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The Effect of ESG on Working Capital: Two for the Price of One

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Abstract

We examine the relationship between environmental, social, and governance (ESG) scores and working capital management in 4,212 traded firms across 65 countries (2010–2023), emphasizing the role of financial constraints. We find that higher ESG scores, mainly driven by environmental and social pillars, are associated with lower working capital requirements. When disaggregating the cash conversion cycle components, we observe that ESG-strong firms collect payments from customers more quickly and secure extended payment terms from suppliers, reflecting trust-based relationships and more efficient liquidity strategies. ESG performance is associated with a mitigation of the impact of financial constraints, suggesting that sustainability practices enhance financing conditions. These results are robust to propensity score matching and industry-adjusted specifications. Our findings highlight ESG as a strategic lever for improving liquidity efficiency and managing capital-market friction through enhanced stakeholder engagement.

1. Introduction

While working capital management (WCM) has long played a prominent role in corporate finance, the field has gained increasing attention following the financial turbulence of the last few years (Baños-Caballero et al., 2019; Prasad et al., 2019). In an insightful report based on more than 19,000 listed companies worldwide, PwC (2024) identifies over €1.5 trillion of excess working capital globally that could be freed up for investment in operational transformation and business model reinvention. Similarly, JP Morgan (2023) estimates that $633 billion in working capital is currently

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trapped in S&P 1500 firms, underscoring the growing need for companies to optimize their liquidity and cash flow management. The literature has shown that effective WCM enhances firm value, mitigates risks, and optimizes financial performance, ensuring sufficient cash flow to meet short-term obligations and maintain operational stability (Baños-Caballero et al., 2014; Coelho, Oliveira, et al., 2024; Sah et al., 2022).

At the same time, corporate sustainability has gained increasing relevance as sustainable development and non-financial performance indicators have been prioritized to enhance firm value (Whelan et al., 2021). In recent years, investors, decision-makers, and other users of financial information have shifted their focus toward sustainable development and corporate finance (Alvarez-Perez & Fuentes, 2024; de Souza et al., 2024; Habib, 2022; Whelan et al., 2021). Numerous empirical studies support a positive relationship between corporate sustainability performance and various value creation metrics, such as improved profitability, reduced risks, enhanced innovation, and strengthened corporate reputation (El Ghoul et al., 2011; Vishwanathan et al., 2020; Whelan et al., 2021).

Despite the established benefits of sustainability, the link between environmental, social, and governance (ESG) scores and WCM remains underexplored, with Barros *et al.* (2022), Moin (2023), and Karki *et al.* (2024) being the only exceptions we are aware of. Moreover, the disparities in working capital efficiency across firms and regions highlight the need to integrate ESG factors into WCM strategies. In this vein, PwC (2024) notes that days' sales outstanding have increased by 6.6% over the past five years, leading to higher net working capital days and greater liquidity pressures. Additionally, smaller firms have experienced a steady decline in days payable outstanding since 2021, which has created further constraints in managing their cash flow. These trends highlight the importance of understanding how ESG scores influence WCM, particularly in mitigating financial constraints.

Regulatory developments further reinforce the need to examine this relationship. The European Union is implementing new payment term regulations, which could reduce the outstanding days payable and increase pressure on receivables and inventory management. In this sense, Deutsche Bank (2022) discusses the German Supply Chain Act, which mandates stricter compliance with ESG standards, making it imperative for firms to integrate sustainability into their financial and operational strategies.

Beyond regulatory changes, technological advancements are also reshaping WCM strategies. Forbes (2024) highlights that businesses are increasingly leveraging automation, digitalization, and process optimization to enhance efficiency and resilience in WCM. These transformations align with the growing emphasis on sustainability, reinforcing the role of ESG-driven financial practices in improving liquidity management and supplier relationships.

In this context, ESG scores emerge as a mechanism that, when properly integrated into business strategy, can mitigate underlying asymmetric information problems, facilitate access to financing, and promote more efficient WCM. Accordingly, this paper makes three key contributions. We are the first to examine the relationship between ESG scores and WCM using an international sample, expanding upon prior evidence based on single-country studies. Second, we divide the cash conversion cycle (CCC) into its three components to analyze how each relates to the ESG pillars, offering more in depth insights into how sustainability practices influence

accounts receivable, inventory, and payable management. Finally, we explore how ESG scores moderate the impact of financial constraints on WCM, aligning with global trends that highlight ESG-linked financing as a growing corporate strategy (Deutsche Bank, 2022).

Our results indicate that ESG practices contribute to operational stability. We find that higher overall ESG scores are associated with lower working capital requirements (WCR), while the environmental pillar exhibits a significant and negative relationship with the CCC. More sustainable firms also display shorter days of accounts receivable (DAR) and longer days of accounts payable (DAP), reflecting competitive advantages in managing customer and supplier relationships. Furthermore, ESG performance mitigates the association between financial constraints and WCM, suggesting that strong sustainability credentials enhance access to favorable financing terms and foster supplier trust, ultimately leading to more balanced WCM.

The remainder of the article is structured as follows: Section 2 presents our theoretical framework, reviews existing literature, and introduces the hypotheses to be tested. Section 3 describes the empirical part of the research: the dataset and empirical method. In Section 4, we report and discuss our results. Finally, Section 5 provides the main conclusions and suggests some directions for future research.

2. Literature Review

2.1 ESG and Working Capital Management

The importance of ESG factors in corporate finance has grown significantly, reflecting a stakeholder-driven shift toward ethical and sustainable business practices (Chouaibi & Zouari, 2022; Whelan et al., 2021). Stakeholder theory posits that long-term firm growth depends on understanding and addressing the needs of multiple constituencies, including shareholders, employees, customers, suppliers, and society in general (Freeman, 1984; Wang, 2024). From this perspective, the adoption of ESG practices not only reinforces investor–industry legitimacy (Clark & Dixon, 2024) but also cultivates enduring stakeholder support (Wang, 2024).

A substantial empirical literature documents that higher ESG performance enhances risk management, corporate reputation, and innovation, key drivers of sustainable competitive advantage (de Souza et al., 2024; Vishwanathan et al., 2020; Whelan et al., 2021). In particular, voluntary ESG disclosure has been shown to increase transparency, reduce information asymmetry, and improve borrowing costs, market valuations, and overall financial performance (Cho et al., 2013; Kong, 2023; Yang et al., 2018). These effects can be explained through the lens of signaling theory, which interprets ESG investments and disclosures as credible and observable indicators of low firm risk and high managerial quality, thereby enhancing investor and creditor confidence (Spence, 1978; Zhang, 2025). Meanwhile, legitimacy theory suggests that aligning firm operations with societal norms through ESG engagement enhances a firm's social license to operate and reduces reputational and regulatory obstacles (Clark & Dixon, 2024; Wang, 2024).

WCM translates these reputational and financing advantages into operational outcomes. Since working capital often represents a large share of a firm's invested

capital, efficient management of receivables, inventories, and payables mitigates financing costs, prevents production disruptions, and sustains customer service (Dhole et al., 2019; Nguyen & Van Nguyen, 2018; Sah et al., 2022; Sharma & Kumar, 2011; Zeidan & Shapir, 2017). Conversely, overinvestment in working capital can be counterproductive, it raises carrying costs and diminishes profitability (Palombini & Nakamura, 2012; Zeidan & Shapir, 2017). Identifying an optimal level of working capital investment is therefore critical for maximizing financial performance (Coelho, Lisboa, et al., 2024).

Despite the theoretical linkages, the empirical evidence on the ESG–WCM nexus remains mixed. Barros *et al.* (2022) and Karki *et al.* (2024) find that higher environmental and social ESG scores are associated with lower WCR in U.S. and Indian samples, respectively, Moin (2023), examining Swedish firms, reports no significant relationship between ESG and the CCC, but does observe a negative association between ESG and WCR. Coelho, Lisboa, *et al.* (2024) further identify an optimal CCC level that maximizes shareholder wealth in Europe, underscoring the value of component-level analysis. These disparate findings suggest that the effectiveness of ESG as a working capital signal may vary by market context, ESG pillar, and firm characteristics.

In this context of conflicting results, meta-analytic reviews provide additional nuance. Huang (2021) and Lu and Taylor (2016) document a positive yet economically modest, link between ESG and corporate financial performance, with stronger effects on operational metrics than on accounting or market-based measures. From this viewpoint, robust ESG practices may signal superior operational efficiency, enabling firms to streamline receivables, inventories, and payables, and thus maintain leaner working capital reserves. Accordingly, a negative association between ESG scores and working capital requirements is anticipated. However, agency theory offers a countervailing prediction: managers might deploy ESG initiatives opportunistically to obscure underperformance or further private agendas (Ferrell et al., 2016). Indeed, Di Giuli and Kostovetsky (2014) document instances in which elevated CSR ratings coincide with declines in firm profitability, implying that ESG expenditures can strain liquidity and compel higher working capital holdings. Under such agency-driven scenarios, ESG may be associated with longer CCC or higher WCR instead.

Nevertheless, it must be recognized that current ESG ratings exhibit notable shortcomings. Methodological heterogeneity across rating agencies, delays in updating data, and a reliance on backward-looking indicators can lead to misaligned scores with firms' actual, contemporary sustainability practices (Edmans, 2023). Moreover, greenwashing—whereby companies selectively emphasize "sustainable" actions without substantive change—can inflate ESG scores and obscure genuine behavior (Starks, 2023). These measurement challenges introduce error and potential bias into empirical analyses, suggesting that observed associations be interpreted cautiously and motivating the development of more standardized, forward-looking ESG metrics in future research.

In sum, signaling, stakeholder, and legitimacy theories predict that stronger ESG performance should be associated with leaner working capital management, whereas agency conflicts could reverse this association. To adjudicate between these competing perspectives, we formulate the following hypothesis, suggesting that firms with higher ESG performance are likely to optimize their working capital

management, reduce excess investment in short-term assets, and achieve greater liquidity efficiency:

$\boldsymbol{H_1}$**.** ESG scores have a negative relationship with working capital.

2.2 The role of Financial Constraints

Financial constraints, induced by information asymmetry and agency costs, raise the effective price of external capital, forcing firms to rely more heavily on internal cash flows (Altaf & Ahmad, 2019; Fazzari & Petersen, 1993). As a result, firms facing tighter financing conditions often maintain precautionary working-capital reserves, lengthening their CCC and increasing their WCR to safeguard liquidity (Baños-Caballero et al., 2014; Dhole et al., 2019).

The CCC and WCR serve as key indicators of working capital efficiency: reducing the CCC can enhance shareholder value, improve cash flow, and strengthen corporate liquidity, while optimizing WCR through effective inventory control and trade-credit management minimizes dependence on external funding (Deloof, 2003; Jalal & Khaksari, 2020; Tran et al., 2017; Zeidan & Shapir, 2017). However, in the presence of financing constraints, these metrics tend to reflect more conservative policies—higher CCC and WCR—to hedge against funding shortfalls.

Significantly, ESG performance can mitigate the impact of financial constraints through several interrelated mechanisms. According to signaling theory, transparent ESG disclosures and genuine sustainability investments reduce information gaps and risk premiums, thereby, improving terms with lenders and trade creditors. From a stakeholder theory perspective, strong ESG engagement deepens trust with suppliers, facilitates extended payment terms, and reassures investors regarding managerial stewardship, easing access to capital. Legitimacy theory further posits that aligning with societal and regulatory expectations through ESG practices reduces reputational and compliance barriers, thereby smoothing the path to external financing (Kong, 2023; Zhang et al., 2023). Empirical evidence corroborates these channels: firms with superior ESG ratings are shown to secure credit at lower costs and more favorable terms, ultimately reducing their reliance on internal liquidity reserves (Apergis et al., 2022; Atif & Ali, 2021).

When external financing becomes severely restricted, managers may defer long-term ESG investments to preserve immediate liquidity, limiting ESG's capacity to alleviate working-capital pressures (Schauer et al., 2019). However, because ESG disclosures complement traditional financial statements, enhancing transparency, reducing perceived risk, and strengthening stakeholder confidence, strong ESG performance can nonetheless offset the need for precautionary working capital reserves under constraint. On this basis, we posit that firms with higher ESG performance are better positioned to mitigate the adverse effects of financial constraints. By enhancing their credibility and trustworthiness in the eyes of investors and creditors, these firms can access resources more easily, thereby reducing the limitations that financial constraints impose on efficient working capital management. In turn, we propose the following hypothesis:

$\boldsymbol{H_2}$**.** ESG scores attenuate the impact of financial constraints on working capital.

3. Data, Variables, and Method

3.1 Sample Description and Variables

Our sample includes 4,212 firms from 65 countries[1], representing 19 sectors between 2010 and 2023, with 47,285 firm-year observations (Table 1). We obtain our data from the *Refinitiv Eikon* database. Financial firms are excluded due to their unique characteristics, allowing us to focus on publicly traded non-financial firms. Additionally, firms with fewer than seven observations for key variables, such as WCR, CCC, and ESG components, over the 14-year period were removed from the dataset.

We use two main measures of WCM: the CCC and the WCR. The CCC is widely recognized as a measure to assess the efficiency of WCM (Coelho, Oliveira, et al., 2024; Deloof, 2003; Prasad et al., 2019). It is defined as the lapse time between acquiring raw materials and collecting payment for finished goods. Thus, a longer CCC increases the investment in working capital. Prior studies have found a significant negative relationship between CCC and firms' profitability, suggesting that managers can create value for shareholders by reducing the CCC to a reasonable minimum level (Dong & Su, 2010; Habib, 2022). We also divide the CCC into its three components: days of accounts receivable (DAR), days of inventory (DI), and days of accounts payable (DAP).

The WCR is another important measure used to assess the efficiency of WCM. It represents the proportion of working capital in relation to a firm's sales and provides insight into how well a company is utilizing its short-term assets and liabilities. A lower WCR suggests more efficient management of working capital, as the firm can generate higher sales with less reliance on short-term financing. Prior research has established that a lower WCR is associated with improved operational efficiency and profitability (Barros et al., 2022; Moin, 2023; Yeboah & Kjærland, 2024).

Additionally, we also use the difference between a firm's CCC and WCR relative to the industry average (CCC_diff and WCR_diff) to capture specific firm-level effects that deviate from industry standards. Variables are winsorized at the 2.5% and 97.5% percentiles to minimize the impact of outliers.

The ESG scores provided by *Refinitiv Eikon* range from 0 to 100. These scores, which are adjusted by excluding controversy-related factors, are derived from self-reported information. In addition to the overall ESG metric, we also use the scores for each of the three pillars: environmental (ENV), social responsibility (SOC), and corporate governance (GOV).

[1] The countries included in the sample are: Argentina, Australia, Austria, Bahrain, Belgium, Bermuda, Brazil, Canada, Chile, Colombia, Cyprus, Czech Republic, Denmark, Egypt, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Jersey, Kazakhstan, Kenya, Korea, Kuwait, Luxembourg, Macau, Malaysia, Malta, Mauritius, Mexico, Monaco, Morocco, Netherlands, New Zealand, Norway, Oman, Peru, Philippines, Poland, Portugal, Qatar, Russia, Saudi Arabia, Singapore, South Africa, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States of America, Vietnam, Zimbabwe.

Table 1 Composition of the Sample by Region and Sector

	# firms	%	# obs.	%
Panel A. Sample distribution by region				
Africa	99	2.35	1,218	2.58
Asia	1,039	24.67	12,999	27.49
Europe	875	20.77	10,237	21.65
North America	1,771	42.05	17,925	37.90
Oceania	290	6.89	3,361	7.11
South America	138	3.27	1,545	3.27
Total	**4,212**	**100**	**47,285**	**100**
Panel B. Sample distribution by sector				
Accommodation and Food Services	89	2.11	962	2.03
Administrative and Support and Waste Management and Remediation Services	66	1.57	737	1.56
Agriculture, Forestry, Fishing and Hunting	20	0.47	196	0.41
Arts, Entertainment, and Recreation	26	0.62	297	0.63
Construction	187	4.44	2,192	4.64
Educational Services	12	0.28	130	0.27
Insurance	55	1.31	554	1.17
Health Care and Social Assistance	64	1.52	661	1.40
Information	360	8.55	3,913	8.28
Management of Companies and Enterprises	1	0.02	13	0.03
Manufacturing	1,633	38.77	18,497	39.12
Mining, Quarrying, and Oil and Gas Extraction	329	7.81	3,948	8.35
Other Services (except Public Administration)	16	0.38	156	0.33
Professional, Scientific, and Technical Services	251	5.95	2,561	5.42
Real Estate and Rental and Leasing	298	7.08	3,179	6.72
Retail Trade	252	5.98	2,924	6.18
Transportation and Warehousing	202	4.80	2,318	4.90
Utilities	209	4.96	2,452	5.19
Wholesale Trade	142	3.37	1,595	3.37
Total	**4,212**	**100**	**47,285**	**100**

To enhance the comparability of our research, following prior studies, we control for some factors that may influence WCM (Baños-Caballero et al., 2014; Barros et al., 2022; Coelho et al., 2024; Moin, 2023; Moussa, 2019; Sharma & Kumar, 2011). We incorporate firm size (SIZE), leverage ratio (LEV), current ratio (CR),

gross profit margin (GPM), and Tobin's Q (QTOBIN). Additionally, a dummy variable, DCRISIS, accounts for the COVID-19 pandemic period in the dataset, with a value of 1 for 2020 and 2021 and 0 for other years, following Boțoc and Anton (2017).

The industry in which a firm operates is a key factor influencing WCM, and there are significant variations in WCR across industries (Baños-Caballero et al., 2014; Jalal & Khaksari, 2020; Moussa, 2019). Thus, we control for industry-level factors by including a set of dummy variables based on the North American Industry Classification System (NAICS). We also control for country and time effects with two additional sets of dummy variables.

To test Hypothesis 2, the moderating effect of ESG scores on the relationship between financial constraints and working capital, we include financial constraints and their interaction with ESG scores in our analysis. We use three proxies to measure financial constraints: the K-Z index (FC1), firm size (FC2), and firm age (FC3). The K-Z index, developed by Kaplan & Zingales (1997), measures financial constraints based on factors like cash flow, assets, debt, dividends, and firm size (Table 2). Higher index values suggest more severe financial constraints, indicating reduced access to external financing and increased reliance on internal cash flow. This index is widely used in the literature (Chan et al., 2017; Schauer et al., 2019). In addition, Hadlock and Pierce (2010) found that the firm size and age are strong indicators of financial constraints. Accordingly, we take the inverse of size and age to define FC2 and FC3, such that higher FC1, FC2, and FC3 values reflect more significant financial constraints.

Table 2 reports a summary of the variables, symbols, and definitions.

Table 2 Overview of Variable Definitions

Description	*Symbol*	*Definition*
	Dependent variables	
Cash Conversion Cycle	CCC	No. of Days Accounts Receivable + No. of Days of Inventory - No. of Days Accounts Payable
No. of Days Account Receivable	DAR	(Accounts receivables/sales) x 365
No. of Days Inventory	DI	(Inventory / Cost of goods sold) x 365
No. of Days Account Payable	DAP	(Accounts payable / Cost of goods sold) x 365
Working Capital Requirements	WCR	(Receivables + Inventories - Payables) / Net sales
Difference in the Cash Conversion Cycle	CCC_dif	The difference between the firm's CCC and the industry average for each year
Difference in Working Capital Requirements	WCR_dif	The difference between the firm's WCR and the industry average for each year
	Independent variables	
ESG scores minus ESG controversies score	ESG	Overall company score based on self-reported information on the environmental, social, and corporate governance pillars.
Environmental pillar scores	ENV	Composite score based on three measures (resource use, emission reduction, and innovation)
Social pillar scores	SOC	Composite score based on four measures (workforce, human rights, community, and product responsibility)
Government pillar score	GOV	Composite score based on three measures (management, shareholders, and CSR strategies)
K-Z index	FC1	–1.001909*Cash flows / Total assets+ 0.2826389*TobinQ+3.139193*Debt / Total capital– 39.368*Dividends / Total assets–1.315*Cash / Total assets
Inverse size	FC2	- (Log of total assets)
Inverse age	FC3	- (Current year - year of incorporation)
	Control variables	
Firm size	SIZE	Log of total assets
Leverage ratio	LEV	Total debt / Total assets
Current ratio	CR	Current assets / Current liabilities
Gross profit margin	GPM	(Net sales - Cost of goods sold) / net sales
Tobin's *q*	QTOBIN	(Equity market capitalization + Total liabilities) / Total assets
Period of crisis	DCRISIS	Dummy variable that takes 1 for the years 2020 and 2021 and zero otherwise

3.2 Method

To explore the potential relationship between ESG scores and working capital, we estimate the following baseline equation (1). The ESG scores are introduced with a one-period lag to reduce concerns regarding simultaneity and reverse causality:

$$WCM_{it} = \beta_0 + \beta_1 ESG_{it-1} + \beta_2 Controls_{it} + YEAR + SEC + CTY + z_i + \varepsilon_{it} \quad (1)$$

Where WCM_{it} is the working capital management of the firm i, in the period t. The main explanatory variable is the lagged ESG score (ESG_{it-1}). $Controls_{it}$ is a vector of control variables, widely used in the literature. z_i refers to the fixed effects for each firm, and ε_i is the error term. YEAR, SEC, and CTY are sets of dummy variables to control for time, sector, and country effects.

To study the moderating effect of ESG on the impact of financial constraints, we estimate Equation (2), where ESG is treated as a continuous variable. This allows us to capture more granular interactions between ESG performance and varying degrees of financial constraints:

$$WCM_{it} = \beta_0 + \beta_1 FC_{it} + \beta_2 FC \cdot ESG_{it-1} + \beta_3 ESG_{it-1} + \beta_4 Controls_{it} + YEAR + SEC + CTY + z_i + \varepsilon_{it} \quad (2)$$

Since our dataset combines cross-sectional and time-series observations, we employ the panel data method to obtain more precise parameter inferences and effectively control for unobservable heterogeneity across individuals (Arellano & Bond, 1991; Bond, 2002; Hsiao, 2007). We run the variance inflation factor (VIF) to rule out multicollinearity among independent variables. Additionally, we apply the Wald heteroskedasticity test, the Wooldridge autocorrelation test, and the Hausman test. The results indicate that the robust fixed-effects model is the most suitable for addressing issues such as unobserved time-invariant heterogeneity, heteroskedasticity and autocorrelation (Moreno-Brieva et al., 2019). Our methodological choice is supported not only by the outcomes of the statistical tests but also by prior research employing similar approaches (Bajra & Wagner, 2024; Barros et al., 2022; Moin, 2023; Ng et al., 2023).

Additionally, we conduct a robustness check using Propensity Score Matching (PSM) to address potential selection bias. This method compares firms with similar observable characteristics but differing ESG levels, allowing us to isolate the average treatment effect of ESG performance on working capital. The matching is performed using nearest-neighbor estimation with replacement, and the propensity scores are obtained through a probit model that includes firm size, leverage, liquidity, profitability, and market valuation as covariates. Covariate balance was verified by a mean bias reduction of less than 5% and a pseudo R^2 value close to zero, indicating successful matching.

4. Results, Analysis, and Discussion

4.1 Descriptive Analysis

Table 3 presents the descriptive statistics, while Table 4 shows the pairwise correlations among the variables. During the study period, the CCC exhibits a mean (median) of 54 (50) days, indicating that, on average, firms in the sample take 54 days to convert their revenues into cash outflows; meanwhile, the WCR averages (median) 15.4% (12.9%) of sales. Regarding the components of the ESG score, the highest performance is observed in the governance pillar, with a mean (median) of 51.9 (53), whereas the environmental pillar scores the lowest, with a mean (median) of 41.3 (42.1) on a scale of 0 to 100. The control variables fall within expected ranges, consistent with conventional standards.

Table 3 Summary Statistics

Variable	*Obs.*	*Mean*	*Std. Dev.*	*Q25*	*Median*	*Q75*
CCC	32,467	54.403	84.069	5.991	50.186	100.141
DAR	37,545	45.889	46.869	10.875	38.445	64.589
DI	34,692	76.258	60.051	30.435	62.735	105.184
DAP	38,543	62.643	58.228	25.315	47.418	76.508
WCR	32,849	0.154	0.109	0.004	0.129	0.252
CCC_dif	27,882	0.499	62.073	-40.085	-1.499	37.241
WCR_dif	32,055	-0.013	0.099	-0.104	-0.032	0.051
ESG	46,442	45.923	20.091	30.244	46.066	61.479
ENV	46,602	41.337	29.076	13.903	42.184	66.142
SOC	46,433	48.604	24.400	29.034	48.247	68.629
GOV	46,586	51.923	22.479	34.285	53.058	70.166
SIZE	45,966	22.09	1.55	21.14	22.15	23.14
LEV	45,888	0.258	0.184	0.114	0.248	0.375
CR	45,888	1.872	1.365	1.055	1.498	2.224
GPM	37,785	0.377	0.200	0.215	0.352	0.535
QTOBIN	45,101	1.818	1.965	0.785	1.166	1.967

Notes: Number of observations, means, standard deviation and quartiles of the main variables.

This data aligns with prior research. The WCR in our study averages 15.4% of sales, a value comparable to 16.9% reported by Barros et al. (2022) and 22.4% observed by Moin (2023). Similarly, the CCC averages 51 days, which is lower than the 69 days documented for U.S. firms (Barros et al., 2022; Boisjoly et al., 2020), the 90-day mean found for European firms (Coelho, Oliveira, et al., 2024), and the 97-day average reported for Swedish companies (Moin, 2023). Regarding the components of the CCC, the average payable period, average receivable period, and average inventory duration are 62, 45, and 76 days, respectively, closely aligning with values reported by Banerjee et al. (2021).

Table 4 Correlation Matrix

Variables	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*
(1) CCC	1.00															
(2) DAR	0.37***	1.00														
(3) DI	0.69***	0.07***	1.00													
(4) DAP	-0.51***	0.04***	0.13***	1.00												
(5) WCR	0.36***	0.05*	0.07*	0.16**	1.00											
(6) CCC_dif	0.90**	0.37*	0.57	-0.49	0.37*	1.00										
(7) WCR_dif	0.35*	0.36	0.77	0.08	-0.05*	0.96	1.00									
(8) ESG	-0.10*	-0.01*	-0.04*	0.23**	0.03*	-0.15*	-0.20*	1.00								
(9) ENV	-0.14*	-0.07*	-0.01**	0.20*	-0.02*	-0.20*	-0.21*	0.82***	1.00							
(10) SOC	-0.07*	-0.07*	-0.05*	0.22*	0.10*	-0.10*	-0.10*	0.86***	0.74*	1.00						
(11) GOV	-0.07	-0.05*	0.01	0.16*	0.04*	-0.09*	-0.15*	0.65***	0.40*	0.44*	1.00					
(12) SIZE	0.22***	-0.04**	-0.11*	0.16*	-0.02**	-0.19*	-0.11*	0.41**	0.51**	0.41**	0.25**	1.00				
(13) LEV	0.12*	-0.02	0.10	0.06	0.04*	-0.04*	0.01*	0.07*	0.07*	0.08*	0.05*	0.27	1.00			
(14) CR	0.40*	0.07	0.28	-0.10*	0.05*	0.32*	0.07*	-0.15*	-0.19*	-0.14*	-0.10*	-0.28	-0.35	1.00		
(15) GPM	-0.09*	-0.13	0.22	0.22	0.16	0.18	0.12	0.01*	-0.06*	0.05*	0.01*	-0.02	0.05*	0.07	1.00	
(16) QTOBIN	0.10*	0.04	-0.10	-0.01	0.01*	0.06	0.03*	0.01	-0.02	0.03*	0.01	-0.15	-0.12	0.09*	0.12	1.00

Notes: Correlation matrix for the key variables in our analysis. ***, **, and * for 1%, 5%, and 10% significance level.

The ESG scores in our sample follow a pattern consistent with previous studies, with governance achieving the highest score and environmental performance the lowest. Likewise, Barros *et al.* (2022) identify governance as the strongest pillar (49.67) and the environmental component as the weakest (28.47). The mean financial leverage (25%) aligns with findings from similar studies, such as 25% for Swedish firms and 20% for Indian firms (Karki et al., 2024; Moin, 2023).

4.2 ESG Scores and WCM

Table 5 presents the estimates of Equation (1). As shown in Column 1, there appears not to be any relationship between the overall ESG scores and the CCC. When we divide the ESG scores into the three components (Columns 2–4), only the coefficient of the environmental pillar is significant, showing a negative relationship with the CCC.

Although the null finding for overall ESG and CCC might appear surprising, it is consistent with prior research, such as Barros *et al.* (2022), who did not find a statistically significant relationship between CCC and combined ESG scores. An explanation may be related to the distribution of the CCC variable. Boisjoly *et al.* (2020) have shown that working capital ratios, including CCC, often exhibit skewness and non-normality. These distributional characteristics may affect the validity of regression tests and could, at least partially, explain the lack of statistical significance in our findings. Additionally, improvements in WCM over time have led to a gradual reduction in CCC, introducing variability that may obscure a clear relationship between ESG scores and CCC. Therefore, the connection between ESG and CCC may be more complex than initially anticipated, with additional factors, beyond the scope of this analysis, potentially influencing this relationship.

Regarding WCR, Columns 5-8 of Table 5 indicate a negative association with total ESG scores, consistent with Barros *et al.* (2022) and Moin (2023). This suggests that firms with higher ESG scores tend to reduce their working capital investment requirements, enabling more efficient and profitable operations. Decomposition by pillar reveals that both environmental and social commitments drive this effect, consistent with the view that sustainable practices foster operational efficiencies and tighter resource management.

Given the lack of a significant association between the CCC and ESG, Table 6 disaggregates its components, namely days of accounts receivable (DAR), days of inventory (DI), and days of accounts payable (DAP), as dependent variables. Here, the story becomes clearer: higher ESG scores (both aggregate and pillar-specific) are significantly associated with shorter DAR and longer DAP, while showing no consistent relation with DI. These findings confirm H1 and show that ESG-strong firms both accelerate receivables collection, reflected in shorter DAR, and secure more favorable trade-credit terms, enabling them to negotiate extended payment periods with suppliers.

Table 5 Baseline Estimate: WCM and ESG Scores

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	CCC	***CCC***	***CCC***	***CCC***	***WCR***	***WCR***	***WCR***	***WCR***
ESG_{t-1}	-0.021				-0.003*			
	(0.497)				(0.056)			
ENV_{t-1}		-0.026*				-0.003**		
		(0.078)				(0.027)		
SOC_{t-1}			-0.026				-0.005**	
			(0.392)				(0.022)	
GOV_{t-1}				-0.005				-0.002
				(0.597)				(0.149)
SIZE	7.014***	7.091***	6.859***	6.932***	0.015***	0.015***	0.015***	0.015***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	15.994***	15.801***	16.013***	15.710***	0.014**	0.013**	0.013**	0.013**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.013)	(0.013)	(0.014)	(0.016)
CR	5.021***	4.985***	5.051***	5.031***	0.008	0.008	0.008	0.009
	(0.000)	(0.000)	(0.000)	(0.000)	(0.366)	(0.367)	(0.383)	(0.330)
GPM	-14.450**	-14.356**	-15.225***	-14.374**	-0.029***	-0.028***	-0.030***	-0.029***
	(0.050)	(0.051)	(0.039)	(0.050)	(0.001)	(0.001)	(0.001)	(0.001)
QTOBIN	0.127	0.123	0.149	0.122	0.002***	0.001***	0.001***	0.001***
	(0.679)	(0.687)	(0.625)	(0.688)	(0.000)	(0.000)	(0.000)	(0.000)
Intercept	-106.227	-107.773	-102.461	-105.472	-0.263	-0.261	-0.260	-0.259
	(0.005)	(0.004)	(0.007)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)
Obs.	20,152	20,216	20,144	20,312	20,131	20,188	20,114	20,182
Adj.-R^2	0.030	0.029	0.029	0.029	0.027	0.026	0.026	0.022
Hausman test	920.91***	900.43***	915.22***	900.43***	256.04***	247.86***	294.54***	247.86***

Notes: Coefficients (p-value) of the robust fixed effect estimation of robustness analysis. The dependent variable is CCC in Columns 1-4 and WCR in Columns 5-8. All the estimations include time, country and sector controls. ***, **, and * for 1%, 5%, and 10% significance level.

Table 6 Components of CCC and ESG Scores

	(1) *DAR*	*(2)* *DAR*	*(3)* *DAR*	*(4)* *DAR*	*(5)* *DI*	*(6)* *DI*	*(7)* *DI*	*(8)* *DI*	*(9)* *DAP*	*(10)* *DAP*	*(11)* *DAP*	*(12)* *DAP*
ESG_{t-1}	-0.014*				-0.002				0.138***			
	(0.084)				(0.226)				(0.000)			
ENV_{t-1}		-0.002*				-0.025*				0.132***		
		(0.081)				(0.092)				(0.000)		
SOC_{t-1}			-0.014*				-0.023				0.079***	
			(0.079)				(0.289)				(0.004)	
GOV_{t-1}				-0.010*				-0.006				0.056***
				(0.090)				(0.680)				(0.005)
SIZE	3.757***	3.723***	3.753***	3.733***	6.312***	6.448***	6.220***	6.322***	6.729***	6.472***	6.909***	7.023***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	1.816	1.777	1.770	1.793	16.541***	16.399***	16.689***	16.388***	3.935	4.026	4.188	3.647
	(0.106)	(0.112)	(0.115)	(0.109)	(0.000)	(0.000)	(0.000)	(0.000)	(0.288)	(0.276)	(0.262)	(0.326)
CR	0.174	0.174	0.186	0.174	0.982*	0.983*	1.008*	0.996*	-2.602***	-2.563***	-2.603***	-2.619***
	(0.290)	(0.288)	(0.257)	(0.287)	(0.079)	(0.077)	(0.069)	(0.075)	(0.000)	(0.000)	(0.000)	(0.000)
GPM	-3.599**	-3.526*	-3.649**	-3.586**	38.719***	38.718***	38.558***	38.795***	58.396***	57.843***	58.078***	57.850***
	(0.048)	(0.053)	(0.045)	(0.049)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
QTOBIN	0.456***	0.457***	0.453***	0.459***	-0.229	-0.228	-0.266	-0.234	0.005	-0.002	0.030	-0.004
	(0.000)	(0.000)	(0.000)	(0.000)	(0.426)	(0.427)	(0.352)	(0.415)	(0.983)	(0.992)	(0.903)	(0.986)
Intercept	-56.239	-56.267	-56.256	-56.012	-77.448	-79.174	-74.183	-77.552	-115.055	-108.513	-115.898	-116.54
	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.007)	(0.012)	(0.009)	(0.022)	(0.001)	(0.001)	(0.001)
Obs.	23,208	23,278	23,199	23,275	21,853	21,918	21,840	21,910	23,602	23,671	23,586	23,664
Adj.-R^2	0.035	0.034	0.035	0.035	0.069	0.069	0.068	0.069	0.055	0.056	0.054	0.053
Hausman test	334.49***	337.51***	420.69***	351.10***	725.08***	737.85***	703.16***	625.17***	707.97***	160.84***	137.04***	287.66***

Coefficients (p-value) of the robust fixed effect estimation of Equation 1. The dependent variable is DAR in Columns 1-4, DI in Columns 5-8 and DAP in Columns 9-12. All the estimations include time, country and sector controls. ***, **, and * for 1%, 5%, and 10% significance level.

These results align with prior research that has shown that voluntary ESG disclosure alleviates information asymmetries and strengthens creditor confidence. Kong (2023) and Yang *et al.* (2018) demostrate that such transparency enhance perceptions of a firm's solvency and responsibility, leading to more favorable credit terms. Additionally, the social dimension of ESG appears particularly influential in shaping supplier relationships. Ma *et al.* (2022) report that companies exhibiting strong corporate social responsibility are viewed more positively by their trading partners, who in turn grant those firms extended payment horizons. Longer days accounts payable (DAP) thus reflect a deliberate liquidity-management strategy. As Palombini and Nakamura (2012) argue, securing generous trade-credit terms enables firms to optimize cash flow and fund operations more flexibly.

The mechanisms underpinning these empirical patterns can be understood through two complementary theoretical lenses. Signaling theory suggests that, in environments characterized by information asymmetry, firms employ costly, observable actions, such as robust ESG initiatives and transparent reporting, to convey their operational quality credibly to stakeholders. Such signals reduce uncertainty, encouraging customers to pay plomptly and creditors to offer more favorable terms. Meanwhile, stakeholder theory posits that sustained value creation relies on fostering trust throughout a firm's entire network of stakeholders. From this perspective, strong ESG performance fosters deeper relationships with suppliers and customers alike, who reciprocate by accelerating their receivables and granting longer payablement terms. By integrating these theoretical perspectives, it is shown how ESG disclosure and performance jointly lead to two critical improvements in WCM: shorter cash collection periods and extended supplier credit. Together, these effects enable firms with strong ESG profiles to operate with leaner working capital and enhanced financial flexibility.

Control variables exhibit values consistent with existing literature. Larger firms (SIZE) tend to have higher WCR requirements and longer CCC, which may be attributed to the greater complexity of their operations or broader access to financial resources (Moin, 2023; Palombini & Nakamura, 2012). The results also indicate that financial leverage (LEV) and current ratio (CR) are positively related to CCC (though insignificantly with WCR), suggesting that higher liquidity may extend the CCC (Barros et al., 2022; Jalal & Khaksari, 2020). Conversely, the gross profit margin (GPM) exhibits a negative relationship with the CCC, as more profitable firms operate more efficiently and require shorter times to convert operations into cash (Barros et al., 2022). Finally, Tobin's Q is positively related to WCR, which could imply that firms with higher growth expectations adjust their working capital requirements to align with these projections.

4.3 The Role of Financial Constraints

Table 7 presents the estimates of Equation (2). As shown in Column 1, financial constraints measured by the K-Z index (FC1) are positively associated with CCC, suggesting that financially constrained firms experience longer CCC due to difficulties in managing working capital efficiently. However, the interaction term is negative and statistically significant, indicating that firms with high ESG scores can mitigate the adverse effects of financial constraints on CCC. This supports the

argument that ESG-oriented firms benefit from enhanced stakeholder trust, which facilitates better financing conditions and operational efficiencies (Wu et al., 2014).

Table 7 Financial Constraints and the Moderating Role of ESG Scores

	(1) CCC	(2) CCC	(3) CCC	(4) WCR	(5) WCR	(6) WCR
FC1	0.045*			0.002*		
	(0.073)			(0.078)		
*FC1 * ESG $_{t-1}$*	-0.008**			-0.001*		
	(0.065)			(0.063)		
FC2		-7.996***			-0.016***	
		(0.000)			(0.000)	
*FC2 * ESG $_{t-1}$*		0.021*			0.002*	
		(0.89)			(0.070)	
FC3			-2.651***			0.002***
			(0.001)			(0.000)
*FC3 * ESG $_{t-1}$*			-0.003**			-0.001*
			(0.049)			(0.059)
ESG $_{t-1}$	-0.015	0.465	-0.133***	-0.001	0.001	-0.001***
	(0.647)	(0.465)	(0.006)	(0.394)	(0.836)	(0.003)
SIZE	6.231***		7.554***	0.020***		0.015***
	(0.001)		(0.000)	(0.003)		(0.000)
LEV	16.682***	14.745***	13.316***	0.017	0.104	0.011**
	(0.000)	(0.000)	(0.002)	(0.157)	(0.081)	(0.039)
CR	4.819***	5.049***	4.994***	-0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.729)	(0.203)	(0.232)
GPM	-6.844	-9.710	-10.411	-0.030*	-0.023**	-0.019*
	(0.397)	(0.175)	(0.168)	(0.084)	(0.023)	(0.067)
QTOBIN	0.148	-0.023	0.190	0.006***	0.002***	0.001***
	(0.651)	(0.940)	(0.534)	(0.001)	(0.000)	(0.000)
Intercept	-82.319	-128.705	-233.560	-0.375	-0.261	-0.186
	(0.019)	(0.002)	(0.001)	(0.017)	(0.000)	(0.001)
Obs.	17,877	22,002	20,232	20,777	23,169	21,309
Adj.-R^2	0.028	0.028	0.028	0.035	0.021	0.022
Hausman test	798.08***	905.88***	856.37***	245.40***	335.05***	223.35***

Notes: Coefficients (p-value) of the robust fixed effect estimation of Equation 2. The dependent variable is CCC in Columns 1-3, and WCR in Columns 4-6. FC1 measures financial constraints using the K-Z index; FC2 and FC3 use the inverse of firm size and firm age, respectively. All the estimations include time, country and sector controls. ***, **, and * for 1%, 5%, and 10% significance level.

Further, Column 2 examines the impact of firm-size constraints (FC2, inverse firm size) and its interaction with ESG. The results indicate that smaller firms (those with higher FC2) have significantly lower CCC. This result, which aligns with prior

studies, may be attributed to more aggressive working capital policies aimed at minimizing financing costs (Attari & Raza, 2012; Boisjoly et al., 2020; Jabbouri et al., 2024; Uyar, 2009). Moreover, the positive and statistically significant interaction suggests that ESG attenuates the negative effect of size-related constraints on CCC, potentially reflecting a shift toward more conservative liquidity management among smaller ESG-oriented firms. Column 3 extends the analysis to firm-age constraints (FC3, inverse firm age), showing that younger firms (higher FC3) tend to have shorter CCC, consistently with Baños-Caballero et al. (2010) and Banerjee et al. (2021). Interestingly, the interaction term is negative and significant, suggesting that ESG practices reinforce the liquidity advantages of younger firms by further shortening their CCC. This finding may reflect how ESG enhances operational discipline and strengthens relationships with stakeholders, even among already agile firms, enabling more aggressive and efficient working capital strategies.

Columns 4–6 of Table 7 present the estimates for WCR. The results for FC1 and FC3 indicate that firms facing greater financial constraints tend to hold higher levels of WCR, likely as a precautionary measure to mitigate liquidity risks and ensure operational stability. This aligns with the argument that financially constrained firms have limited access to external financing and must rely more on internal liquidity reserves (Altaf & Ahmad, 2019; Baños-Caballero et al., 2014). However, the interaction term between FC and ESG suggests that stronger ESG performance helps alleviate this effect, leading to a reduction in WCR. Nevertheless, an exception is observed for FC2 (inverse firm size) in column 5, where the interaction term is positive and significant, indicating that ESG weakens the negative effect of size-related constraints on WCR—implying slightly more conservative liquidity management among smaller ESG-oriented firms. This finding supports the notion that firms with higher ESG engagement may experience improved stakeholder trust, enhanced creditworthiness, and better access to external funding, ultimately allowing for more efficient WCM (Apergis et al., 2022; Kong, 2023; Wu et al., 2014).

The overall picture from columns 1-3 of Table 7 appears inconsistent due to the opposing signs of the coefficients for the financial constraint variables (FC1, FC2, and FC3), as well as discrepancies among the interacted variables. To clarify this, and following our previous approach, we divide the CCC into its main components. Based on the results in Table 6, we focus on the days of accounts receivable (DAR) and days of accounts payable (DAP). This approach provides more insightful and consistent findings. Columns 1-3 of Table 8 show that financially constrained firms tend to collect payments from customers more rapidly, likely as a means of maintaining liquidity in a situation of financial constraints. However, the positive and significant interaction suggests that firms with strong ESG commitments extend their collection periods, potentially reflecting improved customer relationships and a reduced need for aggressive credit collection policies (Banerjee et al., 2021).

Table 8 Results Financial Constraints and the Moderating Role of ESG Scores (DAR and DAP)

	(1) DAR	(2) DAR	(3) DAR	(4) DAP	(5) DAP	(6) DAP
FC1	-0.002*			0.020*		
	(0.059)			(0.076)		
*FC1 * ESG $_{t-1}$*	0.003***			-0.009*		
	(0.000)			(0.054)		
FC2		-3.288***			0.086***	
		(0.000)			(0.000)	
*FC2 * ESG $_{t-1}$*		0.126**			-0.878**	
		(0.035)			(0.043)	
FC3			-0.845**			0.293***
			(0.012)			(0.0016)
*FC3 * ESG $_{t-1}$*			0.001*			-0.025***
			(0.072)			(0.000)
ESG $_{t-1}$	-0.015*	-0.118	-0.015	-0.273	-0.226	-0.351
	(0.099)	(0.282)	(0.242)	(0.273)	(0.181)	(0.295)
SIZE	3.577***		3.647***	7.473***		6.700***
	(0.000)		(0.000)	(0.000)		(0.000)
LEV	1.190	0.868**	0.848*	1.266	1.360	1.406*
	(0.329)	(0.042)	(0.060)	(0.174)	(0.161)	(0.076)
CR	0.032	0.145	0.141	-2.691***	-3.345***	-2.507***
	(0.160)	(0.135)	(0.169)	(0.000)	(0.000)	(0.000)
GPM	-3.076	-2.608*	-3.093**	5.376***	6.485***	6.192***
	(0.120)	(0.083)	(0.089)	(0.000)	(0.000)	(0.000)
QTOBIN	0.435***	0.444***	0.443***	-0.231**	-0.205	-0.013
	(0.000)	(0.000)	(0.000)	(0.036)	(0.216)	(0.484)
Intercept	-52.178	-45.422	-16.921	-73.325	-69.742	-80.178
	(0.000)	(0.000)	(0.092)	(0.000)	(0.000)	(0.085)
Obs.	21,236	25,372	23,168	21,070	25,797	23,583
Adj.-R^2	0.032	0.033	0.034	0.035	0.036	0.036
Hausman test	177.24***	112.39***	267.47***	124.37***	115.08***	142.00***

Notes: Coefficients (p-value) of the robust fixed effect estimation of Equation 2. The dependent variable is DAR in Columns 1-3 and DAP in Columns 4-6. FC1 measures financial constraints using the K-Z index, while FC2 and FC3 utilize the inverse of firm size and firm age, respectively. All the estimations include time, country, and sector controls. ***, **, and * for 1%, 5%, and 10% significance level.

In contrast, Columns 4-6 show that constrained firms delay payments to suppliers as a means of financing operations, consistent with the notion that trade credit serves as an alternative source of funding when access to bank credit is limited (Molina & Preve, 2012; Petersen & Rajan, 1997). However, the negative and significant interaction indicates that ESG-oriented firms are less reliant on extending payment terms, possibly due to their stronger reputation and trust-based supplier relationships, which enable more flexible financing arrangements (Wu et al., 2014).

These findings suggest that ESG scores may play a role in mitigating the adverse effects of financial constraints on WCM. Firms facing financial constraints often shorten DAR and extend DAP to manage liquidity effectively. However, high ESG scores appear to counteract these tendencies, enabling firms to operate with more balanced credit and payment policies. This suggests that sustainable business practices not only enhance corporate reputation but also improve financing conditions and operational efficiency, ultimately contributing to more effective working capital management.

Nevertheless, regarding WCR, inconsistencies apperar across the different metrics of financial constraints. While the results for the K-Z index and firm age support H2, the mixed findings for FC2 (which relates to firm size) suggest that the moderating effect of ESG may depend on the specific dimension of financial constraint being captured. Specifically, ESG appears to mitigate constraints when they stem from financing frictions (as measured by the K-Z index) or firm age, but not when they are associated with structural characteristics such as firm size. These mixed results further imply that the role of ESG in alleviating financial constraints is not uniform across firms and may vary depending on how such constraints are defined and operationalized.

4.4 Additional Analyses

To address potential sample heterogeneity, robustness was assessed via nearest-neighbor propensity score matching (PSM), a method commonly used to estimate average treatment effects and mitigate endogeneity bias arising from non-random treatment assignment and functional form misspecification (Shipman et al., 2017). Firms in the highest ESG tercile were designated as the treated group, and those in the lowest tercile as the control group; observations in the intermediate tercile were excluded. Propensity scores were estimated using a probit regression that included firm size, leverage, current ratio, gross profit margin, and Tobin's Q. Table 9 reports the average treatment effect on the treated (ATT) for both CCC and WCR in both unmatched and matched samples.

Table 9 Robustness Check: Results of Propensity Score Matching

Dependent variable	ESG High (Treated)	ESG Low (Control)	Difference (ATT)	Standard Error	t-static
CCC (Unmatched)	48.34	52.12	-3.78	1.01	-3.74***
CCC (Matched: Nearest Neighbor)	48.34	49.73	-1.39	0.81	-1.72*
WCR (Unmatched)	0.226	0.255	-0.029	0.010	-2.61**
WCR (Matched: Nearest Neighbor)	0.226	0.241	-0.015	0.008	-1.64*

Notes: Coefficients (p-value) of the treatment effect (ATT) estimation using the nearest neighbor matching method. The dependent variables are CCC and WCR, presented for both the unmatched and the matched samples. The propensity score was estimated using a probit regression model that included the following covariates: firm size, financial leverage, current ratio, gross profit margin, and Tobin's Q.

The Average Treatment Effect on the Treated (ATT) suggests that firms with higher ESG scores tend to exhibit a lower CCC and a slightly lower WCR. While the estimated effects are negative across both variables, they are only marginally statistically significant (p-values ≈ 0.08 for CCC and p ≈ 0.10 for WCR).

Covariate balance was assessed using the *pstest* command for both CCC and WCR; the results confirm appropriate matching quality for both variables (mean standardized bias = 2.3%; pseudo R^2 = 0.002).

Standard errors do not account for the variability in the estimated propensity scores.

In the unmatched sample, high-ESG firms exhibited a CCC that was 3.78 days shorter than low-ESG firms. After matching, the association narrowed to -1.39 days. For WCR, the unmatched ATT was -0.029, which decreased in magnitude to -0.015 following matching. Although point estimates were attenuated post-matching, the negative association between ESG scores and both working capital metrics remained at marginal levels of significance. Covariate balance was verified, yielding a mean standardized bias of 2.3% and a pseudo-R^2 of 0.002, indicating well-balanced matched samples. It is worth noting that the reported standard errors do not account for uncertainty in the estimated propensity scores. Overall, these PSM results corroborate the baseline findings by demonstrating that higher ESG performance is stably associated with leaner working capital requirements, even after explicitly controlling for observed heterogeneity across firms.

In Table 10, we present additional analyses using the values of CCC and WCR as dependent variables relative to the industry average. The results are even more precise than those reported above and corroborate H1, indicating a negative relationship between ESG and working capital. Both the overall ESG score, and the three pillars are significantly related to the excess of CCC and WCR relative to the industry average. In turn, firms with better sustainable practices operate more efficiently and require less working capital than their industry peers. Taken together, our findings confirm that ESG scores disclose relevant information, build a framework for relationships with customers and suppliers, and provide operational and financial advantages by reducing the CCC and WCR relative to the industry average.

Table 10 WCM Relative to the Industry Average and ESG Scores

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	CCC_dif	CCC_dif	CCC_dif	CCC_dif	WCR_dif	WCR_dif	WCR_dif	WCR_dif
ESG	-0.251***				-0.008***			
	(0.000)				(0.000)			
ENV		-0.220***				-0.006***		
		(0.000)				(0.000)		
SOC			-0.186***				-0.006***	
			(0.000)				(0.000)	
GOV				-0.135***				-0.005***
				(0.000)				(0.000)
SIZE	4.014	5.450	3.548	2.827	0.023***	0.025***	0.022***	0.019***
	(0.253)	(0.120)	(0.310)	(0.345)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	10.579***	10.339***	10.451***	11.180***	0.013**	0.012**	0.011**	0.015***
	(0.005)	(0.006)	(0.006)	(0.003)	(0.011)	(0.014)	(0.020)	(0.003)
CR	3.300***	3.375***	3.507***	3.336***	-0.001	-0.006	-0.005	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.230)	(0.385)	(0.410)	(0.308)
GPM	-12.942*	-13.697*	-12.170*	-12.796*	0.006	0.006	0.007	0.008
	(0.066)	(0.049)	(0.083)	(0.072)	(0.512)	(0.539)	(0.484)	(0.410)
QTOBIN	-0.203	-0.128	-0.248	-0.159	0.001***	0.002***	0.001***	0.002***
	(0.447)	(0.539)	(0.353)	(0.548)	(0.000)	(0.000)	(0.000)	(0.000)
Intercept	-28.058	-43.452	-26.774	-23.147	-0.187	-0.219	-0.185	-0.167
	(0.400)	(0.192)	(0.421)	(0.484)	(0.000)	(0.000)	(0.000)	(0.000)
Obs.	22,769	22,849	22,768	22,841	25,164	25,247	25,151	25,232
Adj.-R^2	0.027	0.028	0.025	0.024	0.044	0.035	0.034	0.031
Hausman test	438.41***	421.98***	460.98***	424.19***	226.92***	194.35***	334.53***	212.22***

Notes: Coefficients (p-value) of the robust fixed effect estimation of Equation 1. The dependent variable is CCC_dif in Columns 1-4, and WCR_dif in Columns 5-8. All the estimations include time, country and sector controls. ***, **, and * for 1%, 5%, and 10% significance level.

5. Conclusions

This study examines the relationship between ESG scores and WCM, emphasizing the role of financial constraints. Based on a sample of 4,212 publicly traded non-financial firms across 65 countries from 2010 to 2023, our analysis yields three key findings. First, higher ESG scores, driven mainly by the environmental and social pillars, are associated with improved operational efficiency, as reflected in reduced WCR. Second, disaggregating the CCC into days of accounts receivable (DAR) and days of accounts payable (DAP) reveals that firms with higher ESG scores

collect payments from customers more quickly (shorter DAR) and negotiate extended payment terms with suppliers (longer DAP), thereby enhancing their liquidity efficiency. Third, ESG performance appears to attenuate the impact of financial constraints on CCC and WCR, particularly when measured via the K-Z index and the firm age, suggesting that sustainability commitments enhance firms' ability to mitigate liquidity pressures through improved stakeholder trust and access to favorable financing. However, results for the firm size proxy are mixed, indicating that ESG may not uniformly moderate all types of constraints.

These findings make several contributions to the literature. By adopting a global sample and examining component-level WCM metrics, we extend prior work, focused mainly on single markets or aggregate measures, and demonstrate that the ESG–WCM link holds across diverse institutional contexts. Our results also address a gap concerning the interplay between ESG and financial constraints, showing that sustainability can serve as a strategic lever to mitigate financing frictions. Ultimately, by examing the distinct roles of environmental, social, and governance dimensions, we provide more granular insights into which ESG activities yield the most significant operational benefits.

From a managerial standpoint, our results underscore the value of integrating ESG into core financial strategies. Executives should view sustainability investments not merely as compliance costs but as enablers of more efficient working capital cycles and stronger supplier and creditor relationships. For investors and lenders, ESG metrics can serve as informative signals of liquidity resilience, guiding capital allocation and credit decisions. At the policy level, regulators and standard setters might consider tax incentives, concessional financing schemes, or mandatory disclosure requirements to encourage ESG adoption, given it demonstrated impact on operational efficiency and financial stability.

This study is subject to several limitations. First, our sample is confined to publicly listed firms, and the generalizability of results to small and medium-sized enterprises remains to be established. Second, ESG scores are treated as aggregated indices; future research would benefit from finer-grained measures that distinguish between sub-dimensions and the quality of disclosure. Edmans (2023) highlights inconsistencies across rating agencies, time lags in data, and backward-looking biases that can misrepresent current practices. Starks (2023) warns of greenwashing risk, where firms may promote superficial or selectively reported "sustainable" actions. Such measurement challenges indicate that the findings should be interpreted with caution and underscore the need for standardized, forward-looking ESG metrics in future research. Third, while we control for country and time effects, our global framework does not explicitly account for heterogeneity in economic development, regulatory environments, or cultural norms that may condition the ESG–WCM nexus.

To build on these insights, future research can explore the role of contextual factors, such as legal origin, governance quality, and cultural attitudes toward sustainability, in shaping the effectiveness of ESG initiatives. Investigating the joint impact of ESG and other intangibles (e.g., corporate culture, digital transformation) on liquidity management may further enrich our understanding of modern corporate finance. Finally, examining the dynamic evolution of ESG effects during periods of

economic stress or shocks would highlight the resilience-enhancing properties of sustainability under real-world disruptions.

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