase firms' ability to generate output from their asset base.

H1: ESG-performance is positively associated with asset turnover.

ESG may also influence production efficiency beyond its effects on operational performance. Improvements in energy use, waste management, and process organization can enhance production processes (Kalyani and Mondal, 2024; Khamis et al., 2025). However, ESG implementation may require structural and operational adjustments that could temporarily affect production processes in the short run (Tang et al., 2023). Consequently, the net effect of ESG may reflect a combination of potential efficiency gains and short-term adjustment dynamics.

H2: ESG-performance is associated with capacity utilization, reflecting potential efficiency gains and possible short-term adjustment dynamics.

ESG includes several dimensions that can influence firm performance through distinct mechanisms. Environmental practices are linked to resource efficiency, social practices to employee productivity, and governance practices to monitoring and decision-making quality (da Cunha et al., 2025). Empirical evidence indicates that these dimensions do not have uniform effects, as their impact varies across operational settings and firm-specific conditions (Tang et al., 2023).

H3: ESG pillars have differential effects on inventory turnover.

Within the dynamic capabilities' framework, ESG-oriented firms tend to invest more in innovation in response to sustainability requirements and regulatory pressures. ESG engagement can also support the development of new technologies and improvements in production processes (Lim et al., 2022; Li et al., 2024).

H4: ESG-performance is positively related to firms' R&D intensity.

ESG engagement can improve firm reputation, enhance customer satisfaction, and strengthen stakeholder relations, thereby increasing demand and supporting sales growth (Luo and Bhattacharya, 2006; Servaes and Tamayo, 2013; Albuquerque et al., 2020).

H5: ESG-performance is positively related to firms' sales growth.

The effect of ESG on firm performance can vary across institutional settings. Firms with higher export exposure are subject to stricter international ESG standards and sustainability requirements, which may strengthen the impact of ESG practices (Narula et al., 2024).

H6: Export intensity moderates the linkage between ESG-performance and firm-level efficiency, such that the effect of ESG may vary depending on firms' exposure to international markets.

ESG investments are often characterized as dynamic processes and may involve adjustment costs. These costs can arise from organizational restructuring, compliance requirements, and changes in production processes. As a result, firms may experience short-term variations in efficiency before potential long-term benefits emerge, although the empirical evidence remains mixed (Tang et al., 2023; Narula et al., 2024). In this context, lagged ESG effects may capture the transitional dynamics associated with these adjustment processes.

H7: Lagged ESG-performance is negatively related to firms' production efficiency.

3.2. Data Set

This study analyzes the relation between ESG-performance and firm-level efficiency in the Turkish manufacturing sector. The sample includes 16 firms listed on Borsa Istanbul over the period 2019-2023, resulting in a balanced panel of 80 firm-year observations. The empirical analysis uses a set of dependent, independent, and control variables, as reported in Table 1.

Table 1. Variable Definitions

Variable	Abbrev.	Role	Measurement
ESG Score	ESG	Independent	Composite ESG score (0–100)
Environmental Score	ENV	Independent	ESG environmental score
Social Score	SOC	Independent	ESG social score
Governance Score	GOV	Independent	ESG governance score
Asset Turnover	AT	Dependent	Net sales / Total assets
Inventory Turnover	IT	Dependent	Cost of goods sold / Average inventory
Capacity Utilization	CU	Dependent	Actual output / Maximum potential output
R&D Intensity	RD	Control	R&D expenditures / Sales
Sales Growth	GR	Control	Annual percentage change in sales
Firm Size	SIZE	Control	ln(Total assets)
Leverage	LEV	Control	Total debt / Total assets
Profitability	PROF	Control	Net income / Total sales
Export Ratio	EXP	Moderator	Export sales / Total sales

ESG-performance is used as the primary independent variable and is proxied by the ESG score. The aggregate score is further decomposed into its environmental, social, and governance pillars. Firm-level efficiency is captured through both operational and production-based indicators. Operational efficiency is represented by asset turnover and inventory turnover, while production efficiency is measured by capacity utilization. The model controls firm size, leverage, profitability, R&D intensity, and sales growth. Export ratio is included as both a

control and a moderate variable to capture firms' international exposure. In additional model specifications, R&D intensity and sales growth are alternatively treated as dependent variables.

The firms in the sample represent different manufacturing industries, providing sectoral diversity. ESG data and most financial variables are sourced from the Refinitiv Eikon database. In contrast, capacity utilization (CU) data are manually compiled from publicly available sources, including firms' annual reports. The sample composition and sectoral distribution are reported in Table 2.

Table 2. Sample Firms

No	Firm	Sector	No	Firm	Sector
1	AKSA	Chemicals	9	SAHOL	Diversified Holding
2	ARCLK	Consumer Durables	10	SISE	Glass
3	ASELS	Defense	11	TAVHL	Airport Operations
4	BIMAS	Food Retail	12	TCELL	Telecommunications
5	EREGL	Steel	13	THYAO	Air Transportation
6	FROTO	Automotive	14	TOASO	Automotive
7	KCHOL	Diversified Holding	15	TUPRS	Energy (Refining)
8	PETKM	Petrochemicals	16	VESTL	Electronics

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ESG Score	80	73.54	12.73	21.17	94.47
Environmental Score	80	73.98	17.17	11.71	99.29
Social Score	80	82.02	13.35	30.96	97.25
Governance Score	80	59.43	17.91	9.05	90.17
Asset Turnover	80	1.34	0.72	0.42	4.04
Inventory Turnover	80	8.74	7.88	1.45	41.35
Capacity Utilization (CU)	80	0.80	0.15	0.48	1.00
Ln Firm Size	80	24.05	1.49	21.60	27.62
Leverage	80	0.63	0.15	0.21	0.84
Profitability (Net Profit Margin)	80	0.094	0.082	-0.039	0.393
R&D Intensity	80	0.006	0.007	0.0002	0.0306
Export Ratio	80	0.375	0.222	0.094	0.832
Sales Growth	80	0.953	1.248	-0.294	5.012

Source: Authors' calculations

Descriptive statistics for the variables are reported in Table 3. The mean ESG score is 73.54, suggesting that the sampled firms display relatively high levels of sustainability performance. Across ESG pillars, the social dimension has the highest average value (82.02), whereas governance scores are lower (59.43). This

pattern reflects differences across ESG pillars and suggests that firms may place varying levels of emphasis on sustainability dimensions.

Operational efficiency indicators show notable variation across firms. The mean asset turnover is 1.34, while inventory turnover averages 8.74, both with relatively high dispersion. This variation reflects differences in firms’ operational structures and efficiency levels. The average capacity utilization is 0.80, indicating that firms operate at about 80% of their installed capacity. However, the range suggests considerable differences in production intensity across firms. In terms of firm characteristics, the average firm size is 24.05. The mean leverage ratio is 0.63, pointing to a relatively high use of debt financing. The export ratio averages 0.375, indicating moderate exposure to international markets, although the variation across firms is substantial. Innovation and growth indicators also differ across the sample. The average R&D intensity is relatively low (0.006), but its dispersion suggests that some firms invest more heavily in innovation. Similarly, sales growth varies widely, reflecting differences in firm-level growth patterns. The descriptive statistics reveal considerable variation across firms in terms of ESG-performance, efficiency indicators, and firm characteristics. This supports the application of panel data methods that account for firm-specific effects.

Table 4 presents the correlation matrix and shows the relations among ESG-performance, firm-level efficiency indicators, and control variables.

Table 4. Correlation Matrix

Variables	ESG	AT	IT	CU	SIZE	LEV	PROF	RD	EXP	GR
ESG	1.000									
AT	0.124	1.000								
IT	0.048	0.636***	1.000							
CU	0.072	-0.407***	-0.301***	1.000						
SIZE	0.209*	0.441***	0.320***	0.178	1.000					
LEV	0.142	-0.043	-0.278**	-0.072	-0.321***	1.000				
PROF	-0.297***	-0.216*	-0.160	0.080	-0.073	-0.261**	1.000			
RD	0.152	0.014	-0.236**	-0.500***	-0.101	0.381***	0.011	1.000		
EXP	0.258**	0.072	-0.051	-0.111	0.093	0.411***	0.005	0.685***	1.000	
GR	-0.036	0.441***	0.144	-0.056	0.374***	-0.109	0.057	0.004	-0.027	1.000

Notes: This table reports Pearson correlation coefficients. AT, IT, and CU denote asset turnover, inventory turnover, and capacity utilization, respectively. SIZE is the natural logarithm of total assets, LEV is leverage, PROF is profitability, RD is R&D intensity, EXP is export ratio, and GR represents sales growth.

*** p<0.01, ** p<0.05, * p<0.10

Source: Authors’ calculations

Correlation analysis does not reveal a statistically significant relation between ESG-performance and key efficiency measures, including asset turnover ($r = 0.124$), inventory turnover ($r = 0.048$), and capacity utilization ($r = 0.072$). This indicates that ESG is not directly linked to traditional efficiency indicators and that its effects may operate through indirect or context-dependent channels. In contrast, several control variables are more strongly associated with operational performance. Firm size is positively correlated with both asset turnover ($r = 0.441$, $p < 0.01$) and inventory turnover ($r = 0.320$, $p < 0.01$), suggesting that larger firms tend to use their assets and inventories more efficiently. Sales growth is also positively related to asset turnover ($r = 0.441$, $p < 0.01$), pointing to the importance of demand conditions. Capacity utilization shows negative correlations with asset turnover ($r = -0.407$, $p < 0.01$) and inventory turnover ($r = -0.301$, $p < 0.01$). This pattern indicates that these variables capture different aspects of firm performance. Turnover ratios reflect short-term operational efficiency, whereas capacity utilization is more closely linked to production intensity. With respect to multicollinearity, correlations among explanatory variables remain within acceptable limits. Although export ratio and R&D intensity are relatively highly correlated ($r = 0.685$, $p < 0.01$), this level does not indicate a serious multicollinearity problem.

The correlation analysis does not reveal a statistically significant relation between ESG-performance and firm-level efficiency in the short term. These preliminary results support the use of multivariate panel models to account for confounding factors, time dynamics, and unobserved heterogeneity.

3.3. Research Model

To analyze the relation between ESG-performance and firm-level outcomes, this study employs a panel data framework. Firm-level outcomes are captured using multiple indicators, including asset turnover, capacity utilization, inventory turnover, R&D intensity, and sales growth. The baseline model is specified as follows:

$$Y(it) = \beta_0 + \beta_1 ESG(it) + \beta_2 Controls(it) + \mu_i + \lambda t + \varepsilon(it) \quad (1)$$

Here, $Y(it)$ represents firm-level outcome variables for firm i at time t , including asset turnover, capacity utilization, inventory turnover, R&D intensity, and sales growth, and $Controls(it)$ is a vector of control variables including firm size, leverage, profitability. Depending on the model specification, additional variables such as R&D intensity, export ratio, and sales growth are included as controls. μ_i captures unobserved firm-specific effects, λt represents time fixed effects, and $\varepsilon(it)$ is the idiosyncratic error term.

To capture the multidimensional nature of firm performance, several model specifications are estimated. First, operational efficiency is examined using asset turnover as the dependent variable:

$$AssetTurnover(it) = \beta_0 + \beta_1 ESG(it) + \beta_2 Controls(it) + \mu_i + \lambda t + \varepsilon(it) \quad (2)$$

Second, production efficiency is analyzed using capacity utilization (CU) as the dependent variable:

$$CU(it) = \beta_0 + \beta_1 ESG(it) + \beta_2 Controls(it) + \mu_i + \lambda t + \varepsilon(it) \quad (3)$$

To capture potential temporal dynamics and examine possible short-term adjustment effects, a lagged specification of ESG is estimated:

$$CU(it) = \beta_0 + \beta_1 ESG(i, t - 1) + \beta_2 Controls(it) + \mu_i + \lambda t + \varepsilon(it) \quad (4)$$

To examine whether ESG dimensions exert differential effects, the aggregate ESG score is decomposed into its environmental, social, and governance pillars, and the model is estimated using inventory turnover as the dependent variable:

$$InventoryTurnover(it) = \beta_0 + \beta_1 ENV(it) + \beta_2 SOC(it) + \beta_3 GOV(it) + \beta_4 Controls(it) + \mu_i + \lambda t + \varepsilon(it) \quad (5)$$

Finally, to test the moderating role of export intensity, an interaction model is estimated using asset turnover as the dependent variable:

$$AssetTurnover(it) = \beta_0 + \beta_1 ESG(it) + \beta_2 Export(it) + \beta_3 (ESG \times Export)(it) + \beta_4 Controls(it) + \mu_i + \lambda t + \varepsilon(it) \quad (6)$$

Given the panel structure of the data, fixed-effects estimators are employed to control for unobserved firm-specific heterogeneity that may be correlated with ESG-performance. Time fixed effects are also included to account for common macroeconomic shocks affecting all firms. The validity of the empirical specification is evaluated using a set of standard diagnostic procedures, including tests for multicollinearity, heteroskedasticity, autocorrelation, and cross-sectional dependence. Based on these diagnostics, appropriate robust standard error estimators are employed to ensure reliable statistical inference.

4. Findings

4.1. Diagnostic Tests and Model Justification

Prior to model estimation, a set of diagnostic tests was conducted to assess the suitability of the econometric specification. The results are presented in Table 5. Multicollinearity does not appear to be a concern, as the mean Variance Inflation Factor (VIF) is 1.61, which is well below commonly accepted thresholds. The Hausman test (Hausman, 1978) produces an insignificant statistic ($\chi^2 = 8.21$, $p > 0.10$), indicating that the random-effects model cannot be rejected. Nevertheless,

the fixed-effects specification is retained on theoretical grounds, since unobserved firm characteristics are likely to be correlated with ESG-performance (Baltagi, 2021; Wooldridge, 2010). The Modified Wald test indicates the presence of heteroskedasticity ($p < 0.01$), and the Wooldridge test detects first-order autocorrelation ($p < 0.01$). These results imply that conventional standard errors may be biased. By contrast, the Pesaran CD test does not provide evidence of cross-sectional dependence ($p > 0.10$), suggesting that cross-sectional correlation is not a major issue in the sample (Pesaran, 2004).

Based on these findings, fixed-effects estimators with cluster-robust standard errors at the firm level are employed (Arellano, 1987), following standard panel data approaches (Gujarati and Porter, 2009; Greene, 2012). As an additional robustness check, the models are also estimated using Driscoll-Kraay standard errors, which account for both temporal and cross-sectional dependence (Driscoll and Kraay, 1998). Overall, the diagnostic results are broadly in line with the chosen empirical strategy.

Table 5. Diagnostic Tests

Test	Statistic	p-value	Interpretation
Mean VIF	1.61	-	No multicollinearity
Hausman Test	$\chi^2 = 8.21$	0.223	RE cannot be rejected
Wald Test	$\chi^2(16) = 1287.92$	0.000***	Heteroskedasticity
Wooldridge Test	$F(1,15) = 15.51$	0.001***	Autocorrelation
Pesaran CD	-0.524	0.600	No evidence of cross-sectional dependence

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Source: Authors' calculations

Table 6. ESG and Asset Turnover (Fixed Effects)

Variable	Coef.	Std. Error	p-value
ESG Score	0.0035	0.0027	0.217
Ln Firm Size	0.0203	0.0416	0.633
Leverage	-1.0681	0.9608	0.284
Profitability	-0.3536	0.4313	0.425
R&D Intensity	-28.6259*	16.0400	0.095
Export Ratio	-0.9745**	0.3494	0.014
Sales Growth	0.2070***	0.0462	0.000
Constant	1.6445	1.5446	0.304
Firm FE	Yes		
Year FE	Yes		
Observations	80		
R ² (within)	0.6885		

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Source: Authors' calculations

Table 6 reports the fixed effects estimates for asset turnover. The ESG coefficient is positive but lacks statistical significance, indicating that ESG-performance does not improve operational efficiency in the short term.

The magnitude of the coefficients is also relatively small, suggesting a limited economic impact. Among the control variables, sales growth has a positive and statistically significant effect, while export intensity is negatively associated with asset turnover. R&D intensity shows a weak negative effect. These findings suggest that market dynamics and firm characteristics play a more important role in operational efficiency than ESG-performance. Overall, findings do not provide support for the hypothesis that ESG enhances short-term asset utilization.

Table 7 reports the baseline fixed effects estimates for capacity utilization. The ESG coefficient is positive; however, it is not statistically significant ($\beta = 0.0017$, $p > 0.10$). This result indicates that ESG-performance does not have a statistically significant contemporaneous effect on production efficiency. The estimated magnitude is also economically small in economic terms. Most control variables are statistically insignificant, suggesting that short-term variation in production efficiency is not strongly explained by firm-level characteristics within the sample period. Overall, the evidence provides limited support for the hypothesis that ESG improves production efficiency in the short term.

Table 7. ESG and Capacity Utilization (Fixed Effects)

Variable	Coef.	Std. Error	p-value
ESG Score	0.0017	0.0010	0.117
Ln Firm Size	-0.0033	0.0067	0.635
Leverage	0.1978	0.1212	0.123
Profitability	0.0260	0.1518	0.866
R&D Intensity	3.1256	6.1160	0.617
Export Ratio	0.0322	0.1200	0.792
Sales Growth	-0.0027	0.0040	0.504
Year FE	Yes		
Firm FE	Yes		
Observations	80		
R ² (within)	0.4455		

Source: Authors' calculations

To examine the dynamic dimension of ESG, lagged ESG variables are introduced. Table 8 presents the results. While the contemporaneous ESG coefficient remains statistically insignificant, the lagged ESG variable is also not statistically significant ($\beta = 0.00075$, $p > 0.10$). These findings indicate that ESG-performance does not exert a meaningful short-term effect on capacity utilization, either contemporaneously or with a one-period lag. The similarity of the contemporaneous and lagged results suggests that the ESG-efficiency relation remains weak in the short-term. The results do not provide evidence of short-term adjustment costs associated with ESG implementation.

Table 8. ESG and Capacity Utilization (Dynamic Models)

Variables	Model 1: ESG (t)	Model 2: ESG (t-1)
ESG	0.0017 (0.117)	
ESG (t-1)		0.00075 (0.335)
Ln Firm Size	-0.0033 (0.635)	-0.0053 (0.627)
Leverage	0.1978 (0.123)	0.1971* (0.090)
Profitability	0.0260 (0.866)	-0.0252 (0.858)
R&D Intensity	3.1256 (0.617)	1.6205 (0.781)
Export Ratio	0.0322 (0.792)	-0.0013 (0.991)
Sales Growth	-0.0027 (0.504)	-0.0028 (0.688)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	80	64
R ² (within)	0.4455	0.2197

Notes: *** p<0.01, ** p<0.05, * p<0.10

Source: Authors' calculations

Table 9 reports the fixed effects estimates for inventory turnover. The results show that none of the ESG pillars, namely environmental, social, and governance scores, have a statistically significant effect on inventory efficiency.

Table 9. ESG Pillars and Inventory Turnover (Fixed Effects)

Variables	Coef.
Environmental Score	0.0340 (0.0414)
Social Score	-0.0230 (0.0436)
Governance Score	-0.0159 (0.0256)
Ln Firm Size	-0.1129 (0.4558)
Leverage	-24.6293*** (4.6312)
Profitability	-11.0421* (5.5850)
R&D Intensity	-152.9695 (250.9506)

Export Ratio	-8.6203 (5.6022)
Sales Growth	0.4633 (0.2892)
Constant	32.0858** (13.2985)
Firm FE	Yes
Year FE	Yes
Observations	80
R ² (within)	0.5389

Notes: *** p<0.01, ** p<0.05, * p<0.10

Source: Authors' calculations

This finding indicates that ESG dimensions do not exert differential impacts on inventory turnover in the short term. In contrast, leverage has a negative and statistically significant effect, suggesting that higher debt levels are associated with lower inventory efficiency. Overall, the results do not support the hypothesis that ESG pillars influence inventory turnover in the short term.

Table 10 presents the fixed-effects results for innovation, growth, and moderation effects.

Table 10. ESG, Firm Outcomes, and Moderating Effect of Export Intensity

Panel A: Innovation and Growth Models

Variables	R&D Intensity	Sales Growth
ESG Score	-0.00000004 (0.0000139)	-0.0082 (0.0142)
Ln Firm Size	0.0003 (0.0002)	0.8571*** (0.0942)
Leverage	-0.0013 (0.0016)	1.6618 (1.1009)
Profitability	-0.0034* (0.0019)	-0.1082 (1.7991)
R&D Intensity		-146.1674 (105.7004)
Export Ratio	-0.0044 (0.0038)	2.7318** (1.0412)
Sales Growth	-0.0002 (0.0001)	
Constant	0.0022 (0.0058)	-20.2412*** (2.5361)
Observations	80	80
R ² (within)	0.1503	0.3595

Panel B: Moderation Model (Asset Turnover)

Variables	Asset Turnover
ESG Score	-0.0099 (0.0081)
Export Ratio	-3.0143 (1.8869)
ESG × Export	0.0379 (0.0253)
Ln Firm Size	0.1989*** (0.0442)
Leverage	-0.4957 (0.9010)
Profitability	0.1130 (0.8234)
Constant	-2.3570* (1.3118)
Observations	80
R ² (within)	0.3940

Notes: *** p<0.01, ** p<0.05, * p<0.10

Source: Authors' calculations

ESG-performance does not have a statistically significant effect on R&D intensity, suggesting that ESG engagement is not associated with higher innovation activity in the short term. Similarly, ESG is not significantly related to sales growth ($\beta = -0.0082$). In contrast, export intensity has a positive and statistically significant effect on sales growth ($\beta = 2.7318$), indicating that exposure to international markets is associated with firm expansion

Panel B reports the results of the moderation analysis. The interaction term between ESG and export intensity is not statistically significant ($\beta = 0.0379$), suggesting that export intensity does not systematically alter the linkage between ESG-performance and firm-level efficiency. Overall, these findings indicate that ESG effects do not materialize in the short term and may operate through longer-term mechanisms.

4.2. Robustness Checks

To assess robustness, the models are re-estimated using Driscoll-Kraay standard errors. Table 11 presents the results.

Under this specification, the contemporaneous ESG coefficient becomes statistically significant, indicating that the results are sensitive to the estimation method. The lagged ESG coefficient also becomes weakly significant at the 10% level. These findings suggest that ESG effects may emerge under alternative estimation approaches, highlighting the importance of methodological choices.

Overall, the evidence points to a method-sensitive relation rather than a robust short-term effect.

Table 11. Robustness Checks (Driscoll-Kraay)

Variable	FE (Clustered)	Driscoll-Kraay
ESG (t)	0.0017 (0.0010)	0.0021 (0.0003)***
ESG (t-1)	0.00075 (0.00077)	0.00075 (0.00024)*
Observations	80 / 64	80 / 64

Notes: *** $p < 0.01$, * $p < 0.10$

Source: Authors' calculations

Additional analyses further examine the robustness of the results. First, a nonlinear specification including a quadratic ESG term is estimated. The results show that neither the linear ESG term ($\beta = 0.00020$, $p = 0.936$) nor the quadratic term ($\beta = 0.000015$, $p = 0.406$) is statistically significant, indicating the absence of a nonlinear relation between ESG-performance and production efficiency. Second, alternative lag structures are introduced to capture potential delayed effects. The first lag of ESG is negative but statistically insignificant ($\beta = -0.0039$, $p = 0.101$), while the second lag is positive but also insignificant ($\beta = 0.0020$, $p = 0.126$), providing no evidence of consistent delayed effects. Third, interaction models are estimated to assess potential heterogeneity across firms. The interaction terms between ESG and firm size ($\beta = -0.00025$, $p = 0.286$), as well as ESG and leverage ($\beta = -0.00111$, $p = 0.775$), are not statistically significant, indicating no systematic variation in ESG effects across firm characteristics. Taken together, these findings reinforce the main results by showing that ESG-performance does not exert a robust short-term effect on firm-level efficiency.

4.3. Empirical Results

Table 12 summarizes the empirical results for all hypotheses. A clear pattern emerges from the analysis. ESG-performance does not have a statistically significant effect on short-term operational efficiency, innovation, or firm growth. Its contemporaneous effect on production efficiency remains weak and varies across estimation methods. The lagged ESG coefficient is statistically insignificant in the baseline model but becomes weakly significant under alternative estimation methods. Overall, ESG does not appear to generate robust immediate performance gains in the short term.

The first set of results evaluates the effect of ESG on operational efficiency, measured by asset turnover. No statistically significant relation is found between ESG and asset turnover across all model specifications. Although the coefficient is positive, it is not significant, indicating that ESG engagement does not improve asset utilization in the short term. Among the control variables, sales growth has a strong positive effect, while export intensity is negatively associated with asset turnover. These results suggest that market demand and firm orientation play a more

important role in operational efficiency than ESG-performance. Therefore, H1 is not supported

Table 12. Summary of Hypotheses and Empirical Results

Hypothesis	Relation	Expected Sign	Empirical Result	Interpretation
H1	ESG - Asset Turnover	+	Not Supported	ESG does not improve short-term asset utilization
H2	ESG - Capacity Utilization	±	Weak / Method-sensitive	Limited contemporaneous effect; sensitive to estimation methods
H3	ESG Pillars - Inventory Turnover	±	Not Supported	No differential effect across ESG dimensions
H4	ESG - R&D Intensity	+	Not Supported	No significant relation between ESG and R&D intensity in the short term
H5	ESG - Sales Growth	+	Not Supported	No immediate growth effect
H6	ESG × Export - Efficiency	±	Not Supported	Export intensity does not moderate ESG effects
H7	Lagged ESG - Capacity Utilization	±	Weak / Method-sensitive	Weak evidence under alternative

Source: Authors' calculations

The second set of results focuses on production efficiency, proxied by capacity utilization. In the baseline fixed-effects model, ESG has a positive but insignificant coefficient, indicating no robust contemporaneous relation. Under alternative estimation methods, the coefficient becomes statistically significant, although its magnitude remains small, suggesting that the contemporaneous effect is weak and sensitive to estimation techniques. When lagged ESG is included, the coefficient remains statistically insignificant in the baseline model but becomes weakly significant under Driscoll-Kraay estimation. This finding indicates that ESG-performance does not exert a robust short-term effect on production efficiency, either contemporaneously or with a lag. These results provide limited support for H2 and only weak, method-sensitive evidence for H7.

The analysis also examines whether environmental, social, and governance pillars have different effects on inventory turnover. None of the individual pillars are statistically significant. This indicates that ESG effects are not driven by a specific dimension but reflect a broader and more diffuse relation. Accordingly, H3 is not supported.

The linkage between ESG and broader firm outcomes is further evaluated. No statistically significant effect is observed between ESG and R&D intensity, indicating that ESG engagement is not associated with higher innovation activity in the short term. Similarly, ESG does not have a significant impact on sales growth. In contrast, export intensity has a positive and statistically significant effect on sales growth, suggesting that international market exposure plays a key role in firm expansion. Overall, these results do not support H4 and H5.

The moderating role of export intensity is tested using interaction terms. The ESG-export interaction is not statistically significant, indicating that export intensity does not alter the relation between ESG-performance and firm-level efficiency. Therefore, H6 is not supported.

4.4. Discussion

The findings show that ESG-performance has no statistically significant effect on short-term operational efficiency indicators, including asset turnover, inventory turnover, R&D intensity, and sales growth. This result differs from earlier studies reporting positive ESG-performance relations (Eccles et al., 2014; Friede et al., 2015). However, it is in line with more recent research indicating that ESG effects depend on context and may not materialize in the short run (Shaikh, 2022; Tang et al., 2023; Narula et al., 2024). In emerging markets, differences in institutional structures and market conditions may delay the realization of ESG-related benefits.

The results also indicate that ESG is not a uniform driver of firm efficiency. The absence of statistically significant effects across multiple performance indicators suggests that ESG-performance alone does not lead to immediate efficiency gains. Instead, ESG outcomes appear to depend on firm-specific capabilities, implementation processes, and contextual conditions. In addition, the lagged ESG specification does not yield statistically significant results in the baseline model but becomes weakly significant under Driscoll-Kraay estimation. This finding suggests that ESG-performance does not exert a robust short-term effect even when temporal dynamics are considered, although some method-sensitive evidence may emerge. Overall, ESG-related benefits, if present, are more likely to materialize over longer time horizons rather than through immediate or short-term adjustments.

These findings can be interpreted within a broader theoretical perspective. Recent evidence indicates that ESG-performance relations may exhibit nonlinear patterns, suggesting that the effects of ESG vary across different levels of engagement (Singhania and Gupta, 2024; Omri and Guenichi, 2026). In addition, ESG outcomes may depend on the interaction among its pillars rather than their isolated effects (Nguyen and Nguyen, 2025). This configurational perspective helps explain why ESG does not exhibit a uniform effect across different efficiency measures.

Another explanation relates to the role of institutional context. In emerging markets, ESG practices may partly function as signaling mechanisms shaped by external pressures rather than reflecting substantive operational improvements (Singh, 2024). This may limit the direct impact of ESG on firm performance, particularly in the short term. Furthermore, ESG effects may operate through indirect channels, such as stakeholder relations, innovation, and reputational dynamics, which typically unfold over longer time horizons (Blach et al., 2025). Another important result relates to methodological sensitivity. The contemporaneous ESG coefficient is not significant in the baseline fixed-effects model but becomes weakly significant under Driscoll-Kraay estimation. This difference indicates that empirical results may vary depending on the estimation

approach and highlights the importance of methodological choices in ESG research (Tang et al., 2023).

To further validate these findings, additional analyses are conducted. Nonlinear specifications do not reveal any evidence of a nonlinear linkage between ESG-performance and production efficiency. Similarly, alternative lag structures do not provide consistent support for delayed ESG effects. Interaction models also fail to identify systematic heterogeneity across firms. Taken together, these additional analyses reinforce the main results by confirming that ESG-performance does not exert a robust short-term effect on firm-level efficiency. Overall, the findings point to a more differentiated interpretation of ESG-performance. ESG does not generate immediate efficiency gains in the short term. Instead, its effects appear to be gradual, context-dependent, and potentially indirect. This interpretation is in line with the resource-based view and the dynamic capabilities perspective, which emphasize that the benefits of strategic investments emerge over time.

This study contributes to literature in several respects. First, it shows that ESG performance does not significantly improve firm-level outcomes in the short term. Second, it demonstrates that ESG effects are context-dependent and may not be observable within short time horizons. Third, it highlights the potential importance of nonlinear and configurational dynamics in ESG-performance relations. Fourth, it suggests that ESG outcomes may be influenced by signaling behavior and indirect stakeholder-related mechanisms. The results underline the importance of methodological considerations in empirical ESG research.

5. Conclusions

This study analyzes the relation between ESG-performance and firm-level outcomes in Turkish manufacturing firms over the period 2019–2023. Using panel data models with alternative estimation approaches, it evaluates the short-term implications of ESG across multiple dimensions, including operational efficiency, production efficiency, innovation, and firm growth.

The results show that ESG-performance does not have a statistically significant effect on operational efficiency, innovation, or firm growth in the short term. The contemporaneous effect on production efficiency remains weak and depends on the estimation method, while the lagged ESG coefficient is statistically insignificant in the baseline model but becomes weakly significant under alternative estimation approaches. These findings indicate that ESG does not generate robust short-term performance gains. Instead, ESG appears to operate as a gradual and context-dependent investment process, the effects of which may materialize only over longer horizons. These results highlight the importance of time horizon and methodological choices when evaluating ESG-performance relations.

The results have important implications for policymakers, firms, and investors. For policymakers, promoting ESG adoption based on expectations of

immediate gains may be misleading. Policy frameworks should adopt a longer-term perspective and recognize that ESG benefits may not be observable in the short term. This is especially relevant in emerging markets, where institutional constraints may shape the effectiveness of ESG implementation. For firms, ESG should be treated as a strategic, long-term investment rather than a short-term performance tool. The evidence suggests that ESG initiatives do not translate into immediate efficiency gains, emphasizing the importance of sustained and well-integrated implementation strategies. For investors, the absence of short-term performance effects highlights the need for a long-term evaluation perspective, as short-term indicators may not fully capture the value implications of ESG.

Several limitations should be noted. First, the sample includes only 16 manufacturing firms listed on Borsa Istanbul, which may limit the generalizability of the results. Future research could expand the sample across sectors or countries to provide broader evidence. Second, the analysis focuses on short-term outcomes, whereas ESG investments are inherently long-term. Extending the time horizon may offer a clearer understanding of dynamic effects. Third, the study relies on aggregate ESG scores and their pillars. Future studies could use alternative or more granular ESG measures to better capture underlying mechanisms. Fourth, the findings are sensitive to estimation methods, indicating the importance of methodological choices. Future research may apply alternative econometric approaches, such as dynamic panel models or causal inference techniques. Fifth, potential endogeneity concerns should be acknowledged. Although fixed-effects models and lagged specifications are employed to mitigate unobserved heterogeneity and reverse causality, these approaches may not fully eliminate endogeneity. Firm performance may influence ESG engagement, or both may be driven by omitted factors. Given the relatively small sample size, more advanced techniques such as GMM may not be suitable in this context. Future research could address these issues by employing alternative identification strategies, such as instrumental variable approaches. Finally, additional moderating factors, including institutional quality and industry-specific dynamics, may further explain how ESG influences firm performance.

Declaration of AI Use

During the preparation of this study, artificial intelligence tools were used for language editing and grammar refinement.

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