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# The relationship between ecological accounting information and financial performance through the moderating role of business sector

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**Abstract:** The study aims to analyze the relationship between the use of ecological accounting information and financial performance in Vietnamese enterprises and consider the moderating role of the business sector. Data were collected from enterprises operating in various fields such as manufacturing, services, and trade, thereby assessing the level of application of ecological accounting information in the decision-making process and financial management. The results of the study show that the use of ecological accounting information has a positive impact on the financial performance of enterprises by controlling environmental costs, improving operational efficiency, and enhancing compliance with legal requirements related to environmental protection. However, the business sector factor does not show a statistically significant difference in this relationship, meaning that the impact of ecological accounting information on financial performance is similar across types of enterprises. This finding demonstrates the role of ecological accounting in financial management, regardless of the field of operation, and suggests policy and practice recommendations to promote the wider application of ecological accounting in Vietnamese enterprises.

***Keywords:*** *Decisions, Ecological accounting, Information, Managers.*

## 1. Introduction

In the context of increasing awareness of sustainable development and social responsibility, ecological accounting information is increasingly seen as an important tool to support businesses not only in controlling environmental impacts but also in improving financial performance. Integrating environmental costs and benefits into the accounting system helps businesses more fully reflect the risks and opportunities related to natural resources.

When environmental costs are identified, measured and reported transparently, managers have the basis to make more effective decisions in optimizing costs, improving operational efficiency and improving the business image in the eyes of stakeholders - thereby positively affecting overall financial performance.

The relationship between ecological accounting and financial performance is not simply a direct or inverse relationship, but a complex interactive relationship. When properly implemented and integrated into the development strategy, ecological accounting can contribute positively to improving financial performance through cost control, improving operational efficiency and creating sustainable competitive advantage. However, the relationship between ecological accounting information and financial performance is not completely uniform across businesses, but may be subject to significant regulation by the business sector. Industries with high environmental impacts such as manufacturing, resource extraction or energy are often under greater pressure to implement eco-accounting, which demonstrates a clear link between the


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quality of environmental information and financial performance. In contrast, in service or information technology industries – where environmental impacts are lower – this relationship may be less pronounced. Therefore, the business sector plays an important role as a moderator, influencing how and to what extent eco-accounting information impacts corporate financial performance.

## 2. Theoretical Basis

According to Bebbington, et al. [1] ecological accounting is defined as a comprehensive approach to integrating environmental issues into the accounting system, including new branches of accounting that address environmental impacts within the context of a defined economic system [2]. In a broad sense, ecological accounting provides records and summaries of the physical interactions between business activities and the natural environment. Similar to traditional accounting systems, ecological accounting performs the basic functions of collecting, classifying, recording, analyzing and reporting data. However, the key difference is that environmental impacts are not quantified in monetary units but in physical units, such as kilograms of $CO_2$ emitted. Most current assessment methods convert these physical units into artificial indicators, such as ozone depletion potential, to indicate the environmental impact of a particular activity. Ecological accounting is closely linked to the perspective of ecological economics – a new development school that arises from the need to rationally use natural resources, optimize ecosystems and from a deep understanding of the relationship between society and nature. This perspective reflects the awakening to the resource and environmental crises, emphasizing the harmony between economic development and sustainable operation of the ecological environment. In this context, the construction of environmental information systems, such as environmental statistics and green GDP calculation, plays an important role in quantifying and integrating environmental factors into the economic decision-making process. Historically, ecological accounting is viewed as an extension of financial accounting, emerging when the traditional accounting system reaches a certain stage of development. In its early stages, ecological accounting focused mainly on adjusting financial accounting entries to accurately reflect environmental costs incurred. However, with the increasing awareness of the community and authorities on the importance of environmental protection, ecological accounting gradually developed into a relatively independent system of theory and methods. This is an interdisciplinary field, combining accounting, sociology and environmental science, acting as part of the current accounting system or as a supplementary accounting system. In the context of sustainable development, ecological accounting not only expands the scope of traditional accounting but also plays a role in regulating development strategies and providing tools to control the environmental impacts of enterprises. Thereby, the accounting system has a new function in supporting decision-making towards the harmony between economic development and environmental protection.

Ecological accounting helps businesses identify and control potential environmental costs, such as waste disposal costs, legal compliance costs, and risks arising from environmental regulatory violations. By recording and analyzing physical data (e.g. emissions, energy, water, and raw material consumption), businesses can optimize production processes and minimize waste, thereby reducing operating costs and improving profit margins. The application of ecological accounting can enhance the image of a business, increasing the trust of investors, customers, and the community. In the context of investors increasingly interested in ESG (Environmental, Social and Governance) criteria, transparency in environmental impact reporting helps businesses access capital more easily, with lower capital costs and higher financial mobilization capacity. Ecological accounting supports businesses in orienting long-term strategies, in line with the requirements of sustainable development. Instead of focusing solely on short-term profits, businesses use ecological accounting to make investment and production decisions based on environmental costs and benefits, contributing to long-term financial stability Cholily, et al. [3] believes that the role of ecological accounting is important because it is how organizations react and respond to environmental changes to increase their competitiveness and organizational performance. Previously, in a 2015 study, Gunarathne and Lee [4] also pointed out the contribution of ecological accounting

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information in improving operational efficiency through emission reduction. Hojnik and Ruzzier [5] studied companies in Slovenia to examine the relationship between ecological accounting and managerial performance. The results showed that ecological accounting has a positive relationship with managerial decision making, economic performance and competitive advantage. With similar results, in a study of businesses in China, Chen, et al. [6] also examined the relationship between ecological accounting and corporate financial performance. The research results have shown that there is a positive relationship between ecological accounting, financial performance and business performance. However, the level of ecological information in different business sectors will be different, so the author finds that the business sector is a factor affecting the financial performance in enterprises with a need to use ecological accounting information more or less. Building on previous studies, the author hypothesizes:

*$H_1$: Ecological accounting information has a positive impact on financial performance in Vietnamese enterprises*

*$H_2$: The relationship between ecological accounting information and financial performance in Vietnamese enterprises is moderated by business sector*

Based on various studies conducted previously, several variables were applied in this study to measure the impact of ecological accounting information on financial performance. Ecological accounting information is accepted as an independent variable with three observed variables, according to Schaltegger and Figge [7], including Internal ecological accounting information (ST1), External ecological accounting information (ST2), Other ecological accounting information (ST3).

Based on previous studies by Scarpellini, et al. [8]; Sainaghi, et al. [9] and Wang, et al. [10] the financial performance of enterprises is measured by 03 variables, including Return on total assets (FE1); Return on common equyty (FE2), Return on Sales (FE3).

Thus, in this study, the relationship between ecological accounting information and financial performance in Vietnamese enterprises is moderated by the variable "Business sector". The variable "Business sector" is divided into 3 groups: trade (NN1), service (NN2) and manufacturing (NN3). From the theoretical model, it is identified that this is a model of intermediate variables explained by moderating variables. In the statistical model, group NN1 is used as the basis for comparison. Therefore, the arrows affecting the decision include NN2 x ST and NN3 x ST (assessing the moderating role).

## 3. Research Model

In this study, the author applied the probability sampling method to collect data through questionnaires distributed directly and indirectly through personal relationships. To ensure the reliability of the collected data, the survey subjects were carefully selected, including senior managers such as General Directors, Directors, Deputy Directors, and Financial Directors; middle managers such as Chief Accountants, Department Heads, and Deputy Department Heads of Finance; along with management accounting and general accounting experts at enterprises. Each individual is considered a representative of the enterprise in which they are working. The study focused on businesses operating in three main sectors: manufacturing, trade and services. Of the total 165 surveys, by size, by size: Medium enterprises (10 - 100 people): Accounting for 45,1%, the largest group. Next is large enterprises (100 - 200 people): Accounting for 25,8%. Very large enterprises (over 200 people): Accounting for 13,8%, equal to the small enterprise group. Small enterprises (under 10 people): Accounting for 15,3%, the lowest among the groups. By sector, the service group (44,2%) accounts for the highest proportion. Next is the manufacturing group (31,8%) and the trade group (24,0%).

From the original data table, transform the categorical variable NN into three dummy variables NN1, NN2 and NN3 in binary form. Choose NN1 as the basis for comparison to create two interaction variables, which are ST x NN2 and ST x NN3.

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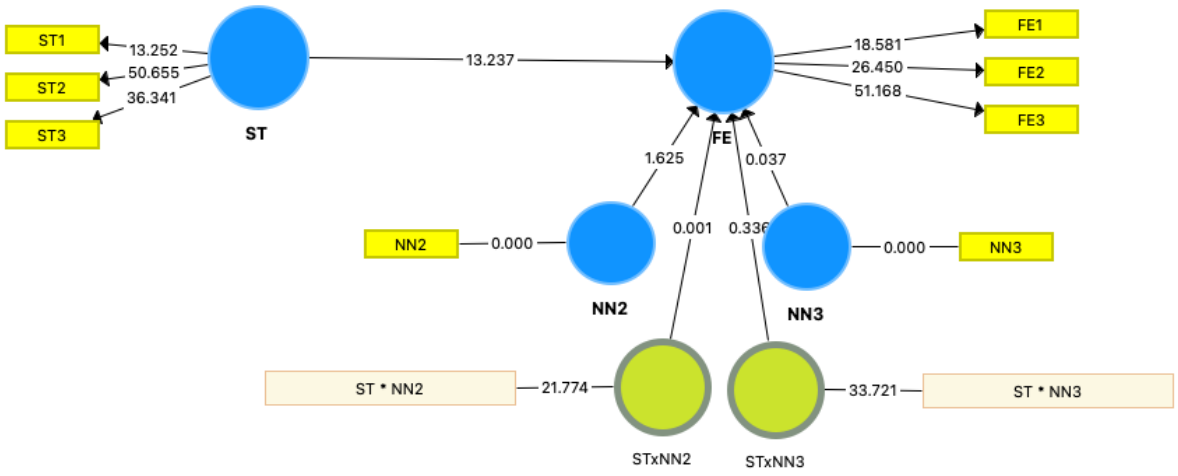


**Figure 1.**
Research model.

## 4. Research Results

### *4.1. Measurement Model Analysis*

According to Hair Jr, et al. [11] the observed variables related to quality need to have an external factor loading of at least 0.7. Six observed variables have factor loadings higher than 0.7, so all six observed variables (ST1, ST2, ST3, FE1, FE2, FE3) are considered to be of high quality based on the survey findings.

**Table 1.**
Outer Loadings.

| | FE | NN2 | NN3 | ST | STxNN2 | STxNN3 |
|---|---|---|---|---|---|---|
| FE1 | 0.781 | | | | | |
| FE2 | 0.805 | | | | | |
| FE3 | 0.895 | | | | | |
| NN2 | | 1.000 | | | | |
| NN3 | | | 1.000 | | | |
| ST * NN2 | | | | | 1.059 | |
| ST * NN3 | | | | | | 0.951 |
| ST1 | | | | 0.773 | | |
| ST2 | | | | 0.904 | | |
| ST3 | | | | 0.882 | | |

Then, the author evaluates the reliability of the scale after ensuring the quality of the observed variables. Cronbach's Alpha and Composite Reliability are two basic metrics used to evaluate the reliability of the variables of the measurement model. Many scholars, including Hair Jr, et al. [11] and Bagozzi and Yi [12] agree that 0.7 is an appropriate assessment criterion. In this study, ecological accounting information and financial performance both have Cronbach's Alpha and Composite Reliability values higher than 0.7. Therefore, the scales used in the study ensure validity.

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**Table 2.**
Construct Reliability and Validity.

| | Cronbach's alpha | rho_A | Composite reliability | Average variance extracted (AVE) |
|---|---|---|---|---|
| FE | 0.769 | 0.779 | 0.867 | 0.686 |
| NN2 | 1.000 | 1.000 | 1.000 | 1.000 |
| NN3 | 1.000 | 1.000 | 1.000 | 1.000 |
| ST | 0.815 | 0.833 | 0.891 | 0.732 |
| STxNN2 | 1.000 | 1.000 | 1.000 | 1.000 |
| STxNN3 | 1.000 | 1.000 | 1.000 | 1.000 |

The author uses the average variance extracted (AVE) index to assess convergence. According to Back-Hock [13] if the AVE is 0.5 or greater, the scale exhibits convergent validity. Both ecological accounting information and financial performance have AVE values greater than 0.5 (Table 2). Therefore, the convergence of the variables is acknowledged.

To assess the discrimination level of measurement models, the author evaluated cross-loading coefficients, evaluated HTMT coefficients, and performed Bootstrap tests on HTMT coefficients.

**Table 3.**
Cross Loadings.

| | FE | NN2 | NN3 | ST | STxNN2 | STxNN3 |
|---|---|---|---|---|---|---|
| FE1 | 0.781 | -0.012 | -0.075 | 0.516 | -0.020 | -0.064 |
| FE2 | 0.805 | 0.067 | -0.098 | 0.514 | 0.150 | -0.169 |
| FE3 | 0.895 | -0.021 | 0.009 | 0.607 | 0.117 | -0.102 |
| NN2 | 0.012 | 1.000 | -0.505 | -0.134 | -0.109 | 0.116 |
| NN3 | -0.062 | -0.505 | 1.000 | -0.011 | 0.104 | -0.006 |
| ST * NN2 | 0.102 | -0.109 | 0.104 | 0.153 | 1.000 | -0.510 |
| ST * NN3 | -0.134 | 0.116 | -0.006 | -0.187 | -0.510 | 1.000 |
| ST1 | 0.478 | -0.116 | 0.007 | 0.773 | 0.122 | -0.139 |
| ST2 | 0.615 | -0.107 | -0.023 | 0.904 | 0.108 | -0.175 |
| ST3 | 0.592 | -0.124 | -0.009 | 0.882 | 0.164 | -0.164 |

The out-of-item loadings are all greater than the cross-item loadings according to Table 3. Thus, the first step in assessing the level of discrimination accuracy is assured. Henseler, et al. [14] presented the HTMT index, stating that discriminant validity is guaranteed if the value is less than 0.9. The HTMT index of ST and FE is 0.829, as shown in Table 4. Therefore, all variables have discriminant validity.

**Table 4.**
HTMT.

| | FE | NN2 | NN3 | ST | STxNN2 | STxNN3 |
|---|---|---|---|---|---|---|
| FE | | | | | | |
| NN2 | 0.046 | | | | | |
| NN3 | 0.084 | 0.505 | | | | |
| ST | 0.829 | 0.150 | 0.017 | | | |
| STxNN2 | 0.132 | 0.109 | 0.104 | 0.170 | | |
| STxNN3 | 0.154 | 0.116 | 0.006 | 0.207 | 0.510 | |

Bootstrap 95% confidence interval was applied to perform the test. Observing the values of the two columns 2,5% and 97,5%, it shows that the HTMT values of ST and FE in the 95% interval are less than

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1. Therefore, the analysis results conclude that the measurement indexes for ST and FE achieve a level of discrimination accuracy.

**Table 5.**
Confidence Intervals Bias Corrected.

| | Original Sample (O) | Sample Mean (M) | Bias | 2.5% | 97.5% |
|---|---|---|---|---|---|
| NN2 -> FE | 0.103 | 0.103 | 0.000 | -0.014 | 0.228 |
| NN3 -> FE | -0.003 | -0.006 | -0.003 | -0.138 | 0.142 |
| ST -> FE | 0.671 | 0.679 | 0.008 | 0.550 | 0.750 |
| STxNN2 -> FE | 0.000 | 0.001 | 0.001 | -0.117 | 0.111 |
| STxNN3 -> FE | -0.022 | -0.019 | 0.002 | -0.167 | 0.094 |

*4.2. Structural Model Analysis*

According to Hair Jr, et al. [11] the model is highly likely to have multicollinearity if the VIF is greater than or equal to 3. According to the analysis results, the obtained VIF coefficients are all less than 3, indicating that the model does not have multicollinearity.

**Table 6.**
Inner VIF Values.

| | FE | NN2 | NN3 | ST | STxNN2 | STxNN3 |
|---|---|---|---|---|---|---|
| FE | | | | | | |
| NN2 | 1.394 | | | | | |
| NN3 | 1.373 | | | | | |
| ST | 1.063 | | | | | |
| STxNN2 | 1.377 | | | | | |
| STxNN3 | 1.390 | | | | | |

The results of the structural model analysis show that the P-Values of the impacts (ST -> FE) are less than 0.05, so these impacts are statistically significant. Specifically, the results of PLS-Sem confirm that ecological accounting has a positive impact on the financial performance of Vietnamese enterprises, supporting hypothesis H1.

**Table 7.**
Path Coefficients.

| | Original Sample (O) | Sample Mean (M) | Standard Deviation (STDEV) | T Statistics (\|O/STDEV\|) | P Values |
|---|---|---|---|---|---|
| NN2 -> FE | 0.103 | 0.103 | 0.063 | 1.625 | 0.105 |
| NN3 -> FE | -0.003 | -0.006 | 0.070 | 0.037 | 0.970 |
| ST -> FE | 0.671 | 0.679 | 0.051 | 13.237 | 0.000 |
| STxNN2 -> FE | 0.000 | 0.001 | 0.059 | 0.001 | 0.999 |
| STxNN3 -> FE | -0.022 | -0.019 | 0.064 | 0.336 | 0.737 |

To evaluate the impact of one or more independent variables on a dependent variable in the SEM model, the author uses the adjusted R square index. The adjusted R square of FE is 0.43, so the independent variable (ST) explains 43% of the variation (variance) of the FE variable. In addition, to evaluate the importance of the independent variable on the dependent variable, Cohen [15] proposed the f square index. The f square index of ST on FE is 0.767, so this impact level is considered large.

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In the case of using NN1 as a basis for comparison, the results are shown in Table 7. The P-Values result shows that there is no difference in financial performance between the NN2 and NN1 groups, and there is no difference in financial performance between the NN3 and NN1 groups. Whether the relationship between ecological accounting information and financial performance in Vietnamese enterprises will vary by business sector or not is shown in Table 7. The analysis results show that the P-Values are all greater than 0.05, so this relationship is not statistically significant. That is, the relationship between ecological accounting information and financial performance in Vietnamese enterprises is not affected by business sector. Or the hypothesis H2 is rejected.

## 5. Conclusion

The research results support hypothesis H1 and reject hypothesis H2. That is, ecological accounting information has a significant positive impact on the financial performance of Vietnamese enterprises. Ecological accounting is important because it is the way organizations respond and cope with environmental changes to increase their competitiveness and organizational performance. Ecological accounting information in improving operational efficiency through emission reduction. In the context of green economic development, combined with the unique geographical characteristics of the region, Vietnamese business managers are interested in ecological accounting information to make business decisions. By recording, measuring and analyzing costs and impacts related to the environment, ecological accounting helps businesses clearly identify potential costs, thereby better controlling the process of resource use and minimizing waste. This information not only supports the management board in making effective management decisions but also contributes to improving the image and reputation of the business in the market, especially in the context of consumers and investors increasingly interested in sustainable development.

However, the research results also show that the relationship between ecological accounting information and financial performance in enterprises in Vietnam does not differ significantly between business sectors. Whether enterprises operate in the manufacturing, service or trading sectors, the use of ecological accounting information in the management decision-making process still plays an important and relatively consistent role. This shows that, regardless of industry characteristics, managers are still aware of the importance of integrating environmental information into the accounting system to support cost analysis, risk assessment and sustainable development strategy planning. This fact also reflects the general trend in modern business management, when environmental factors are no longer a problem of the manufacturing industry alone but have become a concern throughout the entire business operation. Therefore, the implementation of ecological accounting is considered a tool of universal value, which can be effectively applied to many different types of businesses without being limited by a specific field of operation.

To improve the use of ecological accounting information in enterprises, it is necessary to first focus on raising awareness among leaders and staff about the importance of environmental accounting for financial efficiency and sustainable development. Enterprises should organize training programs and seminars to disseminate knowledge, and at the same time include ecological accounting content in internal training programs. In addition, integrating ecological accounting into the internal accounting system is a key factor. Enterprises need to develop appropriate indicators, accounts and tools to fully reflect the costs and environmental impacts in the production and business process, such as applying activity-based cost accounting or product life cycle accounting. In addition, the application of modern information

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technology and software will help the process of collecting, analyzing and reporting ecological information become more accurate and effective. Enterprises also need to develop internal policies to encourage environmentally friendly activities, integrate ecological criteria into the process of evaluating work performance and rewarding. These solutions not only help enterprises use ecological accounting information more effectively, but also create a solid foundation for long-term sustainable development.

## Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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