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Effectiveness of internal control in green credit: Influential factors in Vietnam's commercial banking sector

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ABSTRACT

This study investigates the effectiveness of internal controls governing green credit operations in Vietnamese commercial banks. We employ regression analysis to identify key factors influencing control effectiveness. Six key areas emerge: Risk Management, Macroeconomic Factors, Monitoring Activities, Group Benefits, Work Motivation, and Information and Communication. Independent sample T-tests and one-way ANOVA tests reveal significant variations in control effectiveness based on employee age groups and positions within the banks. Further analysis categorizes these factors into strong and weak impact groups based on their Beta coefficients. Risk Management and Macroeconomic Factors emerge as strong influencers, highlighting the critical role of robust risk management practices and favorable economic conditions. Conversely, Monitoring Activities, Group Benefits, Information and Communication, and Work Motivation have weaker but still notable impacts, suggesting areas for improvement in internal supervisory practices, communication systems, and employee motivation strategies. The findings underscore the critical role of risk management and macroeconomic factors while highlighting opportunities for enhancing supervisory practices, internal communication, and employee motivation within Vietnamese commercial banks.

Keywords: Risk management, Green credit control, Information systems, Sustainability

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1. Introduction

In recent decades, the imperative to address environmental degradation and foster sustainable development has become increasingly urgent globally. Vietnam, a country undergoing rapid economic growth and industrialization, is not exempt from these challenges. As the nation strives to balance economic expansion with environmental preservation, the concept of green credit emerges as a promising avenue for promoting sustainable practices within its commercial banking sector.

Since the inception of the Renovation policy in 1986, Vietnam has shifted from a centrally planned economy to a market-oriented one, witnessing impressive economic growth and advancements in social development. However, this growth trajectory has been accompanied by environmental degradation, including air and water pollution, and a rising carbon footprint. These environmental challenges not only threaten the health and well-being of Vietnam's citizens but also undermine the country's long-term economic prospects and its ability to achieve sustainable development goals.

Recognizing the urgent need for action, various stakeholders, including government agencies, financial institutions, and civil society organizations, have sought innovative solutions to reconcile economic growth with

environmental sustainability. One such solution gaining traction is the concept of green credit, which involves the provision of financial resources to projects and initiatives that promote environmental protection, resource efficiency, and climate resilience.

In Vietnam, the commercial banking sector plays a pivotal role in mobilizing and allocating capital to fuel economic activities. As the country endeavors to transition towards a green economy, the role of commercial banks in facilitating green credit becomes increasingly significant. However, the effectiveness of green credit initiatives depends on a multitude of factors, ranging from regulatory frameworks and institutional capacities to market demand and stakeholder engagement.

This research paper aims to investigate the influential factors shaping the implementation and effectiveness of green credit initiatives within Vietnam's commercial banking sector. By examining the regulatory landscape, institutional practices, market dynamics, and stakeholder perspectives, this study seeks to provide insights into how green credit can be leveraged as a tool for promoting sustainable development in Vietnam.

Through a comprehensive analysis of these factors, this research aims to identify key challenges and opportunities for enhancing the efficacy of green credit programs in Vietnam. By elucidating the drivers and barriers to green credit adoption, this study endeavors to inform policymakers, banking professionals, and other stakeholders on strategies to foster a more sustainable and resilient banking sector in Vietnam.

As Vietnam strives to navigate the complex interplay between economic growth and environmental sustainability, the adoption of green credit represents a promising avenue for promoting environmentally responsible finance within the commercial banking sector. By understanding the influential factors that shape green credit initiatives, stakeholders can work collaboratively to harness the transformative potential of finance in advancing sustainable development goals in Vietnam.

2. Research method

2.1. Theoretical framework

2.1.1. The efficacy of internal control

Regulatory theory

While internal control frameworks like COSO are well-established, this research incorporates Regulatory Theory. This theory explores the potential influence of group interests within regulatory organizations on the effectiveness of internal controls for green credit. By examining potential conflicts between maximizing group benefits and achieving optimal controls, we gain a deeper understanding of the regulatory environment surrounding green credit practices in Vietnam.

Regulatory theory encompasses various fundamental concepts, with three primary theories prevailing:

- Public-Interest Theory: This theory posits that regulations are essential to address societal demands, rectifying market inefficiencies or injustices to safeguard broader societal interests.
- Private-Interest Theory: Contrarily, this theory presupposes that regulatory officials act based on their personal interests within regulatory organizations.

Regulatory theory elucidates the legal oversight mechanisms governing the banking sector and the operational frameworks of Internal Control Systems (ICS) within individual banks. It also delineates how group interests within banks originate from individuals within regulatory organizations. By applying regulatory theory to this research, it's anticipated that banks will enact regulations to maximize their members' interests, potentially compromising the overall effectiveness of the ICS.

Theory of planned behavior

The Theory of Planned Behavior (TPB) elucidates the relationship between individual beliefs and behaviors. Building upon the Theory of Reasoned Action (Ajzen and Fishbein, 1975), TPB, developed by Ajzen (1991), emphasizes three key factors that shape behavior:

- Attitudes: This refers to the individual's positive or negative evaluations of performing a particular behavior. It encompasses beliefs about the outcomes of the behavior and the value attached to these outcomes.

- Subjective Norms: Subjective norms involve perceptions of social pressure or influence from significant others, such as family, friends, or society at large. These norms reflect the perceived expectations regarding whether one should or should not engage in a specific behavior.
- Perceived Behavioral Control: This factor reflects individuals' perceptions of their ability to perform the behavior under consideration, considering internal and external constraints. It includes factors such as self-efficacy, perceived difficulty, and the presence of facilitating or inhibiting conditions.

According to TPB, these three factors collectively shape an individual's behavioral intention, which, in turn, predicts actual behavior. However, TPB acknowledges that behavioral intentions do not always lead to behavior due to factors such as situational constraints or unforeseen circumstances.

TPB has been applied to various domains, including health behavior, environmental sustainability, consumer behavior, and organizational behavior. Its versatility lies in its ability to provide insights into the underlying psychological mechanisms that drive human actions, thereby informing the design of effective interventions and behavior change strategies.

These factors are considered driving forces propelling individuals to engage in particular behaviors. In organizational contexts, TPB elucidates the construction of control activities and monitoring mechanisms within the ICS. Therefore, it's hypothesized that when control and monitoring activities are robustly established, the effectiveness of the ICS is enhanced.

Motivation theory

Motivation theory pertains to organizational strategies designed to stimulate desired behaviors among individuals. According to Pinder (1998), work motivation encompasses internal and external energy sources that initiate work-related behaviors, ultimately influencing their manner, direction, intensity, and duration. It is considered a continuous process of motivational psychology. Higher motivation levels correspond to increased effort and satisfaction in achieving organizational goals, while diminished motivation results in reduced efficiency.

Expectancy theory

Expectancy theory, rooted in Vroom's (1964) seminal research, posits that individuals are driven by expectations of desired outcomes and the attractiveness of those outcomes. Applying expectancy theory to real-world contexts suggests that employees are motivated to exert effort when they believe that such effort will yield favorable outcomes, aligning with their personal goals (Robbins and Judge, 2017).

2.1.2. Influential Factors on the efficacy of green credit internal control activities

Utilizing the Committee of Sponsoring Organization (COSO) 2013 framework as a foundation, the author outlines the key components influencing the effectiveness of green credit control operations, encompassing five crucial elements: control environment, risk assessment, control activities, information communication, and monitoring activities [9]. Furthermore, drawing insights from prior research, the study team identifies two pertinent factors: group benefits and work motivation, while also suggesting the incorporation of a novel macroeconomic factor.

Control environment: As stated by Ramos (2004), the control environment serves as the bedrock of an organization's ethos and cultural ethos, embodying the overall ambiance of the organization and influencing the control awareness of its members [14]. Fostering and sustaining a robust control environment can bolster the bank's capacity to navigate pressures stemming from both internal and external sources. Conversely, weaknesses in the control environment create opportunities for fraudulent behavior to develop, highlighting the importance of building a robust control environment as a prerequisite for establishing effective internal control.

Risk assessment: As outlined by Lannoye (1999), risk assessment entails the identification, analysis, and mitigation of risks that could impede the attainment of organizational objectives, with the ultimate aim of proficient risk management [13]. Leaders cannot eliminate risks entirely but can only place them at an acceptable level and strive to minimize them as much as possible. Risk assessment also involves evaluating factors that impede the organization from achieving its mission. To conduct risk assessment, organizations must have clear and appropriate objective systems. Risk assessment tasks include identifying risks, analyzing risks, estimating potential hazards, assessing the frequency of risk occurrence, and methods for risk management.

The researchers observe that consistent risk assessment and analysis by leadership are essential prerequisites for mitigating credit risks, thereby amplifying the efficacy of green credit control initiatives.

Control activities: As per the COSO report, control activities encompass a series of policies and procedures crafted by management to ensure the comprehensive execution of management directives. These control activities are pervasive across all units, levels, and operational facets within the organization. Jenkinson's research (2008) suggests that to achieve organizational goals effectively, control activities must be established and enforced. Specifically, green credit, being a new field in banking activities, entails many unpredictable risks, leading to ineffective credit control. Consequently, crafting suitable control policies and procedures via risk assessment stands as a measure to bolster the effectiveness of this endeavor.

Information and communication: Truong Nguyen Tuong Vy (2018) highlights the information system as a centralized data repository housing comprehensive information, including internal regulations, State Bank regulations, and relevant laws [1]. Furthermore, Hevesi's study (2005) underscores information communication as a pivotal factor impacting the effectiveness of internal control endeavors [12]. In the context of green credit control operations, the information communication system facilitates data provision, aids officers in evaluating and approving green credit issuance, and assists in identifying, assessing, and managing risks. Efficient information exchange must encompass multiple directions: from top to bottom, from bottom to top, and among different organizational levels. Each individual should grasp their role and responsibilities within the organization, along with how their actions impact others' work. Furthermore, effective communication with external stakeholders, including customers, shareholders, and relevant agencies, is essential for success.

Therefore, building a comprehensive, accurate, and timely updated information communication system will contribute to enhancing the effectiveness of green credit internal control activities.

Monitoring activities: Spinger (2004) asserts that monitoring constitutes the ultimate phase of the internal control system [15]. Monitoring activities are intricately linked with control measures. They serve to assess the establishment and execution of control procedures, as well as to evaluate the ongoing quality of the internal control system over time. According to Calmiris et al. (1991), effective monitoring should identify the shortcomings of internal control systems and provide feedback to senior management to make timely adjustments [16]. Thus, monitoring activities play a crucial and positive role in ensuring the effectiveness of internal control activities.

Group benefits: Group benefits, by definition, refer to the benefits of a group of people bound together, supporting each other, helping each other to achieve mutual benefits and protect those interests. Based on the concept of Group benefits theory, the foundation of forming group benefits in banks originates from individuals within regulatory organizations. This shows that interest groups always exist in banks, and they will issue regulations to maximize the benefits of members without considering the common interests of the bank (Bui Thanh Son, 2019) [20]. Therefore, when group benefits increase, the effectiveness of green credit control activities decreases.

Work Motivation: From the Motivation theory, work motivation is a combination of internal and external sources of energy for an individual to initiate work-related behaviors, helping to determine the method, direction, intensity, and time for that work. Higher levels of motivation, effort, and satisfaction to achieve this goal are stronger and more effective. Conversely, lower levels of motivation, lack of motivation to accomplish organizational goals, result in lower effectiveness. According to experts interviewed by the research team, work motivation of employees also stems from internal factors such as satisfaction, job interest, which stimulates their work productivity. Therefore, work motivation originating from internal factors is an important stimulator, leading to high work efficiency. Thus, the research team will further add the internal work motivation factor to analyze and evaluate the dedication and responsibility of employees towards green credit activities in the bank.

Macroeconomic F=factor: According to the PEST analysis model, the macroeconomic factor includes legal institutional factors (political), economics, socio-cultural factors, and technology. These factors directly affect green credit control activities. In particular, macroeconomic factors directly impacting green credit operations encompass heightened environmental awareness, increased demand for green consumption, and similar variables. When these factors experience an upsurge, the efficacy of green credit control activities is thereby fortified.

2.2. Research model and hypotheses

Based on the theory presented in the COSO report (2013), the author constructs the components constituting the Internal Control System (ICS) of Green Credit Activities (GCA) at Vietnamese Credit Institutions, including Control Environment, Risk Assessment, Control Activities, Information Communication, and Monitoring Activities, along with 17 specific principles aimed at ensuring the rationality of credit activities, positively impacting the effectiveness of ICS in GCA.

Furthermore, drawing upon the theory of policy formation, planned behavior theory, motivation theory, and the PEST model, the research team inherits and supplements three new variables directly affecting the ICS in green credit activities at Vietnamese Credit Institutions. Therefore, the author constructs a model and formulates the research hypotheses as follows:

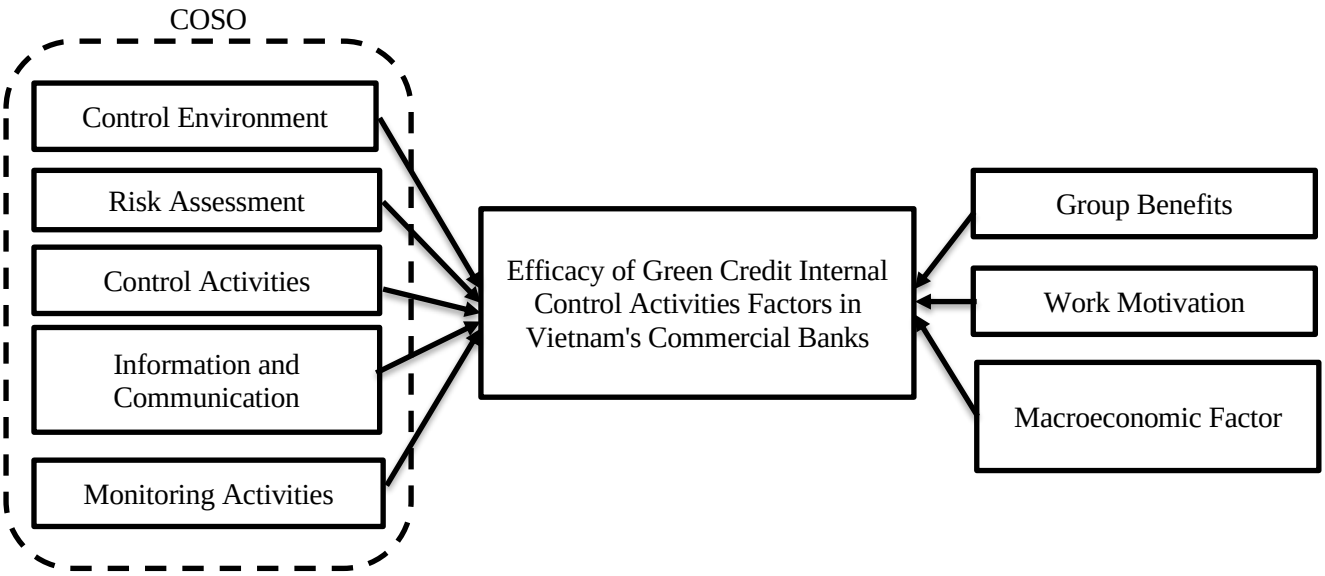

Figure 1. Research model

Based on the proposed research model outlining the factors influencing the effectiveness of the Internal Control System (ICS) in Green Credit Activities (GCA) at Vietnamese Credit Institutions, and drawing upon the theories mentioned above, the research hypotheses are identified as follows:

Hypothesis H1: Control Environment positively impacts the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H2: Risk Assessment positively impacts the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H3: Control Activities positively impact the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H4: Information Communication positively impacts the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H5: Monitoring Activities positively impact the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H6: Group Benefit negatively impacts the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H7: Work Motivation positively impacts the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H8: Macro Factors positively impact the efficiency of control measures for green credit within Vietnamese credit institutions.

2.3. Research data

2.3.1. Preliminary Study

A pilot study served as a crucial preliminary step to refine the research instrument.

Sample Size and Composition: A sample of 50 participants, likely consisting of officials and leaders involved in green credit activities at Vietnamese commercial banks, was chosen for the pilot study.

This phase aimed to:

- Assess the reliability of the measurement scales used in the survey instrument. Cronbach's Alpha coefficient was likely employed to evaluate internal consistency and identify any scales requiring refinement.
- Conduct Exploratory Factor Analysis (EFA) to explore the underlying structure of the data and potentially refine the draft scales into a more robust and concise measurement tool. This analysis helps identify groups of related questions (factors) that can be used to assess the various aspects influencing internal control effectiveness for green credit.

2.3.2. Formal Study

Following the pilot study, a formal survey was conducted to gather comprehensive data for the main analysis.

Target Population: The target population for the formal study included:

- Officials and leaders within Vietnamese commercial banks who are directly involved in green credit activities.
- Researchers and educators specializing in banking and green credit sectors.

Experience criteria: Participants were required to have a minimum of three years of experience working in the banking and green credit industry to ensure a strong understanding of the relevant practices and challenges.

Sample size calculation: Based on the guidelines suggested by Bollen (1989), a minimum sample size was determined to ensure a sufficient power for statistical analysis. Considering the anticipated number of observed variables in the survey instrument, the calculated minimum sample size required was 215.

Sampling method: A survey questionnaire was employed for data collection. The questionnaire was disseminated through various means to reach a broad range of potential participants:

- Distribution on social media platforms frequented by professionals in the banking and green credit sectors.
- Email distribution to relevant personnel working in green credit departments or units at both branch offices and headquarters of Vietnamese commercial banks.

Sampling period: The data collection period for the formal study spanned from January 2024 to March 2024.

Sample information: Upon data collection, the responses were carefully screened. Individuals who did not meet the experience criteria or provided inconsistent answers throughout the survey were excluded to ensure data quality. This resulted in a final sample size of 511 valid responses, representing a response rate of approximately 92.9% of the total of 550 collected surveys.

2.4. Data analysis

The research employed Statistical Package for Social Sciences (SPSS) software version 20.0 to analyze the collected data. The specific techniques used are as follows:

Data cleaning: Prior to analysis, the raw data was processed using Microsoft Excel software to check for missing entries and ensure data integrity.

Reliability analysis: Cronbach's Alpha coefficient was again employed to assess the internal consistency and reliability of the measurement scales used in the final survey instrument.

Factor analysis: Building upon the insights gained from the pilot study's EFA, a more comprehensive factor analysis, potentially Confirmatory Factor Analysis (CFA), would likely be conducted on the formal study data. This analysis helps confirm the hypothesized structure of the factors influencing internal control effectiveness and refine the measurement model.

Correlation analysis: The relationships between the identified factors and the effectiveness of internal controls in green credit operations were examined using correlation analysis. This technique helps identify potential associations between variables.

Regression analysis: Regression analysis will likely be employed to determine the extent to which the identified factors predict the effectiveness of internal control in green credit activities. This allows for a more nuanced understanding of how each factor contributes to the overall effectiveness.

Hypothesis testing: Formal statistical tests will be conducted to evaluate the research hypotheses proposed in the study. These tests will assess the significance of the relationships identified between the independent variables and the dependent variable (effectiveness of internal control).

By employing these rigorous data collection and analysis methods, the research aims to achieve a comprehensive understanding of the factors influencing the effectiveness of internal controls in green credit operations within Vietnamese commercial banks. This will provide valuable insights for policymakers, banking institutions, and stakeholders involved in promoting sustainable development through green credit initiatives.

3. Results and discussion

3.1. Sample descriptive statistics

The descriptive statistical data provides important information about the variables in the study sample. In terms of gender, the distribution between males and females is quite balanced, with males accounting for 44.2% and females for 55.8%. Regarding age, most participants fall within the age range of 31 to 40 years old, accounting for 46.97% of the total. Concerning positions, there is clear diversity, with branch officers representing the highest proportion at 39.14%. Finally, concerning the banking group, Joint Stock Commercial Banks (JSCBs) constitute the majority with a rate of 80.6%, while State-owned Commercial Banks (SCBs) only account for 19.4%. This data provides an overview of the characteristics of the study sample and may be useful for analyzing and evaluating future results.

Table 1. Sample Descriptive Statistics

Items	Quantity	Percentage
1. Gender		
Male	220	43.1%
Female	291	56.9%
2. Age Group		
Under 22 years old	25	4.9%
23 - 30 years old	102	20.0%
31 - 40 years old	239	46.8%
41 - 50 years old	130	25.4%
Over 51 years old	15	2.9%
3. Job title		
Headquarters leadership	77	15.1%
Branch leadership	93	18.2%
Headquarters staff	106	20.7%
Branch staff	200	39.1%
Others	35	6.9%
4. Bank Group		
State-owned Commercial Banks	99	19.4%
Joint-stock Commercial Banks	412	80.6%

Source: Data processing results, author's survey

3.2. Evaluation of the scale using Cronbach's alpha reliability coefficient

The test results in Table 2 indicate that all factors have Cronbach's Alpha coefficients greater than 0.6, thus the scales are well-assessed. All observed variables also have total inter-item correlations greater than 0.3. Therefore, the research team concludes that the scales meet the reliability standards, and the factors are suitable for the study.

Table 2. Cronbach's Alpha Reliability Coefficient

No	Variables	Number of scales	Cronbach's Alpha
1	Control Environment (CE)	6	0.928
2	Risk Assessment (RA)	4	0.912
3	Control Activities (CA)	4	0.895
4	Information and Communication (IC)	4	0.904
5	Monitoring Activities (MA)	4	0.913
6	Group Benefits (GB)	4	0.934
7	Work Motivation (WV)	4	0.928
8	Macroeconomic Factor (MF)	8	0.915

Source: Compiled from the analysis results on SPSS

3.3. Exploratory factor analysis (EFA)

3.3.1. Exploratory factor analysis of independent variables

The results of the analysis after one round revealed the removal and consolidation of 37 observed variables from the original model. As a result, six novel factors were identified as influencers of the effectiveness of green credit initiatives. Particularly, the observed variable VM2 within the Macro factor was omitted from the model due to its factor loading falling below the standard threshold. Additionally, observed variables from three factor categories - Control Environment, Control Activities, and Risk Assessment - were consolidated.

Table 3. Exploratory Factor Analysis of Independent Variables

No	Variables	Scales	Explain
1	RM	CE1, CE2, CE3, CE4, CE5, CE6, CA1, CA2, CA3, CA4, RR1, RA2, RA3, RA4	Risk Management
2	MF	MF1, MF3, MF4, MF5, MF6, MF7, MF8	Macroeconomic Factor
3	GB	GB1, GB2, GB3, GB4	Group Benefits
4	WM	WM1, WM2, WM3, WM4	Work Motivation
5	MA	MA1, MA2, MA3, MA4	Monitoring Activities
6	IC	IC1, IC2, IC3, IC4	Information and Communication
Total Variance Extracted		74.599%	
KMO		0.950	
Barlet:		17269.874	
Sig:		0.000	

Source: Compiled from the analysis results on SPSS

The results of the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test indicate that the KMO statistic is 0.950, and Bartlett's test yields a value of 17269.874 (Sig = 0.000), suggesting that the observed variables entered into the analysis are linearly correlated. The extracted variance is 74.59%, exceeding the threshold of 50%, which meets the requirement. Additionally, all variables used have factor loadings greater than 0.5.

3.3.2. Exploratory factor analysis of dependent variables

The results of the KMO and Bartlett's tests show that the KMO value is 0.860 and Bartlett's test yields a value of 1669.244 (Sig = 0.000), indicating that the observed variables entered into the analysis are correlated with each other. The extracted variance is 72.925% (> 50%), meeting the requirement. Additionally, all variables used have factor loadings greater than 0.5.

Based on the EFA findings, the research team noted a reconfiguration of the initial 37 observed variables, with some variables combining and others separating across different components. This led to the emergence of six distinct factor groups influencing the efficacy of the green credit management system. Moving forward, the authors will delve into analyzing, interpreting, and assigning names to these newly identified factor groups.

Table 4. Exploratory Factor Analysis of Dependent Variables

Scales	Factor
EA3	0.887
EA5	0.863
EA2	0.852
EA1	0.845
EA4	0.821
Total Variance Extracted	72.925%
KMO	0.860
Barlet:	1669.244
Sig:	0.000

Source: Compiled from the analysis results on SPSS

3.3.3. Conclusion of exploratory factor analysis and research hypotheses

Following the exploratory factor analysis conducted on 38 independent variables, the research team observed that out of 37 valid variables, they formed six new factor groups instead of eight, corresponding to six new hypotheses based on the proposed research model suggesting factors influencing the effectiveness of green credit management operations at Commercial banks in Vietnam. Based on the theories mentioned above, the new research hypotheses are identified as follows:

Hypothesis H1: Risk management positively impacts the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H2: Macroeconomic factors positively influence the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H3: Monitoring activities positively impact the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H4: Group benefits negatively affect the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H5: Work motivation positively affects the efficiency of control measures for green credit within Vietnamese credit institutions.

Hypothesis H6: Information and Communication positively influences the efficiency of control measures for green credit within Vietnamese credit institutions.

3.4. Correlation coefficient between factors

Table 5 reveals significant correlations between the majority of independent variables and the dependent variable. Notably, the correlation coefficients for Risk management, Macroeconomic factors, Monitoring activities, Work motivation, and Information and Communication stand at 0.725, 0.701, 0.630, 0.690, and 0.595, respectively, at a 1% significance level. These findings demonstrate a robust positive correlation between these independent variables and the dependent variable, Effectiveness.

The two variables Group benefits and Effectiveness exhibit a negative correlation but not strongly, with r = -0.322 at a significance level of 1%.

Among the independent variables, there are relatively high correlation coefficients, but none exceed 0.8. According to Nguyen Tuan et al. (2016), as long as the correlation coefficient does not exceed 0.8, multicollinearity is unlikely to occur.

Table 5. The correlation coefficient between factors

	EA	RM	MF	MA	GB	WM	IC
EA	1	.725**	.701**	.630**	-.322**	.690**	.595**
RM		1	.655**	.695**	-.069*	.721**	.710**
MF			1	.605**	-.205**	.582**	.510**
MA				1	-.010	.516**	.614**
GB					1	-.250**	-.155**
WM						1	.680**
IC							1

**, * indicate statistical significance at 1%, 5% level, respectively.

Source: Compiled from the analysis results on SPSS

3.5. Regression analysis and testing hypotheses

3.5.1. Regression results

The results from Table 6 show that the adjusted R-squared of the study is 0.691. Therefore, 69.1% of the variation in the effectiveness of TDX control operations is explained by the six independent variables, while the remaining 30.9% is due to external variables and random error. Thus, the study is considered good.

The F value is 191.083 with Sig = 0.000 < 0.05. Therefore, it can be concluded that the observed variables are significant, and the model fits the real data. In other words, the independent variables have a linear correlation with the dependent variable.

Table 6. Regression result

Model	Unstandardized Coefficients	VIF
(Constant)	0.184	
(Std. Error)	(0.135)	
RM	0.394**	2.562
	(0.039)	
MF	0.324**	1.679
	(0.034)	
MA	0.073*	1.846
	(0.033)	
GB	-0.057**	1.087
	(0.016)	
WM	0.094**	1.977
	(0.030)	
IC	0.079**	1.918
	(0.030)	
Observation	511	
Adjusted R2	0.691	
Durbin-Watson	2.006	
F Testing	191.083	
(p-value)	(0.000)	

**, * indicate statistical significance at 1%, 5% level, respectively.

Source: Compiled from the analysis results on SPSS

Based on the results obtained, the research team concludes that the factors directly influencing the effectiveness of green credit control operations at Vietnamese credit institutions can be represented by the following linear regression equation:

$$EA = 0.184 + 0.394\times RM + 0.324\times MF + 0.073\times MA - 0.057\times GB + 0.094\times WM + 0.079\times IC \quad (1)$$

3.5.2. Testing violations of assumptions in linear regression

- Multicollinearity: In the variance analysis section, the survey results show a clear relationship between the independent variables, with relatively high correlation indices, leading to the possibility of multicollinearity. Therefore, the research team examined the presence of multicollinearity in the model through the Variance Inflation Factor (VIF). The results in Table 3.13 show that all VIF values are < 10. Therefore, the research team concludes that the model does not suffer from multicollinearity.

- Autocorrelation: Based on the results obtained from Table 6, we have 1<d=2.006 <3. Therefore, the research team concludes that the model does not suffer from autocorrelation.

- Heteroscedasticity: From Figure 2, the authors observed a normal distribution curve overlaid on the frequency chart. This curve has a bell shape, consistent with the graph of a normal distribution, where the mean value is close to 0, and the standard deviation is 0.994~1, indicating that the residual distribution is approximately normal. Therefore, the research team concludes that the assumption of normal distribution of residuals is not violated.

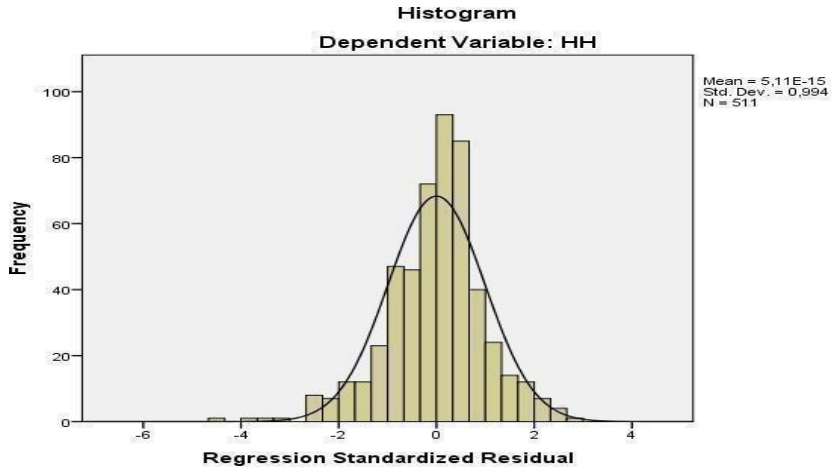

Figure 2. Scatter plot of standardized residuals

The results obtained from Figure 3 indicate that the quantile points in the distribution of residuals concentrate along a diagonal line, thus the assumption of normal distribution of residuals is not violated.

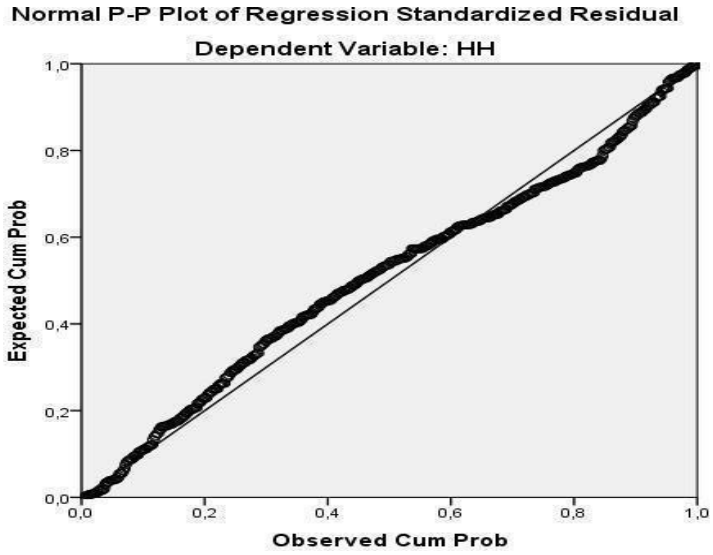

Figure 3. The scatter plot of standardized residuals

The results from Figure 4 indicate that the distribution of residuals forms a straight line and is distributed around the horizontal axis of 0. Therefore, the research team concludes that the assumption of linear relationship is satisfied.

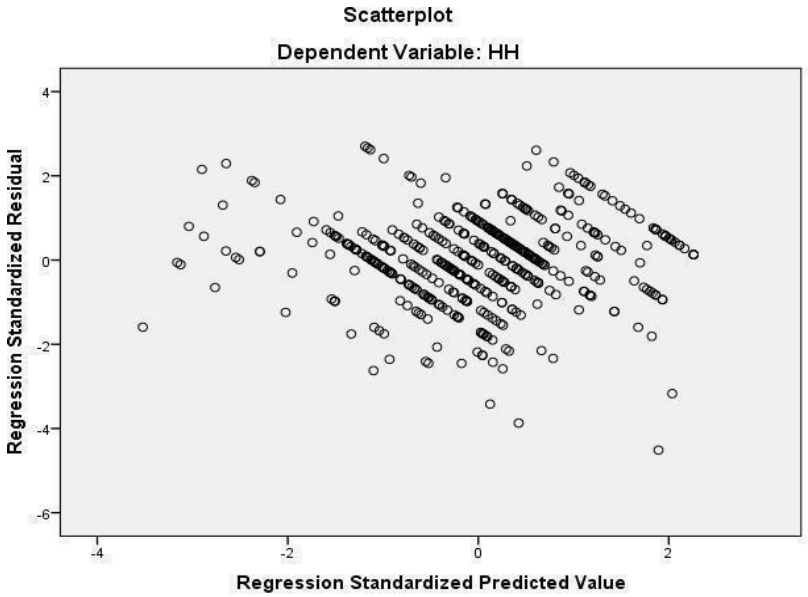

Figure 4. The graph of standardized predicted values.

3.5.3. Results of testing the main hypotheses

Following data processing and regression analysis on factors influencing the efficiency of control measures for green credit within Vietnamese credit institutions, the study identified six key factors: Risk Management, Macroeconomic Factors, Monitoring Activities, Group Benefits, Work Motivation, and Information and Communication.

Table 7. Results of Testing the Main Hypotheses

Code	Hypothesis	Regression Coefficient	Significance Level	Conclusion
H1	Risk management has a positive impact on the efficiency of control measures for green credit within Vietnamese credit institutions.	.394	.000	Hypothesis not rejected
H2	Macroeconomic factors have a positive impact on the efficiency of control measures for green credit within Vietnamese credit institutions.	.324	.000	Hypothesis not rejected
H3	Supervisory activities have a positive impact on the efficiency of control measures for green credit within Vietnamese credit institutions.	.073	.026	Hypothesis not rejected
H4	Group benefits have a negative impact on the efficiency of control measures for green credit within Vietnamese credit institutions.	-.057	.000	Hypothesis not rejected
H5	Work motivation has a positive impact on the efficiency of control measures for green credit within Vietnamese credit institutions.	.094	.002	Hypothesis not rejected
H6	Communication information has a positive impact on the efficiency of control measures for green credit within Vietnamese credit institutions.	.079	.009	Hypothesis not rejected

The strong impact group includes Risk Management and Macroeconomic Factors. Effective risk management emerged as the most influential factor, positively impacting green credit control effectiveness, followed by macroeconomic factors.

Conversely, the weak impact group comprises Supervision, Group Benefits, Communication Information, and Work Motivation. While these factors contribute moderately to green credit control effectiveness, they offer avenues for improvement.

Specifically, enhancing internal supervision processes and fostering effective communication systems can bolster effectiveness. Moreover, addressing issues related to group benefits and incentivizing workforce motivation are vital for maximizing green credit control efficiency.

Overall, these findings underscore the critical role of risk management and macroeconomic factors in green credit control effectiveness while highlighting opportunities for enhancement in supervisory practices, internal communication, and employee motivation.

3.6. Testing differences in evaluating the effectiveness of green credit control operations according to some auxiliary hypotheses

3.6.1. Testing differences in evaluating effectiveness by gender

Hypothesis H7a: There is a difference in evaluating the efficiency of control measures for green credit within Vietnamese credit institutions among different genders.

The control variable Gender is a dichotomous variable with two values: Male - 1 and Female - 2. The research team conducted an Independent Sample T-Test with the first value being the Sig of Levene's Test. The results of hypothesis testing are as follows:

Table 8. Testing Gender Differences in Evaluating the Effectiveness of Green Credit Operations at Vietnamese Commercial Banks

Gender	Mean		Sig (Levene's Test)	Sig (T-Test)
Male	3.6248	Equal Variance Hypothesis	0.971	0.549
Female	3.6618	Unequal Variance Hypothesis		0.549

Source: Compiled from the analysis results on SPSS

The test result yields a Sig value of 0.971, which is greater than 0.05, indicating that the variances of the two populations are not different. The t-test result for the assumption of equal variances has a Sig. value of 0.549, also greater than 0.05, indicating no significant difference in the evaluation of effectiveness between gender groups.

3.6.2. Testing differences in effectiveness evaluation by bank group

Hypothesis H7b: There is no difference in the evaluation of effectiveness in green credit activities among different bank groups at Vietnamese commercial banks, with the control variable Bank Group as a dichotomous variable with two values: Joint Stock Commercial Banks - 1 and State Commercial Banks - 2.

The research team conducted an Independent Sample T-Test with the first value being the Sig. of Levene's Test. The test results are as follows:

Table 9. Testing Differences in Effectiveness Evaluation of Green Credit Activities at Vietnamese commercial banks by Bank Group

Bank Group	Mean		Sig (Levene's Test)	Sig (T-Test)
Joint Stock Commercial Banks	3.6383	Equal Variance Hypothesis	0.010	0.639
State Commercial Banks	3.6747	Unequal Variance Hypothesis		0.593

Source: Compiled from the analysis results on SPSS

The test results show that Sig. = 0.010 < 0.05, indicating that the variances of the two populations are different. The t-test result for the assumption of equal variances has a Sig. = 0.593 > 0.05, indicating no significant difference in effectiveness evaluation by bank group.

3.6.3. Testing differences in effectiveness evaluation by position

Hypothesis H7c: There is no difference in the evaluation of effectiveness in green credit activities among different positions at Vietnamese commercial banks.

The research team conducted a Levene's Test in the Test of Homogeneity of Variances table. The test results are as follows:

Table 10. Testing Differences in Effectiveness Evaluation of Green Credit Activities at Vietnamese commercial banks by Position

Hypothesis	Sig. (Leven test)	Sig (Welch test)	Conclusion
There is a difference in the evaluation of the effectiveness of green credit activities among different positions at Vietnamese commercial banks.	0.011 < 0.05	0.021< 0.05	Not rejected

The result of the Levene test shows that the value of Sig. = 0.011 < 0.05, indicating a violation of the homogeneity of variance assumption among the groups of the categorical predictor variable. Therefore, the research team conducted a Welch's analysis. The result of the test shows that the value of Sig. = 0.021 < 0.05, leading to the conclusion that there is a significant difference in the evaluation of the efficiency of control measures for green credit within Vietnamese credit institutions across different job position groups.

3.6.4. Testing differences in effectiveness evaluation by age groups

Hypothesis H7d: There are differences in the evaluation of the efficiency of control measures for green credit within Vietnamese credit institutions across different age groups.

The research team conducted a Levene test as shown in the Test of Homogeneity of Variances table. The results of the hypothesis test are as follows:

Table 11. Testing Differences in Effectiveness Evaluation of Green Credit Activities at Vietnamese commercial banks by Age groups

Hypothesis	Sig. (Leven test)	Sig (Welch test)	Conclusion
There are differences in the evaluation of the efficiency of control measures for green credit within Vietnamese credit institutions across different age groups.	0.133 > 0.05	0.004< 0.05	Not rejected

The Levene test results show a Sig. value of 0.133 > 0.05, indicating homogeneity of variances across control variable groups. Therefore, the research team conducted an ANOVA analysis. The hypothesis test results show a Sig. value of 0.004 < 0.05, concluding that there are differences in the evaluation of the efficiency of control measures for green credit within Vietnamese credit institutions across age groups.

Table 12. Testing Differences in Effectiveness Evaluation of Green Credit Activities at Vietnamese commercial

Code	Hypothesis	Conclusion
H7a	There is a difference in the evaluation of the efficiency of control measures for green credit within Vietnamese credit institutions across different genders	Rejected
H7b	There is a difference in the evaluation of the efficiency of control measures for green credit within Vietnamese credit institutions across different banking groups	Rejected
H7c	There is a difference in the evaluation of the efficiency of control measures for green credit within Vietnamese credit institutions across different positions	Not rejected
H7d	There is a difference in the evaluation of the efficiency of control measures for green credit within Vietnamese credit institutions across different age groups	Not rejected

4. Conclusions

This paper investigates the efficiency of control measures for green credit within Vietnamese credit institutions by analyzing various factors influencing this aspect. Through regression analysis, six key factors are identified: Risk Management, Macroeconomic Factors, Supervision, Group Benefits, Work Motivation, and Communication Information. The study employs Independent Sample T-Test and One-way ANOVA tests to reveal significant differences in green credit control effectiveness based on age groups and positions within the banks.

Further analysis categorizes these factors into strong and weak impact groups based on their Beta coefficients. Risk Management and Macroeconomic Factors emerge as strong influencers, emphasizing the importance of effective risk management and economic conditions in green credit control. Conversely, Supervision, Group Benefits, Communication and Information, and Work Motivation have weaker but still notable impacts, suggesting areas for improvement in internal supervision, communication systems, and employee motivation strategies.

Based on the findings, several recommendations can be made to enhance the efficiency of control measures for green credit within Vietnamese credit institutions:

- Strengthen Risk Management: Banks should prioritize the development and implementation of robust risk management frameworks to identify, assess, and mitigate environmental and credit-related risks effectively.
- Enhance Supervision Practices: Improving internal supervision mechanisms and oversight procedures can help banks ensure compliance with green credit control standards and identify areas for improvement in environmental risk management.
- Foster Employee Motivation: Banks should invest in strategies to enhance employee motivation and engagement, such as training programs, recognition schemes, and career development opportunities, to foster a culture of environmental responsibility and commitment to green credit control objectives.
- Improve Communication Channels: Enhancing communication channels and information-sharing practices can facilitate the dissemination of environmental policies, regulatory updates, and best practices, promoting greater awareness and alignment among bank staff regarding green credit control initiatives.
- Continuous Monitoring and Evaluation: Regular monitoring and evaluation of green credit control practices are essential to assess their effectiveness, identify emerging risks, and adapt strategies accordingly. Banks should establish robust monitoring frameworks to track key performance indicators and measure progress toward environmental sustainability goals.

By implementing these recommendations, Vietnamese commercial banks can strengthen their green credit control operations, mitigate environmental risks, and contribute to sustainable development efforts in Vietnam.

Declaration of competing interest

The authors declare that they have no any known financial or non-financial competing interests in any material discussed in this paper.

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