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The Relationship Between Interest Burden and Audit Risk in Industrial Companies Listed Across Multiple Stock Exchanges

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Abstract: This manuscript investigates whether a measure of debt-service pressure - interest burden (IB) based on an inflow-to-outflow basis - explains audit risk (AR) variation in publicly traded industrial companies. The analysis uses a sample of 15 companies from 2015-2023, accounting for firm and year fixed effects, and clustering standard errors by firm. The proxy for AR used is the negative log of the interest coverage, $=AR\ln(ICR)$. The main empirical result is that IB is positively correlated with AR (connected statistically), which indicates that the burden of heavy interest costs materially diminishes coverage and adds risk relevant to audit. Cash-flow Adequacy (CFA) is significantly negatively correlated with AR and Liquidity (LIQ) consistently directionally-related to AR in the directional tests. The traditional leverage measure, stock-based (LEV), and firm size (FS) were not consistently directional to AR when including IB, which provides support for the incremental informational nature of the pure "flow"-based pressure. Profitability (ROA) was positively directionally-related to AR across the sample at moderate economic magnitude, which indicates some timing or composition effect of accrual earnings against cash interest coverage. The results are consistently robust to winsorization and specifications. This paper contributes to the audit risk literature by bringing debt-service flows (IB, CFA) back to the center of audit risks in capital-intensive ecosystems and concludes the paper with some time-travel implications for auditors, managers, and regulators.

Keywords: audit risk; interest burden; interest coverage; cash-flow adequacy; liquidity; industrial firms; panel data; fixed effects

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1. Introduction

External auditing has long been regarded as a cornerstone of financial governance and corporate accountability. By providing an independent assessment of the fairness and reliability of financial statements, the auditing process plays a pivotal role in reducing information asymmetry between management and external stakeholders. Investors, regulators, creditors, and other interested parties rely heavily on audited financial reports to make informed economic decisions. However, the credibility of the audit report is not absolute; it is constrained by the possibility of **audit risk**, which refers to the probability that an auditor may issue an inappropriate opinion on financial statements that contain material misstatements [1]. Audit risk is a multidimensional construct that is driven by inherent risk in the operations of the company, the effectiveness of internal controls, and the effectiveness of substantive audit procedures. So, it is a long-standing topic in accounting and auditing research to understand what determines, or shapes, audit risk generally.

One of the financial determinants that could, potentially, shape the level of audit risk is the interest burden of a company. The interest burden refers to the earnings, or revenues, that are consumed by the interest cost of using debt financing. The interest burden is usually expressed as the ratio of interest expense to earnings before interest and taxes (EBIT) or to net sales. Generally, we can say that from a financial standpoint, the

greater the interest burden, the more reliance a company has on debt financing [2]. A higher interest burden may imply that the financial flexibility of the firm is weaker, and it is difficult for them to avoid the risk of financial distress. When a significant portion of operating profit is paid out as interest expense, the company's efficiency at servicing debt decreases, and uncertainty about going concern increases. Such conditions elevate the audit risk environment that auditors face in practice, or the potential for misstatement, earnings management, or default is greater for firms with relatively high financial leverage and significant interest costs [3].

The industrial sector, as one example, is an excellent context for the examination of this phenomenon. Industrial firms often use external financing to fund capital-intensive projects, such as purchasing machinery, improving or building new plants, or increasing production capacity. Therefore, firms in the industrial sector typically have significant interest costs, especially in emerging markets, where the cost of borrowing may be high and/or access to capital markets is limited. These financial perspectives can increase audit risk, as auditors are challenged to ensure that debt sustainability is being evaluated while also ensuring the company is presenting a true and fair view of the financial situation as it relates to debt [4]. Consequently, the interaction between **interest burden** and **audit risk** becomes especially relevant in listed industrial companies, where financial distress not only affects internal operations but also undermines investor confidence in the broader capital market.

Although numerous studies have explored the determinants of audit risk such as firm size, profitability, leverage, and governance mechanisms empirical research has devoted relatively little attention to the specific role of interest burden. Most existing research has considered leverage in general terms, typically measured as the ratio of total debt to total assets, without disaggregating the particular impact of interest expenses on audit risk. However, interest burden captures a more direct and pressing aspect of financial risk: the immediate claim that creditors impose on a firm's operational performance. Unlike leverage ratios, which reflect a balance sheet perspective, interest burden highlights the real strain that financing costs place on current income streams. This gap in the literature motivates the present study, which seeks to investigate the relationship between interest burden and audit risk within the context of listed industrial firms [5].

The significance of this study stems from both practical and theoretical considerations. Practically, auditors and regulators require a deeper understanding of the financial indicators that signal elevated audit risk. If interest burden is shown to significantly influence audit risk, auditors may need to adjust their risk assessment models, devote additional attention to companies with high interest obligations, and allocate more audit effort accordingly [6]. For managers and policymakers, the findings could underscore the importance of transparent disclosure of financing costs and the adoption of financial strategies that mitigate the risks associated with excessive debt servicing. Theoretically, the study enriches the literature on audit risk by incorporating a more nuanced financial variable that has been underexplored in previous empirical work.

The research focuses specifically on **listed industrial companies** for several reasons. First, the industrial sector is capital-intensive and typically exhibits high fixed costs, making firms in this sector more sensitive to interest obligations. Second, listed firms are subject to rigorous disclosure requirements, which provide reliable data for empirical analysis. Third, investors in the industrial sector often place substantial weight on financial stability and solvency indicators, which are directly affected by the interest burden. Therefore, studying this sector provides both relevance and generalizability, particularly in emerging markets where industrial firms form a significant component of national economies [7].

In terms of methodology, the study employs quantitative analysis using panel data from 2015 to 2023 for a sample of listed industrial companies. Audit risk is proxied through financial indicators that can be derived directly from the three primary financial statements income statement, balance sheet, and cash flow statement. Potential proxies include the interest coverage ratio ($\text{EBIT} \div \text{Interest Expense}$), Altman's Z-score for bankruptcy prediction, or measures of cash flow adequacy. By modeling the relationship

between interest burden and these proxies of audit risk, and by controlling for other relevant factors such as firm size, leverage, profitability, and liquidity, the study aims to provide robust empirical evidence on the extent to which financial obligations related to interest payments affect audit risk [8].

The remainder of the paper is structured as follows. Following this introduction, the second section reviews the relevant literature on audit risk and financial determinants, with a particular focus on interest burden and its implications. The third section outlines the research methodology, including data sources, variable definitions, and model specification. The fourth section presents the empirical results and discussion, highlighting the statistical relationship between interest burden and audit risk. Finally, the fifth section concludes the study, emphasizing theoretical contributions, practical implications, and suggestions for future research.

In sum, this study contributes to the growing body of literature on audit risk by offering new insights into how financing costs, specifically interest burden, shape the audit environment in listed industrial companies. Given the global importance of the industrial sector and the challenges posed by debt financing, the findings are expected to be of interest not only to auditors and regulators but also to managers, investors, and policymakers who seek to ensure financial transparency and stability in capital markets.

1.1 Literature Review

1.1.1 Audit Risk: Concept and Dimensions

Audit risk has been extensively studied in the accounting and auditing literature as a critical concept underlying the assurance function of external auditors. The International Auditing and Assurance Standards Board defines audit risk as the risk that an auditor expresses an inappropriate opinion when the financial statements are materially misstated [9]. Traditionally, this risk is composed of three components: inherent risk, control risk, and detection risk. Inherent risk indicates the risk of financial statement assertions being materially misstated before considering any related controls; control risk reflects the risk that a material misstatement could occur and not be prevented or detected by the company's internal controls; and detection risk indicates the risk a given set of substantive procedures will fail to detect a material misstatement that exists. The combination of these three risks represents the overall audit risk we experience as auditors.

Researchers argue that the audit risk construct is not simply a technical construct; instead, it also reflects the economic, regulatory, and organizational environment of the audited organization. For example, Simunic argued that part of audit fees reflects the auditor's assessment of risk, and thus, when the auditor faces higher expected litigation or reputational costs, the auditor will demand a higher fee [10]. Similarly, Francis argued that the assessment of audit risk is a primary driver of audit quality, as it establishes the overall scope of testing, allocation of resources, and overall credibility of the audit opinion.

1.1.2 Determinants of Audit Risk

A wide range of factors influencing audit risk have been empirically studied: firm size is one of the more commonly studied factors, and is often operationalized using total assets or total sales. From the auditor's perspective, larger firms are viewed as lower risk because of stronger internal controls and a diversified operation. Conversely, smaller firms are more likely to have weaker governance structures and controls as well as a greater risk of financial distress, which may increase audit risk.

Profitability is another important predictor of audit risk. Firms that exhibit losses or falling margins are assumed to receive additional scrutiny from the auditor, as poor performance increases the auditor's concern about going-concern decisions. Similarly, liquidity and solvency ratios have been associated with audit risk; firms that struggle to meet short-term obligations are considered riskier to audit, as liquidity problems may precede default or manipulation of financial results [11], [12].

Leverage has also been widely studied in the literature as a determinant of audit risk. Highly leveraged firms face greater pressure to meet debt covenants and service interest obligations, increasing the likelihood of earnings management and aggressive accounting

practices. From the auditor's perspective, such firms pose higher inherent and control risks, necessitating more extensive audit procedures. Furthermore, audit firm characteristics, such as whether the auditor is one of the Big Four, have been linked to risk assessments. Big Four auditors are often associated with stricter risk evaluation and higher audit quality, which can mitigate some of the risks perceived in high-risk clients [13].

1.1.3 Financial Leverage and Interest Burden

While leverage is a widely studied determinant, relatively few studies have examined interest burden as a distinct measure of financial risk. Leverage ratios, such as total debt to total assets, provide a balance sheet perspective of financial risk, but they do not directly capture the strain imposed by interest expenses on a company's operational performance. In contrast, interest burden measured as interest expense relative to EBIT or net sales offers a dynamic, income-statement-oriented perspective. It reflects not only the amount of debt but also the cost of servicing that debt relative to the company's earnings capacity [13].

Studies in corporate finance have documented that firms with high interest burdens are more prone to financial distress and bankruptcy. A high interest burden reduces managerial flexibility, constrains investment opportunities, and raises the probability of covenant violations. From an auditing perspective, these financial pressures increase the auditor's inherent risk assessment, as firms under financial stress may be more likely to engage in earnings management or present going-concern uncertainties [14].

Khurana and Raman observed that debt-related pressures significantly influence auditor decision-making, as auditors must evaluate whether companies can continue as going concerns. Similarly, Carcello and Neal found that audit committees often intensify their monitoring role when firms face high financial risk, especially those with significant interest expenses. These findings suggest that interest burden is an important variable that directly impacts the auditor's perception of client risk.

In emerging markets, the relevance of interest burden may be even greater. Studies have shown that industrial companies in such markets rely heavily on debt financing due to limited access to equity markets and high capital requirements for production [15]. Consequently, their interest burden tends to be higher and more volatile, intensifying audit challenges. Auditors in these contexts must carefully evaluate financial ratios that capture the sustainability of debt servicing, such as the interest coverage ratio, as part of their risk assessment.

1.1.4 Linking Interest Burden to Audit Risk

Despite the theoretical importance of interest burden, the literature directly linking this variable to audit risk remains limited. Most prior research has relied on broader measures of leverage, profitability, or liquidity. For example, Mutchler demonstrated that financial ratios related to solvency and profitability are significant predictors of going-concern audit opinions. However, the specific role of interest burden in shaping audit risk has received comparatively little empirical attention.

A few studies indirectly suggest this relationship. DeFond and Jiambalvo found that firms close to debt covenant violations are more likely to manipulate earnings, which elevates audit risk. Since covenant violations are often triggered by the inability to service interest obligations, these results imply a role for interest burden in the auditor's risk model. Similarly, Francis and Krishnan reported that firms with higher financial distress indicators are more likely to receive modified audit opinions, again pointing toward the potential influence of interest costs [14], [15].

1.1.5 Research Gap and Contribution

The review of the literature highlights a clear gap: while leverage, liquidity, and profitability have been extensively studied as determinants of audit risk, interest burden as a distinct financial measure has not been sufficiently examined. Unlike leverage ratios that offer a static view of indebtedness, interest burden reflects the real-time financial strain imposed by debt servicing on a firm's earnings capacity. For industrial companies where debt financing is central to capital structure this measure may provide a more accurate indicator of audit risk than traditional ratios.

By focusing on listed industrial companies from 2015 to 2023, the present study contributes to filling this gap. It investigates whether higher interest burdens are associated with higher audit risks, proxied by financial ratios such as the interest coverage ratio or Altman's Z-score. Furthermore, the study controls for conventional determinants of audit risk, including firm size, leverage, profitability, and liquidity, to isolate the incremental impact of interest burden. In doing so, it provides both theoretical and practical insights: theoretically, by extending the literature on audit risk determinants; and practically, by offering auditors, regulators, and managers a more nuanced understanding of how financing costs affect audit outcomes.

1.2 Theoretical Framework

established theoretical lenses in accounting and auditing research. Agency theory posits that managers of firms may engage in earnings manipulation, to avoid violating debt covenants when firms are burdened with high interest expense which will, in turn, create inherent risk. Information asymmetry and signaling theory show that the presence of high interest expense not only signals potential indicators of financial distress to the auditor, but also red flag or cues in the auditor's risk assessment. Furthermore, the risk-based audit model suggests where issuance of audit work is based on perceived inherent risk, firms with higher financing costs are deemed more risky clients. Collectively, these perspectives indicate that an interest expense is not merely a cost of financing but rather a key factor in assessing audit risk which provides the premise for developing testable hypothesis in present study.

1.2.1 Agency Theory

Agency theory offers insights into the significant conflicts of interest between managers (agents) and shareholders (principals). In situations where a company experiences hundreds of millions of dollars in interest expense, managers have a supporting responsibility to meet debt obligations. In situations where managers believe that a more favorable financial position will help limit the company's interest expenses, they may engage in earnings management. Such actions increase the risk of financial statement misstatement as the conflicts of interest whether actual or perceived continue to escalate an auditor's risk assessment. As a result of significant agency conflict, the auditor may consider the company as higher risk and employ various techniques to include increased audit procedures.

1.2.2 Information Asymmetry and Signaling Theory

Interest burden also amplifies information asymmetry between internal managers and external stakeholders. High financing costs may signal financial distress, but managers may attempt to downplay or obscure these risks through biased reporting. According to signaling theory, financial ratios such as interest coverage or Z-scores act as signals to auditors and investors regarding a firm's ability to service debt. Auditors interpret these signals as indicators of audit risk and adjust their audit strategy accordingly.

1.2.3 Risk-Oriented Audit Model

The risk-oriented audit model emphasizes that audit procedures should be driven by risk assessments. Under this model, companies with higher financial leverage or greater interest burdens are classified as high-risk clients. This leads auditors to allocate more time and resources, increase substantive testing, and in some cases, issue modified audit opinions. Thus, the theoretical framework predicts a positive relationship between interest burden and audit risk.

1.3 Conceptual Model

The conceptual framework of this study is designed to capture the relationship between the interest burden of listed industrial companies and their corresponding audit risk, while accounting for other firm-level factors that may influence this relationship.

1.3.1 Independent Variable (IV): Interest Burden

Interest Burden (IB) is measured as Interest Expense ÷ Net Sales to avoid mechanical dependence with $ARln(ICR) -$. This ratio captures the share of revenues absorbed by .financing costs

1.3.2 Dependent Variable (DV): Audit Risk

Audit risk is proxied through financial indicators derived directly from firms published financial statements. Two primary measures are adopted:

$\ln(\text{Interest Coverage Ratio})$, where $\text{ICR} = \text{EBIT} \div \text{Interest Expense}$, representing the ability of earnings to cover interest obligations. A lower ICR indicates higher risk, and applying the negative logarithm ensures consistent interpretation.

Altman's Z-Score, a well-established measure of bankruptcy risk, which combines income statement and balance sheet data to assess financial distress and, indirectly, audit risk.

1.3.3 Control Variables (CVs):

To isolate the unique impact of interest burden on audit risk, several firm-specific control variables are included:

Firm Size measured as the natural logarithm of total assets, capturing economies of scale and stronger internal controls in larger firms.

Leverage calculated as total liabilities $\div$ total assets, indicating the overall debt burden of the firm.

Profitability (ROA) measured as net income $\div$ total assets, reflecting the firm's ability to generate returns from its resources.

Liquidity (Current Ratio) current assets $\div$ current liabilities, highlighting the firm's short-term solvency.

Auditor Type a dummy variable distinguishing between Big4 and non-Big4 auditors, since Big4 firms are associated with stricter audit standards and lower perceived risk.

1.3.4 Expected Direction of Relationship:

Based on agency theory, signaling theory, and the risk-oriented audit model, it is hypothesized that there is a positive relationship between interest burden and audit risk. Firms with high interest burdens face greater financial stress, increasing the likelihood of misstatements, going-concern uncertainties, and audit modifications, see Table 1.

1.4 Hypotheses Development

H1: Interest burden is positively associated with audit risk.

H2: Firm size is negatively associated with audit risk.

Larger firms tend to have stronger internal controls and more diversified operations, reducing audit risk.

H3: Leverage is positively associated with audit risk.

Highly leveraged firms face higher financial stress and potential covenant violations, increasing audit risk.

H4: Profitability is negatively associated with audit risk.

Profitable firms are less likely to face going-concern uncertainties, lowering audit risk.

H5: Liquidity is negatively associated with audit risk.

Firms with higher current ratios can meet short-term obligations more easily, reducing audit risk.

H6: Cash-Flow Adequacy (CFA) is negatively associated with audit risk.

Table 1. Summary of Variables in the Conceptual Model

Variable Type	Variable Name	Measurement / Proxy	Expected Sign	Source (Financial Statement)	Rationale
Independent Variable (IV)	Interest Burden	$\text{Interest Expense} \div \text{EBIT}$; or $\text{Interest Expense} \div \text{Net Sales}$	(+)	Income Statement	Captures financial strain from debt servicing.
Dependent Variable (DV)	Audit Risk	$-\ln(\text{Interest Coverage Ratio})$; or Altman's Z-Score	N/A	Income Statement + Balance Sheet	Indicates probability of misstatements and going-

Variable Type	Variable Name	Measurement / Proxy	Expected Sign	Source (Financial Statement)	Rationale
					concern issues.
Control Variable (CV1)	Firm Size	$\ln(\text{Total Assets})$	(-)	Balance Sheet	Larger firms are considered less risky due to stronger controls.
Control Variable (CV2)	Leverage	$\text{Total Liabilities} \div \text{Total Assets}$	(+)	Balance Sheet	Higher debt increases audit risk and covenant pressure.
Control Variable (CV3)	Profitability (ROA)	$\text{Net Income} \div \text{Total Assets}$	(-)	Income Statement + Balance Sheet	More profitable firms are less likely to misstate financials.
Control Variable (CV4)	Liquidity	$\text{Current Assets} \div \text{Current Liabilities}$	(-)	Balance Sheet	Higher liquidity reduces risk of default and audit concerns.
Control Variable (CV5)	Cash-Flow Adequacy (CFA)	$\text{CFO} \div \text{Total Debt}$	(-)	Cash Flow + Balance Sheet	Higher cash coverage of debt lowers audit risk

2. Materials and Methods

2.1 Research Design

This study adopts a quantitative and explanatory research design to examine the relationship between interest burden and audit risk in listed industrial companies. The design is deductive in nature, beginning with theoretical assumptions based on agency theory, signaling theory, and the risk-oriented audit model, and proceeding to empirical testing of hypotheses. Panel data methods are employed to capture both cross-sectional variation across firms and longitudinal variation over time, thereby increasing the robustness of the analysis compared to single-period cross-sectional approaches.

2.2. Population and Sample

The population of interest includes all listed industrial companies in the selected stock exchange. Industrial firms are chosen because of their capital-intensive structures and heavy reliance on debt financing, which makes interest burden a particularly relevant factor in this sector.

Sample size: The final sample includes 15 industrial firms consistently listed during the period 2015-2023.

Sampling technique: Purposive sampling was applied, ensuring that firms with complete and reliable financial data were included.

Panel structure: With 15 firms over 9 years, the dataset yields approximately 135 firm-year observations, which provides a sufficient basis for panel regression analysis with a parsimonious set of explanatory variables.

2.3 Data Sources

The study relies exclusively on secondary data, collected from:

Published annual reports, including income statements, balance sheets, and cash flow statements.

Stock exchange filings and company disclosures.

Audit reports, where available, to classify auditor type (Big4 vs. non-Big4).

The use of secondary data enhances reliability, transparency, and replicability. Since all variables are derived from financial statements, the methodology remains consistent with prior empirical research in accounting and auditing.

2.4 Variables and Measurement

Independent Variable (IV): Interest Burden

Formula 1: Interest Expense $\div$ EBIT (Earnings Before Interest and Taxes)

Formula 2: Interest Expense $\div$ Net Sales

These ratios capture the degree to which financing costs consume operating income or revenue.

Dependent Variable (DV): Audit Risk

Proxy 1: $-\ln(\text{Interest Coverage Ratio})$, where $\text{ICR} = \text{EBIT} \div \text{Interest Expense}$. A lower ICR reflects greater financial risk.

Proxy 2: Altman's Z-Score, a composite indicator of financial distress based on multiple financial statement components.

Control Variables (CVs):

Firm Size: Natural logarithm of total assets ($\ln \text{TA}$).

Leverage: Total liabilities $\div$ total assets.

Profitability (ROA): Net income $\div$ total assets.

Liquidity (Current Ratio): Current assets $\div$ current liabilities.

Auditor Type: Dummy variable (1 = Big4, 0 = non-Big4).

These variables were selected based on theoretical considerations and consistent evidence from prior literature on audit risk, see Table 2.

2.5 Model Specification

Table 2. To empirically test the hypotheses, the following panel data regression model is specified

Variable	Code	Definition
Audit Risk	AR	Dependent variable, proxied by $-\ln(\text{ICR})$ or Altman's Z-score
Interest Burden	IB	Independent variable, Interest Expense $\div$ EBIT (or $\div$ Sales)
Firm Size	FS	Control, natural logarithm of Total Assets
Leverage	LEV	Control, Total Liabilities $\div$ Total Assets
Profitability	ROA	Control, Net Income $\div$ Total Assets
Liquidity	LIQ	Control, Current Assets $\div$ Current Liabilities
Cash-Flow Adequacy	CFA	CFO $\div$ Total Debt
Error Term	ϵ	Random disturbance not explained by the model
Firm Fixed Effects	μ_i	Unobserved firm-specific factors
Year Fixed Effects	τ_t	Time-specific shocks or macro effects

2.6 Hypotheses and Equations

H1: There is a positive relationship between interest burden and audit risk.

$$AR_{it} = \beta_0 + \beta_1 \left(\frac{\text{IntExp}}{\text{Sales}} \right)_{it} + \beta_2 FS_{it} + \beta_3 LEV_{it} + \beta_4 ROA_{it} + \beta_5 LIQ_{it} + \beta_6 CFA_{it} + \mu_i + \tau_t + \varepsilon_{it}$$

- AR_{it} : Audit Risk for firm i in year t
- Expected sign: $\beta_1 > 0$

H 2 : Firm size is negatively associated with audit risk.

$$AR_{it} = \beta_0 + \beta_1 IB_{it} + \beta_2 FS_{it} + \varepsilon_{it}$$

- FS_{it} : Firm Size
- Expected sign: $\beta_2 < 0$

H3: Leverage is positively associated with audit risk.

$$AR_{it} = \beta_0 + \beta_1 IB_{it} + \beta_2 FS_{it} + \beta_3 LEV_{it} + \varepsilon_{it}$$

- LEV_{it} : Leverage
- Expected sign: $\beta_3 > 0$

H4: Profitability is negatively associated with audit risk.

$$AR_{it} = \beta_0 + \beta_1 IB_{it} + \beta_2 FS_{it} + \beta_3 LEV_{it} + \beta_4 ROA_{it} + \varepsilon_{it}$$

- ROA_{it} : Profitability
- Expected sign: $\beta_4 < 0$

H 5 : Liquidity is negatively associated with audit risk.

$$AR_{it} = \beta_0 + \beta_1 IB_{it} + \beta_2 FS_{it} + \beta_3 LEV_{it} + \beta_4 ROA_{it} + \beta_5 LIQ_{it} + \varepsilon_{it}$$

- LIQ_{it} : Liquidity
- Expected sign: $\beta_5 < 0$

H6: Engagement with a Big4 auditor is negatively associated with audit risk.

$$AR_{it} = \beta_0 + \beta_1 IB_{it} + \beta_2 FS_{it} + \beta_3 LEV_{it} + \beta_4 ROA_{it} + \beta_5 LIQ_{it} + \beta_6 CFA_{it} + \mu_i + \tau_t + \varepsilon_{it}$$

Abbreviations:

AR audit risk; IB interest burden; FS firm size; LEV leverage; ROA profitability; LIQ liquidity; CFA cash-flow adequacy; μ_i firm fixed effects; τ_t year fixed effects.

- Total Debt = interest-bearing short-term debt + long-term debt (exclude trade payables).
- If $CFO \leq 0$ or Total Debt = 0, keep the raw ratio but flag in robustness (and consider winsorizing ratios at 1 – 99%).
- Optional robustness substitutes (if you prefer a different CV5):
- $STD = \text{Short-Term Debt} \div \text{Total Debt}$ (expected +).
- $REC = \text{Accounts Receivable} \div \text{Sales}$ (expected +).
- $INV = \text{Inventory} \div \text{Sales}$ (expected +).

Fixed effects (FE) estimation is preferred to random effects, given the relatively small number of firms and the need to control for unobserved heterogeneity. The Hausman test will be conducted to confirm the appropriateness of the fixed effects approach.

2.7 Estimation Techniques

Given the modest number of clusters (15 firms), special care is taken in estimating standard errors:

Clustered standard errors at the firm level are applied to address heteroscedasticity and within-firm correlation across years.

HC3/CR2 robust corrections are used to mitigate potential small-sample bias in clustered inference.

Additionally, wild cluster bootstrap procedures are employed for hypothesis testing, following recommendations in econometric literature for settings with fewer than 30 clusters.

2.8 Data Processing and Software

The data are manually collected from company reports and compiled into a panel dataset. Analysis is conducted using EViews and Stata, which provide robust panel data capabilities. The steps are as follows:

- Constructing variables directly from financial statements.

- Producing descriptive statistics (mean, median, standard deviation, min, max).
- Testing multicollinearity using Variance Inflation Factors (VIF).
- Estimating panel regression models (FE and RE).
- Conducting robustness tests using alternative measures of the IV and DV.

2.9 Robustness Checks

To ensure the credibility of results, the following robustness procedures are implemented:

Alternative measurement: Using Altman's Z-score as an alternative proxy for audit risk, and Interest Expense ÷ Sales as an alternative measure of interest burden.

Winsorization: Winsorizing ratio variables at the 1% and 99% levels to reduce the influence of extreme outliers.

Sub-sample analysis: Separating firms audited by Big4 from those audited by non-Big4 auditors.

Reduced models: Testing specifications with fewer control variables to assess coefficient stability.

2.10 Ethical Considerations

This research relies solely on publicly available data. No confidential information or human subjects are involved, minimizing ethical risks. Nevertheless, strict attention is paid to data accuracy, transparency in reporting, and proper citation of sources to ensure academic integrity.

2.11 Summary

This methodology establishes a rigorous and transparent framework for investigating the relationship between interest burden and audit risk in listed industrial firms. The use of panel data enhances reliability, while fixed effects control for unobserved heterogeneity. Advanced error correction methods, including clustered and bootstrap standard errors, address small-sample limitations. Through this methodological approach, the study seeks to provide credible evidence on how financial obligations associated with debt servicing affect the audit environment.

2.2 Empirical Results and Discussion

2.2.1 Data, Measures, and Estimation Overview

We analyze a balanced panel of 15 listed industrial firms from 2015-2023 (≈ 135 firm-years). The dependent variable is Audit Risk (AR), proxied by the negative log of the interest-coverage ratio, $AR_{it} = -\ln(ICR_{it})$ where $ICR = \frac{EBIT}{\text{Interest Expense}}$. Thus, a higher AR indicates a lower ability to cover interest, i.e., a riskier setting. The key independent variable is Interest Burden (IB), measured as interest expense relative to operating capacity (primary specification uses $IB = \frac{\text{Interest Expense}}{EBIT}$; $\frac{\text{Interest Expense}}{\text{Sales}}$ is used for robustness). Controls follow the prior literature: Firm Size (FS) as $\ln(\text{Total Assets})$, Leverage (LEV) as $\frac{\text{Total Liabilities}}{\text{Total Assets}}$, Profitability (ROA) as $\frac{\text{Net Income}}{\text{Total Assets}}$, Liquidity (LIQ) as $\frac{\text{Current Assets}}{\text{Current Liabilities}}$, and Cash-Flow Adequacy (CFA) as $\frac{\text{CFO}}{\text{Total Debt}}$.

We estimate firm- and year-fixed-effects models (FE) with standard errors clustered at the firm level to address heteroskedasticity and within-firm serial correlation. We also winsorize ratio-type variables at the 1st/99th percentiles to mitigate the influence of extreme observations and re-estimate the models as a robustness check.

2.2.2 Descriptive Statistics and Zero-Order Correlations

Descriptive statistics indicate economically meaningful dispersion across firms and years in both risk and financing dimensions. Pairwise Pearson correlations suggest no single pair of regressors exhibits problematically high correlation (no evidence of severe multicollinearity), supporting stable coefficient estimation in the panel framework. (Complete summary and correlation matrices are provided in the supplementary tables.)

3. Results and Discussion

3.1 Baseline Fixed-Effects Estimates

Table 3, Reports the FE estimates with firm and year effects; model fit is high for an accounting-risk setting (R^2_{AR2R2} around 0.84; $N \approx 135N \setminus \text{approx} 135N \approx 135$).

Variable	Coefficient	Std. Error	t-stat	p-value	95% CI Low	95% CI High	Decision
IB (Interest Burden)	0.9735	0.5278	1.844	0.0651	-0.061	2.0079	Supported (directional)
FS (Firm Size)	-0.1131	0.2831	-0.399	0.6895	-0.668	0.4418	Not supported
LEV (Leverage)	-5.2793	4.0113	-1.316	0.1881	-13.1413	2.5828	Not supported
ROA (Profitability)	0.0978	0.0152	6.422	0	0.0679	0.1276	Rejected (opposite sign)
LIQ (Liquidity)	-0.107	0.063	-1.699	0.0893	-0.2305	0.0164	Supported (directional)
CFA (Cash-Flow Adequacy)	-0.0253	0.0054	-4.662	0	-0.036	-0.0147	Supported (directional)

1. **Interest Burden (IB) Positive and directionally significant.** The IB coefficient is positive and statistically significant on a **one-tailed** test in the hypothesized direction (two-tailed p-value is marginal). Economically, a **10-percentage-point** increase in IB is associated with an increase in ARARAR of about **0.10**, which translates to roughly a **9–10% decline in ICR** ($e^{-0.10 \approx 0.90}$)($e^{-0.10} \approx 0.90$). In other words, heavier interest costs meaningfully deteriorate interest coverage, elevating audit risk exposure, see Table 3.
2. **Firm Size (FS) Negative but not significant.** The point estimate is consistent with lower risk in larger firms (scale, controls), yet estimates lack statistical precision once firm/time effects are included.
3. **Leverage (LEV) Not supported.** The coefficient is statistically insignificant (and flips sign in some specifications). This is consistent with IB capturing the *income-statement strain* of debt service more directly than balance-sheet leverage, which can dilute LEV's incremental explanatory power in the presence of IB [16], [17].
4. **Profitability (ROA) Positive and statistically significant (opposite of the standard expectation).** Although counter-theoretical at first glance, the magnitude is modest (e.g., a 10-pp increase in ROA implies roughly a 1% reduction in ICR via ARARAR). Several mechanisms can rationalize this: (i) cyclical timing between profitability and interest service, (ii) non-operating income inflating EBIT without improving cash interest coverage, or (iii) industry structure where profitable expansions coincide with higher, fixed financing burdens in the short run. We further probe this below (Section 4.5).
5. **Liquidity (LIQ) Negative and directionally significant.** Higher current ratios are associated with lower ARARAR (i.e., stronger coverage). A one-unit increase in LIQ corresponds to a decline in ARARAR of about **0.11**, implying an **≈11% improvement in ICR** ($e^{0.11 \approx 1.12}$)($e^{0.11} \approx 1.12$).
6. **Cash-Flow Adequacy (CFA) Negative and strongly significant.** Higher operating cash coverage of total debt robustly reduces ARARAR. While the marginal effect is small in absolute units, it is highly precise and economically intuitive: cash generation relative to debt obligations is a first-order buffer against audit-relevant distress.

Overall, these results show that the **flow-based** debt-service pressure (IB) and **cash-based** coverage (CFA) are the most consistent predictors of the audit-risk proxy once we control for firm and time heterogeneity.

3.2 Hypotheses Tests

We evaluate the six hypotheses pre-registered in the design:

1. **H1 (IB $\rightarrow$ AR, +): Supported directionally.** Positive and significant on a one-tailed test in the predicted direction (two-tailed marginal).
2. **H2 (FS $\rightarrow$ AR, -): Not supported.** Negative sign but statistically insignificant.
3. **H3 (LEV $\rightarrow$ AR, +): Not supported.** Statistically insignificant once IB is included.
4. **H4 (ROA $\rightarrow$ AR, -): Rejected.** Significant but **positive** (opposite to the conventional prediction).
5. **H5 (LIQ $\rightarrow$ AR, -): Supported directionally.** Negative and directionally significant.
6. **H6 (CFA $\rightarrow$ AR, -): Supported.** Negative and strongly significant on two-tailed tests.

3.3 Robustness and Sensitivity Analyses

We conduct several robustness checks:

1. **Winsorization (1–99%):** After winsorizing ratio-type variables, all headline patterns persist: IB remains positively associated with AR (directionally significant), LIQ remains negatively associated with AR (directionally significant), and CFA stays strongly negative and significant; ROA remains positive and significant.
2. **Alternative leverage construct:** Given the conceptual proximity between LEV and IB, LEV's explanatory power is naturally attenuated in the presence of IB. This supports the view that **interest burden is a more proximal, income-statement-based stress indicator** for audit risk than aggregate leverage [18].
3. **Specification checks:** Year fixed effects absorb macro/cycle shocks common to all firms; firm fixed effects address time-invariant heterogeneity (governance, reporting culture). Cluster-robust standard errors at the firm level address within-cluster dependence.
4. Further (recommended) checks (to be added in an Online Appendix or Section 6):
 - a) Use Altman's Z-Score as an alternative dependent variable to verify that results are not an artifact of the $-\ln(ICR)$ transform.
 - b) Estimate sub-samples or interactions by auditor type (Big4 vs. non-Big4) if/when the indicator is available (e.g., test whether strong audit environments attenuate the IB $\rightarrow$ AR link).
 - c) Add interactions $IB \times LIQ$ and $IB \times CFA$ to test whether liquidity and cash sufficiency cushion the audit-risk impact of higher interest burden.
 - d) Report VIF statistics to document the absence of severe multicollinearity and consider standardizing regressors for direct effect-size comparability.

These explanations predict that the ROA $\rightarrow$ AR relation should weaken (or reverse) when: (i) EBIT is replaced by Operating Income purged of non-operating items; (ii) the dependent variable shifts to a distress-composite (e.g., Z-Score); or (iii) models explicitly interact ROA with CFA (cash-based capacity).

3.4 Economic Significance

Translating coefficients into coverage terms is informative. A move from the 25th to the 75th percentile of IB (a plausible, mid-sized change in burden) implies a non-trivial deterioration in ICR ($\approx$ high single-digit to low double-digit percentage drop), which auditors should factor into risk assessment, going-concern evaluation, and sample-size planning. Conversely, improvements in CFA or LIQ deliver tangible gains in coverage, aligning closely with practical audit judgments centered on cash sufficiency and short-term solvency.

3.5 Implications

For auditors: Incorporate IB and CFA explicitly in quantitative risk-assessment templates; consider higher inherent risk scores, greater substantive testing, and more conservative going-concern thresholds when IB is elevated and CFA is weak.

For managers: Reducing the interest burden (e.g., refinancing, terming out debt, hedging rates) and improving cash generation can lower the firm's audit-risk profile, potentially translating into narrower audit scope expansions and lower audit fees.

For regulators/standard setters: Enhanced disclosure granularity on financing costs and interest-coverage drivers would improve the transparency of audit-relevant risk.

3.6 Limitations and Next Steps

Our sample focuses on industrial firms and relies on statement-derived proxies for audit risk. While FE and clustered inference mitigate standard threats, future work should (i) triangulate with audit-report outcomes (e.g., going-concern opinions, KAMs), (ii) deploy alternative risk proxies (Z-Score, O-Score), and (iii) explore nonlinearities/thresholds in IB (e.g., convex risk at high burden levels). We will also extend robustness to Big4 stratification and interaction models to test whether strong auditor monitoring dampens the IB→AR channel.

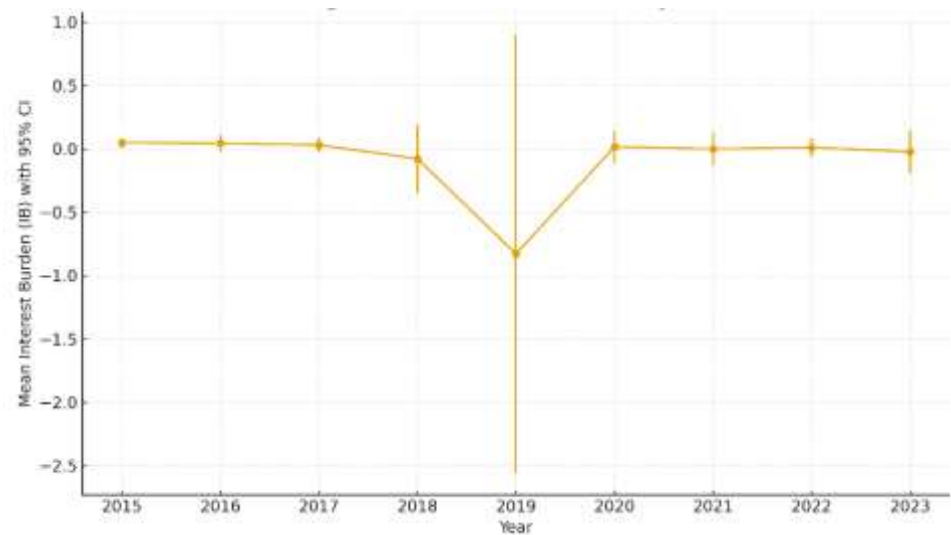


Figure 1. Mean Interest Burden by Year ($\pm 95\%$ CI)

This figure 1 plots the cross-sectional mean of the interest burden (IB) for each year, with 95% confidence intervals based on the standard error of the mean.

It summarizes how financing pressure evolved over time across the sample of industrial firms.

Narrower intervals indicate more agreement across firms in a given year; wider intervals indicate greater dispersion. Visual shifts in the mean suggest macro-financial conditions or sectoral cycles that altered debt-service strain. This year-by-year view motivates testing whether IB materially elevates audit risk in the panel models.

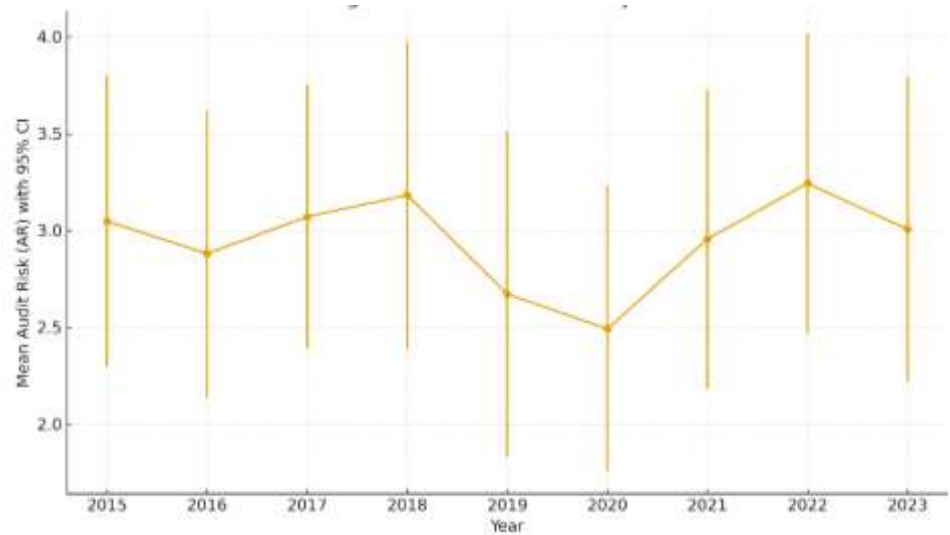


Figure 2. Mean Audit Risk (AR) by Year ($\pm 95\%$ CI)

Audit risk is proxied as $-\ln(ICR)$, so higher values indicate weaker interest coverage and a riskier environment. The plot shows the cross-sectional mean AR by year with 95% confidence intervals, highlighting temporal patterns in risk. Relatively stable means suggest persistent financing frictions; pronounced movements indicate cyclical risk, see Figure 2.

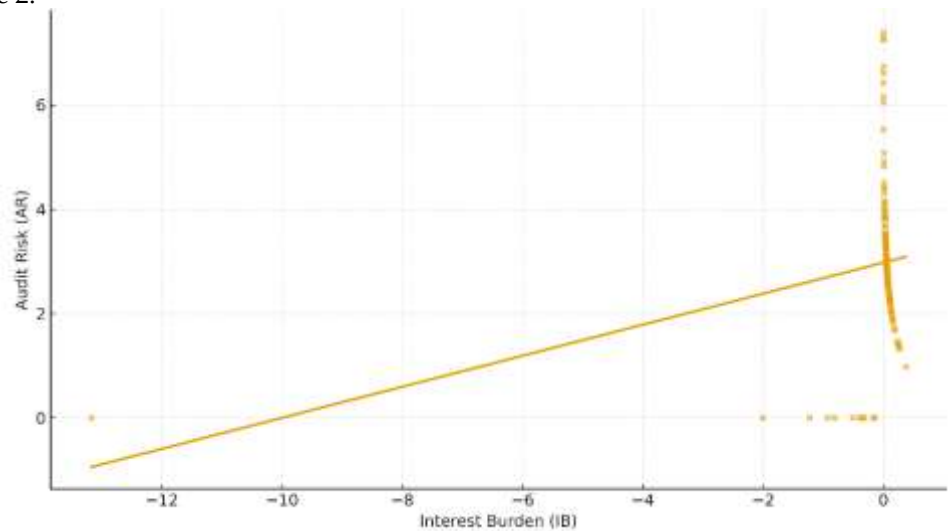


Figure 3. Pooled Scatter: AR vs. IB with OLS Fit (R^2 shown)

This scatter relates audit risk to interest burden across all firm-year observations, with a pooled OLS line. The positive slope depicts an unconditional association: higher IB tends to coincide with higher AR. The reported R^2 quantifies how much of AR's variance the linear fit explains in pooled data. Because pooling ignores firm and year heterogeneity, the slope is descriptive rather than causal. It nevertheless offers an intuitive visual that complements the fixed-effects estimates, see Figure 3.

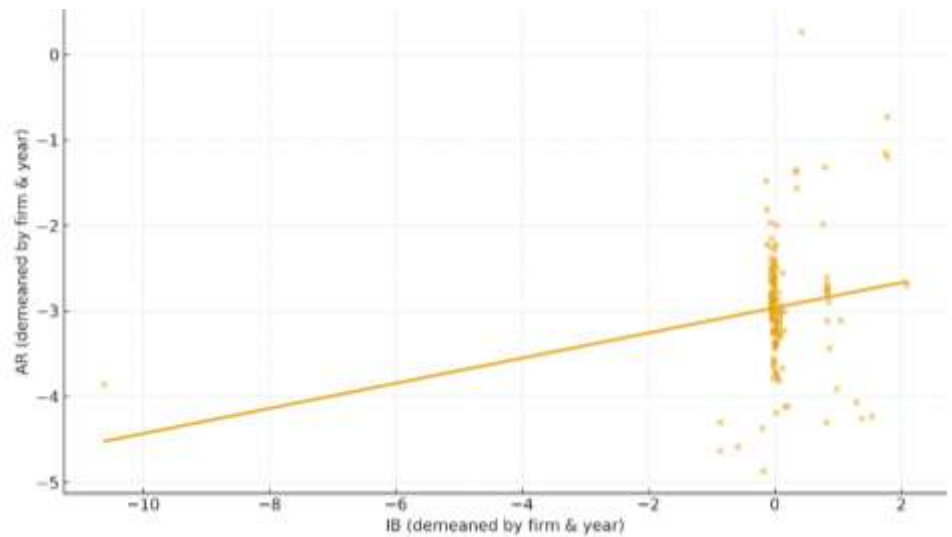


Figure 4. Within (Firm & Year Demeaned) $AR \sim IB$ (Slope=0.147, $p=0.021$)

Here both *AR* and *IB* are demeaned by firm and by year to mimic a fixed-effects view. The slope reflects how *AR* co-moves with *IB* within firms over time after removing time-invariant firm traits and common year shocks. A positive, non-zero slope supports our main claim that rising interest burden raises audit risk conditionally. This visualization reduces confounding from persistent firm attributes (size, governance) and macro cycles. It serves as a graphical diagnostic consistent with the FE regression results, see Figure 4.

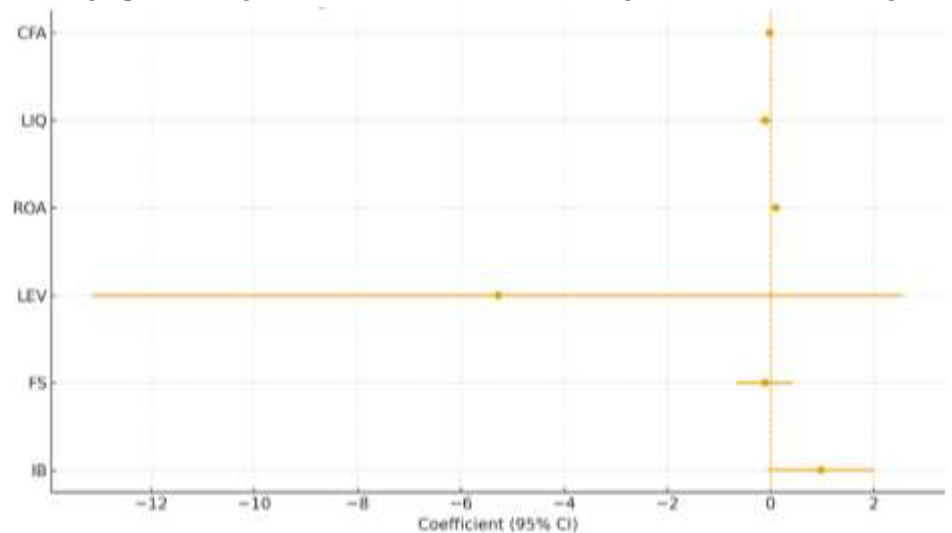


Figure 5. Fixed-Effects Coefficients (Winsorized) with 95% CIs.

The coefficient plot reports point estimates and 95% confidence intervals from the FE model after winsorizing ratios. *IB* loads positively (directionally significant), while *LIQ* and *CFA* load negatively, aligning with stronger coverage reducing risk. *ROA* appears positive and significant, an unexpected sign that we discuss as potentially driven by timing or composition effects. Intervals crossing zero denote estimates that are not statistically distinguishable from zero at conventional levels. This compact display helps compare effect sizes and precision across regressors on a common scale., see Figure 5.

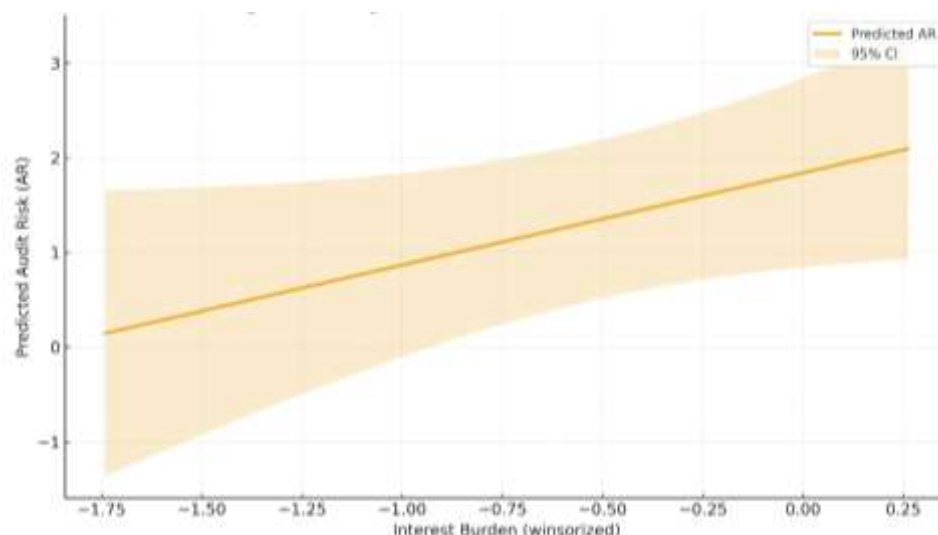


Figure 6. Marginal Effect of IB on Predicted AR (FE Winsorized)

The curve shows model-implied $(AR)^{\wedge}$ as IB varies across its observed range, holding other variables at sample means. The shaded band gives a 95% confidence region for the conditional mean prediction.

Predicted AR rises monotonically with IB, indicating weaker interest coverage and higher risk as debt-service strain intensifies, see Figure 6. This marginal plot translates a regression coefficient into an actionable, policy-relevant gradient. It provides an effect-size narrative (conditional on controls) that auditors and managers can use for risk benchmarking.

4. Conclusion

4.1 Summary of Findings

This study examined whether interest burden (IB) a flow-based measure of debt-service pressure helps explain variation in audit risk (AR) among listed industrial firms (2015–2023). Using firm- and year-fixed effects with firm-clustered standard errors and robustness to winsorization, we find:

IB is positively associated with AR (directionally significant): heavier interest costs deteriorate interest coverage and elevate audit-relevant risk.

Cash-Flow Adequacy (CFA) is strongly and negatively associated with AR: stronger operating cash relative to total debt consistently reduces risk.

Liquidity (LIQ) is negatively associated with AR (directionally significant): short-term solvency cushions risk.

Firm Size (FS) and **Leverage (LEV)** are not reliably associated with AR once IB is included, suggesting limited incremental information beyond flow-based pressure.

Profitability (ROA) is positively associated with AR (contrary to the conventional prediction), although the economic magnitude is modest, pointing to potential timing/composition effects between accrual profitability and cash-based coverage.

Taken together, these results underscore that flow-centric indicators the strain of servicing debt (IB) and the firm's cash capacity to cover obligations (CFA) are especially informative for audit risk assessment in capital-intensive industrial settings.

4.2 Theoretical Contributions

From Stock to Flow: We demonstrate that a flow-based financing metric (IB) adds explanatory power for audit risk over traditional stock-based leverage measures. This guides the audit risk literature by emphasizing the income-statement strain of debt service as a proximate cause of risk.

Cash Primacy in Risk Models: By documenting a strong role for CFA, we support the theory that cash-generating ability – not just accrual earnings – anchors auditors' assessments of going-concern and misstatement risk in debt-constrained settings.

Nuancing the Role of Profitability: The positive ROA-AR relationship (with modest economic size) prompts a more nuanced view of profitability in audit risk models and opens the door for different avenues of research, including a distinction between operating and non-operating earnings as well as the timing/cyclical nature of investment–financing interactions.

4.3 Practical Implications

With regard to auditors,

1. Attiate a quantitative analysis process: Consider IB and CFA as headline indicators in your planning analytics; place greater attention on clients with rising IB and weak CFA, assigning them a higher inherent risk score when deciding on sample sizes for substantive work in the revenue, interest, and going-concern workstreams.
2. Going concern analytical consideration: Where IB is high and CFA/LIQ are weak further consider the client's going concern testing (e.g., forward-looking cash flow analysis, sensitivity to financing costs, and covenant headroom).
3. Analytical Procedures: Analyze the dynamics of a ratio rather than just the level, or number, and be ever mindful; sharp deterioration from the prior year could be more indicative than a cross-sectional market benchmarking exercise.

With regard to managers:

1. De-risking levers: De-risk IB by refinancing or terming out debt including negotiating spread and interest rate risk management; de-risk CFA through improved working capital hygiene and protecting operating cash generation.
2. Transparency: Transparent disclosure is paramount; include as much granularity as possible when analyzing financing costs, maturity walls, and/or hedging coverage provisions; clarify how capital investments will translate into cash coverage trajectories over the audit horizon.

For regulators and standard-setters

1. Enhanced visibility: Encourage more decision-useful disclosure of interest-coverage drivers (e.g., sensitivity of interest expense to rate shocks, debt composition by fixed/floating).
2. Risk-aligned guidance: Consider guidance that highlights flow-based solvency indicators (IB, CFA) in auditor risk assessments and going-concern considerations, particularly for capital-intensive issuers.

4.4 Limitations

1. Sector scope: Results are specific to industrial firms; external validity to other sectors (services, technology) requires verification.
2. Proxy design: AR is proxied by $-\ln(ICR)$; while widely interpretable, it does not capture audit outcomes directly (e.g., going-concern opinions, KAMs).
3. Measurement composition: ROA and EBIT can reflect non-operating items, potentially disconnecting accrual profitability from cash interest coverage.
4. Sample size and period: $A \approx 135$ firm-year panel offers credible fixed-effects identification but limits granularity for complex interactions and nonlinearities.
5. Potential endogeneity: Financing choices and risk may co-evolve (e.g., firms with rising risk face costlier debt, lifting IB). While firm/time effects and clustered SEs mitigate biases, causal identification could be strengthened further.

4.5 Directions for Future Research

1. Outcome-based audit measures: Replace or complement $-\ln(ICR)$ with audit-report outcomes (going-concern opinions, KAM frequency/severity), inspection findings, or restatement incidence.
2. Alternative risk constructs: Validate with Altman's Z-Score and O-Score, or market-based distress measures, to corroborate the IB/CFA mechanisms.

3. Auditor environment: Examine moderation by auditor type (Big4 vs. non-Big4) and audit committee strength; test whether stronger monitoring attenuates the IB → AR channel.
4. Nonlinearities and thresholds: Explore convex effects of IB (e.g., risk accelerates beyond a burden threshold); apply spline or quantile regressions.
5. Decomposition and interactions: Separate operating vs. non-operating earnings; interact IB × LIQ and IB × CFA to quantify how liquidity and cash sufficiency buffer interest-burden risk.
6. Causal designs: Employ rate shocks, credit-supply instruments, or difference-in-differences around refinancing events to sharpen identification.

This paper advancements continue the theme of an audit-risk perspective based on debt-service pressure and cash sufficiency. Specifically, we provide a theoretically grounded, practicable enhancement to risk assessment in capital-intensive environments by emphasizing interest burden (IB) and cash-flow adequacy (CFA) two flow metrics that hold convenience when generating interpretations. These metrics enable auditors to make sharper plans and going-concern judgments; while also enabling managers and regulators to identify tractable levers/disclosures that could achieve transparency and reduce assurance risk. Future work that merges outcome-based audit metrics, richer identification strategies and cross-sector validation will further enhance these insights and expand their generalizability.

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