THE IMPACT OF FINANCIAL FACTORS AND ISO 22000 ON FINANCIAL DISTRESS OF LISTED FOOD PROCESSING FIRMS IN VIETNAM

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ABSTRACT

This study examines the determinants of financial distress among listed food processing firms in Vietnam from 2018 to 2023, utilizing Altman's Z-score as the measure of financial distress. Drawing on a theoretical framework grounded in financial distress and international trade literature, the analysis investigates the effects of internal factors profitability (Return on Assets, ROA), financial leverage, liquidity, and firm size and the external factor of exchange rate volatility, with ISO 22000 certification as a moderating variable. Employing robust econometric methods, including Ordinary Least Squares (OLS), High-Dimensional Fixed Effects (HDFE), and HDFE with Entropy Balancing, the study ensures reliable and unbiased estimates. Results indicate that ROA and liquidity significantly enhance Z-scores, reducing financial distress ($p < 0.01$), while financial leverage exerts a significant negative effect, particularly in the fresh food subsample ($p < 0.05$). Firm size demonstrates a negative association in the dry food subsample, suggesting potential inefficiencies, whereas exchange rate volatility significantly impacts fresh food firms due to their export orientation. ISO 22000 certification positively moderates the relationships between leverage, exchange rate volatility, and financial distress in the full sample and fresh food subsample, underscoring its role in enhancing operational resilience and creditworthiness. Subsample analysis reveals that fresh food firms, exposed to global trade dynamics under the EU-Vietnam Free Trade Agreement, benefit more from ISO certification compared to domestically focused dry food firms. These findings contribute to the financial distress literature by integrating macroeconomic factors and quality management standards, offering practical implications for firms to optimize financial strategies and for policymakers to support certification and risk management initiatives in Vietnam's food processing sector.

Keywords: *Financial distress, Z-score, HDFE, Entropy Balancing, ISO 22000, food processing, exchange rate volatility.*

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1. INTRODUCTION

The food processing industry plays a vital role in Vietnam's economy, contributing approximately 10 - 15% of agricultural export value and reaching an export turnover of around USD 10 billion in 2024 [23]. The sector's robust growth not only meets domestic consumption demand but also facilitates international market expansion through free trade agreements such as the EVFTA and CPTPP. However, the industry remains highly vulnerable to financial risks due to its lengthy supply chains, fluctuations in raw material prices, dependency on export markets, and exchange rate volatility. These factors increase the likelihood of financial distress, potentially undermining firms' liquidity and long-term sustainability.

Although financial risk in enterprises has attracted significant scholarly attention, most existing studies in Vietnam have primarily focused on the manufacturing sector as a whole or analyzed financial factors at an industry-wide level. Few studies have examined the unique characteristics of the food processing industry a sector that is highly sensitive to macroeconomic conditions and quality standards. Furthermore, the moderating role of quality management systems, such as ISO 22000 which is widely regarded as a tool for enhancing competitiveness and mitigating operational risks has yet to be empirically validated in this context. This research gap highlights the urgent need to examine the interaction between financial attributes, macroeconomic factors, and quality certification in influencing financial distress among firms in the food processing industry.

Building upon this gap, the present study pursues two primary objectives: (i) To assess the impact of financial and macroeconomic factors including ROA, financial

leverage, liquidity, firm size, and exchange rate volatility on the level of financial distress of listed food processing firms in Vietnam; and (ii) To analyze the moderating role of ISO 22000 certification in the relationship between these determinants and financial distress.

The remainder of the paper is structured as follows. Section 2 provides a literature review and theoretical foundation related to financial distress and the role of quality standards in the food industry. Section 3 presents the theoretical framework and research hypotheses. Section 4 outlines the research methodology, including regression models and entropy balancing techniques. Section 5 describes the data and variables. Section 6 reports the empirical findings, covering both the overall analysis and sub-sample analysis by industry segments. Finally, Section 7 discusses managerial implications and suggests directions for future research.

2. LITERATURE REVIEW

2.1. Overview of Financial Distress

Financial distress is defined as a stage in which a firm experiences a substantial deterioration in its financial condition, often serving as a warning signal preceding bankruptcy [28]. This concept reflects not only temporary difficulties but also long-term viability concerns, particularly during economic downturns or global crises. Taffler [32] emphasized that the probability of financial distress surges during crises, such as the 1997 Asian financial crisis, when revenues decline, and debt repayment pressures intensify [32]. In Vietnam, this condition is increasingly prevalent in the food processing sector, where listed firms such as Vinamilk (VNM) and Masan (MSN) face raw material price fluctuations and exchange rate volatility, leading to heightened financial risks during 2018 - 2023 [25].

Financial distress typically occurs when firms fail to meet periodic financial obligations, such as interest or principal payments [15, 19, 29]. Andrade and Kaplan [3] argued that firms with high financial leverage are particularly susceptible to distress, especially when cash flows decline. Van Gestel et al. [35] highlighted that financial distress triggers a negative spiral characterized by asset-liability imbalances, restricted access to new capital, and increased capital costs due to loss of investor confidence. It is important to distinguish between "insolvency" a state in which assets are insufficient to cover liabilities and "bankruptcy," the ultimate legal resolution [29]. Asquith et al. [4] noted that firms may opt for debt restructuring to avoid bankruptcy, but failure in such efforts often leads to formal bankruptcy proceedings.

Financial statements play a critical role in predicting financial distress, with ratios such as liquidity and profitability serving as reliable risk indicators [31]. Beaver [6], Chen and Shimerda [7], and Singh and Schmidgall [30] confirmed the predictive power of financial ratios. A prominent model is Altman's Z-score (1968), which combines liquidity, profitability, leverage, and activity ratios, achieving a 75 - 90% accuracy rate when adjusted for context [2, 27]. This study adopts the Z-score to measure financial distress, which is particularly suitable for Vietnam's listed food processing firms that face risks from raw material costs and exchange rate fluctuations [10].

2.2. Determinants of Financial Distress

Internal Factors: Internal factors stem from a firm's operational and financial management decisions, influencing its resilience against distress. This study focuses on four key variables: Return on Assets (ROA), liquidity, leverage, and firm size, selected for their empirical robustness and applicability to Vietnam's food industry, where efficient resource utilization and capital management are critical amid rising input costs and competitive pressures.

Return on Assets (ROA): ROA measures a firm's profitability relative to its total assets, serving as an indicator of operational efficiency. Seminal work by Beaver [6] demonstrated that declining ROA is a strong predictor of financial failure, as it signals inefficient asset utilization and reduced earnings capacity. In Vietnam, Đào [10] found an inverse relationship between ROA and distress among manufacturing firms, attributing this to poor cost controls in labor-intensive sectors. However, Elam [12] reported mixed results, suggesting that industry context moderates this effect; for instance, in capital-intensive industries like food processing, ROA's impact may be diluted by asset depreciation cycles. More recent studies in emerging markets, confirm ROA's negative association with distress, with a 1% drop in ROA increasing bankruptcy probability by up to 15%. In Vietnam's food sector, where firms like Vinamilk and Masan Group face margin pressures from raw material inflation, low ROA exacerbates distress by limiting reinvestment in technology [25]. This variable is included in our model to capture profitability dynamics specific to listed firms.

Liquidity: Liquidity, commonly proxied by the current ratio (current assets divided by current liabilities) or quick ratio (excluding inventory), reflects a firm's ability to meet short-term obligations. Beaver [6] identified liquidity as a primary buffer against distress, with higher ratios correlating to lower failure rates. Altman [1] incorporated working capital metrics into his Z-score model, emphasizing that liquidity shortages precipitate cash flow crises. Empirical evidence is generally supportive, but mixed; for example, in Vietnam, studies like Tran and Le [20] on manufacturing firms show that liquidity reduces distress risk by 20 - 30% in export-oriented industries, yet during the COVID-19 pandemic, food processors experienced liquidity strains from disrupted supply chains. The inconsistency in findings may arise from measurement variations e.g., current vs. quick ratio or contextual factors like inventory perishability in food processing. This study employs the current ratio to assess liquidity's role, given its relevance to inventory-heavy operations in Vietnam's agrifood sector.

Leverage: Leverage, measured as the debt-to-equity or debt-to-asset ratio, represents the extent of debt financing and its associated risks. Opler and Titman [26] argued that high leverage amplifies distress by increasing interest burdens and covenant violations, particularly during economic downturns. Zmijewski [39] extended this by noting industry variations; in cyclical sectors like food processing, leverage effects are pronounced due to revenue instability from commodity prices. Positive associations between leverage and distress are well-documented, with a 10% leverage increase raising failure odds by 8 - 12% in emerging markets [8]. In Vietnam, high leverage has been linked to distress in SMEs, exacerbated by limited access to equity markets [37]. However, some firms use leverage strategically for growth, as seen in food exporters leveraging debt for expansion under EVFTA. This variable is selected to examine capital structure decisions in a context where Vietnamese firms often rely on bank loans amid underdeveloped capital markets.

Firm Size: Firm size, typically logged total assets or sales, proxies for resource endowments and diversification. Larger firms benefit from economies of scale, better access to credit, and stronger bargaining power, reducing distress vulnerability [9]. Honjo [17] highlighted that smaller firms are more prone to failure due to limited reserves and higher fixed costs relative to revenues. In Asian contexts, Shumway [31] integrated size into hazard models, finding it inversely related to distress. For Vietnam's food industry, larger listed firms like those on the Ho Chi Minh Stock Exchange (HOSE) exhibit lower Z-scores volatility compared to SMEs. Yet, rapid growth in small processors can lead to overextension, as evidenced during the 2022 - 2023 inflation spike. This factor is included to control for scale effects, addressing the heterogeneity among listed firms.

These internal factors are chosen for their alignment with prior distress models and their pertinence to Vietnam's food sector, where operational efficiency and prudent financing are vital for sustaining competitiveness.

External Factor: Exchange Rate Volatility

Beyond internal controls, external macroeconomic shocks play a pivotal role in financial distress, especially in open economies. Exchange rate volatility (EX), measured as the standard deviation of currency fluctuations (e.g., VND/USD), disrupts trade-dependent industries by altering import costs and export revenues. In Vietnam, the food processing sector is highly exposed, with imports of raw materials (e.g., wheat, soybeans) exceeding USD 15 billion annually and exports reaching USD 10 billion in 2023 [36]. Nguyen and Doan [25] found that a 1% increase in EX reduces firm Z-scores by 5 - 7%, as it inflates foreign-denominated debts and erodes profit margins. Eichengreen and Hausmann [11] termed this "original sin" in emerging markets, where firms borrow in foreign currencies without adequate hedging. In the food context, EX volatility under EVFTA has heightened risks, with post-2020 fluctuations contributing to distress in export-oriented processors [20]. Despite its importance, EX remains underexplored in food-specific distress studies, representing a gap in integrating macroeconomic variables with firm-level outcomes.

2.3. Moderating Role of ISO Certification

ISO 22000 certification a standard for food safety management moderates the relationship between ROA, leverage, liquidity, EX, and Z-score. ISO implementation improves operational efficiency, enhances market reputation, and reduces costs related to product defects [34]. Regarding ROA, ISO amplifies the positive effect by optimizing production processes [14]. For leverage, ISO reduces debt-related pressures by strengthening creditworthiness [22]. With EX, ISO contributes to supply chain stability, mitigating exchange rate risks, especially under the EVFTA framework [20]. However, the moderating effect may vary by firm size, as smaller firms often face higher compliance costs [13].

2.4. Research Gap

To date, no study has exclusively examined financial distress within Vietnam's food processing industry while incorporating macroeconomic factors (EX) and a moderating variable (ISO 22000 certification). Given the industry's heavy dependence on exports (under EVFTA) and imported inputs, evaluating EX and the role of ISO in mitigating financial risk offers a novel contribution to both theory and practice.

3. THEORETICAL FRAMEWORK AND HYPOTHESES

3.1. Theoretical Framework

This study constructs its theoretical foundation based on three core financial theories: Agency Theory**,** Trade-off Theory**,** and the Resource-Based View (RBV)**.** These theories collectively explain how internal factors (ROA, Leverage, Liquidity, Firm Size), a macroeconomic factor (Exchange Rate Volatility), and the moderating role of ISO 22000 certification influence financial distress in Vietnam's listed food processing companies, measured using Altman's Z-score model [1].

Agency Theory: Agency Theory addresses the conflict of interest between shareholders and managers regarding financial decisions. High leverage can exacerbate this conflict, as managers might prioritize short-term goals such as boosting profits through increased borrowing over long-term financial stability. This behavior can lead to financial distress when operating cash flows are insufficient to cover debt obligations [18]. In the Vietnamese food sector, firms like Vinh Hoan (VHC) and Masan (MSN), which rely on foreign currency debt for export operations, face amplified financial risks during exchange rate fluctuations [25].

Trade-off Theory: The Trade-off Theory posits that firms balance the tax benefits of debt against the costs associated with financial distress. While leverage provides a tax shield, it also heightens bankruptcy risk due to higher debt-servicing costs, particularly in industries exposed to volatile input prices such as food processing [26]. In Vietnam (2018 - 2023), seafood exporters confronted significant risks from foreign currency-denominated debt as exports reached USD 10 billion [36], while domestic-oriented firms like KIDO (KDC) faced competitive pressures in the local market.

Resource-Based View (RBV): RBV emphasizes that internal resources, such as ISO 22000 certification, create sustainable competitive advantages and mitigate financial risk. ISO 22000 enhances operational efficiency, improves brand reputation, and facilitates access to finance, thereby reducing the adverse effects of high leverage or exchange rate fluctuations [5, 22]. For Vietnam's food industry, ISO 22000 compliance is critical for meeting EVFTA requirements, especially for exporters to the EU, as it lowers defect-related costs and stabilizes supply chains [34].

3.2. Hypotheses Development

Based on the theoretical framework and prior research on financial distress [1, 6], the following hypotheses are proposed to examine the effects of internal and external factors, as well as the moderating role of ISO 22000 certification, on Z-scores in Vietnam's food processing industry during 2018 - 2023:

- H1: ROA significantly affects the financial distress of listed food processing firms.

- H2: Financial leverage significantly affects the financial distress of listed food processing firms.

- H3: Liquidity significantly affects the financial distress of listed food processing firms.

- H4: Firm size significantly affects the financial distress of listed food processing firms.

- H5: Exchange rate volatility significantly affects the financial distress of listed food processing firms.

- H6: ISO 22000 certification moderates the relationship between independent variables and financial distress.

+ H6a: ISO 22000 certification moderates the relationship between ROA and financial distress.

+ H6b: ISO 22000 certification moderates the relationship between leverage and financial distress.

+ H6c: ISO 22000 certification moderates the relationship between liquidity and financial distress.

+ H6d: ISO 22000 certification moderates the relationship between firm size and financial distress.

+ H6e: ISO 22000 certification moderates the relationship between exchange rate volatility and financial distress.

4. RESEARCH METHODOLOGY

4.1. Research Model

This study employs a panel data regression model to analyze factors influencing financial distress measured by Altman's Z-score (1968). The model specification is as follows:

$$Zscore_{i,t} = \beta_0+\beta_1 ROA_{i,t}+\beta_2 LEV_{i,t}+\beta_3 LI_{i,t}+\beta_4 Size_{i,t}+\beta_5 EX_{i,t} +\beta_6(ISO_{i,t}\times ROA_{i,t})+\beta_7(ISO_{i,t}\times LEV_{i,t})+\beta_8(ISO_{i,t}\times LI_{i,t}) +\beta_9(ISO_{i,t}\times Size_{i,t})+\beta_{10}(ISO_{i,t}\times EX_{i,t})+\epsilon_{i,t}$$

Where:

$Zscore_{i,t}$: Financial distress indicator of firm i at time t; a lower value indicates a higher bankruptcy risk [1].

$ROA_{i,t}$: Return on Assets, measuring financial performance.

$LEV_{i,t}$: Financial leverage (debt-to-total-assets ratio), reflecting debt risk.

$LI_{i,t}$: Short-term liquidity (current ratio), measuring the firm's ability to meet short-term obligations.

$Size_{i,t}$: Firm size (log of total assets), representing economies of scale.

$EX_{i,t}$: Exchange rate volatility, capturing macroeconomic risk.

$ISO_{i,t}$: Binary variable (1 if the firm is ISO 22000 certified, 0 otherwise), moderating the impact of independent variables.

$\epsilon_{i,t}$: Random error term.

4.2. HDFE Regression Method

This study employs a High-Dimensional Fixed Effects (HDFE) regression model to simultaneously control for firm-specific and time-specific fixed effects, addressing the limitations of single-dimensional Fixed Effects (FE) or Random Effects (RE) models. The Hausman test (p-value < 0.05) indicates a correlation between independent variables and unobserved effects, rejecting the null hypothesis of no correlation in the RE model, thereby confirming the suitability of the FE approach. HDFE is preferred because it effectively controls for both firm-level heterogeneity (e.g., managerial characteristics of companies such as MSN and VHC) and time-specific shocks (e.g., exchange rate volatility in 2020 due to COVID-19), making it particularly appropriate for panel data and the context of Vietnam's food processing industry.

4.3. HDFE Regression with Entropy Balancing

To enhance robustness and address selection bias, this study integrates HDFE with Entropy Balancing. Entropy Balancing reweights observations to balance the distribution of independent variables (e.g., ROA, Leverage) between large firms and small firms, reducing endogeneity and improving estimation accuracy. This approach is particularly suitable for Vietnam's food processing sector, where large firms (e.g., Vinamilk) and smaller firms exhibit distinct financial characteristics. Combining HDFE with Entropy Balancing effectively controls for unobserved factors such as management practices or macroeconomic shocks, ensuring reliable results in the context of Vietnam's food industry.

4.4. Post-Estimation Diagnostics

To validate the model's reliability, the following tests were conducted:

Multicollinearity: Variance Inflation Factor (VIF) < 10 for all variables, confirming no severe multicollinearity.

Heteroskedasticity: Breusch-Pagan test (p-value < 0.05) indicates the presence of heteroskedasticity, addressed by clustering standard errors at the firm level.

Autocorrelation: Wooldridge test (p-value > 0.05) suggests no serial correlation.

Robustness: Subsample analysis (dry food vs. fresh food) and alternative model specifications (OLS, HDFE without year fixed effects) were performed to assess the stability of the results.

Standard errors were clustered at the firm level to account for heteroskedasticity and autocorrelation, ensuring the statistical validity of coefficient estimates. These diagnostic checks provide a solid foundation for analyzing the interplay between firm-specific and macroeconomic factors and the moderating role of ISO 22000 in Vietnam's food processing industry.

5. DATA AND VARIABLES

5.1. Sample

This study employs a balanced panel dataset comprising 39 publicly listed food processing firms on the Ho Chi Minh Stock Exchange (HOSE) and Hanoi Stock Exchange (HNX) over the period 2018 - 2023, yielding a total of 234 firm-year observations (39 firms × 6 years). The sample was selected based on the following criteria:

(i) The firm operates within the food processing sector (industry classification according to Vietstock.vn), including dry food and fresh food/seafood; (ii) Continuous listing on HOSE or HNX during 2018 - 2023; (iii) Availability of complete and publicly disclosed financial statements.

Financial data were collected from reliable sources, including audited financial statements available on Vietstock.vn and Cafef.vn, while ISO 22000 certification status was verified using annual reports and official company websites.

5.2. Measurement of Variables

The variables in the research model are measured as described in the Table 1, drawing on prior financial studies [1, 6] and adapted to the characteristics of Vietnam's food processing industry.

Table 1. Variables in the research model

Variables	Symbol	Measurement	Meaning	Data source
Dependent variable				
Financial Distress	Z-score	$Z=1.2X_1+1.4X_2+3.3X_3+0.6X_4+1.0X_5$ Where: X_1: Ratio of Working Capital to Total Assets *(Working Capital / Total Assets)* - measures short-term liquidity. X_2: Ratio of Net Profit after Tax to Total Assets *(Profit after tax / Total Assets)* - reflects the ability to accumulate retained earnings over time. X_3: Ratio of Earnings Before Interest and Taxes (EBIT) to Total Assets *(EBIT / Total Assets)* - assesses the efficiency of asset utilization. X_4: Ratio of Market Value of Equity to Total Liabilities *(Market Value of Equity / Total Liabilities)* - measures capital structure and bankruptcy risk. Here, Market Value of Equity (MVE) = Book Value of Equity × Market Adjustment Factor (P/B ratio) *(Data collected as of December 31 each year, consistent with the balance sheet date)*. X_5: Ratio of Sales to Total Assets *(Sales / Total Assets)* - indicates how efficiently assets are used to generate revenue.	The Z-score is a multivariate classification tool developed by Edward I. Altman to predict the bankruptcy likelihood of manufacturing firms. It provides a composite index for classifying financial risk into three zones: - Safe Zone ($Z > 2.99$) - Gray Zone ($1.81 < Z < 2.99$) - Distress Zone ($Z < 1.81$) This index serves as a key measure for determining the level of financial distress among food processing companies.	The Z-score is calculated based on financial data extracted from the companies' financial statements. These data were obtained from the website https://cafef.vn/
Control variable				
ISO 22000 Certification	ISO	A dummy variable that takes the value 1 if the firm is certified with ISO 22000, and 0 otherwise		The information was obtained from the companies' annual reports. The data were downloaded from the website https://cafef.vn/.
Independent variables				
Profitability	ROA	= Net Profit After Tax / Total Assets	ROA (Return on Assets) is an indicator that reflects the efficiency of using assets to generate profit. It shows how much net profit after tax is generated for every unit of total assets. A higher ROA indicates that the company utilizes its assets more effectively.	The index is calculated based on financial data extracted from the companies' financial statements. The data were downloaded from the website https://cafef.vn/

Table 1. Variables in the research model (continue)

Variables	Symbol	Measurement	Meaning	Data source
Leverage	LEV	= Total Debt / Total Assets	The debt ratio indicates the percentage of a company's total assets that are financed by debt. A low debt ratio may suggest inefficient use of leverage, while a high debt ratio reflects a significant debt burden, which could lead to potential insolvency.	The indicator is calculated based on financial data from the company's financial statements. The data were downloaded from the website https://cafef.vn/
Liquidity	LI	Current Ratio = Current Assets / Current Liabilities	This ratio indicates whether a company has enough current assets to cover its short-term liabilities. - If the ratio > 1: The company can meet its short-term obligations without selling long-term assets. - If the ratio < 1: The company may face liquidity risk and might need to borrow or liquidate long-term assets to pay off debts.	The indicator is calculated based on financial data from the company's financial statements. The data were downloaded from the website https://cafef.vn/
Firm Size	Size	Log of Total Assets	Total assets reflect the scale of resources a company owns, including both current and non-current assets. Taking the natural logarithm helps reduce skewness in the asset data, especially when there are significant differences between small and large firms in the Vietnamese food industry. This transformation ensures comparability and consistency across companies.	The indicator is calculated based on financial data from the company's financial statements. The data were downloaded from the website https://cafef.vn/
Exchange Rate Volatility	EX	$= \frac{NEER_t - NEER_{t-1}}{NEER_{t-1}} \times 100\%$ ERit: Annual NEER fluctuation This variable represents the yearly change in the Nominal Effective Exchange Rate (NEER) and can be calculated as the percentage change from the previous year.	This index reflects the fluctuations of the multilateral exchange rate over time. The NEER (Nominal Effective Exchange Rate) measures the value of the Vietnamese dong (VND) against a basket of major trading partner currencies (such as USD, CNY, JPY). It provides a composite measure of exchange rate movements, capturing the combined impact of multiple currencies. This is particularly relevant for the Vietnamese food industry, which is heavily involved in import and export activities.	The NEER data is sourced from global datasets provided by Trading Economics, accessible at: https://tradingeconomics.com/vietnam/real-effective-exchange-rate-wb-data.html.

6. EMPIRICAL RESULTS

6.1. Descriptive Analysis

Table 2. Descriptive Statistics of Variables in the Model Examining Factors Affecting Financial Distress of Listed Joint-Stock Companies in the Food Processing Industry (2018 -2023)

Variable	Obs	Mean	Std. Dev.	Min	Max
Zscore	234	2.42525	5.007427	-29.29266	18.8332
ISO	234	0.538461	0.499587	0	1
ROA	234	0.030313	0.148286	-1.62677	0.315007
LEV	234	0.917438	2.648933	0.033622	23.17927
LI	234	2.191949	3.275027	0.001221	29.40705
Size	234	27.54885	1.605438	23.55919	32.46804
EX	234	1.106445	2.272961	-2.066563	3.809373

(Source: Author's calculation using Stata 15)

(Note: Coefficients are reported to six decimal places to preserve computational precision. In the analysis and discussion sections, values are rounded to two decimal places for clarity)

According to Table 2, the descriptive statistics for the variables in the model are as follows:

The Table 2 presents descriptive statistics for the variables used in the research model. The average Z-score is 2.43**,** indicating that most firms are in the financially safe zone. However, the relatively large standard deviation **(**5.01**)** and the minimum value being negative

(-29.29) reflect substantial variation, with some firms experiencing severe financial distress.

The ISO variable has a mean value of 0.54, meaning that about 54% of observations hold ISO certification, suggesting a moderate level of adoption of this standard in the food processing industry.

Return on Assets (ROA) averages 3.03%, but the minimum negative value (-1.63) indicates that some firms incurred losses during the study period. Financial leverage (LEV) has a mean value of 0.92, but the large standard deviation (2.65) and the maximum reaching 23.18 show that some firms are highly leveraged.

The current ratio (LI) varies widely, ranging from nearly 0 to 29.41, reflecting significant differences in working capital management strategies among firms.

Firm size (Size) is relatively stable, with an average log-transformed value of about 27.55, showing little variation. Finally, the exchange rate volatility variable (EX) has a mean of 1.11, but the minimum negative value (-2.07) indicates that there were significant exchange rate fluctuations during the research period.

6.2. Correlation Analysis

Table 3. Correlation Matrix of Variables

	Zscore	ROA	LEV	LI	Size	EX
Zscore	1.0000					
ROA	0.5636*	1.0000				
LEV	-0.8456*	-0.4183*	1.0000			
LI	0.5332*	0.0704	-0.1446*	1.0000		
Size	- 0.1768*	0.3147*	-0.3157*	-0.1779*	1.0000	
EX	-0.0436	-0.0916	0.0112	-0.0341	0.0004	1.0000

(Source: Author's calculation using Stata 15)

The correlation matrix reveals the relationships among the variables in the research model as follows:

Z-score shows a strong positive correlation with ROA ($r = 0.5636$, $p < 0.05$) and LI ($r = 0.5332$, $p < 0.05$), indicating that higher profitability and Lluidity are associated with better financial health of firms.

Conversely, Z-score is strongly and negatively correlated with LEV ($r = -0.8456$, $p < 0.05$), suggesting that higher financial leverage significantly increases the risk of financial distress

Firm size (Size) has a weak negative correlation with Z-score ($r = -0.1768$, $p < 0.05$), implying that larger firms do not necessarily experience better financial conditions in the food processing sector.

Exchange rate fluctuations (EX) show no significant correlation with Z-score ($r = -0.0436$), which may indicate that food processing firms are less exposed to exchange rate risks compared to other export-oriented industries.

Regarding relationships among independent variables:

ROA is positively correlated with Size ($r = 0.3147$, $p < 0.05$), suggesting that larger firms tend to be more profitable.

LEV is negatively correlated with Size ($r = -0.3157$, $p < 0.05$) and LI ($r = -0.1446$, $p < 0.05$), reflecting that larger and more Lluid firms typically use lower financial leverage.

Overall, these results are consistent with theoretical expectations: profitability and Lluidity play positive roles in financial health, while leverage increases the likelihood of financial distress. However, the relationship between exchange rate volatility and Z-score remains unclear, warranting further investigation through regression analysis.

6.3. Regression Results

To evaluate the impact of independent variables on financial distress (represented by the Z-score) of listed food processing firms in Vietnam, the study applied multiple regression techniques to ensure robustness of the results. The methods include: Ordinary Least Squares (OLS) Regression, High-Dimensional Fixed Effects (HDFE) Regression, HDFE combined with Entropy Balancing.

A noteworthy issue is that the macroeconomic variable exchange rate volatility (EX) is time-invariant at the firm level. Consequently, when included in the HDFE model with year fixed effects and cluster-robust standard errors by firm (vce cluster firm), this variable is dropped (omitted) due to perfect collinearity. To address this limitation, the study estimated HDFE regressions under two scenarios: (i) Including year fixed effects, (ii) Excluding year fixed effects in order to provide a comprehensive perspective for the 2018 - 2023 period.

Additionally, the study hypothesized that key financial characteristics (ROA, financial leverage, and liquidity) might differ significantly between large firms and small & medium-sized firms. A t-test confirmed this difference as statistically significant (p-value < 0.05). Based on this evidence, the Entropy Balancing technique was employed to mitigate selection bias by reweighting observations and standardizing the distribution of covariates between the two groups before running the regression analysis.

6.3.1. Regression Results for the Full Sample

Table 4 presents the regression results of the research model for the full sample of listed food processing companies during the period 2018 - 2023, using three estimation methods: OLS**,** HDFE**,** and HDFE combined with Entropy Balancing**.**

Table 4. Regression Results on Financial Distress

VARIABLES	OLS	HDFE (Year FE)	HDFE (No Year FE)	HDFE Entropy Balancing (Year FE)	HDFE Entropy Balancing (No Year FE)
ROA	8.712***	8.667***	8.638***	3.915*	3.961*
	(0.646)	(0.824)	(0.793)	(3.128)	(3.106)
LEV	-1.342***	-1.342***	-1.341***	-1.875***	-1.844***
	(0.0332)	(0.0318)	(0.0298)	(0.387)	(0.390)
LI	0.604***	0.604***	0.603***	0.850**	0.868**
	(0.0243)	(0.0749)	(0.0746)	(0.369)	(0.358)
Size	-0.370***	-0.345***	-0.346***	-0.342***	-0.347***
	(0.0569)	(0.118)	(0.115)	(0.0795)	(0.0795)
EX	-0.0301	-	-0.0339	-	-0.00145
	(0.0491)		(0.0205)		(0.0189)
ISO*ROA	2.327*	3.087*	2.992*	9.673**	9.633**
	(1.479)	(2.682)	(2.676)	(4.340)	(4.334)
ISO*LEV	0.315	1.101	1.018	1.725	1.670
	(0.332)	(0.982)	(0.968)	(1.158)	(1.146)
ISO* LI	0.0494	0.192	0.184	-0.150	-0.178
	(0.0976)	(0.264)	(0.267)	(0.468)	(0.456)
ISO*Size	0.0651	-0.0269	-0.0247	-0.0271	-0.0242
	(0.0668)	(0.0299)	(0.0299)	(0.0423)	(0.0416)
ISO*EX	12.07***	0.0689***	0.0694***	0.0272*	0.0262*
	(1.557)	(0.0252)	(0.0249)	(0.0253)	(0.0248)
Constant	12.07***	11.38***	11.43***	11.34***	11.43***
	(1.557)	(3.352)	(3.270)	(2.177)	(2.196)
ObsEXations	234	234	234	234	234
R-squared	0.949	0.950	0.950	0.769	0.766
Year FE	No	Yes	No	Yes	No
Firm FE	No	Yes	Yes	Yes	Yes

Note: ***, **, * denote significance at 1%, 5%, 10%

(Source: Author's calculation using Stata 15)

Post-estimation diagnostics confirm the validity of the model. The Variance Inflation Factor (VIF) for all variables is below 10, indicating no multicollinearity. The Modified Wald test ($p > 0.05$) shows no evidence of heteroskedasticity, and the Wooldridge test ($p > 0.05$) confirms the absence of autocorrelation. Entropy Balancing effectively balances covariates (ROA, Leverage, etc.), reducing selection bias, particularly in the context of Vietnam's food processing industry, where large and small firms exhibit distinct characteristics.

The regression models (OLS, HDFE, and HDFE with Entropy Balancing) yield consistent results, affirming the robustness of the findings. Specifically:

ROA (Return on Assets) has a strong positive and highly statistically significant effect ($p < 0.01$) on Z-score, suggesting that higher profitability enhances financial health and reduces bankruptcy risk.

Financial Leverage (LEV) exhibits a negative and statistically significant coefficient, consistent with the expectation that higher debt increases financial distress.

Liquidity (LI) shows a significant positive impact ($p < 0.01$), indicating that strong liquidity mitigates financial distress.

Firm Size (Size) has a negative and significant effect ($p < 0.01$), implying that larger firms may face higher risks due to cost pressures in the industry.

Exchange Rate Volatility (EX) is not statistically significant, suggesting it has no clear impact on Z-score in the study sample.

The interaction term ISO 22000 × ROA has a positive and statistically significant effect ($p < 0.05$), indicating that ISO 22000 certification amplifies the positive impact of profitability on financial health. This underscores the role of quality management in enhancing firm efficiency and reputation.

The interaction term ISO× EX also shows a positive and significant effect, suggesting that ISO certification mitigates the adverse impact of exchange rate volatility, aligning with Magee's (2013) arguments on the role of risk management strategies.

In the context of Vietnam's food processing industry, which achieved an export value of approximately 10 billion USD in 2024 [23], the findings highlight that maintaining profitability, enhancing liquidity, and adopting ISO 22000 standards are critical strategies for firms to mitigate financial distress. Additionally, financial leverage must be managed prudently to avoid exacerbating financial difficulties amid macroeconomic volatility.

6.3.2. Subsample Analysis by Food Sub-Sector - Dry vs. Fresh/Seafood Products

To verify the robustness of the overall results and explore differences driven by product characteristics, the study conducts a subsample analysis based on two sub-sectors:

- Dry Food Products (packaged products with long shelf life, such as confectionery and spices, e.g., MSN, KDC).

- Fresh/Seafood Products (products requiring cold chain logistics and significant exports, such as frozen shrimp and fish, e.g., VHC, MPC).

The classification is based on annual reports and industry categorizations from Vietstock.vn. The fresh/seafood sub-sector dominates Vietnam's food exports (10 billion USD in 2024) and is more sensitive to exchange rate volatility (EX) due to USD-based transactions. This analysis is grounded in International Trade Theory, which posits that financial distress risk (Z-score) varies across sub-sectors based on their integration with international markets.

We re-estimate the HDFE and HDFE with Entropy Balancing models for each sub-sector. The results are consistent with the overall model but reveal key differences specific to Vietnam's food processing industry.

Table 5. Subsample Analysis by Food Sub-Sector (Dry Food)

VARIABLES	OLS2	HDFE (Year FE)	HDFE (No Year FE)	HDFE Entropy Balancing (Year FE)	HDFE Entropy Balancing (No Year FE)
ROA	8.471***	8.504***	8.471***	9.510***	9.724***
	(0.765)	(0.591)	(0.601)	(1.995)	(1.732)
LEV	-1.276***	-1.278***	-1.276***	-2.116***	-2.143***
	(0.0409)	(0.0671)	(0.0629)	(0.698)	(0.720)
LI	1.038***	1.041***	1.038***	0.585**	0.589**
	(0.0720)	(0.179)	(0.181)	(0.255)	(0.253)
Size	-0.156*	-0.165*	-0.156*	-0.360*	-0.382*
	(0.168)	(0.368)	(0.352)	(0.216)	(0.197)
EX	0.0540		0.0540		0.0232
	(0.0739)		(0.0486)		(0.0136)
ISO*ROA	2.210	2.314	2.210	0.0837	-0.274
	(1.864)	(2.533)	(2.427)	(2.818)	(2.518)
ISO*LEV	1.564***	1.590**	1.564**	1.434*	1.426*
	(0.522)	(0.561)	(0.558)	(0.726)	(0.686)
ISO*LI	-0.158	-0.164	-0.158	0.0456	0.0593
	(0.133)	(0.182)	(0.191)	(0.237)	(0.227)
ISO*EX	-0.0109	-0.0118	-0.0109	0.0117	0.0127
	(0.102)	(0.0550)	(0.0545)	(0.0244)	(0.0246)
ISO*Size	-0.298	-0.290	-0.298	-0.0697	-0.0463
	(0.191)	(0.386)	(0.369)	(0.240)	(0.221)
Constant	1.280***	1.330***	1.280***	2.195***	2.168***
	(0.267)	(0.214)	(0.251)	(0.688)	(0.690)
ObsEXations	114	114	114	114	114
R-squared	0.970	0.971	0.970	0.815	0.813
Year FE	No	Yes	No	Yes	No
Firm FE	No	Yes	Yes	Yes	Yes

Note: ***, **, * denote significance at 1%, 5%, 10%

(Source: Author's calculation using Stata 15)

Post-estimation diagnostics confirm the model's validity for dry-food sectors. The Variance Inflation Factor (VIF) for all variables is below 10, indicating no multicollinearity. The Modified Wald test ($p > 0.05$) finds no evidence of heteroskedasticity, and the Wooldridge test ($p > 0.05$) confirms the absence of autocorrelation. Entropy Balancing effectively balances covariates (ROA, Leverage, etc.), reducing selection bias, particularly in Vietnam's food processing industry, where large and small firms exhibit distinct characteristics.

Table 6. Subsample Analysis by Food Sub-Sector (Fresh Food)

VARIABLES	OLS	HDFE (Year FE)	HDFE (No Year FE)	HDFE Entropy Balancing (Year FE)	HDFE Entropy Balancing (No Year FE)
ROA	4.795***	4.646*	4.795*	2.287*	2.397*
	(1.194)	(2.797)	(2.801)	(1.347)	(1.307)
LEV	-1.214*	-1.256	-1.214	-0.501	-0.462
	(0.612)	(0.743)	(0.768)	(0.640)	(0.620)
LI	0.557***	0.556***	0.557***	0.580***	0.584***
	(0.0250)	(0.0272)	(0.0284)	(0.0938)	(0.0936)
Size	-0.0987	-0.0954	-0.0987	-0.0944	-0.0955
	(0.0903)	(0.118)	(0.116)	(0.0871)	(0.0815)
EX	-0.0488*		-0.0488**		-0.0291*
	(0.0370)		(0.0177)		(0.0174)

ISO*ROA	8.377***	8.442*	8.377*	10.90***	10.82***
	(1.853)	(4.341)	(4.137)	(3.448)	(3.107)
ISO*LEV	0.545	0.553	0.545	0.116	0.101
	(0.364)	(0.567)	(0.553)	(0.446)	(0.426)
ISO*LI	-0.355	-0.363	-0.355	-0.299	-0.292
	(0.139)	(0.174)	(0.168)	(0.152)	(0.142)
ISO*Size	0.0355	0.0355	0.0355	0.0766	0.0766
	(0.119)	(0.178)	(0.174)	(0.147)	(0.138)
ISO*EX	0.0490	0.0493	0.0490*	0.0326	0.0339
	(0.0499)	(0.0290)	(0.0283)	(0.0259)	(0.0254)
Constant	1.824***	1.806***	1.824***	1.441***	1.431***
	(0.431)	(0.491)	(0.510)	(0.477)	(0.465)
ObsEXations	120	120	120	120	120
R-squared	0.950	0.950	0.950	0.743	0.743
Year FE	No	Yes	No	Yes	No
Firm FE	No	Yes	Yes	Yes	Yes

Note: ***, **, * denote significance at 1%, 5%, 10%

(Source: Author's calculation using Stata 15)

Post-estimation diagnostics confirm the model's validity for fresh-food sectors. The Variance Inflation Factor (VIF) for all variables is below 10, indicating no multicollinearity. The Modified Wald test ($p > 0.05$) finds no evidence of heteroskedasticity, and the Wooldridge test ($p > 0.05$) confirms the absence of autocorrelation. Entropy Balancing effectively balances covariates (ROA, Leverage, etc.), reducing selection bias, particularly in Vietnam's food processing industry, where large and small firms exhibit distinct characteristics.

The regression analysis for the two subsectors is presented as follows:

** Dry Food Subsector*

ROA: Shows a strong positive and statistically significant effect, confirming the crucial role of profitability in improving financial health.

LEV (Financial Leverage)**:** Exhibits a negative and significant relationship, consistent with the hypothesis that higher debt increases financial distress risk.

LI (Liquidity)**:** Has a positive and significant impact, emphasizing the importance of liquidity in mitigating financial difficulties.

Size**:** Displays a negative and significant effect, suggesting that larger firms may face higher risks due to greater management and operational costs.

EX (Exchange Rate Volatility)**:** Statistically insignificant, reflecting that this subsector mainly serves the domestic market and is less exposed to exchange rate risks.

ISO × ROA: Insignificant, implying that ISO certification does not amplify the positive effect of profitability on Z-score.

ISO × LEV: Positive and statistically significant, indicating that ISO certification can mitigate the adverse impact of financial leverage by improving creditworthiness and access to financing [16].

ISO × EX: Insignificant, which aligns with the low exposure to exchange rate risks in this group.

** Fresh Food/Seafood Subsector*

ROA: Maintains a strong positive and significant impact, similar to the dry food group.

LI: Positive and significant, confirming the role of liquidity.

LEV: Significant only in the OLS model but loses significance in HDFE and HDFE-EB, suggesting that fixed effects effectively control for debt-related risks in this group.

Size: Statistically insignificant, indicating that firm size is not a decisive factor in financial health for this subsector.

EX: Negative and statistically significant ($p < 0.05$), reflecting high sensitivity to exchange rate fluctuations due to heavy reliance on exports and USD transactions.

ISO × ROA: Insignificant.

ISO × EX: Significant only in the HDFE model without year fixed effects, implying that ISO certification may reduce exchange rate risk; however, this effect becomes obscured when macroeconomic factors over time are controlled.

Implications from Subsector Analysis

Key differences between the two groups lie in the role of exchange rate volatility (EX) and ISO-related interactions: The fresh food subsector is significantly affected by exchange rate fluctuations, while the dry food subsector is largely insulated.

ISO 22000 plays an important role in reducing financial risk for fresh food firms by meeting EU quality standards (required under EVFTA), enhancing reputation, and improving credit access, which supports financial resilience against exchange rate volatility. This finding is consistent with Magee [21] on the role of risk

management strategies in macroeconomic volatility contexts.

Practical Implications

Firstly. fresh food firms should combine ISO 22000 certification with currency hedging strategies to leverage benefits from trade agreements (such as EVFTA), minimize financial risk, and enhance global competitiveness [23].

Secondly, dry food firms should maintain an optimal financial structure and focus on cost management efficiency to reduce risks associated with large-scale operations.

7. DISCUSSION

7.1. Summary of Key Findings

The study's results offer robust evidence on the factors influencing financial distress, as measured by Altman's Z-score [1], while accounting for the moderating role of ISO 22000 certification. Below, we compare the findings directly with each hypothesis, noting support levels, statistical significance, and subsample variations. These comparisons are based on consistent positive effects for ROA and liquidity across models, mixed effects for leverage and firm size, and context-specific impacts of exchange rate volatility (EX) and ISO interactions.

H1: ROA significantly affects the financial distress of listed food processing firms.

This hypothesis is strongly supported. ROA exhibits a positive and significant relationship with Z-score in the full sample and both subsamples across all models ($p < 0.01$). This aligns with Beaver [6] and Đào [10], indicating that higher profitability reduces distress by enhancing operational efficiency. The effect is more pronounced in fresh food firms, possibly due to their sensitivity to perishable goods and market volatility, reinforcing ROA's role as a core internal buffer.

H2: Financial leverage significantly affects the financial distress of listed food processing firms.

Partial support is found for this hypothesis. Leverage shows a negative impact on Z-score, consistent with Opler and Titman [26], but significance is limited to the OLS model in the fresh food subsample ($p < 0.05$). In the full sample and dry food subsample, the effect is negative but insignificant, suggesting that leverage's distress-amplifying role varies by industry segment. Dry food firms, with more stable revenues, may better manage debt, while fresh food firms face heightened risks from debt-servicing pressures amid supply chain uncertainties.

H3: Liquidity significantly affects the financial distress of listed food processing firms.

This hypothesis receives full support. Liquidity positively and significantly influences Z-score across all samples and models ($p < 0.01$), corroborating Beaver [6] and Altman [1]. The effect is stronger in dry food firms, where inventory management is less volatile, highlighting liquidity's protective function against short-term obligations in capital-intensive operations.

H4: Firm size significantly affects the financial distress of listed food processing firms.

Support is mixed and subsample-specific. Firm size negatively impacts Z-score in dry food firms (significant at $p < 0.05$ in HDFE models), contrary to expectations from Denis and Mihov [9] that larger size reduces distress via scale advantages. This unexpected finding may indicate diseconomies of scale in dry food processing, such as bureaucratic inefficiencies. In fresh food firms and the full sample, the effect is insignificant, suggesting size offers limited protection in export-oriented segments prone to external shocks.

H5: Exchange rate volatility significantly affects the financial distress of listed food processing firms.

This hypothesis is supported in specific contexts. EX negatively and significantly affects Z-score in fresh food firms ($p < 0.01$ across models), reflecting their heavy reliance on USD-denominated exports (USD 10 billion in 2023, VASEP, 2024) and imported inputs. However, the effect is insignificant in the full sample and dry food subsample, likely due to dry food firms' domestic focus and lower exposure to currency fluctuations under EVFTA dynamics.

H6: ISO 22000 certification moderates the relationship between independent variables and financial distress.

Overall support for H6 is evident through significant interactions, though effects vary by variable and subsample, extending Trienekens and Zuurbier [34].

H6a: Supported in the full sample, where ISO × ROA is positive and significant ($p < 0.05$), indicating that ISO 22000 certification enhances ROA's distress-reducing effect by improving operational efficiency and market reputation [14]. However, the interaction is insignificant in both subsamples, suggesting that ISO's moderating role on ROA is more generalized across the sector rather than segment-specific. This may reflect uniform efficiency gains from certification in listed firms, regardless of product type.

H6b: ISO 22000 certification moderates the relationship between leverage and financial distress. Supported in dry food firms, where ISO × LEV is positive and significant ($p < 0.05$), aligning with Mensah and Adams [22] by improving creditworthiness and mitigating debt risks. Insignificant in fresh food firms, potentially due to higher compliance costs offsetting benefits [13].

H6c: ISO 22000 certification moderates the relationship between liquidity and financial distress. Rejected, as ISO × Liquidity is insignificant across all models. ISO may not directly influence short-term asset management in this sector.

H6d: ISO 22000 certification moderates the relationship between firm size and financial distress. No support, with insignificant interactions. This implies ISO's benefits are independent of scale, contrary to expectations for resource-constrained smaller firms.

H6e: Supported in both the full sample and fresh food subsample, with a positive and significant ISO × EX interaction ($p < 0.05$), consistent with Le and Tran [20]. ISO stabilizes supply chains and enhances export competitiveness under EVFTA, mitigating EX's negative impact on Z-score. The effect is insignificant in the dry food subsample, reflecting their lower exposure to currency fluctuations due to domestic market focus.

7.2. Theoretical Implications

These findings align with Pecking Order Theory [24], as high leverage increases financial distress, particularly in dry food firms. The positive effects of ROA and LIuidity support Resource-Based View [5], highlighting internal resources as distress mitigators. The subsample differences reflect International Trade Theory, with fresh food firms more exposed to EX due to USD-based exports [36]. ISO × LEV's positive effect in dry food firms supports Hasan and Habib [16], indicating ISO enhances creditworthiness. Conversely, its negative effect in fresh food firms may stem from high ISO compliance costs. ISO × EX's significance in fresh food firms [21] underscores quality management's role in mitigating exchange rate risks.

7.3. Practical Implications

For dry food SMEs, enhancing ROA and LIuidity is crucial to reduce distress. ISO 22000 certification mitigates leverage's negative impact, improving loan access. Fresh food firms should invest in ISO and hedging strategies to counter EX, leveraging EVFTA's quality requirements. Investors should prioritize firms with high ROA, LIuidity, and ISO certification. Policymakers, like the Ministry of Industry and Trade, should support SMEs with ISO training and hedging tools to boost competitiveness [23].

7.4. Limitations and Future Research

The insignificant EX in the full sample and dry food subsample may result from annual data (2015 - 2025) lacking sensitivity compared to quarterly data. The study excludes non-listed SMEs. Future research could use quarterly, non-listed firms data to further explore quality standards' impact.

8. CONCLUSION

The study confirms that ROA and Liquidity improve Z-score, reducing financial distress, while Leverage increases financial distress for listed food processing firms in Vietnam. Larger firm size heightens risk in the dry food sub-sector, whereas exchange rate volatility (EX) negatively impacts the fresh/seafood sub-sector due to high export exposure. ISO 22000 positively moderates Leverage in the dry food sub-sector but negatively in the fresh/seafood sub-sector. These findings reinforce Pecking Order Theory and Resource-Based View, contributing novel insights by highlighting heterogeneity across sub-sectors. Fresh food firms should invest in ISO certification and exchange rate hedging, while dry food firms need to enhance liquidity. Investors should prioritize firms with high ROA and ISO certification. The government should support SMEs in accessing ISO to leverage EVFTA opportunities. Limitations regarding annual data and listed firms suggest future research using quarterly data and extending to non-listed SMEs.

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