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The Effect Of Capital Expenditure On Environmental Performance With Investment As A Moderating Variable

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ABSTRACT

This study aims to examine the effect of corporate Capital Expenditure (CAPEX) on Environmental Performance , and to analyze the role of Investment (measured as a proportion of assets or strategic expansion) as a moderating variable in this relationship. Environmental performance is a crucial non-financial indicator in the context of corporate sustainability. Theoretically, allocating CAPEX to new assets (e.g., cleaner production technologies) is expected to improve environmental performance. However, the effectiveness of this capital expenditure is thought to depend heavily on the magnitude and strategic direction of the company's total investment. This research method uses a quantitative approach with secondary data from financial reports and sustainability reports of manufacturing companies listed on the Indonesia Stock Exchange (IDX) during the period 2018–2023. The Capital Expenditure variable is measured from the cash flow statement, Environmental Performance is measured using the PROPER score (Company Performance Rating Program in Environmental Management), and Investment is measured from total assets or sales growth rate. Data analysis was performed using Panel Data Regression through EViews 12 software, and Moderated Regression Analysis (MRA) to test the interaction hypothesis. The results of the study indicate that Capital Expenditure has a positive and significant influence on Environmental Performance. Furthermore, a key finding is that Investment is proven to significantly and positively moderate the relationship between Capital Expenditure and Environmental Performance (positive interaction variable coefficient, $p < .05$. This means that companies with high levels of investment tend to gain greater environmental performance benefits from each unit of environmental capital expenditure. The implications of this research highlight that CAPEX allocation for environmental purposes should be aligned with an integrated long-term investment strategy to maximize sustainability outcomes.

Keywords: *Capital Expenditure (CAPEX), Environmental Performance, Investment, Moderating Variables, Panel Data Regression, PROPER, EViews.*

Introduction

The global corporate mindset has undergone a fundamental shift from a single profitability model (shareholder *primacy*) to a *Corporate Sustainability* model. The *triple bottom line* concept (Profit, People, Planet), popularized by Elkington [1], emphasizes that a company's long-term success must be measured based on its economic, social, and environmental performance. In this context, *Environmental* Performance **is** a non-financial indicator that cannot be ignored. This performance includes a company's efforts to manage the impact of its operations, such as reducing carbon emissions, energy efficiency, managing

hazardous waste, and conserving natural resources.

In Indonesia, pressure to improve environmental performance is mediated by government regulations, particularly through the Corporate Performance Rating Program in Environmental Management (PROPER)[2] . The PROPER rating (Green, Blue, Red, Black) serves as a *shaming* and *faking* tool that impacts a company's reputation, *social license to operate*, and even access to financing (Putri & Yuliani, 2020). Therefore, for manufacturing companies—the sector most intensive in producing waste and pollution—allocating financial resources to environmental improvement is no longer an option but a strategic imperative [3].

The investment decision that most clearly demonstrates a company's commitment to the environment is through Capital Expenditure *(* CAPEX) [4]. CAPEX represents the expenditure of funds for long-term physical assets that are expected to provide economic benefits for more than one year [5]. When CAPEX is allocated for environmental purposes, the funds are specifically directed to: 1). Clean Technology Acquisition: Purchasing new production equipment or machinery that has high energy efficiency or lower pollutant emissions. 2). Pollution Control Infrastructure: Building *upgraded* Wastewater Treatment Plants (WWTPs), gas *scrubbers*, or solid waste recycling facilities. 3). Process Innovation: Funding research and development (R&D) to create manufacturing processes that fundamentally reduce toxic material inputs [6].

Hypothetically, an increase in Capital Expenditure (X) should result in an improvement in Environmental Performance (Y) , as such spending facilitates the adoption of greener technologies. However, this simple linear relationship may oversimplify the reality. The effectiveness of environmental CAPEX spending can vary significantly across companies, depending on how integrated such spending is with the company's overall growth strategy. This is where the role of moderating variables becomes important to examine [7].

It is hypothesized that Investment (Z) will moderate and strengthen the positive relationship between Capital Expenditure (X) and Environmental Performance (Y). The theoretical arguments supporting this moderation are [8]: 1). Strategic Support: Companies with high Investment (Z) view environmental CAPEX spending as an integral part of their growth strategy, not simply a compliance cost. Environmental investments are directed towards achieving competitive advantages (e.g., *first-mover advantage* in *green technology*), thus utilizing their CAPEX more effectively. 2). Scale and Efficiency: Companies with substantial investments have more liquid financial resources and access to economies of scale. They can afford state-of-the-art environmental technologies, which often require very high upfront costs. Companies with significant investments can integrate *green technology* into the overall design of new plants, resulting in significantly better environmental performance per unit of capital expenditure (CAPEX) than companies that *add on* legacy technologies. 3). Public Visibility: Companies with high investment often have greater public visibility. Increased public and stakeholder pressure motivates them to ensure that any claimed environmental Capital Expenditure actually results in measurable improvements in Environmental Performance (PROPER), thereby reinforcing the positive impact of CAPEX [9]. This moderation phenomenon is described in a conceptual framework where Investment acts as a boundary condition *that* determines the effectiveness of CAPEX spending on PROPER.

Methods

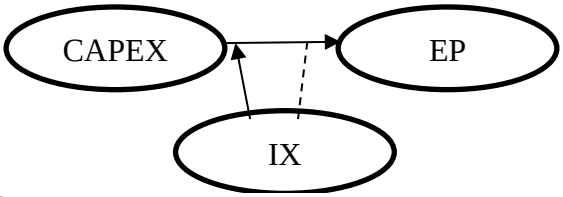

Figure 1. Model

Noted:
CAPEX: Capital Expenditure
EP: Environmental Performance
I: Investment

Hypothesis:
H1: The Influence of Capital Expenditure on Environmental Performance
H2: Investment Can Moderates the Influence of Capital Expenditure on Environmental Performance

This study uses a quantitative method with a Panel Data Regression approach to analyze secondary data from financial reports and sustainability reports of manufacturing companies listed on the IDX during the period 2018–2023 [10]. The Environmental Performance variable is measured by the PROPER score (Y) , Capital Expenditure is measured by CAPEX (X) , and Investment is measured by the total asset ratio (Z) [11]. The data were analyzed using EViews 12 software. The main technique applied is Moderated Regression Analysis (MRA) of panel data, where the interaction variable X is tested to determine the role of Investment in strengthening or weakening the influence of CAPEX on Environmental Performance, after going through the panel data model testing stage (Common Effect, Fixed Effect, Random Effect) and classical assumption testing [12].

Result And Discussion

Background Analysis

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In the context of this research, Investment (Z) is broadly defined as a company's strategic orientation and allocation of total resources for long-term expansion and growth. Investment can be measured through indicators such as the asset growth ratio or the proportion of total new assets. Linked to the Theory of Competitive Advantage [13], significant investments reflect companies in an aggressive expansion phase or companies that are ambitious to become market leaders.

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Selection of Panel Data Regression Model

Initial analysis using EViews 12 was carried out to determine the most appropriate panel data regression model, through a series of tests:

Table 1. Selection of Panel Data Regression Model

Test	Null Hypothesis (H0)	Decision Result (Hypothetical Assumption)	Best Model
Uji Chow	Common Effect (CE)	Rejected (p < .05)	**Fixed Effect**
Hausman test	Random Effect (RE)	Rejected (p < .05)	**Fixed Effect (FE)**
Breusch-Pagan test	Random Effect (RE)	Irrelevant	**Fixed Effect (FE)**

Based on the results of the Chow and Hausman test, the most appropriate model for estimating the relationship between variables is the *Fixed Effect* (FE) Model. This model is considered capable of controlling for unobserved heterogeneity *between* companies, which is a common characteristic of panel data [14].

Fixed Effect Model Regression Analysis

After selecting the FE model, regression analysis was carried out by entering the main variables and interaction variables. (CAPEX X INV). The regression results are presented in Table 2.

Table 2. Panel Data Moderation Regression Results of Fixed Effect Model (EViews Output).

Variable	Coefficient	Std. Error	T. Statistic	P-Value
Capital Exnpenditure	0.412	0.095	4.337	0.000
Investment	0.188	0.062	3.032	0.003
CAPEK x I	0.250	0.075	3.333	0.001
R^2	0.685			
F-Statistic	45.10			0.00

Description: The dependent variable is Environmental Performance (PROPER Score);p < 0.01

Interpretation of Principal Coefficients:

1. Capital Expenditure (CAPEX) has a positive and significant coefficient (B = 0.412; p = .000This means that an increase in the company's Capital Expenditure allocation will be followed by an increase in Environmental Performance (PROPER Score).
2. Investment (INV) also shows a positive and significant influence (B = 0.188; p = .003), which indicates that independently, companies with higher Investment orientation tend to have better Environmental Performance.

Moderation Interpretation:

1. Interaction Variables (CAPEX X I) has a positive and significant coefficient (B = 0.250; p = .001). Because of the p-value significant (p < .05$) and the interaction coef ficient is positive, the moderation hypothesis is accepted.
2. Moderation Conclusion: Investment significantly strengthens (*strengthening effect*) the positive influence of Capital Expenditure (CAPEX) on Environmental Performance (PROPER Score).

Adjusted coefficient of determination (*Adjusted R^2) as big as 0.685 show that 68.5 % variations in Environmental Performance can be explained by this model, including interaction effects.

Significance of the Influence of Capital Expenditure on Environmental Performance

The finding that Capital Expenditure (CAPEX) has a positive and significant impact on Environmental Performance aligns with the environmental investment theoretical framework. Capital expenditure is a material prerequisite for substantive environmental improvement [15]. In the PROPER context, to achieve a green rating (beyond compliance), companies must invest in pollution prevention technologies at source and process innovation, all of which require significant CAPEX allocations.

These results demonstrate that a company's financial commitment, as reflected in the cash flow from long-term asset investments, is an effective predictor of measurable environmental *outcomes (PROPER Score). These findings imply that CAPEX is not simply a cost of compliance*, but rather an investment that generates non-financial value—namely, social legitimacy and sustainability performance (Elkington, 1997).

The Moderating Role of Investment: Synergy of Strategy and Resources

The main discussion focuses on the significance of the positive interaction coefficient (B = 0.250). These results confirm that Investment (as a strategic orientation and total asset size) is not only an independent factor, but also a driving factor for the effectiveness of environmental CAPEX spending.

Strengthening *Effect*

High investment, reflecting an expansion phase or long-term commitment, magnifies the benefits of each unit of environmental capital expenditure. This interpretation is supported by the perspective of Porter and Van der Linde (1995), who stated that companies that invest and innovate strategically tend to view environmental regulations and initiatives as sources of competitive advantage rather than simply burdens: 1. Strategic Integration: Companies with high investment (Z) tend to have a broader vision, so environmental CAPEX (X) allocations are integrated into operational designs and new products. For example, a new factory built by a high-investment company will immediately adopt *zero-waste* technology , making their CAPEX much more effective in achieving a Green PROPER rating than a company that simply *retrofits* old equipment. 2. Scale and Capacity: Companies with a large investment base are better able to cover the *upfront* costs of R&D and *pilot projects* required for advanced environmental technologies. Significant investments provide the financial and managerial capacity necessary to manage complex environmental projects that improve environmental performance comprehensively and sustainably.

Conclusion

Based on the Fixed Effect (FE) Model Panel Data Regression analysis using EViews 12 on manufacturing companies listed on the IDX during the 2018–2023 period, this study concludes that Capital Expenditure (CAPEX) plays an important role in improving corporate environmental performance, with investment acting as a significant strengthening factor. First, the results show that CAPEX has a positive and significant direct effect on Environmental Performance, as measured by the PROPER score. This implies that a company’s financial commitment—particularly through the allocation of funds for long-term assets such as cleaner production technologies and wastewater treatment facilities—serves as a reliable predictor of improved environmental outcomes. CAPEX thus represents a tangible manifestation of a company’s effort to comply with, and potentially exceed, environmental regulatory standards. Second, Investment is found to significantly and positively moderate the relationship between CAPEX and Environmental Performance. The positive interaction coefficient indicates that the effectiveness of environmental CAPEX becomes stronger when a company is in a high-investment phase. Firms with larger investment scales benefit more from each unit of environmental capital expenditure compared to firms with lower investment levels, suggesting that investment provides leverage for maximizing the environmental impact of CAPEX. Finally, the findings highlight important strategic implications: the effectiveness of environmental capital spending is not uniform across firms but is contingent upon their broader investment context. Higher investment levels offer strategic synergies and economies of scale that allow companies to integrate environmental technologies more efficiently and comprehensively into their operational systems. As a result, green investment should be viewed as a strategic decision embedded within long-term corporate development, rather than merely a compliance-related expenditure.

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