
Do ESG Scores and Controversies Improve Corporate Financial Distress Prediction? Evidence from Machine Learning in Asia-Pacific Markets

Submitted 23/04/26, 1st revision 05/05/26, 2nd revision 20/05/26, accepted 30/06/26

Hassan Raza¹, Syeda Hina Zaidi², Eleftherios Thalassinos³

Abstract:

Purpose: This study investigates whether ESG information provides incremental predictive value for corporate financial distress beyond established accounting-based predictors. Focusing on twelve Asia-Pacific markets, we evaluate the complete LSEG/Refinitiv ESG framework, including the headline ESG score, pillar and category scores, and the ESG Controversies score, within a rigorous machine-learning framework.

Design/Methodology/Approach: The analysis is based on 47,253 firm-year observations spanning 2016–2024. The benchmark model incorporates the principal predictors established in the financial distress literature, including traditional accounting ratios, liquidity measures, funds-flow indicators, earnings-manipulation variables, and macroeconomic conditions. Model performance is evaluated using a strict out-of-time validation design in which models are trained on 2016–2022 observations and tested exclusively on 2023–2024 data. Gradient boosting and complementary machine-learning algorithms are employed, while SHAP analysis is used to examine feature contributions.

Findings: The results reveal three principal findings. First, ESG coverage is highly selective, encompassing only approximately one-fifth of firm-year observations and declining to negligible levels in frontier markets, while distressed firms are substantially less likely to receive ESG ratings than financially healthy firms. Second, although ESG variables possess modest standalone predictive ability, they provide no incremental improvement once comprehensive financial fundamentals are incorporated into the prediction model. Third, SHAP attribution assigns considerable importance to ESG variables despite their negligible contribution to out-of-time predictive performance, highlighting that feature importance should not be interpreted as evidence of incremental predictive value. Furthermore, the U-shaped relationship between ESG performance and financial distress documented for U.S. firms is not observed across Asia-Pacific markets.

Practical Implications: This study provides the first comprehensive out-of-time machine-learning assessment of the full LSEG/Refinitiv ESG architecture for corporate financial distress prediction across twelve Asia-Pacific economies.

¹Associate Professor, Department of Management Sciences, SZABIST University, Pakistan, ORCID: 0000-0002-9394-4961, e-mail: Dr.hassanszabistisb@gmail.com;

²PhD, Department of Management Sciences, Capital University of Science and Technology, Pakistan, ORCID: 0000-0003-2271-5229, e-mail: syedahenzaidi@gmail.com;

³Professor, University of Piraeus, Greece, Affiliate Professor University of Malta, Malta, ORCID: 0000- e-mail: thalassinos@ersj.eu;

Originality/Value: *By evaluating ESG information against one of the most comprehensive benchmarks of classical distress predictors, the study demonstrates that ESG ratings currently offer limited incremental value for financial distress prediction in the region, while identifying insufficient ESG coverage as a fundamental constraint for both practitioners and policymakers.*

Keywords: *ESG, corporate financial distress, machine learning, ESG controversies, bankruptcy prediction, Asia-Pacific, SHAP.*

JEL codes: *G33, G32, Q56, C45, G34.*

Paper type: *Research article.*

1. Introduction

Environmental, social, and governance (ESG) considerations have rapidly evolved from a voluntary corporate responsibility initiative into an integral component of modern financial decision-making. Investors, creditors, regulators, and other stakeholders increasingly regard ESG performance as a potential indicator of corporate resilience, long-term sustainability, and risk exposure.

Consequently, ESG ratings have become an important source of non-financial information in investment analysis, credit assessment, and portfolio management. The rapid expansion of the global ESG ratings industry reflects the growing expectation that firms demonstrating stronger ESG performance should also exhibit greater financial stability and lower default risk. Despite this widespread acceptance, empirical evidence regarding the predictive value of ESG information for corporate financial distress remains inconclusive.

The existing literature presents conflicting perspectives on the relationship between ESG performance and corporate distress. A substantial body of research, particularly within the banking sector, suggests that stronger ESG performance is associated with lower risk-taking, improved financial stability, and a reduced probability of default. High-quality ESG practices may strengthen stakeholder confidence, enhance corporate governance, improve operational efficiency, and mitigate regulatory and reputational risks, thereby contributing to greater organizational resilience.

Conversely, recent evidence indicates that this relationship may be considerably more complex than previously assumed. For example, evidence from U.S. listed firms suggests a non-linear association in which companies experiencing severe financial distress may continue to exhibit relatively high ESG ratings, potentially because ESG disclosures can be enhanced at comparatively low-cost during periods of financial deterioration. Such findings raise important questions regarding whether

ESG scores genuinely capture underlying financial resilience or merely reflect firms' disclosure strategies and reporting capabilities.

These concerns are further reinforced by well-documented limitations in ESG measurement. ESG ratings produced by different providers frequently exhibit substantial disagreement because of variations in methodologies, weighting schemes, indicator selection, and data interpretation. Rather than measuring an objective construct, ESG scores often represent provider-specific assessments of corporate sustainability performance.

In addition, previous studies consistently demonstrate that ESG ratings are strongly associated with firm size, disclosure capacity, and institutional visibility. Larger firms generally possess greater financial and organizational resources to prepare sustainability reports and respond to rating agencies, whereas smaller firms, despite potentially similar sustainability practices, often remain unrated.

Consequently, part of the apparent relationship between ESG performance and financial stability may simply reflect firm characteristics that are already captured by conventional financial indicators. These measurement concerns become particularly important when ESG variables are incorporated into financial distress prediction models. Financial distress prediction has been extensively studied for more than five decades, beginning with the pioneering work of Altman (1968) and subsequently expanded through probabilistic, accounting-based, market-based, and machine-learning approaches.

Over time, researchers have identified a comprehensive set of financial indicators - including profitability, leverage, liquidity, operating cash flow, earnings dynamics, and accounting quality - that consistently explain corporate failure with high predictive accuracy. If ESG ratings primarily proxy for these underlying firm characteristics, their apparent predictive contribution may disappear once sufficiently comprehensive financial information is incorporated into the modelling framework. Accordingly, evaluating ESG variables against a weak benchmark risk overstating their true incremental value.

One important limitation of the existing literature is precisely the widespread reliance on relatively simple benchmark models. Many studies compare ESG variables only with traditional accounting ratios or linear statistical specifications, making it difficult to determine whether ESG information genuinely contributes additional predictive content or merely captures information already embedded within established financial indicators. Under such circumstances, almost any variable correlated with firm quality is likely to produce measurable improvements in predictive performance. A more rigorous assessment therefore requires ESG information to be evaluated against a benchmark incorporating the strongest predictors established by the financial distress literature.

Against this backdrop, the present study evaluates the predictive contribution of ESG information using a considerably more demanding empirical framework. Rather than comparing ESG variables with a limited set of accounting ratios, we construct a benchmark that incorporates the principal predictors established in the corporate distress literature.

In addition to conventional financial ratios, the benchmark includes liquidity measures, operating cash-flow indicators, earnings-dynamics variables, earnings-manipulation proxies derived from the Beneish model, and country-level macroeconomic conditions. This comprehensive specification enables a rigorous assessment of whether ESG information contributes genuinely new predictive content beyond what is already embedded in firms' financial fundamentals.

The analysis focuses on the Asia-Pacific region, where the role of ESG information remains comparatively underexplored despite the region's increasing economic significance. Unlike the mature capital markets of North America and Western Europe, ESG disclosure across many Asia-Pacific economies continues to be characterized by considerable heterogeneity in regulatory frameworks, reporting practices, and market development.

While several developed economies within the region have made substantial progress towards mandatory sustainability reporting, disclosure in many emerging and frontier markets remains largely voluntary, resulting in uneven ESG coverage and inconsistent data quality. These institutional differences provide a particularly suitable environment for examining whether ESG information can meaningfully enhance financial distress prediction under conditions of incomplete disclosure and varying reporting quality.

Existing evidence from the region remains limited in both scope and methodology. Recent studies primarily examine the association between ESG performance and accounting-based financial distress proxies, such as Altman's Z-score, or focus on individual national markets.

Although these studies provide valuable insights into the relationship between sustainability performance and corporate financial health, they do not evaluate whether ESG variables improve the prediction of future distress when assessed using modern machine-learning techniques and rigorous out-of-sample validation procedures.

Consequently, an important gap persists regarding the incremental predictive value of ESG information in Asia-Pacific capital markets. To address this gap, we compile a comprehensive panel comprising 47,253 firm-year observations covering twelve Asia-Pacific economies between 2016 and 2024. The sample encompasses developed, emerging, and frontier markets, thereby capturing substantial institutional, regulatory, and economic diversity. We integrate the complete

LSEG/Refinitiv ESG architecture—including the overall ESG score, the three pillar scores, ten category-level scores, and the ESG Controversies score—with an extensive set of accounting and macroeconomic predictors.

Consistent with best practices in predictive modelling, explanatory variables measured in fiscal year t are used exclusively to forecast financial distress in year $t + 1$. Furthermore, all models are evaluated using a strict out-of-time validation framework, in which training is confined to observations from 2016–2022 and performance is assessed only on the previously unseen 2023–2024 sample. This design substantially reduces the risk of look-ahead bias and provides a more realistic evaluation of predictive performance than conventional random cross-validation approaches.

The empirical findings yield three principal insights. First, ESG data availability is highly selective across the region. Overall ESG coverage extends to only around one-fifth of firm-year observations, with virtually no coverage in several frontier markets. Moreover, firms that subsequently experience financial distress are considerably less likely to possess ESG ratings than financially healthy firms. This systematic selection bias indicates that ESG information is least available for precisely those firms where early-warning models are most valuable.

Second, although ESG variables exhibit modest standalone predictive capability, they provide no incremental improvement once comprehensive financial fundamentals are incorporated into the prediction models. Among the classical extensions examined, only the funds-flow indicators proposed by Ohlson contribute meaningful improvements in predictive performance, whereas earnings-manipulation measures, macroeconomic variables, and the complete ESG information set fail to enhance out-of-time model accuracy.

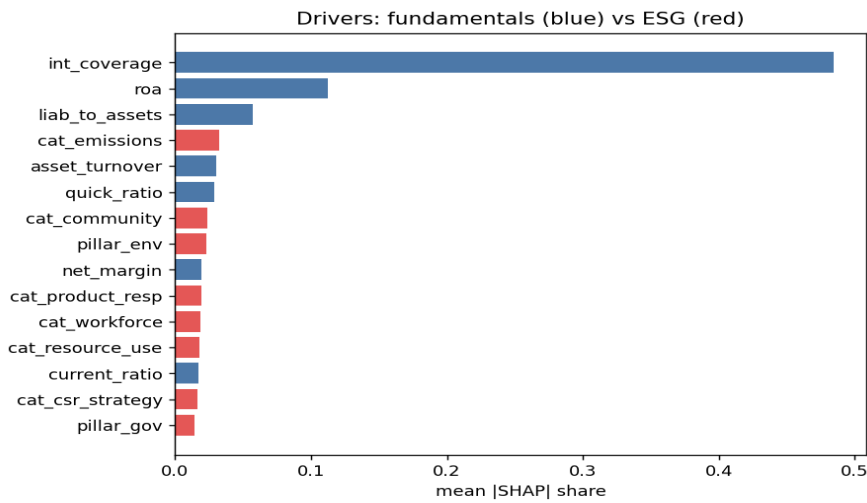
These findings suggest that the information contained in ESG ratings is largely subsumed by conventional financial indicators when sufficiently comprehensive benchmark models are employed.

Third, our explainable machine-learning analysis reveals an important methodological implication. SHAP assigns substantial attribution to ESG variables despite their negligible contribution to predictive performance. This apparent contradiction demonstrates that feature attribution should not be interpreted as evidence of incremental predictive value. Instead, attribution measures indicate how a fitted model utilizes available information rather than whether that information improves predictive performance beyond existing variables. Consequently, studies relying solely on feature-importance measures may overstate the practical relevance of ESG variables in financial distress prediction.

Figure 1 SHAP features attribution for the ESG-augmented XGBoost model. Mean absolute SHAP values are reported for the fifteen most influential predictors in the

out-of-time test sample. Conventional financial variables (blue) and ESG variables (red) jointly determine model predictions. Although ESG variables account for approximately 23.7% of total feature attribution, they do not improve out-of-time predictive performance beyond comprehensive financial fundamentals, illustrating the distinction between model utilization and incremental predictive value.

Figure 1. SHAP attribution in the ESG-augmented XGBoost model.



Source: Own study.

This study makes several important contributions to the literature. First, it provides the first comprehensive out-of-time machine-learning evaluation of the complete LSEG/Refinitiv ESG framework for predicting corporate financial distress across multiple Asia-Pacific economies.

Second, by benchmarking ESG variables against one of the most comprehensive sets of established distress predictors available in the literature, the study offers a more rigorous assessment of ESG's incremental informational value than previous research. Third, it demonstrates that ESG coverage itself represents a significant practical limitation within emerging and frontier markets, where financially vulnerable firms are least likely to receive ESG ratings.

Finally, the findings contribute to the growing literature on explainable artificial intelligence by illustrating the distinction between model attribution and genuine predictive contribution, an issue that extends well beyond ESG research.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature and develops the research hypotheses. Section 3 describes the sample, variables, and data sources. Section 4 outlines the empirical methodology and machine-learning framework. Section 5 presents the empirical findings, while

Section 6 discusses their theoretical and practical implications. The final section concludes the study and identifies avenues for future research.

2. Literature Review and Hypotheses

2.1 ESG Performance and Corporate Financial Distress

The growing integration of environmental, social, and governance (ESG) considerations into corporate decision-making has stimulated extensive research on their implications for financial risk. A prevailing argument within stakeholder and resource-based perspectives suggests that firms demonstrating stronger ESG performance are better positioned to manage operational, regulatory, and reputational risks, thereby enhancing organizational resilience and reducing the likelihood of financial distress. Effective ESG practices may strengthen stakeholder trust, improve governance quality, facilitate access to capital, and mitigate exposure to adverse environmental or social events, all of which can contribute to long-term financial stability.

Empirical evidence, however, remains far from conclusive. Studies within the banking sector generally report a negative association between ESG performance and default risk. Banks exhibiting stronger ESG profiles or experiencing fewer ESG controversies tend to engage in less excessive risk-taking and display greater financial stability. These findings suggest that ESG information may capture dimensions of organizational quality that extend beyond conventional financial statements. For non-financial firms, the evidence is considerably more mixed. While several studies document that stronger ESG performance is associated with lower financial distress, others report weak or statistically insignificant relationships after controlling for firm characteristics.

More recently, evidence from U.S. listed companies has challenged the conventional assumption of a monotonic relationship by documenting a U-shaped association between ESG scores and financial distress. This finding implies that firms approaching financial distress may strategically enhance ESG disclosure to preserve investor confidence, resulting in relatively high ESG ratings despite deteriorating economic fundamentals. If ESG scores partly reflect disclosure behavior rather than underlying financial resilience, their usefulness as early-warning indicators becomes questionable.

Evidence from Asia-Pacific economies remains comparatively limited. Existing studies largely examine associations between ESG measures and accounting-based distress indicators, such as Altman's Z-score, or focus on individual countries rather than conducting comprehensive multi-country predictive analyses.

Although these studies contribute to understanding the relationship between sustainability and corporate financial health, they do not determine whether ESG

information improves the prediction of future financial distress once conventional financial indicators are taken into account. Consequently, whether ESG variables possess genuine incremental predictive value remains an open empirical question.

Accordingly, two competing hypotheses are proposed.

H1a: *ESG scores, pillar scores, category scores, and ESG controversies provide incremental predictive information that improves the out-of-time prediction of corporate financial distress beyond conventional financial fundamentals.*

H1b: *ESG scores, pillar scores, category scores, and ESG controversies do not provide incremental predictive information beyond conventional financial fundamentals because their informational content is already reflected in firms' financial characteristics.*

2.2 Classical Predictors of Financial Distress

The prediction of corporate financial distress represents one of the most extensively researched areas in accounting and finance. Beginning with Altman's pioneering discriminant analysis, subsequent research has consistently demonstrated that financial distress can be predicted using information contained within firms' accounting statements, market indicators, and cash-flow characteristics. Over several decades, numerous prediction models have identified profitability, leverage, liquidity, operating performance, and cash-flow generation as among the most reliable determinants of corporate failure.

Among these established predictors, operating cash flow occupies a particularly important position because it directly reflects a firm's capacity to generate sufficient internal resources to meet its financial obligations. Ohlson's probabilistic bankruptcy model demonstrated that funds flow relative to total liabilities (FUTL) and changes in earnings provide significant incremental information beyond conventional financial ratios. Likewise, Campbell and co-authors highlighted the importance of cash holdings in explaining corporate failure, particularly over extended prediction horizons. Unlike static accounting ratios, cash-flow measures capture the firm's ongoing financial flexibility and liquidity management, enabling earlier identification of deteriorating financial conditions.

Accounting quality has also received considerable attention within the financial distress literature. Financially distressed firms may possess incentives to manipulate reported earnings in an attempt to conceal weakening performance or delay adverse market reactions.

The Beneish M-score and its underlying component ratios have therefore been widely employed to identify potential earnings manipulation and evaluate financial reporting quality. If accounting manipulation systematically precedes corporate

failure, these indicators should improve financial distress prediction, particularly in environments characterized by relatively weak disclosure quality.

Macroeconomic conditions constitute another important source of financial distress risk. Corporate failures frequently increase during periods of economic slowdown, high inflation, or exchange-rate instability because adverse macroeconomic environments reduce corporate profitability while simultaneously increasing financing constraints. Previous research demonstrates that combining firm-specific financial information with macroeconomic variables can improve bankruptcy prediction, particularly when firms operate across diverse economic environments.

Building upon this literature, the present study evaluates the incremental contribution of three classical extensions beyond conventional accounting ratios: liquidity and operating cash-flow measures, earnings-manipulation indicators, and macroeconomic variables. Rather than assuming their predictive relevance, each variable block is subjected to rigorous out-of-time evaluation within the same empirical framework.

Accordingly, the following hypothesis is proposed:

H2: *Liquidity measures, operating cash-flow indicators, earnings-manipulation variables, and macroeconomic conditions provide incremental improvements in out-of-time corporate financial distress prediction beyond conventional accounting ratios.*

2.3 Measurement Challenges in ESG Ratings

Interpreting the predictive role of ESG information requires careful consideration of the limitations inherent in ESG measurement. Unlike traditional accounting variables, ESG ratings lack universally accepted measurement standards. Different rating agencies frequently assign substantially different scores to the same company because of differences in indicator selection, weighting methodologies, data sources, and aggregation procedures. Consequently, ESG ratings should not be viewed as objective measures of sustainability performance but rather as provider-specific evaluations.

Another widely documented characteristic of ESG ratings is their strong association with firm size. Larger corporations typically possess greater financial resources, more sophisticated governance structures, and stronger reporting capabilities, enabling them to produce extensive sustainability disclosures and engage more effectively with rating agencies. Smaller firms, by contrast, frequently remain unrated or receive lower-quality assessments despite potentially comparable sustainability practices. Accordingly, ESG ratings often capture differences in disclosure capacity as much as differences in underlying sustainability performance.

These measurement issues have important implications for financial distress prediction. If ESG ratings primarily reflect firm size, disclosure quality, and governance characteristics already embedded within financial statements, their apparent predictive ability may simply duplicate information contained in conventional accounting variables.

Furthermore, if financially distressed firms strategically enhance ESG disclosure to preserve market confidence, ESG ratings may exhibit non-linear relationships with distress rather than functioning as straightforward indicators of financial risk. To examine this possibility, we test whether the non-linear relationship reported for U.S. firms is also observable across Asia-Pacific markets.

H3: *The relationship between ESG performance and subsequent corporate financial distress follows a U-shaped pattern.*

3. Data

3.1 Sample Selection and Financial Distress Classification

This study employs a comprehensive panel of publicly listed firms drawn from twelve Asia-Pacific equity markets using the LSEG/Refinitiv database. The sample spans the 2016–2024 fiscal years and includes firms from three distinct stages of market development: developed markets (Australia, Hong Kong, and Singapore), emerging markets (India, Indonesia, Malaysia, the Philippines, and Thailand), and frontier markets (Bangladesh, Pakistan, Sri Lanka, and Vietnam).

Following the construction of one-year-ahead prediction labels, the final dataset comprises 47,253 firm-year observations, providing one of the largest multi-country panels assembled for corporate financial distress prediction within the region.

Financial distress is identified using a persistence-based classification framework that combines three complementary indicators of deteriorating financial health: sustained operating losses, persistently negative operating cash flows, and progressive balance-sheet deterioration. Unlike legal bankruptcy events, which occur relatively infrequently and often differ across jurisdictions, this approach captures firms experiencing economically meaningful financial deterioration before formal insolvency occurs.

The resulting distress classification demonstrates strong discriminatory ability when validated against the Altman Z'' -Score for emerging markets, confirming its suitability as an early-warning indicator. To ensure genuine predictive inference, all explanatory variables are measured in fiscal year t , while the distress outcome is observed in fiscal year $t + 1$. Across the pooled sample, distressed observations represent approximately 16.1% of all firm-years.

3.2 ESG Variables

The principal variables of interest are obtained from the LSEG/Refinitiv ESG database. Rather than relying solely on the aggregate ESG score, this study incorporates the provider's complete ESG assessment framework to capture multiple dimensions of corporate sustainability performance. Specifically, the analysis includes the overall ESG Score, the Environmental, Social, and Governance pillar scores, the ten underlying category scores, and the ESG Controversies Score.

The ESG Controversies Score reflects the extent to which firms are associated with adverse ESG-related incidents reported in public media sources. Higher values indicate fewer or less severe controversies, whereas lower scores represent greater exposure to ESG-related controversies. The ESG Combined Score is intentionally excluded from the empirical models because it mechanically combines the overall ESG score with controversy adjustments, thereby introducing unnecessary redundancy into the feature set.

The initial extraction from LSEG/Refinitiv yielded ESG information for 13,502 firm-year observations representing 2,867 listed companies. After matching these observations with the one-year-ahead financial distress dataset, 9,394 ESG-covered firm-year observations remained available for empirical analysis. One important consideration concerns the nature of commercially available ESG databases. Historical ESG scores maintained by Refinitiv are periodically revised as new information becomes available or methodological adjustments are implemented.

Consequently, the archived fiscal-year scores may not perfectly correspond to the information available to market participants in real time. If anything, this characteristic is likely to favor ESG by incorporating revised historical information, implying that the empirical results provide a conservative test of ESG's incremental predictive value.

3.3 Classical Financial Distress Predictors

To evaluate the incremental contribution of ESG information rigorously, the empirical framework incorporates one of the most comprehensive sets of established financial distress predictors available in the literature.

The benchmark model begins with conventional accounting-based indicators capturing liquidity, profitability, operating efficiency, firm size, and leverage. Building upon this foundation, three additional blocks of explanatory variables are introduced sequentially.

The first extension comprises liquidity and operating cash-flow indicators derived from the bankruptcy prediction literature. Cash holdings are measured as cash and

short-term investments relative to total assets, representing a book-value analogue of the CASHMTA measure proposed by Campbell *et al.* (2008).

This variable is available for approximately 90.6% of firm-year observations. Two additional variables originate from Ohlson's (1980) bankruptcy prediction framework: funds flow relative to total liabilities (FUTL), calculated as operating cash flow divided by total liabilities, and the scaled change in net income (CHIN), which captures changes in earnings performance over time. These variables are available for approximately 90.4% and 86.9% of observations, respectively.

The second extension evaluates whether accounting quality contributes additional predictive information. To this end, the analysis incorporates the eight Beneish (1999) earnings-manipulation indicators—DSRI, GMI, AQI, SGI, DEPI, SGAI, LVGI, and TATA—together with the composite Beneish M-score.

These indicators identify potential earnings manipulation by comparing successive financial statements. Because their calculation requires lagged accounting information, coverage varies across individual indicators, with the complete Beneish specification available for approximately 46% of firm-year observations.

The final extension incorporates macroeconomic conditions following the integrated accounting–market–macroeconomic framework proposed by Tinoco and Wilson (2013). Country-level variables include real GDP growth, consumer price inflation, and nominal exchange-rate depreciation against the U.S. dollar. These data are obtained from the World Bank's World Development Indicators and are available for all observations within the sample.

Collectively, these variable blocks provide a demanding benchmark against which the incremental informational value of ESG measures can be evaluated.

3.4 ESG Coverage Across Asia-Pacific Markets

An important contribution of this study is the demonstration that ESG coverage itself exhibits substantial systematic variation across countries and firm characteristics.

Table 1. *ESG Coverage by Market (firm-years with one-year-ahead label, 2016–2024).*

Market	Firm-years	ESG coverage (%)	Distress rate (%)	Coverage among distressed (%)
Australia	3,550	55.2	28.8	29.6
Hong Kong	5,145	35.5	20.1	17.9
India	5,058	33.9	8.4	22.4
Malaysia	4,488	32.6	9.1	29.0
Thailand	5,108	18.4	9.8	15.0
Singapore	4,860	12.5	24.9	1.7
Philippines	2,282	10.9	21.3	1.4

Market	Firm-years	ESG coverage (%)	Distress rate (%)	Coverage among distressed (%)
Indonesia	4,754	9.8	13.8	4.9
Vietnam	4,919	2.6	12.0	4.1
Pakistan	3,950	0.5	20.8	0.0
Sri Lanka	2,108	0.4	18.5	0.0
Bangladesh	1,031	0.0	5.8	0.0
Pooled	47,253	19.9	16.1	—

Source: Own study.

Table 1 reveals pronounced differences in ESG availability across the twelve sample markets. Coverage increases consistently with the level of market development, ranging from virtually zero in Bangladesh, Pakistan, and Sri Lanka to more than half of listed firms in Australia. Emerging markets occupy an intermediate position, although considerable cross-country variation remains evident. This pattern indicates that ESG information is concentrated primarily within larger and more developed capital markets.

Coverage also varies systematically with firm size. Large firms are substantially more likely to receive ESG ratings than small firms, reflecting the well-documented tendency for ESG providers to focus on companies possessing greater reporting capacity, higher institutional visibility, and stronger investor interest. Perhaps the most important finding concerns firms experiencing financial distress. Across virtually every market where meaningful ESG coverage exists, financially distressed firms are considerably less likely to possess ESG ratings than their financially healthy counterparts.

For example, only a small proportion of subsequently distressed firms in Singapore and the Philippines receive ESG ratings despite substantially higher overall market coverage. Similar patterns are observed across other sample countries. These findings have important practical implications. ESG-based early-warning systems cannot effectively identify financially vulnerable firms if those firms are systematically excluded from ESG databases.

Consequently, limited ESG coverage represents not merely a data availability issue but a fundamental constraint on the practical application of ESG information within corporate distress prediction, particularly in emerging and frontier economies.

4. Methodology

4.1 Research Design

The empirical analysis adopts a rigorous out-of-time prediction framework designed to replicate the conditions under which financial distress prediction models are implemented in practice. Unlike conventional random train-test partitions, which

may inadvertently introduce look-ahead bias by allowing future observations to influence model estimation, the present study employs a strictly chronological data split. Models are estimated exclusively using observations from fiscal years 2016–2022, while predictive performance is evaluated only on the previously unseen 2023–2024 observations.

The complete dataset comprises 36,879 firm-year observations in the training sample, including 5,726 distressed firms, and 10,374 observations in the test sample, of which 1,875 correspond to financially distressed firms. The ESG-covered subsample contains 6,149 training observations and 3,245 testing observations, including 554 and 306 distress events, respectively.

This chronological validation strategy provides a substantially more realistic assessment of predictive performance than random cross-validation because it mirrors the information available to decision-makers at the time forecasts are generated.

4.2 Data Pre-Processing

To minimize the influence of extreme observations while preventing information leakage, all continuous explanatory variables undergo preprocessing using parameters estimated solely from the training sample. Continuous financial variables are winsorised at the 1st and 99th percentiles calculated from the training data. These identical thresholds are subsequently applied to the independent test sample, thereby preserving the integrity of the out-of-time evaluation.

Because the Beneish earnings-manipulation variables are ratio-based and particularly sensitive to extreme values, additional truncation procedures are applied before calculating the composite M-score. Specifically, the individual Beneish indicators are capped within economically reasonable ranges, while the TATA variable is subjected to a more conservative threshold owing to its greater variability. Importantly, all preprocessing procedures are completed before model estimation and without reference to test-period information.

4.3 Feature Construction

To evaluate the incremental contribution of different sources of information, explanatory variables are introduced sequentially through a series of nested feature sets. The baseline specification (HARD) contains the conventional accounting variables most frequently employed in financial distress prediction, including liquidity, profitability, operating efficiency, firm size, and leverage measures.

The first extension (HARDX) augments the baseline with three variables representing operating liquidity and earnings dynamics: cash holdings, funds flow relative to total liabilities (FUTL), and the scaled change in net income (CHIN).

These variables capture aspects of corporate financial flexibility that are not fully reflected in traditional accounting ratios.

Subsequent specifications extend the benchmark further by incorporating the Beneish earnings-manipulation indicators and the macroeconomic variables. The most comprehensive financial specification (ALLNEW) combines all accounting, liquidity, earnings-quality, and macroeconomic predictors within a single modelling framework.

For observations with available ESG information, the empirical analysis introduces the complete LSEG/Refinitiv ESG architecture—including the overall ESG score, pillar scores, category scores, and the ESG Controversies Score—to evaluate whether sustainability-related information contributes incremental predictive value beyond the strongest available financial benchmark. This sequential modelling strategy enables each variable block to be evaluated independently while avoiding confounding effects arising from simultaneous inclusion.

4.4 Machine-Learning Models

To ensure that the findings are not driven by a particular modelling approach, predictive performance is evaluated using six complementary machine-learning algorithms representing the principal techniques employed in contemporary bankruptcy prediction research.

The first model is a class-weighted logistic regression, which serves as a transparent statistical benchmark while accounting for the imbalance between distressed and non-distressed observations.

The second model employs Extreme Gradient Boosting (XGBoost), a tree-based ensemble learning algorithm that has consistently demonstrated superior predictive performance across financial classification problems. The XGBoost implementation comprises 400 decision trees, a maximum tree depth of four, a learning rate of 0.05, and class-weighting procedures designed to mitigate class imbalance.

To evaluate robustness across alternative boosting frameworks, the analysis also estimates LightGBM, which utilizes histogram-based tree construction to improve computational efficiency while maintaining predictive accuracy.

Because financial distress prediction typically involves highly imbalanced datasets, an additional XGBoost model is estimated using SMOTE-Tomek resampling. Importantly, oversampling and Tomek-link removal are performed exclusively within the training sample, thereby ensuring that synthetic observations never contaminate the independent test period.

Model calibration is further examined through isotonic calibration, which adjusts predicted probabilities without altering the ranking of observations. Finally, a soft-voting ensemble combines predictions generated by XGBoost and LightGBM to evaluate whether ensemble learning provides additional improvements over individual classifiers. Collectively, these models provide a comprehensive assessment of predictive robustness across both statistical and advanced machine-learning approaches.

4.5 Model Evaluation

Predictive performance is assessed using three complementary evaluation metrics. The primary measure is the Area Under the Receiver Operating Characteristic Curve (ROC-AUC), which evaluates the model's ability to distinguish between distressed and financially healthy firms across all possible classification thresholds.

Given the relatively low incidence of financial distress, particular emphasis is placed on the Area Under the Precision–Recall Curve (PR-AUC). Unlike ROC-AUC, PR-AUC is considerably more informative in imbalanced classification problems because it focuses directly on the trade-off between correctly identifying distressed firms and limiting false-positive classifications.

Model calibration is evaluated using the Brier Score, which measures the accuracy of predicted probabilities rather than simple classification performance. Lower Brier scores indicate better calibration and greater correspondence between predicted probabilities and observed outcomes. The simultaneous use of discrimination and calibration metrics provides a more comprehensive assessment of model performance than reliance on any single evaluation criterion.

4.6 Explainable Machine Learning

Although predictive accuracy remains the primary objective of financial distress modelling, understanding how machine-learning algorithms generate predictions is equally important for both academic interpretation and practical implementation.

Accordingly, this study employs SHapley Additive exPlanations (SHAP) to quantify the contribution of individual variables to model predictions. Derived from cooperative game theory, SHAP decomposes each prediction into additive contributions attributable to individual features while maintaining consistency across complex non-linear models.

Feature importance is evaluated using the mean absolute SHAP values computed across the independent test sample. These values provide insight into the relative influence of different predictors within the fitted model.

Importantly, SHAP measures the extent to which variables contribute to model predictions after model estimation; it does not indicate whether those variables provide incremental predictive information beyond existing predictors. Consequently, SHAP analysis is interpreted alongside the sequential feature-block comparisons rather than as a substitute for evaluating incremental predictive performance. This distinction proves particularly important for interpreting the role of ESG information within corporate financial distress prediction.

5. Results

5.1 Comparative Performance of Classical Financial Distress Predictors

Table 2 presents the out-of-time predictive performance of the sequential feature sets evaluated on the full sample. The comparison provides a direct assessment of the incremental contribution of each block of explanatory variables beyond the conventional accounting-ratio benchmark.

The results demonstrate that the extended liquidity and funds-flow variables constitute the only classical extension that consistently enhances predictive performance. Relative to the baseline specification (HARD), incorporating cash holdings, funds flow relative to total liabilities (FUTL), and the scaled change in net income (CHIN) increases the Precision–Recall Area Under the Curve (PR-AUC) by approximately one percentage point.

Table 2. Out-of-time performance, full sample (test = 2023–2024; base rate 18.1%); XGBoost, soft-voting ensemble in parentheses where it improves.

Feature set	ROC-AUC	PR-AUC	Δ PR-AUC vs. HARD
HARD (ratio benchmark)	0.9735	0.8578	—
HARDX (+ cash, FUTL, CHIN)	0.9751	0.8684 (0.8688)	+0.011
HARDX + Beneish	0.9749	0.8663	+0.009
HARDX + macroeconomic	0.9749	0.8667	+0.009
ALLNEW (all blocks)	0.9747	0.8658	+0.008

Source: Own study.

Although this numerical improvement appears modest, it is economically meaningful given the already high predictive accuracy of the benchmark model. At this level of performance, even a one-percentage-point improvement translates into a substantially greater number of correctly identified financially distressed firms within the out-of-time test period.

In contrast, the remaining extensions provide no meaningful incremental improvement. The inclusion of the Beneish earnings-manipulation indicators leaves predictive performance virtually unchanged, while the addition of country-level macroeconomic variables produces similarly negligible gains. Combining all variable blocks within the comprehensive specification (ALLNEW) likewise fails to

improve upon the extended fundamentals benchmark. These findings provide only partial support for Hypothesis 2. Among the classical predictors examined, operating cash-flow information clearly contributes additional predictive content beyond traditional accounting ratios.

However, neither earnings-manipulation indicators nor macroeconomic variables provide economically meaningful improvements once firm-level financial fundamentals are adequately represented. Importantly, this conclusion is not specific to gradient boosting models. Comparable results emerge from the class-weighted logistic regression, where predictive performance remains essentially unchanged across successive model specifications.

The consistency of these findings across fundamentally different modelling approaches suggests that the absence of incremental predictive value reflects the underlying informational content of the variables rather than limitations of any particular machine-learning algorithm.

The limited contribution of macroeconomic variables should nevertheless be interpreted within the context of the study design. Because out-of-time evaluation is restricted to the 2023–2024 period, macroeconomic variables primarily capture cross-country differences rather than large temporal fluctuations.

Consequently, their contribution during periods of major economic disruption may not be fully reflected in the current evaluation framework. By contrast, the null findings for the Beneish indicators appear considerably more robust. Despite extensive coverage across the sample and evaluation of both individual manipulation ratios and the composite M-score, accounting-quality measures consistently fail to improve predictive accuracy beyond the information already contained within conventional financial variables.

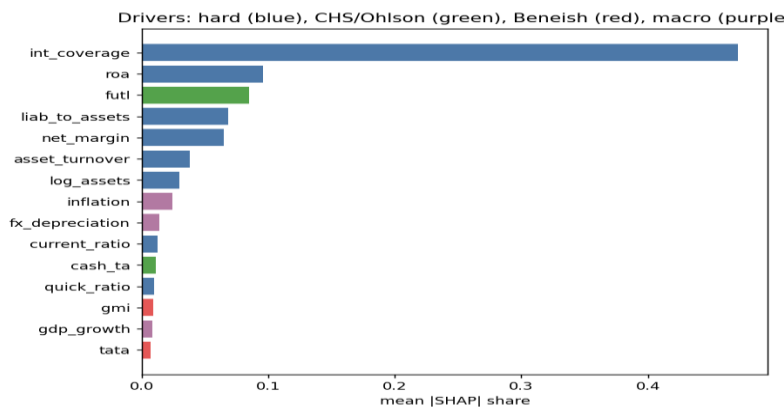
Overall, these results indicate that operating cash-flow measures remain among the most valuable additions to traditional financial distress models, whereas accounting manipulation indicators and macroeconomic conditions are largely subsumed by comprehensive firm-level financial information.

5.2 Interpreting Model Behavior: SHAP Analysis

To better understand the mechanisms underlying model predictions, we next examine feature contributions using SHAP values derived from the comprehensive financial specification. Figure 2 illustrates the relative importance of the principal predictor groups. Conventional accounting fundamentals dominate model behavior, collectively accounting for approximately four-fifths of total feature attribution. Within this group, interest coverage emerges as the single most influential predictor, followed by return on assets, confirming the central role of profitability and debt-servicing capacity in distinguishing financially distressed firms.

Among the extended financial variables, funds flow relative to total liabilities (FUTL) stands out as the most informative addition. Ranking as the third most influential predictor overall, FUTL contributes substantially more explanatory power than conventional liquidity ratios such as the current ratio and quick ratio. This finding suggests that dynamic cash-generation capacity provides considerably richer information regarding impending financial distress than static balance-sheet measures alone. The result also offers contemporary empirical support for Ohlson's (1980) argument that operating cash flows capture an important dimension of financial resilience that is not fully reflected in traditional accounting ratios.

Figure 2. Mean |SHAP| share of the top 15 features in the ALLNEW XGBoost model



Source: Own study.

By comparison, the Beneish indicators and macroeconomic variables receive only modest attribution within the fitted model. More importantly, their limited contribution to model interpretation is entirely consistent with the earlier performance analysis, which demonstrated that these variables fail to enhance predictive accuracy when evaluated out-of-time.

This distinction between feature utilization and predictive improvement is particularly important. Machine-learning algorithms may incorporate information from many variables during model construction, yet the inclusion of those variables does not necessarily improve generalization performance on unseen data. Consequently, feature attribution should not be interpreted as evidence of incremental predictive value without accompanying out-of-sample evaluation.

5.3 ESG Information Does Not Improve Financial Distress Prediction

Table 3 presents the central empirical finding of this study by evaluating whether ESG information contributes incremental predictive value beyond comprehensive financial fundamentals within the ESG-covered subsample. The evidence provides strong and consistent support for Hypothesis H1b while offering no support for Hypothesis H1a. Across all model specifications, the inclusion of the complete

LSEG/Refinitiv ESG architecture—including the overall ESG score, the three pillar scores, the ten category scores, and the ESG Controversies Score—fails to improve out-of-time predictive performance. On the contrary, predictive accuracy declines marginally after ESG variables are introduced, suggesting that they contribute additional complexity without providing new information beyond that already contained in conventional financial variables.

Table 3. Out-of-time ROC-AUC, ESG-covered subsample (test base rate 9.4%); XGBoost.

Feature set	ROC-AUC	Δ vs. benchmark
HARD	0.9856	—
HARD + full ESG	0.9855	−0.0001
HARDX (extended benchmark)	0.9860	—
HARDX + full ESG	0.9852	−0.0008
HARDX + Beneish	0.9851	−0.0009
ALLNEW + ESG	0.9849	−0.0011
ESG only	0.654	—

Source: Own study.

This result remains remarkably stable irrespective of the benchmark specification. When ESG variables are added to the baseline accounting model (HARD), the resulting ROC-AUC remains virtually unchanged. More importantly, once the stronger benchmark incorporating liquidity, operating cash-flow variables, and earnings dynamics (HARDX) is employed, ESG variables again fail to improve predictive performance. Even the most comprehensive specification, combining all financial variables with the complete ESG architecture, performs slightly worse than the financial benchmark alone.

These findings indicate that the information embedded within ESG ratings is largely subsumed by firms' financial characteristics. Although ESG ratings undoubtedly reflect aspects of corporate governance, stakeholder management, and sustainability practices, these characteristics appear to overlap substantially with information already captured through profitability, leverage, liquidity, operating cash flow, and firm size.

Consequently, ESG ratings provide little genuinely new information for predicting one-year-ahead corporate financial distress once financial fundamentals are comprehensively represented. Importantly, this conclusion should not be interpreted as evidence that ESG information is entirely devoid of predictive content. When evaluated independently, ESG variables achieve a ROC-AUC substantially above random classification, demonstrating that they contain meaningful information regarding firms' financial condition. However, this predictive capability disappears after conventional financial variables are introduced into the model. In other words, ESG variables possess absolute predictive value but not incremental predictive value.

This distinction has important implications for both academic research and practical credit-risk assessment. Previous studies reporting improvements associated with ESG variables frequently evaluate them against relatively limited accounting benchmarks.

Under such circumstances, variables correlated with overall corporate quality are naturally expected to improve prediction. By contrast, the present study demonstrates that these apparent improvements vanish once ESG information is evaluated against a comprehensive benchmark incorporating the strongest predictors identified within the financial distress literature.

The ESG Controversies Score exhibits a similar pattern. Although controversies have been proposed as early indicators of deteriorating corporate performance because they capture adverse environmental, social, or governance events before their financial consequences become fully apparent, the present analysis finds no meaningful incremental contribution beyond conventional financial variables. Any small numerical improvements remain well within the range of statistical noise and do not alter the overall conclusion that ESG-related information fails to enhance out-of-time prediction.

Collectively, these findings suggest that, under current reporting practices across Asia-Pacific markets, ESG ratings function primarily as complementary indicators of firm quality rather than independent predictors of impending financial distress.

5.4 Absence of a U-Shaped Relationship Between ESG and Financial Distress

To examine whether the non-linear relationship reported in recent U.S.-based studies extends to Asia-Pacific markets, we estimate a pooled logistic regression including both the linear ESG score and its quadratic term alongside the financial control variables. The results provide no evidence supporting the proposed U-shaped relationship. Although the estimated quadratic coefficient is positive, it remains statistically insignificant, while the linear ESG coefficient is likewise insignificant after controlling for firm-specific financial characteristics. Accordingly, Hypothesis H3 is not supported.

This finding contrasts with recent evidence from the United States, where financially distressed firms have been observed to maintain relatively high ESG scores, potentially through intensified sustainability disclosure during periods of financial deterioration.

The absence of a comparable pattern in Asia-Pacific markets suggests that the relationship between ESG performance and financial distress may depend critically on institutional context, reporting incentives, and market maturity. A plausible explanation lies in the substantial differences in ESG coverage documented earlier in the paper. The U-shaped relationship requires financially distressed firms to remain represented within ESG databases as their financial condition deteriorates.

However, the descriptive evidence presented in Table 1 demonstrates that firms approaching financial distress are considerably less likely to receive ESG ratings across the Asia-Pacific region. Consequently, the upper portion of the proposed U-shaped relationship may simply remain unobservable because many distressed firms never enter—or subsequently disappear from—the ESG coverage universe.

The absence of incremental predictive value from the Beneish earnings-manipulation variables further reinforces this interpretation. If firms were systematically engaging in disclosure management before financial distress, one would expect both earnings-quality indicators and ESG measures to exhibit stronger predictive performance. The consistent null findings across both information sources instead suggest that conventional financial fundamentals already capture the deterioration relevant for one-year-ahead distress prediction.

5.5 ESG Coverage as a Structural Limitation

Beyond the predictive evaluation, the analysis reveals that ESG coverage itself represents a fundamental limitation for applying ESG information within financial distress prediction.

Introducing a simple indicator identifying whether a firm possesses an ESG rating produces only negligible changes in predictive performance. This finding indicates that selection into ESG coverage conveys little additional information beyond firm characteristics already incorporated into the financial variables. More importantly, the descriptive analysis demonstrates that ESG coverage is systematically concentrated among larger firms operating within more developed capital markets. Small firms, frontier-market firms, and financially distressed firms remain substantially underrepresented within commercial ESG databases. As a result, the practical usefulness of ESG information is constrained not only by its limited incremental predictive value but also by its restricted availability for precisely those firms where early-warning systems are most needed.

This finding carries important implications for both researchers and practitioners. Debates regarding the incremental informational content of ESG ratings implicitly assume that ESG data are broadly available across the corporate sector. Our evidence challenges this assumption. Before evaluating whether ESG ratings improve predictive performance, it is necessary to recognize that a significant proportion of financially vulnerable firms remain entirely outside existing ESG coverage. Consequently, improving the breadth and representativeness of ESG reporting may constitute a more pressing policy objective than refining ESG scoring methodologies.

6. Discussion

The findings of this study provide new evidence on the role of ESG information in corporate financial distress prediction and contribute to the broader debate regarding

the economic relevance of ESG ratings. While ESG metrics have become increasingly integrated into investment decision-making and corporate risk assessment, our results demonstrate that their predictive usefulness depends critically on the benchmark against which they are evaluated.

Once financial distress models incorporate a comprehensive set of established accounting, liquidity, cash-flow, earnings-quality, and macroeconomic variables, ESG scores no longer contribute incremental predictive information. This finding suggests that much of the apparent predictive ability attributed to ESG ratings in earlier studies may reflect information already embedded in firms' financial fundamentals rather than genuinely independent risk signals.

An important implication of this study is the central role of benchmark specification in evaluating new predictors of financial distress. Previous research frequently reports statistically significant improvements after incorporating ESG variables; however, these studies often rely on relatively parsimonious baseline models consisting primarily of traditional accounting ratios or linear statistical approaches.

Under such circumstances, variables correlated with overall corporate quality are naturally expected to improve predictive performance. By contrast, the present analysis demonstrates that this apparent contribution disappears once the benchmark reflects the strongest predictors identified in the bankruptcy prediction literature.

Notably, the same conclusion extends beyond ESG variables. Earnings-manipulation indicators and macroeconomic variables likewise fail to improve predictive accuracy when evaluated against the extended financial benchmark, suggesting that the observed null result reflects the strength of the benchmark rather than a limitation unique to ESG information.

The analysis also highlights the enduring importance of operating cash-flow information in financial distress prediction. Among all classical extensions examined, the funds-flow variables derived from Ohlson's framework emerge as the only predictors providing economically meaningful improvements beyond conventional accounting ratios.

In particular, funds flow relative to total liabilities ranks among the most influential variables in the machine-learning models, outperforming several traditional liquidity indicators. This finding reinforces the view that firms' capacity to generate operating cash flows relative to their financial obligations captures an important dimension of financial resilience that static balance-sheet measures cannot fully reflect. More than four decades after its introduction, Ohlson's operating cash-flow measure continues to demonstrate substantial practical relevance within contemporary machine-learning frameworks.

Another important contribution concerns the interpretation of explainable artificial intelligence. SHAP analysis assigns nearly one-quarter of total feature attribution to ESG variables despite their complete absence of incremental predictive value. This apparent inconsistency illustrates a methodological issue with implications extending well beyond ESG research.

Feature-attribution techniques explain how a fitted model utilizes available variables to generate predictions; they do not establish whether those variables improve predictive performance beyond existing information. Consequently, interpreting high SHAP importance as evidence of independent predictive value may lead to misleading conclusions. Future machine-learning studies should therefore combine explainability techniques with rigorous incremental feature evaluation rather than relying on feature-importance measures in isolation.

The study further demonstrates that data availability constitutes an equally important challenge for ESG-based financial risk assessment. Across the twelve Asia-Pacific markets, ESG coverage remains highly uneven, with particularly limited representation among frontier markets, smaller firms, and financially distressed companies. This pattern raises an important practical concern because the firms most likely to experience financial distress are precisely those least likely to receive ESG ratings.

Consequently, even if ESG variables were shown to possess stronger predictive content, their practical application within regional credit-risk assessment would remain constrained by limited market coverage. These findings suggest that expanding the breadth and consistency of ESG reporting across emerging markets may be more valuable than further refinements to existing scoring methodologies. The absence of the U-shaped relationship reported for U.S. firms also offers important theoretical insights. Rather than contradicting previous evidence, our findings suggest that the relationship between ESG performance and financial distress is likely to be context dependent.

Differences in institutional development, disclosure regulation, market maturity, and ESG coverage may fundamentally influence the observed association between sustainability performance and financial vulnerability. In particular, the limited ESG coverage observed across Asia-Pacific markets implies that many financially distressed firms never enter—or subsequently disappear from—the ESG reporting universe. Under these circumstances, the disclosure-driven score management proposed in previous studies cannot be observed consistently. This interpretation highlights the importance of considering institutional and reporting environments when evaluating ESG-related financial outcomes across different geographical settings.

From a practical perspective, the findings provide clear implications for multiple stakeholder groups. For financial institutions, the results suggest that incorporating

operating cash-flow measures into early-warning systems is likely to generate greater improvements in predictive performance than integrating commercially available ESG ratings.

For regulators, the evidence indicates that improving the availability, consistency, and comparability of ESG disclosures should remain a policy priority, particularly within emerging and frontier economies where disclosure remains limited. For ESG rating providers, the results highlight the importance of expanding coverage beyond large, highly visible firms if ESG information is to become a useful component of credit-risk assessment.

Finally, for researchers, the findings emphasize the necessity of evaluating new predictors against sufficiently demanding benchmarks while distinguishing carefully between model interpretation and genuine predictive contribution. Although the empirical evidence presented in this study is robust across multiple machine-learning algorithms and extensive sensitivity analyses, several limitations should be acknowledged.

First, the analysis relies exclusively on ESG ratings obtained from a single provider, and previous research has demonstrated substantial divergence among commercial ESG rating agencies. Second, historical ESG scores may incorporate retrospective revisions, meaning that archived values may not perfectly represent the information available to market participants at the time decisions were made. Third, financial distress is identified using a persistence-based classification rather than formal bankruptcy proceedings, although this approach arguably provides a more appropriate early-warning measure across jurisdictions characterized by heterogeneous insolvency regimes.

Fourth, the relatively short out-of-time evaluation period may limit the ability to capture the full effects of major macroeconomic shocks. Finally, because ESG coverage itself is selective, the incremental predictive results necessarily apply to the population of rated firms rather than to the entire corporate sector.

Future research should revisit these relationships as ESG disclosure frameworks continue to evolve across the Asia-Pacific region. The progressive adoption of mandatory sustainability reporting standards, including the International Sustainability Standards Board framework, is expected to improve both the breadth and quality of ESG information in coming years.

As coverage expands to smaller firms and emerging markets, the incremental predictive contribution of ESG variables may change. Comparative studies across multiple ESG providers, longer forecasting horizons, and alternative definitions of financial distress would further enhance understanding of the role of sustainability information in corporate risk assessment.

7. Conclusion

This study examined whether ESG information enhances the prediction of one-year-ahead corporate financial distress beyond the explanatory power of established financial indicators. Using a comprehensive panel of 47,253 firm-year observations from twelve Asia-Pacific economies and a rigorous out-of-time machine-learning framework, we evaluated the complete LSEG/Refinitiv ESG architecture—including overall ESG scores, pillar scores, category scores, and ESG controversies—against one of the most comprehensive benchmarks of financial distress predictors employed in the literature.

The empirical evidence leads to three principal conclusions. First, ESG coverage across the Asia-Pacific region remains highly uneven and is systematically concentrated among larger firms operating in more developed capital markets. More importantly, firms experiencing subsequent financial distress are substantially less likely to possess ESG ratings, indicating that ESG information is least available for the organizations where early-warning systems are most valuable. This structural limitation represents an important practical constraint on the application of ESG data in corporate credit-risk assessment.

Second, although ESG variables exhibit meaningful standalone predictive capability, they fail to provide incremental predictive value once comprehensive financial fundamentals are incorporated into the modelling framework. The complete ESG architecture—including controversy measures—does not improve out-of-time prediction beyond conventional accounting ratios, liquidity measures, operating cash-flow indicators, earnings dynamics, and other established financial predictors. These findings suggest that the information reflected in commercially available ESG ratings is largely subsumed by firms' underlying financial characteristics.

Third, among the classical extensions examined, only operating cash-flow information contributes economically meaningful improvements in predictive performance. In particular, funds flow relative to total liabilities remains one of the strongest predictors of subsequent financial distress, demonstrating the continuing relevance of cash-flow-based measures within modern machine-learning models. By contrast, earnings-manipulation indicators and macroeconomic variables, similar to ESG measures, fail to improve predictive accuracy once comprehensive financial information is available.

Beyond these empirical findings, the study offers broader methodological and theoretical contributions. Methodologically, it demonstrates the importance of evaluating new predictors against sufficiently demanding benchmark models and highlights the distinction between feature attribution and genuine incremental predictive value. The substantial SHAP attribution assigned to ESG variables despite their negligible contribution to predictive performance illustrates that explainability techniques should complement, rather than replace, rigorous out-of-sample evaluation.

Theoretically, the findings suggest that the relationship between ESG performance and corporate financial distress is strongly influenced by institutional context, market development, and reporting practices. The absence of the U-shaped relationship previously documented for U.S. firms indicates that conclusions regarding ESG's role in financial risk assessment should not be generalized across different regulatory and economic environments without careful consideration of differences in ESG coverage and disclosure quality. From a practical perspective, the findings suggest that lenders, investors, and regulators should exercise caution when incorporating current ESG ratings into corporate distress prediction models.

Under existing reporting conditions across the Asia-Pacific region, improving the availability, consistency, and representativeness of ESG information appears more important than refining increasingly sophisticated ESG scoring methodologies. Until ESG coverage expands substantially, conventional financial fundamentals—particularly operating cash-flow measures—are likely to remain the most reliable foundation for early-warning systems.

As sustainability reporting frameworks continue to mature and mandatory disclosure requirements become more widespread, the informational value of ESG metrics may evolve. Future research should therefore reassess the predictive contribution of ESG information using broader market coverage, multiple ESG data providers, longer forecasting horizons, and alternative definitions of financial distress. Such work will help determine whether the present findings reflect a transitional stage in the development of ESG reporting or a more fundamental limitation of ESG ratings as predictors of corporate financial distress.

Overall, this study provides robust evidence that, within the current institutional environment of Asia-Pacific capital markets, ESG ratings do not offer meaningful incremental value for one-year-ahead corporate financial distress prediction beyond comprehensive financial fundamentals.

While ESG information remains important for numerous dimensions of corporate sustainability and responsible investment, its role as an early-warning indicator of financial distress appears limited under present reporting conditions. The growing reliance on ESG metrics within global capital markets should not be interpreted as evidence that these measures are universally informative across all financial decision-making contexts.

Our findings demonstrate that the predictive value of ESG information depends fundamentally on data coverage, institutional settings, and the strength of the underlying financial benchmark. As ESG disclosure becomes increasingly standardized and comprehensive, its contribution to financial distress prediction may evolve. Until then, conventional financial fundamentals remain the most reliable basis for early-warning models in Asia-Pacific capital markets.

References:

- Altman, E.I. 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance*, 23(4), 589-609.
- Beneish, M.D. 1999. The detection of earnings manipulation. *Financial Analysts Journal*, 55(5), 24-36. <https://doi.org/10.2469/faj.v55.n5.2296>.
- Berg, F., Kölbel, J.F., Rigobón, R. 2022. Aggregate confusion: The divergence of ESG ratings. *Review of Finance*, 26(6), 1315-1344. <https://doi.org/10.1093/rof/rfac033>.
- Campbell, J.Y., Hilscher, J., Szilagyi, J. 2008. In search of distress risk. *The Journal of Finance*, 63(6), 2899-2939. <https://doi.org/10.1111/j.1540-6261.2008.01416.x>.
- Citterio, A., King, T. 2023. The role of environmental, social, and governance (ESG) in predicting bank financial distress. *Finance Research Letters*, 51, 103411. <https://doi.org/10.1016/j.frl.2022.103411>.
- Drempetic, S., Klein, C., Zwergel, B. 2020. The influence of firm size on the ESG score: Corporate sustainability ratings under review. *Journal of Business Ethics*, 167(2), 333-360. <https://doi.org/10.1007/s10551-019-04164-1>.
- Galletta, S., Mazzù, S. 2023. ESG controversies and bank risk taking. *Business Strategy and the Environment*, 32(1), 274-288. <https://doi.org/10.1002/bse.3129>.
- Korzeb, Z., Karkowska, R., Matysek-Jędrych, A. 2024. How do ESG challenges affect default risk? An empirical analysis from the global banking sector perspective. *Studies in Economics and Finance*, 42(1), 89-114. <https://doi.org/10.1108/SEF-09-2023-0540>.
- Lim, B., Choi, H. 2025. ESG controversies and corporate default risk. *Journal of Money & Finance*, 39(4), 1-29. <https://doi.org/10.21023/jmf.39.4.1>.
- Lohmann, C., Möllenhoff, S., Lehner, S. 2025. On the relationship between financial distress and ESG scores. *Corporate Social Responsibility and Environmental Management*, 32(5), 6377-6401. <https://doi.org/10.1002/csr.70033>.
- Lundberg, S.M., Lee, S.I. 2017. A unified approach to interpreting model predictions. In: I. Guyon *et al.* (Eds.), *Advances in Neural Information Processing Systems* (Vol. 30, pp. 4765-4774).
- Maulana, M.A., Setijaningsih, H.T., Widuri, R. 2025. ESG and financial distress: Exploring the moderating role of ESG controversy. *Asian Journal of Interdisciplinary Research*, 8(4), 361-374. <https://doi.org/10.54392/ajir25420>.
- Ohlson, J.A. 1980. Financial ratios and the probabilistic prediction of bankruptcy. *Journal of Accounting Research*, 18(1), 109-131. <https://doi.org/10.2307/2490395>.
- Sihotang, D.G., Siregar, S.V. 2025. The effect of ESG performance on firm value and financial distress with ESG controversies as a moderating variable. *Petra International Journal of Business Studies*, 8(2), 257-270. <https://doi.org/10.9744/petraijbs.8.2.257-270>.
- Tinoco, M.H., Wilson, N. 2013. Financial distress and bankruptcy prediction among listed companies using accounting, market and macroeconomic variables. *International Review of Financial Analysis*, 30, 394-419. <https://doi.org/10.1016/j.irfa.2013.02.013>.