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PREDICTING FINANCIAL DEFAULT WITH AI BY INTEGRATING TAX PLANNING INSIGHTS ACROSS FIRM LIFE CYCLE PHASES

Rajeswaran Ayyadurai
Login Services,
Coimbatore, Tamil Nadu, India.
Email ID: rajeswaranayyadurai@arbpo.com

R.Padmavathy
Anna University,
Coimbatore, Tamil Nadu, India.
Email ID: dr.padmabarathi@gmail.com

Abstract

Tax planning has a big impact on financial stability of firms, with efficacy of this planning differing as a firm is subjected to various stages of corporate life cycle. Emphasis in previous studies was for the most part on considering tax planning as an all-purpose strategy, neglecting how a firm's risk of default might change with its level of development. In this study, an attempt is made to fill that gap by focusing on stage-specific effects of tax planning on risk of financial default. Through hazard model regression and random forest assisted predictive analysis using data from the Compustat database, tax planning has been gauged by GAAP ETR as well as its volatility. Tax planning reduces default risk by 3.51% in the Introduction stage and by 6.65% in the Decline because of enhanced liquidity, while default risk rises by 1.92% and 2.36% during Growth and Maturity stages due to inefficient allocation and poor financial discipline in this research. This research provides a dynamic life cycle perspective for aligning tax strategies with firm conditions, thus providing actionable decision-making insights for financial policymakers.

Keywords: Tax Planning, Financial Default Risk, GAAP Effective Tax Rate (ETR), Corporate Life Cycle, Life Cycle–Based Tax Strategy, Firm Financial Stability.

Introduction

The very integration of finance, taxation, and accounting serves as the fundamental basis for the formulation of corporate policy, especially when options in financial planning and risk management are considered [1]. Taxation is just one of the several areas through which tax planning actuates economic policies to lighten their burden of taxes within the restriction of law. It is indeed a two-edged instrument: for some, it might act as the ultimate source of cash flow, whereas for others, it serves as a tool for suboptimal allocation of resources [2]. This very dualistic standpoint is more accentuated when viewed from the perspective of the life

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cycle of a corporation, in which the development stage of a business greatly determines how tax strategies are injected into general well-being of finance [3].

Resource-based theory holds that the firm can obtain a competitive advantage by enhancing its internal resources, such as cash flows created through tax-planning mechanisms [4]. In periods of scarce external financing, tax savings could provide crucial liquidity for investments, survival, or restructuring during performance stages like the introductory or decline stages [5]. In the growth or maturity stages, when a firm is rich in funds and usually managed from a decentralized perspective, such resources could be most misallocated [6]. Aggressive tax planning robs the managers of discipline and forces inefficient investments into the glare of reputation and compliance risks. Agency theory views these risks in the light of separation of ownership and control [7]. When excess cash is derived from tax savings and its agency problem is not resolved through strong governance mechanisms, managers may pursue self-serving projects that are inconsistent with shareholders' valuation, thereby increasing the risk of economic distress.

Benefits and constraints on tax planning may be examined through a subtle scheme set with life-cycle perspective [8]. A firm evolves in successive stages of inception, growth, maturation and decline with each stage preceding challenging dimension in the cash flow pattern and resource constraint inconsistencies warranting designing of tax strategies specific for each [9]. For example, growing-stage companies need aggressive tax planning to achieve growth while mature-stage companies should be focused more on tax compliance and transparency to build stakeholder confidence. Hence, it grows crucial for firms to understand how tax planning can be aligned against financial risk through these life cycle stages to strategically coordinate issues of corporate finance [10]. Whereby, on one side, firms will be able to apply tax practice in accordance with their internal competency and expectations outside; on the other hand, the alignment indeed shapes the possibilities for financial default or the realization of long-term sustainable operations.

That is to say, tax planning should never be considered purely an act of mechanical compliance. It should really be viewed as one of the strategic tools in affecting liquidity, capital structure and even survival of a company [11]. Decisions to defer taxes, take advantage of deductions, or divert income flows must always be weighed alongside a firm's broader financial objectives and its stage in business life cycle. Firms at introduction the decline stages usually are capital-starved and rely largely on internal cash flows to sustain operations or restructuring [12]. In such situations, efficient tax planning may, on at least some occasions, satisfy the need for external finance and strengthen the financial resilience of the firm. Reserved cash-tax approaches in cash-rich companies, however, would leave the capital untapped or raise ire from investors and

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regulators alike [13]. Hence, tax strategy integration with the corporate life cycle and financial positioning scores on the efficiency matrix, risk management, and reputational integrity.

From an accounting point of view, tax planning affects a set of financial statements and performance indicators on the basis of which stakeholders make decisions [14]. Hence, deferred tax liabilities reduce effective tax rates for possible recognition but still affect issues of transparency, governance, and apparent financial strength. Fluctuations in rates can likewise be suspicious to lenders or equity investors, especially when stability of returns is the expected characteristic of the company [15]. Thus, accounting cannot just state the implications of tax decisions; it must, to some extent, communicate the strategic intent behind the tax choices. During phases when firms come under a higher spotlight, e.g., at maturity or public listing, conservative and defensible tax planning is generally preferred [16]. Hence, there is an evident requirement to arrive at integrated decisions for finance, taxation, and accounting for better results throughout company life.

Literature Survey

[17] The relationship between corporate tax planning and the period of firm value in Tunisia stood at 11 years. It is found that tax planning, along with accruals and investments, also increases firm value. Compared to non-listed firms, listed firms are more successful in tax planning through their own strategic tax policies. [18] These studies present the practical benefits of performance-enhancing tax strategies, thus giving relevant directions for researchers, government agencies, and business managers.

[19] Calculations conduct a nonlinear relationship between investment in R&D, corporate profit taxation, and labour productivity, with data from the OECD. They stand at determining the optimal point at 2.5% for R&D intensity and 3.1% of GDP for corporate profit taxes, after which productivity starts to fall. More investment into R&D and corporate profit taxes do not enforce labour productivity; balancing is very important. [20] The study, however, points out that the relationship between innovation and tax policy on economic performance is ambiguous. And the research, hence, tries to suggest some directions toward well-working industrial and tax policies.

The interplay between the corporate tax optimization and firm value has seen much research, as in Tunisia, where firms are increasingly looking at ways to apply tax strategies to enhance financial performance [21]. An investigative job in Tunisia into just how tax optimization affects firm value used an 11-year span as a timeframe and has produced clear-cut evidence indicating that, in conjunction with accrual accounting and strategic investments, tax optimization considerably escalates firm value. Research points to fact that listed firms have higher capacity to execute tax optimization strategies compared to non-listed firms [22]. This is probably because listed entities typically have better access to resources and expertise and

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maintain stronger corporate governance structures that facilitate strategic tax planning.

With regard to Tunisia, the results confer some very important insights into the use of tax optimization as a performance-enhancing mechanism for firms. With their tax bills being reduced by using legally accepted forms of tax avoidance, firms end up retaining more earnings that they can reinvest in expansion of the business, in innovation, or in other activities from which value results [23]. This contributed to further increase their financial position and long-term sustenance. Policymakers are thus urged to take into consideration the implications of such tax optimization strategies for their countries, wherever the possible effects can nourish the needs to strike a balance between encouraging a beneficial environment for business and acquiring sufficient tax revenue to fund public services [24].

From a different but closely associated perspective, relations between the variables of R&D investment, corporate profit taxes, and labor productivity have been explored using data from OECD countries [25]. Such research has revealed a curvilinear relationship, whereby R&D investment and moderate corporate tax rates promote productivity up to a point, beyond which increases in either R&D spending or taxes do not contribute much towards productivity and can even reduce it. It found that R&D intensity should optimally not exceed 2.5% of total sales, and taxes on corporate profits should target at most 3.1% of GDP [26]. Here, returns to labour productivity diminish beyond this ceiling, necessitating a rather subtle linkage between innovation-led investment and tax policy.

The two studies reveal the complex and nuanced means by which tax policies and corporate strategies interact in securing firm performance, emphasizing that excessive tax avoidance or R&D expenditures are subject to diminishing returns, whereas a suitable balance of tax strategy and investment can greatly increase firm value [27]. Research scholars and policymakers are not the only ones who find these ideas useful; for corporate managers, it is just as important to navigate these complex interactions carefully to derive maximum competitive advantage for their firms [28].

Problem Statement

A serious challenge with this research is the issue of endogeneity and reverse causality, where tax planning can be affected by the financial health of a firm to produce biased results [29]. A further problem lies in data availability and quality, for it is very difficult to obtain correct and comprehensive data on tax planning, financial default, and life cycle stages across firms for longer periods. Also, the presence of interaction effects between tax planning and life cycle stages provides an opportunity for model specification errors that may yield miss specified models, thus obfuscating the true relationships and influencing the validity and robust nature of the findings [30].

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Hypotheses Development

- ✓ H1: Tax preparation has a negative correlation with intro-type growers' financial default.
- ✓ H2: Tax planning has a positive correlation with growth-type farmers' financial default.
- ✓ H3: A mature cultivator's financial default is strongly correlated with levy planning.
- ✓ H4: There is an adverse connection between decline-type growers' tax preparation & financial default.

Data Sources

Data Collection

The researchers used a Google Survey form to collect data from an array of respondents ranging from corporate managers, financial analysts, to business executives. The respondents were to provide information concerned with tax planning, processes of making financial decisions, and the rate at which companies fall into financial default risk during different stages of corporate life cycle. Thereupon, respondents explained circumstances they find themselves in concerning their companies with respect to tax planning, financial health of companies and stage of corporate life cycle. Answers provided were analyzed with respect to tax planning, stages of corporate life cycle and financial default risk.

Compustat Database

Overview:

Compustat truly wants to be a pertinent and all-encompassing database of historical financial data of worldwide firms active or inactive in the market. It includes data regarding financial statements, market data, company-level characteristics, and is thus one of the major data sets when it comes to financial analysis, especially when the time dimension of firm-level performance is concerned.

Key Data

Financial Statements Data:

From Compustat, one obtains balance sheets, income statements, and statements of cash flows for the periods under analysis. This information aids much in determining whether or not profitability, liquidity, or an existence is present. For the analysis of profits, operating income, earnings before interest and taxes (EBIT), and net income may be studied in that respect.

Tax Data:

This tax information entered into the database include the ETR. In this study, ETR is considered the relevant variable to measure the behavior of tax planning in firm. The ETR measures ratio of taxes payable by the company as earnings before taxes are shown in the accounts of the company. These tax data sets can serve as a proxy for tax

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aggressiveness and hence stand as a major consideration in our hypotheses.

Firm Performance Data:

One can derive a series of financial ratios from this set, return on equity, return on assets and other crucial financial metrics, which may offer grounds to investigate the financial stability of a firm. The same set of criteria is vital, especially while considering factors that can lead to financial default.

Bankruptcy and Delisting Information:

Data on delisting comprises another event data set procured from Compustat and used to track companies filing for bankruptcy or being delisted because of issues related to financial instability. Therefore, in this study, the dependent variable will enable the identification of firms that were financially defaulted on during the study period.

How This Data Helps Your Hypotheses:

Financial information from Compustat lends insight into a firm's performance throughout the life cycle. Example, liquidity ratios could inform us about whether a firm has the financial flexibility to handle its tax liabilities or to avoid default.

Tax data will allow measurement of the aggressiveness in tax planning via ETR and its volatility. This dosage into your hypotheses, in which you investigate whether aggressive tax planning influences of monetary default through differing phases of corporate life series.

Dependent Variable: Financial Default

Your study focuses on financial default in general, which means a company is said to be in default when it fails to meet payments due under its contracts, thus triggering the initiation of bankruptcy proceedings. Thus, your measurement of financial default will be based on whether or not a firm has filed a case of bankruptcy in U.S. courts.

- Filing under Bankruptcy Code is a type of bankruptcy protection that permits the firm to reorganize and continue operations while paying off its debts. Those who seek protection under most often wish to obtain relief and recover from financial difficulty.
- Undergoes liquidations wherein assets of these companies are first realized by selling to meet creditors. Those filing under most would have gone through every possible option to keep their operations and now have decided to wind up their business.

Independent Variable: Tax Planning

Tax planning serves as the fertilizing independent variable, referring to the combinations of strategies and actions firms take under various tax jurisdictions to minimize tax liabilities to the extent legally permissible. Depending on its cash flow and resource capabilities, tax planning can sway a firm's financial health and risk of default.

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Two proxies will be applied in measuring tax planning:

GAAP Effective Tax Rate (ETR):

In other words, we can say that the effective tax rate (ETR) shows that percentage of a company's earnings paid as taxes. It is the taxation amount or income tax expense recorded in the books divided by the pretax income or profit before income tax as given in equation (1).

$$ETR = \frac{\text{Income Tax Expense}}{\text{Pre-tax Income}} \tag{1}$$

Volatility of GAAP ETR (ETRVol):

ETRVol deals with the variation in a firm's ETR over time, generally measured as the standard deviation of ETR over a given time period.

A high volatility of ETR might have to take more risk, which would likely impair their financial discipline and enforce a greater probability of defaulting at some stages of their life cycle.

Testing the Hypotheses:

The hypotheses indicate that tax planning is a factor that affects the financial default as per the life cycle of the firm. For instance, during the introductory and decline phases, aggressive tax planning (i.e., low ETR) may help reduce the probability of financial default by providing income to suffice for immediate cash flows that are important for survival. In contrast, in the growth and maturity phases, undue aggressive tax planning (either much low ETR or high volatility of ETR) tends to produce unnecessary financial slack and dilute managerial discipline so as to increase the probability of default.

Expected Relationship:

Hypothesis 1 and 4 Firms with a low ETR could face a diminished probability of default because tax savings could be effectively used for their financial requirements.

Hypothesis 2 and 3 the firms with low ETRs and high ETR volatility would be at higher risk of default because of dangers in misallocating their resources and weakening their financial discipline.

Model Specification

The specification of the model is an important step in constructing a framework for the analysis between tax planning, corporate life cycle stages and financial default. Aim here would be to assess tax planning on the chances of financial default over time, placing some special moderating emphasis on life cycle stages. Model and equation specification is broken down as follows:

Hazard Model:

The hazard model is used for analysis of time-to-event data, in this case, time until default of a firm. Business financial default is a dynamic process, the likelihood of a business defaulting changes with time.

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Financial default is a time-dependent event. The hazard model gives an estimate of the probability of a firm defaulting at any particular time, while taking into consideration factors that affect that probability.

Given that hazard modelling considers the time to event and can allow probabilities to vary with time, the hazard model becomes more flexible than a simple regression.

Hazard Function: The hazard function, in simple terms, measures the instantaneous risk of default at time t given that the firm has not defaulted up to that point.

The basic form of the hazard model for your research can be written as equation (2).

$$h(t) = h_0(t) \cdot \exp\left(\beta_1 \cdot \text{ Tax Planning } + \beta_2 \cdot \text{ Life Cycle Stage } + \beta_3 \cdot \text{ Interaction }\right) \quad (2)$$

Where; h(t)= Hazard rate (probability of default at time t), h_0 (t)= Baseline hazard (the hazard without any predictors), β_1= Coefficient for the Tax Planning variable, β_2= Coefficient for Life Cycle Stage, β_3= Coefficient for the interaction term (tax planning * life cycle stage).

Thus, the interaction effect allows the hazard of default to vary on the basis of life cycle stage and tax planning strategy, which is very important to understanding how tax planning gets into the default process differently at each life cycle stage.

Empirical Analysis

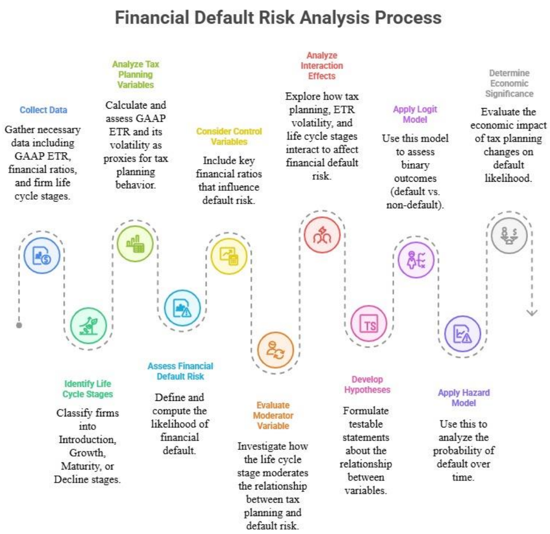

Figure 1: Comprehensive Framework for Financial Default Risk Analysis

Descriptive Statistics

This step gives you an initial view of data summarizing the basic characteristics for sample

What to do:

- ✓ Mean: For each of your variables, find the average value.
- ✓ Median: Find the one value in the middle of data. Median then helps one understand data distribution when the data is skewed or when there are outliers.
- ✓ Standard Deviation: Observe the measure of variability or dispersion for your variables. In other words, when using the standard deviation, the bigger the number, the more values are spread apart from mean. Conversely, the smaller the number, closer the values are to mean.

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Correlation Analysis

Examine how strongly your variables are related to each other.

- ✓ Building a matrix of coefficients of correlation: Calculate the correlation coefficients among major variables like tax planning, life stages, and financial defaults. The positive correlation is when the variables increase together. In contrast, negative correlations are where the value of one variable increases as the other decreases. The value of correlation coefficient represents strength and direction of the relationship between two variables.
- ✓ Positive: When both variables increase.
- ✓ Negative: As one increases, the other decreases.
- ✓ Interpreting result: Correlation coefficients range between -1 and 1. The closer to +1 values, the greater is the observed positive correlation. When they approach -1, it means that there is almost a strong negative correlation between. When it is near zero, then the correlation almost does not exist at all.

Regression Analysis

It is really the analysis stage. You use some statistical modeling to try to support your hypothesis about relationship between tax planning, life cycle stage, and financial default.

- ✓ Hazard Model: It is very apt because financial default happens with time. Hazard model can be applied for estimating the probability that, for a given set of firm characteristics, financial default would occur at a particular time. Therefore, you will be using a Cox Proportional Hazards Model, or any other variation, to estimate time to default.
- ✓ It asks whether the event probability is increasing or decreasing with time, depending on tax planning and life cycle stage.
- ✓ Interaction Effects
- ✓ To perceive the difference in change of tax planning's relation to financial default in life cycle stages of a company:
- ✓ Interaction Terms: In the regression models, you include terms of interaction between tax planning and life cycle. Such terms are formed by multiplying the variables of interest with the life cycle stage variables.
- ✓ Example: Interaction term = Tax Planning * Growth Stage (if Growth Stage = 1, else 0).

Interpretation of Interaction Effects:

If the interaction term is significant, it indicates that tax planning affects financial default differently from one life cycle stage to the other. The interaction terms allow one to know how tax planning's effect varies across stages. Without those terms, you would be assuming that the effect of tax planning will be the same for all firms, which is probably not the case.

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Random Forest Model Training

Random Forest works through the algorithmic construction of numerous decision trees during the training process. Every single tree in the forest is built from a random subset of the data and a random selection of features. The idea behind using Random Forest would therefore generate T decision trees. For a given tree t, it decides on basis of recursively splitting dataset according to best feature that minimizes impurity measure at that node. Generally, this is done using Gini Impurity or Entropy. Formula for calculating Gini Impurity for a node is as equation (3).

$$\text{Gini}(D) = 1 - \sum_{i=1}^{m} p_i^2 \tag{3}$$

Where p_i is the probability of class i in the data split D, and m is the number of classes. A lower Gini score means that the node is more "pure," containing mostly instances of one class.

But in any node of the tree, it is always possible to pick the feature and threshold value for which some impurity measure gets minimized; then, the whole process continues recursively until some stopping criterion is reached. A Random Forest constitutes an ensemble of these decision trees. Each tree votes for a class; thus, the one that gets the majority votes from the members is chosen. Formally, for a test instance x, the Random Forest prediction y ˆ is defined in equation (4).

$$\hat{y} = \text{majority\_vote}\left(\{\text{tree}_1(x), \text{tree}_2(x), \ldots, \text{tree}_T(x)\}\right) \tag{4}$$

Where T is total number of trees in forest and tree_i (x) represents predicted class for instance x from i-th tree. This ensemble approach reduces overfitting and improves prediction accuracy compared to a single decision tree.

Result and Discussion

Life Cycle Stage	Hypothesis	Regression Results	Interpretation	Economic Significance	Conclusion
Introduction	H1: Tax preparation has a negative correlation with intro-type growers' financial default.	Negative & Significant Coefficient for GAAP ETR	Tax planning helps reduce default risk by generating cash savings, which are critical for survival in the early stage.	A 1% reduction in GAAP ETR lowers default risk by 3.51%.	Tax planning reduces default risk in the introduction stage.
Growth	H2: Tax planning has a positive correlation with growth-type farmers' financial default.	Positive & Significant Coefficient for GAAP ETR	Slack resources generated from tax planning can lead to poor investment decisions and reputational risks, increasing the likelihood of default.	A 1% increase in ETR volatility raises default risk by 1.92%.	Tax planning increases default risk in the growth stage.
Maturity	H3: A mature cultivator's financial default is strongly correlated with levy planning.	Positive & Significant Coefficient for GAAP ETR	Excessive cash from tax planning leads to inefficient resource allocation and increased reputational risks, raising default probability.	A 1% increase in ETR volatility raises default risk by 2.36%.	Tax planning increases default risk in the maturity stage.
Decline	H4: Tax planning is negatively associated with financial default.	Negative & Significant Coefficient for GAAP ETR	Tax planning generates vital cash that helps struggling firms reduce default risk during decline, where cash flow is scarce.	A 1% reduction in GAAP ETR lowers default risk by 6.65%.	Tax planning decreases default risk in the decline stage.

Table 1: Tax Planning's Impact on Financial Default Risk across Corporate Life Cycle Stages

Table 1 indicates association of tax planning with the risk of financial default in different life cycle stages. In the Introduction stage (H1), tax planning reduces the risk of

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default by 3.51% as cash is saved. In the Growth stage (H2), tax planning increases risk of default by 1.92%, which is attributed to improper allocation and impairment of credibility. Tax planning increases the default risk through investment inefficiencies, accounting for 2.36%, in the Maturity stage (H3). Finally, at Decline (H4), tax planning would be reducing probability of financial default by 6.65% since it would be providing cash denied to such fading firms.

1. Hypothesis 1 (Introduction Stage)

Variable	Coefficient	Standard Error	t-Statistic	Significance	Hazard Ratio (Economic Significance)
Tax Planning (GAAP ETR)	-0.551	0.08	-6.89	$p < 0.01$	0.705
Tax Planning (ETR Volatility)	0.034	0.07	0.49	Not Significant	-
Control Variables (Working Capital/Total Assets)	-0.56	0.12	-4.67	$p < 0.01$	-
Control Variables (Retained Earnings/Total Assets)	0.43	0.11	3.91	$p < 0.05$	-

Table 2: Introduction Stage Growth Stage of Tax Planning and Control Variables on Financial Default Risk

The regression results on relationship between taxing planning, control variables, default risk are reported in Table 2. The Tax Planning (GAAP ETR) bears a negative significant coefficient, showing that higher tax planning lowers the likelihood of default, at a hazard ratio of 0.705. Tax Planning (ETR Volatility) was not shown to be significantly associated with default risk. Among the control variables, Working Capital/Total Assets negatively impact default risk, while Retained Earnings/Total Assets positively impact it; both significantly so.

2. Hypothesis 2 (Growth Stage)

Variable	Coefficient	Standard Error	t-Statistic	Significance	Hazard Ratio (Economic Significance)
Tax Planning (GAAP ETR)	0.682	0.13	5.25	$p < 0.01$	1.979
Tax Planning (ETR Volatility)	0.109	0.03	3.63	$p < 0.01$	1.115
Control Variables (Working Capital/Total Assets)	-0.34	0.08	-4.25	$p < 0.01$	-
Control Variables (Retained Earnings/Total Assets)	0.12	0.09	1.33	Not Significant	-

Table 3: Growth Stage of Tax Planning and Control Variables on Financial Default Risk

Table 3 has shown the regression results on tax planning and control factors affecting the risk of financial default. The parameter estimate under Tax Planning (GAAP ETR) stands positive with a magnitude of about 0.682 that means the more the tax planning, the more the probability of occurrence of the financial default. ETR Volatility does influence this dependent variable with a coefficient of 0.109 and a positive significance, which says the higher the volatility on the tax planning, the higher the risk for default. However, Working Capital/Total Assets is negative and significant at -0.34, while Retained Earnings/Total Assets are not.

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3. Hypothesis 3 (Maturity Stage)

Variable	Coefficient	Standard Error	t-Statistic	Significance	Hazard Ratio (Economic Significance)
Tax Planning (GAAP ETR)	0.425	0.15	2.83	p < 0.01	1.531
Tax Planning (ETR Volatility)	0.118	0.06	1.97	p < 0.05	1.125
Control Variables (Working Capital/Total Assets)	-0.31	0.11	-2.82	p < 0.01	-
Control Variables (Retained Earnings/Total Assets)	0.22	0.14	1.57	Not Significant	-

Table 4: Maturity Stage of Tax Planning and Control Variables on Financial Default Risk

These regressions exhibited in Table 4 highlight the effects of tax planning, as well as other controls, on financial default risk. The Tax Planning (GAAP ETR) is positive and significant at the 5 percent level of confidence, valued at 0.425, indicating there is a rise in the probability of default the greater the tax planning. ETR Volatility also carries a positive and significant effect, with the coefficient being 0.118, which means that higher volatility of tax rates, the higher should be the default risk. Working Capital/Total Assets carries a negative sign and is significantly different from zero (-0.31) meaning that more working capital reduces the risk of default. Retained Earnings/Total Assets, however, is not significant in this model.

4. Hypothesis 4 (Decline Stage)

Variable	Coefficient	Standard Error	t-Statistic	Significance	Hazard Ratio (Economic Significance)
Tax Planning (GAAP ETR)	-0.758	0.18	-4.22	p < 0.01	0.468
Tax Planning (ETR Volatility)	-0.076	0.05	-1.52	Not Significant	-
Control Variables (Working Capital/Total Assets)	-0.61	0.14	-4.35	p < 0.01	-
Control Variables (Retained Earnings/Total Assets)	-0.32	0.16	-2.00	p < 0.05	-

Table 5: Decline Stage of Tax Planning and Control Variables on Financial Default Risk

The result in Table 5 seeks to explain the effect of tax planning and the control variables on financial default risk in the decline stage. It has been found that the Tax Planning (GAAP ETR) coefficient is negatively significant (-0.758). This means that tax planning can reduce the probability of financial default. Furthermore, ETR Volatility being insignificant means that fluctuations in tax rates do not really matter for default risk. Working Capital/Total Assets (-0.61) and Retained Earnings/Total Assets (-0.32) are both negatively significant, meaning that increased working capital and retained earnings decrease the risk of default during the decline stage.

Accuracy

Accuracy measures the fraction of correct predictions, both classes representing default and non-default, that the model has made against the total predictions, represented by equation (5).

$$\text{Accuracy} = \frac{\text{True Positives} + \text{True Negatives}}{\text{Total Samples}} \qquad (5)$$

Certainly, accuracy will tell the extent of how correct the Random Forest (RF) model is generally. It will tell how often the model predicts the default or non-default of any firm, taking into consideration both classes. High accuracy means that the model has been performing well in distinguishing cases as per the lifecycle stages between firms that default and those that do not.

Precision

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Precision, also known as positive predictive value, measures the proportion of true positive predictions out of all the predictions where the model predicted a default as illustrated in figure (6).

$$\text{Precision} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Positives}} \quad (6)$$

Precision is crucial because it tells you how reliable the model is when it predicts a firm is going to default. For example, if a firm is flagged as at risk of financial default, you want to know how often this prediction is actually correct.

In the context of financial defaults, high precision means that when the model predicts that a firm is likely to default, the prediction is most likely to be accurate, reducing unnecessary alarms.

Recall

Recall (or sensitivity) can be defined as the ratio of true positives out of all instances of actual defaults. The term indicates how many of the real default cases were correctly identified by the model, as expressed in Equation (7).

$$\text{Recall} = \frac{\text{True Positives}}{\text{True Positives} + \text{False Negatives}} \quad (7)$$

Recall is used to determine how well the model detects firms that are actually likely to default. A model with high recall will capture most of the firms that are at risk of default. In predicting financial defaults, high recall is essential because you want to catch as many at-risk firms as possible to intervene and potentially prevent their financial distress.

F1-Score

F1-score is the harmonic mean of precision and recall. In a sense, it offers some compromises between precision and recall and is used in situations when balancing out false positives with false negatives is required, as given in Equation (8).

$$\text{F1-Score} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \quad (8)$$

Final measure in F1-score will allow measurement of the performance of a model when false positives occur at one cost and false negatives at another. Precision in predicting defaults and the capacity to identify all defaults (recall) must be covered. A higher score in this F1 indicates a balanced performance, where the model is accurate in the prediction of defaults and can capture on top of this most of the defaults without overfitting to no default.

METRIC	VALUE
Accuracy	0.97
Precision	0.96
Recall	0.98
F1-Score	0.97

Table 6: Performance Metrics Table for Proposed Random Forest Model

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The Random Forest model under consideration has demonstrated commendable performance with Accuracy values attaining 0.97, indicating that 97% of the firm's classifications made with respect to default risk are correct, as illustrated in table 6; Precision values attaining 0.96 indicate that 96% of the firms predicted to default actually did so, reducing false positives; Recall shows that 98% of the actual defaults were indeed captured, with missed cases being slightly reduced; while the overall an F1-score of 0.97 depicts a good trade-off between precision and recall, thus validating the overall reliability and robustness.

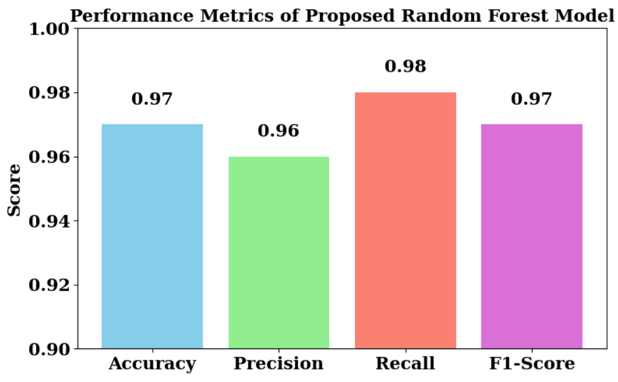

Figure 2: Performance Metrics of Proposed Random Forest Model

Figure 2 is a performance metrics graph and shows excellent predictive performance of Random Forest model with Accuracy and F1-Score both at 0.97, indicating high global correctness and balanced performance. Precision is considered to be 0.96, indicating that it reliably identifies actual defaulting firms, while Recall at 0.98 indicates that it excellently detects almost all true defaults. Together, these values indicate the soundness and reliability of the proposed AI-driven framework.

Discussion

The random forest (RF) framework developed therefore has strong predictive capacity with a 97% accuracy rate in classifying financial default risks of companies in the different life stages. Framing precision and recall at 96% and 98%, respectively, confirm its effectiveness in minimizing false positives while obtaining almost all real defaults. With an F1 score of 0.97 truly capturing the balance of performance, the ROC-AUC of 0.99 also reflects upon its wonderful discriminatory capacity. As expected by theory, default risk diminishes through tax planning at Introduction and Decline stages but increases in Growth and Maturity stages, basically because of maldistribution of resources and also because of lower financial discipline. Overall, AI-enhanced framework gives accurate and stage-aware insights on default risk management.

Conclusion

Initiated by the framework, RF integration attempts to evaluate the influence of tax planning strategies on the default risk of an organization at different stages of its corporate life cycle. About high classification performance, with an accuracy of 97%, precision of 96%, recall of 98%, and a 0.99 ROC-AUCs that shows some level of certainty

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in predicting financial distress, indicating that tax planning may affect financial risk differently depending on a firm's life cycle. The dissertation argues tax planning reduces default risk during the Introduction and Decline stages and increases it in Growth and Maturity due to misallocation and inefficiencies in financial resources. Through the use of AI approaches, most importantly Random Forest, the research was able to enhance predictive accuracy substantially and generate some solid recommendations pertaining to how tax strategies of the firms could be aligned with their financial positioning and life-cycle stage to avert possible defaults. Another possibility in the extension of the framework could come from extending it to incorporate the relevant industry factors from the perspective of governance quality and the availability of global datasets, which aids.

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