Lean Means Less: Operational Leanness and Audit Fees in U.S. Firms

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Abstract

Purpose: This study examines whether and how operational leanness affects audit fees. We propose that lean operations, characterized by reduced inventories, streamlined workflows, and stronger control systems, lower both audit risk and transaction complexity, thereby reducing auditors' expected effort and engagement risk, and consequently, audit fees.

Design/Methodology/Approach: Using a large panel of 58,279 U.S. firm-year observations from 2001 to 2024, we investigate the association between operational leanness and audit fees. We operationalize leanness using deviations in inventory levels relative to industry norms and audit pricing using audit fees scaled by sales and their logarithmic values. We also employ mediation analyses, alternative measures, and instrumental variable approaches to address potential endogeneity concerns and uncover underlying mechanisms.

Findings: We document a robust negative association between operational leanness and audit fees. Mediation analyses reveal that this relationship unfolds through two main channels: (1) reduced audit effort, proxied by shorter audit lags, and (2) fewer inventory-related internal control weaknesses. The negative association between operational leanness and audit fees is stronger for firms audited by industry specialists, those with high-quality information environments, more complex firms, and those led by female CEOs.

Practical Implications: Our findings suggest that lean operations function as a credible signal of lower audit risk. This has implications for auditors, who can more efficiently tailor their procedures, for managers, who can reduce audit costs through operational discipline, and for policymakers concerned with the efficiency and affordability of assurance services.

Originality/Value: This study provides the first large-sample evidence that operational leanness is an important determinant of audit fees. By integrating the audit risk model, transaction cost economics, and signaling theory, we bridge the auditing, corporate governance, and operations management literatures and reconceptualize operational efficiency as a strategic attribute with direct implications for audit pricing.

Keywords: Audit fees, audit risk, audit effort, material control weaknesses, inventory, operational leanness.

JEL classification: G31; M41; M42.

1 Introduction

Audit fees are on the rise. Between 2018 and 2023, average audit fees on the London Stock Exchange's main market jumped by 74% from £733,000 to £1.28 million.[1] Similarly, the average audit fees paid by S&P 500 firms has increased 170% from $4 million in 2003 to $10.8 million in 2022.[2] In a competitive audit market, pricing is determined by the expected audit effort required and the engagement risk borne by auditors in assuring clients' financial statements (Simunic, 1980). Both audit effort and engagement risk are shaped, at least in part, by firm-specific idiosyncratic factors. Indeed, prior research highlights financial complexity, governance structures, ESG performance (Hartlieb and Eierle, 2024), firm value (Pratt and Stice, 1994), and the quality of internal controls (Hay et al., 2006; Ge et al., 2017; Ghafran and O'Sullivan, 2017) as critical determinants of audit pricing. Despite these advances, the role of operational characteristics—particularly inventory management, process discipline, and supply chain efficiency—remains relatively underexplored in the audit pricing literature. This omission is notable given that operational processes directly affect transaction volume, internal control strength, and the scope of substantive audit procedures, all of which are central to auditors' assessment of effort and risk. We contribute to this literature by examining operational leanness as a potential strategic attribute that may influence auditors' risk assessment and audit scope (Fullerton et al., 2013; Kennedy and Widener, 2008).

Operational leanness captures a firm's ability to minimize waste, reduce unnecessary complexity, and streamline operations while maintaining or enhancing productivity and quality (Eroglu and Hofer, 2011; Neukirchen et al., 2024; Bendig et al., 2017; Shah and Ward, 2003). Lean firms are characterized by lower inventory levels, shorter production cycles, simplified workflows, reduced process redundancies, and stronger control systems, which together minimize inefficiencies and transaction frictions (Kristensen and Israelsen, 2014; van der Steen and Tillema, 2018). Our starting point is the proposition that

[1] "Audit fees for UK-listed companies up 75% since 2018, study finds", Financial Times, 26 February 2024

[2] "Audit fee trends of S&P 500", Ideagen, 14 August 2023

operationally lean firms may pay lower audit fees because their streamlined operations reduce both audit effort and engagement risk. To develop this argument, we draw on three complementary theoretical perspectives: the audit risk model, transaction cost economics, and signaling theory.

First, the audit risk model posits that audit pricing reflects the auditor's need to obtain sufficient assurance by tailoring the nature, timing, and extent of procedures to a client's risk profile (Simunic, 1980). Firms with simplified workflows, reduced inventories, and robust internal controls are expected to exhibit lower inherent and control risk. This risk reduction allows auditors to narrow the audit scope and perform fewer substantive and control tests, resulting in lower expected effort and, consequently, lower audit fees (Ge et al., 2017; Hogan and Wilkins, 2008). Second, drawing on transaction cost economics, we argue that lean operations reduce the volume and complexity of verifiable transactions, thereby directly affecting the audit production function (Williamson, 1981). Lower transaction complexity simplifies audit evidence collection, reduces sampling requirements, and lowers monitoring costs, enabling auditors to deliver assurance more efficiently. Finally, signaling theory provides an external validation channel for the audit pricing effect. Lean practices—such as tight inventory control, waste elimination, and process discipline—are observable signals of managerial discipline, competence, and robust internal controls (Balsam et al., 2003; Armstrong et al., 2025). Auditors may interpret these signals as credible indicators of lower misstatement risk, thereby adjusting their pricing decisions to reflect the reduced engagement risk. Together, these perspectives suggest that operational leanness functions as both a risk-reducing attribute and a credible signal that auditors incorporate into their pricing models, ultimately leading to lower audit fees.

Despite these compelling theoretical arguments, prior empirical research has not systematically examined whether operational leanness leads to lower audit fees, nor has it explored the mechanisms underlying this potential relationship. We address this research gap by empirically operationalizing the leanness—audit fee nexus using a comprehensive panel dataset of publicly listed U.S. firms covering close to 60,000 firm-year observations

between 2001 and 2024. Following prior studies exploring operational leanness in other contexts, we operationalize leanness by measuring deviations in inventory levels relative to industry norms (Eroglu and Hofer, 2011; Dah et al., 2014; Neukirchen et al., 2024; Bendig et al., 2017), and audit pricing using the natural log of audit fees and the ratio of audit fees to total sales (Hartlieb and Eierle, 2024). Our baseline model controls for other firm-, auditor-, and industry-specific determinants of audit fees, as well as industry- and year-fixed effects. We cluster standard errors at the firm level to account for within-firm correlation in error terms over time. Our baseline results reveal a robust negative association between operational leanness and audit fees, indicating that leaner firms benefit from lower external audit costs. These results are robust to endogeneity concerns addressed through propensity score matching and two-stage least squares approaches. The results remain consistent when we use alternative measures of operational leanness and audit fees.

Having established a robust baseline, we conduct several tests to verify the channels through which operational leanness reduces audit fees. Consistent with our theoretical argument, we first explore whether lean reduces audit fees by reducing audit effort, proxied by a shorter audit lag—the number of days between the end of the company's fiscal year and the date the auditor signs and issues the audit report. We find strong evidence that audit effort (audit lag) mediates the lean—audit fee nexus. Specifically, Lean operations reduce audit effort, thereby reducing audit fees. Second, we explore whether lean attracts lower audit fees by reducing material internal control weaknesses related to inventory.[3] Our evidence suggests that operational leanness is associated with fewer material internal control weaknesses related to inventory, which reduces auditors' engagement risk and, in turn, contributes to lower audit fees.

Finally, we examine the boundary conditions of the relationship between operational leanness and audit fees. First, the negative association between leanness and audit fees is more pronounced in firms audited by industry specialists, because specialists are better

[3]Material internal control weaknesses related to inventory refer to significant deficiencies in a company's internal controls that create a reasonable possibility of a material misstatement in inventory-related accounts that would not be prevented or detected on a timely basis.

able to recognize the efficiency and control improvements associated with lean operations. Second, a strong information environment—measured by higher earnings quality, the absence of restatements, and greater analyst following—enhances the signaling value of lean practices, thereby reducing audit fees, as auditors can rely more on transparent and reliable information. Third, the audit fee discount is larger in more complex firms, which generally face higher audit risk, because lean practices in these firms meaningfully reduce the effort and risk required by auditors. Fourth, the effect of leanness on audit fees is stronger in firms with female CEOs, likely reflecting the association between female leadership and more disciplined, structured operational practices. Finally, the relationship is particularly salient in manufacturing firms (as opposed to service firms), where effective inventory management is critical to operational performance.

This study makes three interrelated theoretical contributions by integrating the audit risk model, transaction cost economics, and signaling theory. First, our paper expands the audit risk model and advances the audit pricing literature (Hay et al., 2006; Ferguson et al., 2003; Gul et al., 2009; Choi et al., 2008; Yuan et al., 2025) by showing that operational leanness systematically reduces inherent and control risk, thereby narrowing the nature, timing, and extent of audit procedures. Second, our work extends transaction cost economics into the audit context by showing that, by reducing transaction volume and complexity, lean operations effectively reshape the audit production function, lowering the cost of producing assurance. Third, the paper refines signaling theory by positioning operational leanness as a credible, externally observable signal of managerial discipline and robust controls, and by identifying contingencies—such as auditor specialization, information transparency, firm complexity, and leadership characteristics—that amplify or attenuate this signal. To our knowledge, ours is the first large-sample evidence that operational leanness is a determinant of audit fees. By bridging the operations management, corporate governance, and auditing literatures, the paper reconceptualizes operational efficiency as a strategic attribute with direct implications for audit pricing and practice.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature and outlines the development of our hypothesis. Section 3 describes the

data sources, variable construction, and empirical strategy. Section 4 presents the main findings, including robustness checks and additional analyses. Finally, Section 5 offers concluding remarks and discusses the implications of our results.

2 Background literature, theory and hypothesis

2.1 Prior research on the determinants of audit fees

Audit fees are commonly understood to depend on auditor effort and engagement risk (Simunic, 1980). Building on this framework, prior research has identified a wide range of determinants of audit pricing, which can be broadly grouped into client-specific characteristics (Hay et al., 2006), auditor attributes (Ferguson et al., 2003; Gul et al., 2009; Xue and O'Sullivan, 2023), and contextual or market-level factors (Choi et al., 2008; Yuan et al., 2025).

Among client-specific factors, firm size and financial complexity emerge as the most robust predictors of audit fees (Hay et al., 2006). Larger firms with diversified operations, complex organizational structures, and sophisticated financial arrangements require broader audit scopes and face greater exposure to material misstatement, resulting in higher audit effort and fees. Similarly, weaknesses in internal control systems significantly increase audit fees because auditors respond by expanding substantive testing and lowering detection risk (Ge et al., 2017; Hogan and Wilkins, 2008; Xue and O'Sullivan, 2023). The introduction of SOX Section 404 strengthened this relationship by mandating auditor assessments of internal control effectiveness, thereby institutionalizing the pricing link between control quality and audit fees (Ge et al., 2017; Hogan and Wilkins, 2008).

Audit fees also embed premiums for litigation exposure and agency risk. Firms operating in more litigious environments or engaging in aggressive accounting practices face higher audit fees that compensate auditors for elevated engagement risk (Choi et al., 2008). Governance structures further shape pricing, although the direction of the effect is not uniform. On the one hand, strong governance mechanisms such as effective audit committees and independent boards can reduce agency risk and lower audit fees.

On the other hand, some studies show that stronger governance may increase fees when it demands more extensive audit procedures and higher assurance quality (Ghafran and O'Sullivan, 2017; Yuan et al., 2025). This mixed evidence suggests that governance affects audit fees through both risk reduction and demand for audit effort.

On the supply side, auditor characteristics play a central role in fee determination. Industry specialists typically command fee premiums that reflect superior expertise and tailored audit approaches (Ferguson et al., 2003). Auditor tenure can either reduce fees through learning and efficiency gains or increase them when independence concerns dominate (Gul et al., 2009). More recently, Beck et al. (2025) show that auditors with experience auditing high-risk clients can charge lower fees, consistent with improved risk assessment and engagement planning efficiency. Emerging work has also begun to incorporate behavioral and incentive-based factors into audit pricing models. For example, stock-based compensation to rank-and-file employees is associated with higher audit fees due to increased reporting complexity and earnings management risk (Chen et al., 2025).

Despite these advances, research on how firm operations shape audit fees remains surprisingly limited. Existing studies focus primarily on financial complexity, governance structures, and incentive arrangements, while treating operations largely as a background condition. Related evidence indicates that factors increasing operational risk, such as inventory-related weaknesses or process inefficiencies, are positively associated with audit fees. However, the literature has paid little attention to whether and how operational design choices that reduce complexity, such as lean processes, translate into lower audit effort and fees. This omission is notable given that operational processes directly influence transaction volume, control reliability, and the scope of substantive testing, all of which are central to auditors' pricing decisions.

2.2 Background literature on lean

Lean management, originating in the Toyota Production System, is a strategic operating philosophy centered on the systematic elimination of waste, process standardization, and inventory minimization to improve flow and value creation (Womack et al., 1990,

2007). Although initially developed in manufacturing settings, lean has evolved into a broader managerial approach emphasizing continuous improvement, cross-functional coordination, and disciplined, data-driven decision making (Eroglu and Hofer, 2011; Fullerton et al., 2013). Firms that adopt lean practices typically operate with lower inventory buffers, simplified workflows, and tighter coordination across functions, resulting in greater cost efficiency, improved adaptability, and more predictable operations (Kennedy and Widener, 2008; Bendig et al., 2017). Importantly, these features also strengthen internal control environments by reducing transaction complexity and enhancing process visibility, with potential implications for how external parties assess firm risk.

A central insight from the management accounting and control literature is that lean transformations fundamentally reshape internal control and performance measurement systems. Rather than relying on complex, variance-based accounting and ex post monitoring, lean organizations emphasize simplified reporting structures, real-time operational metrics, and decentralized problem solving (Fullerton et al., 2013). These systems combine output, behavioral, and social controls to discipline behavior while maintaining flexibility (Kristensen and Israelsen, 2014). Although traditional accounting frameworks often conflict with lean's flow-oriented logic, adaptations such as lean accounting, visual management, and standardized work procedures reduce information asymmetry within the organization and increase transparency across operational processes (Kennedy and Widener, 2008; van der Steen and Tillema, 2018). As a result, lean firms tend to exhibit more legible and auditable operational environments.

The scope of lean has expanded beyond manufacturing into entrepreneurial, innovation, and service contexts. The Lean Startup approach applies similar principles of experimentation, rapid feedback, and iterative learning to environments characterized by high uncertainty (McGrath, 2024; Blank and Eckhardt, 2024; Becker and Endenich, 2023). Evidence from small firms and crisis settings, including the COVID-19 pandemic, suggests that lean practices can enhance organizational resilience when supported by effective information systems and coordination mechanisms (Lefebvre, 2024; Kinder and Burgoyne, 2013). These findings underscore that leanness is not merely about cost-

cutting, but about designing operating systems that are robust to shocks and capable of maintaining control under stress.

Recent research further positions lean as a complement to digital transformation and advanced monitoring technologies. Lean's emphasis on standardized processes and continuous improvement facilitates the adoption of Industry 4.0 technologies by reducing process noise and increasing data reliability (Nakandala et al., 2024). In parallel, emerging work conceptualizes lean as a governance-relevant attribute rather than a purely operational choice. For example, Neukirchen et al. (2024) show that institutional investors reward lean operations, particularly in settings with weaker formal governance, interpreting leanness as a signal of reduced agency costs and stronger internal controls.

Taken together, prior research portrays operational leanness as more than an efficiency-enhancing practice. It functions as an organizational design choice that simplifies transactions, reinforces internal control systems, and increases operational transparency. Yet, the role of lean operations in external assurance markets remains largely unexplored. If leanness reduces operational complexity and provides credible evidence of disciplined control environments, it should shape auditors' assessments of engagement risk and required audit effort, with direct implications for audit pricing. This study addresses this gap by examining whether operational leanness affects audit fees and by identifying the mechanisms and boundary conditions through which this relationship operates.

2.3 Theory and hypothesis

Operational leanness has implications that extend beyond internal efficiency. We argue that leanness shapes audit pricing through three theoretically distinct but complementary channels: audit risk assessment, the cost of producing assurance, and information transmission under asymmetric information. To capture these channels, we integrate the Audit Risk Model, Transaction Cost Economics, and Signaling Theory. Together, these frameworks provide an integrated explanation of how operational leanness reduces audit fees by reducing assessed audit risk, economizing on audit production costs, and credibly signaling managerial discipline and control quality.

2.3.1 Audit Risk Model and operational sources of audit risk

The Audit Risk Model (Simunic, 1980) has been the dominant framework for explaining audit pricing for over four decades. It conceptualizes audit fees as reflecting the auditor's assessment of engagement risk and the effort required to obtain sufficient assurance, decomposing audit risk into inherent risk, control risk, and detection risk. In Simunic's seminal model, audit services are treated as an economic good supplied by risk-neutral auditors who price engagements to cover expected audit effort and expected loss exposure from litigation (Simunic, 1980). Audit fees, therefore, increase with client size, business complexity, and exposure to misstatement and loss.

While this framework has been foundational, its empirical implementation has largely focused on financial complexity, governance arrangements, and regulatory compliance as determinants of audit risk (Hogan and Wilkins, 2008; Ge et al., 2017). Simunic's original analysis does not explicitly consider how operational characteristics such as process discipline, inventory systems, or production workflows affect the components of audit risk. Subsequent audit pricing research has followed a similar path, emphasizing observable financial and governance proxies while largely ignoring the firm's operational design (Yuan et al., 2025).

A substantial literature confirms that auditors price audit risk. For example, Hogan and Wilkins (2008) show that internal control deficiencies identified under SOX 404 are associated with materially higher audit fees, reflecting increased control risk and expanded substantive testing. Similarly, Ge et al. (2017) document that exemption from SOX 404(b) reduces audit fees but leads to pervasive misreporting and significant economic costs, underscoring the central role of internal controls in mitigating audit risk. These studies, however, examine failures in control environments after they arise, rather than whether superior operational systems reduce risk ex ante.

Direct links between operations and audit risk are rare but informative. Feng et al. (2015), for example, show that inventory-related material weaknesses impair operational efficiency and elevate audit risk. Firms with such weaknesses exhibit lower inventory turnover and more frequent impairments, while remediation improves performance and

cash flows. Their findings imply that operational inefficiencies increase inherent and control risk (Feng et al., 2015). Yet the literature has not examined the converse question of whether operational excellence, manifested through lean systems, systematically reduces audit risk and audit fees.

Auditor pricing of risk also depends on the institutional context and the auditors' capabilities. That is, auditors price not only client risk, but also their own ability to assess, interpret, and manage that risk. On the supply side, Ferguson et al. (2003) document fee premia for industry specialists, reflecting superior risk identification and the ability to tailor audit strategies to client characteristics. Although specialization may raise baseline fees, specialists are also better positioned to recognize credible reductions in operational risk and to align audit procedures more closely with actual exposure. Relatedly, Gul et al. (2009) show that auditor tenure can lower fees through learning and efficiency gains, provided independence concerns do not dominate. Consistent with this view, Beck et al. (2025) find that auditors with experience auditing distressed clients charge lower fees, reflecting improved risk management and execution efficiency.

On the demand side, institutional context and market scrutiny shape how risk is priced. Choi et al. (2008) demonstrate that legal liability regimes affect audit fees, implying that the pricing consequences of operational design depend on enforcement intensity and litigation exposure. Similarly, Yuan et al. (2025) document that shifts in investor scrutiny alter audit fees through heightened reporting incentives.

Yet the operational dimension of audit risk remains largely absent from this literature. This omission is notable because operational processes directly determine transaction volume, opportunities for error, and the reliability of internal controls, all central inputs to auditors' assessments of inherent and control risk. Recent operations and supply chain research shows that complex production and supply networks increase ambiguity and operational risk, whereas lean systems reduce variance through standardized workflows and minimal inventories (De Stefano and Montes-Sancho, 2024; Gualandris et al., 2024; Pankratz and Schiller, 2024). Lean organizations embed visual controls and simplify processes (Kennedy and Widener, 2008; Fullerton et al., 2013), allowing auditors to place

greater reliance on controls and reduce substantive testing (Ge et al., 2017). As a result, operational leanness narrows the nature, timing, and extent of audit procedures, lowering both assessed risk and required effort, the two core determinants of audit fees under the Audit Risk Model.

2.3.2 Transaction Cost Economics and the cost of producing assurance

While the Audit Risk Model explains audit pricing through risk-based adjustments in audit scope and effort, it does not fully capture how operational structures shape the economic cost of producing audit services. Transaction Cost Economics (TCE) (Williamson, 1975, 1979, 1981) offers a complementary perspective by treating transactions as the fundamental unit of analysis and governance structures as mechanisms for economizing on transaction costs. Williamson (1975) argues that hierarchical arrangements emerge in response to market failures arising from bounded rationality and opportunism, particularly when transactions involve asset specificity and uncertainty. By consolidating ownership and introducing subordination, internal organization reduces coordination and monitoring frictions. Subsequent contributions (Williamson, 1979, 1981) refine this argument by emphasizing discriminating alignment, whereby transactions are assigned to governance structures that minimize the joint costs of production and transacting.

Applying this logic to auditing, we conceptualize audit engagements as sequences of transactions subject to adaptation and safeguarding hazards, precisely the conditions TCE was designed to address. Auditors operate under bounded rationality when processing complex, client-specific information and face the risk of opportunism arising from potential managerial misstatement. Audit production, therefore, requires governance choices at multiple stages, including the design of procedures, the degree of reliance on internal controls versus substantive testing, and the allocation of personnel and expertise, each aimed at minimizing measurement, monitoring, and coordination costs. Williamson's characterization of transactions along the dimensions of asset specificity, uncertainty, and frequency (Williamson, 1975) maps naturally onto audit production. Client-specific processes and idiosyncratic inventories increase asset specificity, regulatory

and operational turbulence heighten uncertainty, and transaction volume raises frequency, collectively shaping the cost of producing assurance.

Client operations, particularly inventory-related processes and transactions, shape the auditor's search, documentation, and reconciliation activities, which are the primary loci of transaction costs in audit production. As organizational designs, lean systems reduce complexity and ambiguity by standardizing workflows and minimizing inventories, thereby improving predictability and control (De Stefano and Montes-Sancho, 2024). They also intentionally economize on transactions, for example, by replacing variance-focused metrics with non-financial operational measures and social or behavioral controls (Kennedy and Widener, 2008). Consistent with this view, lean implementation is positively associated with empowerment, visual performance measures, simplified reporting, and value stream costing, and negatively associated with traditional inventory tracking (Fullerton et al., 2013). From a TCE perspective, these configurations reduce transaction heterogeneity, enhance observability, and lower adaptation and safeguarding costs. In turn, they compress the range of auditable conditions that auditors must verify and reduce the number of reconciliation points, enabling more efficient evidence collection and greater reliance on standardized audit procedures.

Synthesizing this literature, we argue that operational leanness operates as a governance mechanism, in Williamson's sense (Williamson, 1975, 1979), that directly lowers the transaction costs of audit production. By standardizing processes, compressing inventories, and enhancing real-time visibility, lean systems reduce the coordination, monitoring, and adaptation costs embedded in audit engagements. This allows auditors to align procedures more precisely with transaction characteristics, consistent with the principle of discriminating alignment, and to deliver assurance at lower cost for a given level of audit quality. Accordingly, lean firms may attract lower audit fees not only because they present lower assessed risk, but because their operations fundamentally reduce the cost of producing audit services. This cost-based efficiency channel complements, rather than replaces, the risk-based channel emphasized by the Audit Risk Model.

2.3.3 Signaling Theory and auditor belief formation

While Transaction Cost Economics emphasizes realized efficiency gains, it does not address how auditors form expectations about risk and cost ex ante. Auditors face significant information asymmetry at the engagement acceptance and pricing stage, as they cannot fully observe managerial competence, operational discipline, or control quality before audit work begins. In such settings, observable signals play a critical role. Signaling theory (Spence, 1973) provides a framework for understanding how firms convey credible information about hidden quality when direct verification is costly.

In Spence's model (Spence, 1973), signals must be costly and differentially burdensome across types so that low-quality firms cannot easily mimic high-quality firms. This logic has been widely applied in corporate finance and assurance contexts (see, for example Leland and Pyle, 1977; Downes and Heinkel, 1982; Beatty and Ritter, 1986; Titman and Trueman, 1986; Datar et al., 1991; Firth and Liau-Tan, 1998). Building on this literature, we argue that operational leanness functions as a credible signal in audit pricing. Lean practices are costly to implement, require sustained organizational commitment, and are difficult to imitate superficially. They are also increasingly observable through disclosures, site visits, supply chain audits, and operational metrics. As such, leanness can signal managerial discipline, robust control environments, and process transparency.

The strength of this signal depends on observability and the auditor's ability to decode it. Supply chain transparency initiatives and climate disclosures enhance the visibility of operational practices (New, 2010; Sodhi and Tang, 2019; Tang, 2018; Blanco, 2021). Auditors with industry specialization or prior exposure to lean systems are better positioned to interpret these signals, consistent with joint signal theory. In high-transparency environments, auditors are more likely to incorporate lean signals into pricing, whereas in opaque settings, they may discount them and adopt conservative risk assessments.

Despite its theoretical plausibility, the signaling role of operational leanness in audit pricing has not been empirically examined. Existing studies focus on financial and governance signals, leaving the operational dimension largely unexplored. Our study addresses this gap by treating leanness as a costly, externally verifiable signal that influences

auditors' beliefs about risk and effort at the pricing stage.

2.3.4 Theory integration and statement of hypothesis

Taken together, the three theoretical frameworks illuminate distinct but interrelated stages of audit fee determination. The Audit Risk Model explains how client characteristics influence auditors' assessments of engagement risk and, in turn, the scope and intensity of audit procedures that determine audit effort and fees. In this framework, operational leanness affects audit fees by lowering inherent and control risk. Lean operations reduce transaction volume, limit opportunities for error, and strengthen the reliability of internal controls, thereby allowing auditors to narrow the nature, timing, and extent of audit testing. Because audit fees increase with both assessed risk and required effort, these reductions translate directly into lower audit fees.

Transaction Cost Economics complements this risk-based explanation by focusing on the cost of producing audit services, conditional on risk. From a TCE perspective, audit engagements consist of sequences of transactions that require searching, verification, documentation, and reconciliation. Audit fees, therefore, reflect not only risk premia but also the transaction costs embedded in audit production. Operational leanness restructures these transactions by standardizing workflows, reducing inventory levels, and enhancing observability. These features reduce transaction heterogeneity, lower adaptation and safeguarding requirements, and diminish coordination and reconciliation costs. As a result, auditors can deliver the same level of assurance with fewer resources, lowering the marginal and total cost of audit production and, consequently, audit fees.

Signaling theory explains how these risk and cost considerations are incorporated into audit fees ex ante, before audit work begins. At the pricing stage, auditors face substantial information asymmetry regarding managerial discipline, operational control, and process quality. Observable signals, therefore, play a critical role in fee setting. Operational leanness functions as a credible signal because it is costly to implement, difficult to mimic superficially, and increasingly visible through disclosures, operational metrics, and auditor interactions with client systems. When auditors observe lean practices, they

update beliefs about both expected audit risk and expected audit effort, leading to lower initial fee quotes. In this way, signaling theory explains how anticipated reductions in risk and production costs are capitalized into audit fees at the time of engagement acceptance.

Integrating these perspectives yields a unified explanation of how operational leanness lowers audit fees through multiple, reinforcing mechanisms. Lean operations reduce assessed audit risk, lower the cost of producing assurance, and credibly signal these efficiencies to auditors at the pricing stage. Prior audit pricing research has largely emphasized financial, governance, and regulatory determinants of audit fees, leaving the operational foundations of fee determination underexplored. By placing operational design at the center of audit pricing, our framework highlights leanness as a fundamental, yet overlooked, driver of audit fees. Accordingly, we hypothesize as follows:

Hypothesis1(H1): Operationally leaner firms are associated with lower audit fees.

3 Research Methodology

3.1 Sample and data

Our study is based on a sample of U.S. firms listed on the NYSE and NASDAQ. We obtain firm-level accounting data from Compustat and audit-related data from Audit Analytics. The initial matched sample includes 160,044 firm-year observations from 2001 to 2024. We exclude firms in the financial (SIC codes 6000–6999) and utility (SIC codes 4900–4999) sectors because these industries have structurally different financial reporting environments and regulatory frameworks compared to other sectors (Tunyi, 2021). We also drop observations from industry-year clusters with fewer than six observations, as our measure of operational leanness (discussed below) is derived from residuals of industry-year cross-sectional regressions, which require a sufficient number of observations within each cluster. Finally, we exclude firm-years with missing values for any of the key variables, including the dependent variable, independent variables, and control variables. Table 1 summarizes the data extraction and sample refinement process.

(Insert Table 1 here)

3.2 Empirical model

We primarily seek to examine whether operationally leaner firms pay lower audit fees. Our baseline empirical model is an ordinary least squares (OLS) regression that estimates the relationship between operational leanness and audit fees, controlling for other well-established determinants of audit fees. The model includes industry and year fixed effects to account for unobserved heterogeneity across industries and over time. Specifically, we estimate the following regression model:

$$Audit\ fees_{it} = \beta_0 + \beta_1 Operational\ leanness_{it} + \sum \beta_k Controls_{it} + v_j + v_t + \epsilon_{it} \quad (1)$$

Our dependent variable is audit fees, measured as the natural logarithm of the dollar amount paid by firms to their statutory auditors for audit services. Consistent with prior literature (Hartlieb and Eierle, 2024), we use the log transformation, denoted as $Audit\ Fees_{it}$ in equation (1), to mitigate skewness and allow for percentage-based interpretation of coefficient estimates. Because audit fees are mechanically correlated with firm size (larger firms generally incur higher fees), we also use audit fees scaled by total sales as an alternative specification to partially control for size effects. Our results are robust across both measures.

Our independent variable is operational leanness. Our starting point for estimating firm-level operational leanness is the model proposed by Eroglu and Hofer (2011), specified as follows:

$$Ln(Inventory)_{it} = \alpha_{it} + \beta Ln(Sales)_{it} + \epsilon_{it} \quad (2)$$

In this model, $Ln(Inventory)_{it}$ is the natural logarithm of the firm's average total inventory (in U.S. dollars) in year t, computed as the average of inventory balances at the end of years $t-1$ and t. $Ln(Sales)_{it}$ is the natural logarithm of the firm's total sales (in U.S. dollars). Following the literature, we estimate the model using industry-year-specific cross-sectional regressions to account for heterogeneity across sectors and over

time (Eroglu and Hofer, 2011). The residual term, ϵ_{it}, captures the portion of inventory not explained by the firm's sales level. Larger residuals indicate excess inventory, and hence, a lower degree of operational leanness. For ease of interpretation, we multiply the residuals by negative one, such that higher values correspond to leaner firms.

One potential criticism of the Eroglu and Hofer (2011) model is the inclusion of the intercept term, α_{it}, which represents a base level of inventory when sales are zero. From a lean operations perspective, particularly within the Just-in-Time philosophy, inventory is viewed as waste, and the ideal state is one of zero inventory (De Haan and Yamamoto, 1999). Building on this conceptual foundation, we redefine leanness as the degree of deviation from a zero-inventory benchmark. Accordingly, our main measure of operational leanness modifies the original Eroglu and Hofer (2011) model by omitting the intercept term, effectively constraining the regression to pass through the origin. This reflects the assumption that, as in Eq.(2), firms with zero sales should also hold zero inventory. Importantly, this modeling choice does not materially alter our findings, as the results remain consistent whether or not the constant is included.

For robustness, in estimating the expected level of inventory in Eq.(2), we use different industry definitions, including Fama & French 48 industries (in our base model), but also 2-digit SIC codes, NAIC codes. We also studentize the residuals and also generate a lean dummy to capture observed values below and above the industry-year median.

Our base model (Eq. (1)) includes a comprehensive set of firm- and auditor-level controls identified in prior research (see, for example, Köhler and Ratzinger-Sakel, 2012; Widmann et al., 2021; Yuan et al., 2025; Truong et al., 2020; Kim et al., 2024, amongst others) as key determinants of audit pricing. Specifically, we control for firm size, leverage, profitability, an indicator for reporting losses, special items in the income statement, audit season (busy period), litigation risk, auditor reputation (Big 4), audit opinion, auditor change, auditor presence in the client's county, and auditor scale. Detailed definitions of all variables are reported in Appendix A. Following Dah et al. (2014), we winsorize all continuous variables at the 1st and 99th percentiles to limit the influence of extreme observations on our estimates.

4 Results and discussions

4.1 Descriptive statistics

Table 2 presents the distribution of firm-year observations across Fama and French's 48 industry classifications. The final sample consists of 58,279 firm-year observations from 2001 to 2024. The industries with the highest representation include Electronic Equipment (8.91%), Pharmaceutical Products (8.22%), Retail (7.35%), Business Services (6.87%), and Medical Equipment (6.23%). These sectors collectively account for over one-third of the sample, reflecting the dominance of high-technology, healthcare, and consumer-facing firms in U.S. capital markets over the sample period. In contrast, industries such as Tobacco Products, Fabricated Products, and Shipbuilding and Railroad Equipment have the fewest observations, each contributing less than 0.5% of the sample. This distribution highlights the heterogeneity of industry representation in our analysis and supports the use of industry fixed effects in our empirical models.

(Insert Table 2 here)

Table 3 presents summary statistics for the variables used in our analysis. Panel A reports descriptive statistics for the dependent variable. The mean natural logarithm of audit fees (Audit fee) is 13.37, with values ranging from 8.85 at the 1st percentile to 16.80 at the 99th percentile. The alternative measure, audit fees scaled by total sales (Audit fee to sales ratio), has a mean of 3.34 and a standard deviation of 8.44, indicating significant variation in audit fees across firms.

Panel B summarizes our main independent variables related to operational leanness. The inventory leanness measure (Operational leanness) has a mean of 0.37 and is approximately symmetrically distributed, whereas the standardized (Operational leanness standardized) and dummy versions (Operational leanness dummy) capture variation across firms and facilitate robustness checks. The lagged and alternative industry classification-based leanness measures (SIC, NAICS) exhibit similar distributions, supporting the stability of our core construct.

Panel C reports descriptive statistics for the control variables. As expected, large variation exists across firm size, profitability, leverage, and other audit-related determinants. For example, 66% of firm-years are audited by a Big 4 auditor, and 66.4% of audits occur during the busy season. The mean profitability (ROA) figure is comparable to that reported by Liu et al. (2021) for the U.S. dataset. Material control weaknesses related to inventory (Inventory-MWIC) are rare (mean of 1.1%) but still relevant in mediation analyses. Overall, the data reveal substantial heterogeneity across the sample, consistent with the breadth of firms included in the study.

Panel D presents descriptive statistics for the moderating and mediating variables used in our additional analyses. Audit lag, which proxies for audit effort, has a mean of 4.17, indicating that most audits are completed within a typical timeframe. Inventory-related material weaknesses (Inventory-MWIC) are infrequent, with a mean of 1.1%, but are important for assessing audit risk. The proportion of firms audited by industry specialists is 19.4%, whereas 43.9% of firms operate in counties with a high prevalence of lean firms. Analyst following varies widely, with a mean of 8.14 analysts per firm, and earnings quality, measured via discretionary accruals, shows substantial dispersion. Only 3.8% of firms are led by female CEOs, whereas 61.3% operate in manufacturing sectors. These variables are explored in detail in the mediation and cross-sectional analyses presented in Sections 4.3 and 4.4.

Appendix B presents a summary of the Pearson correlation matrix and Variance Inflation Factors (VIFs) for the dependent, independent and other control variables included in this study. Although some correlations are high, the VIFs indicate the absence of severe multicollinearity in our baseline regression.

(Insert Table 3 here)

4.2 Baseline results

Table 4 reports the results of our baseline regressions examining the relationship between operational leanness and audit fees. Columns (1) to (3) use the natural logarithm of audit fees as the dependent variable, while Columns (4) to (6) use audit fees scaled

by total sales to account for firm size effects. Standard errors are clustered at the firm level across all models. Across all specifications, operational leanness is negatively and significantly associated with audit fees, providing robust evidence in support of our main hypothesis (H1).

Specifically, in Column (1), the unstandardized inventory leanness measure is negatively associated with the log of audit fees, with a coefficient of -0.031 ($standarderror = 0.006$). This effect is statistically significant at the 1% level. Interpreting this effect economically, a one-standard-deviation increase in operational leanness corresponds to a 0.037 (-0.031×1.204) decrease in the natural log of audit fees. Consistent, statistically significant, and economically meaningful results are observed when using the standardized leanness measure in Column (2) and the leanness dummy in Column (3). Columns (4) to (6), which use the audit fee-to-sales ratio as the dependent variable, further reinforce this pattern. In Column (4), a one-standard-deviation increase in operational leanness is associated with a 0.483 (-0.401×1.204) reduction in the audit fee-to-sales ratio. These findings, robust across alternative specifications and measurement approaches, provide strong evidence that operational leanness is systematically linked to lower audit fees.

Control variables behave as expected. Larger firms (firm size), firms with losses, and those audited during the busy season are associated with higher audit fees. Auditors also charge higher fees when they have a significant county presence, when they are more reputable (Big 4 auditors). Clients with clean audit opinions tend to pay lower fees relative to peers. The adjusted R-squared for the log audit fee model is high (82.6%). This is partly because the natural log of audit fee is strongly driven by firm size and measures of auditor characteristics, which we control for. As shown in Columns (3) to (6), our results remain robust when the audit fee is normalised by total sales, although the R-squared is now more reasonable at 25.3%.

These findings are consistent with the theoretical predictions. The negative association between operational leanness and audit fees aligns with the Audit Risk Model (Simunic, 1980), indicating that lean firms likely present lower inherent and control risk, which reduces the scope and intensity of audit procedures (Ge et al., 2017; Hogan and

Wilkins, 2008). Similarly, from a Transaction Cost Economics perspective, the results suggest that lean operations lower the volume and complexity of verifiable transactions, thereby reducing coordination and monitoring costs for auditors (Williamson, 1981). Finally, the findings are also in line with Signaling Theory, as lean practices appear to serve as credible signals of managerial discipline and operational transparency, shaping auditors' perceptions of engagement risk (Balsam et al., 2003; Armstrong et al., 2025).

(Insert Table 4 here)

Although our baseline results give substantial evidence linking leanness to audit fees, concerns about endogeneity may constrain the validity of our conclusions. These concerns include self-selection bias and the potential influence of omitted variables. For example, "lean" firms might systematically differ from their "non-lean" counterparts in ways that also affect audit fees. If these characteristics are not controlled for in the regression, the estimated coefficients on operational leanness in Table 4 will capture both the effect of leanness and the effect of the omitted variables, leading to biased and inconsistent estimates. To address this omitted variable bias, we use propensity score matching to pair lean firms with non-lean firms that share similar observable characteristics, thereby isolating the effect of leanness. Specifically, we first partition the full sample into two groups: a treatment group comprising firms with high leanness and a control group comprising firms with low leanness. High (low) leanness is defined as firms with leanness scores above (below) the cross-sectional median in each year. We apply nearest-neighbor matching without replacement to ensure comparability between the two groups. This approach helps eliminate the significant differences in observed covariates between matched firms.

Appendix C reports univariate mean comparisons between treatment and control firms' characteristics using the same control variables included in our baseline regression. As seen in the table, there is a marked difference in firm characteristics between the treated and control group in the unmatched sample (i.e., $Match = U$), but this difference is eliminated through PSM in the matched sample (i.e., $Match = M$), where there is no statistically significant difference in firms' characteristics of both groups. This confirms

that the matching process successfully removes observable differences between these two groups.

We then estimate our baseline model using the matched sample derived from PSM. Our results are presented in Column (1) of Table 5. The model includes all controls in the baseline model as well as industry and year fixed effects. The coefficient of operational leanness is -0.045 (standard error of 0.007), significant at the 1% level. This confirms previous findings of a significant negative relationship between operational leanness and audit fees. In untabulated results, we also establish qualitatively similar findings using our alternative measures of lean (operational leanness standardized and operational leanness dummy).

Another potential source of endogeneity in our design is reverse causality, as higher audit fees or greater auditor scrutiny could influence a firm's decision to adopt lean practices. To address this, we employ an instrumental variables (IV) approach using the two-stage least squares (2SLS) estimator (Kennedy and Widener, 2008). Specifically, we instrument for operational leanness using the percentage of lean firms in each industry within a county in the same fiscal year. The rationale is that firms are more likely to adopt lean practices when they operate in environments where such practices are prevalent, reflecting local peer effects and industry clustering (Neukirchen et al., 2024; Alcácer and Chung, 2007; Bell, 2005). This instrument is expected to be positively correlated with the firm-level leanness measure, satisfying the relevance condition. At the same time, it plausibly satisfies the exclusion restriction: while the local prevalence of lean firms influences a firm's adoption of lean practices, it is unlikely to directly affect the firm's audit fee except through its effect on operational leanness. This approach allows us to isolate exogenous variation in leanness and obtain consistent estimates of its effect on audit fees.

Column (2) of Table 5 shows the first-stage regression results. The coefficient on the instrument (lean firms in the industry within the county) is positive and significant, as expected. Moreover, the endogeneity test is significant across all models, thereby justifying the use of the 2SLS regression. Results for the under-identification test (Kleibergen-Paap

rk LM statistic) are significant across all models, rejecting the null hypothesis of under-identification. Similarly, consistent with the instrument's strengths, the Cragg-Donald Wald F-statistics are higher than the stock-Yogo critical values at 10% in all cases, confirming that the instrument is strong. Taken together, these tests indicate the selected instrument is correctly identified, strong and valid. Our instrumented measure of operational leanness, derived from the first-stage regression, is then used to predict audit fees in Column (3). Our baseline results continue to hold. That is, operational leanness (instrumented) has a negative and statistically significant (at the 1% level) relationship with audit fees. Again, we find that these results hold when we use an alternative measure of operational leanness (i.e., operational leanness standardized) and an alternative measure of audit fees (the audit fee-to-sales ratio). For brevity, we do not present these results here; however, they are available upon request. Overall, these results confirm a causal link between operational leanness and audit fees.

(Insert Table 5 here)

4.3 Mechanisms: Mediation analysis

In developing our main hypothesis, we proposed two main channels through which operational leanness may influence audit fees. Conceptually, leanness is expected to reduce audit effort by simplifying workflows, lowering inherent risk, and reducing operational complexity. While inherent risk and complexity are distinct constructs, they are closely intertwined with audit effort and are empirically proxied by audit lag in our analysis. In addition, we examine audit risk more directly through the presence of inventory-related internal control weaknesses. Table 6 presents the results of our mediation analysis to formally test these mechanisms.

We begin with audit effort, proxied by audit lag. Audit lag refers to the number of days between a firm's fiscal year-end and the date the auditor signs the audit report (Jha et al., 2021). Longer audit lags typically reflect greater audit effort, often due to complexity, risk, or client inefficiencies. We argue that leaner firms, by virtue of reduced complexity and more standardized operations, require less auditor effort and can thus be

audited more quickly or efficiently, resulting in shorter audit lags and ultimately lower audit fees.

Results in Column (1) of Table 6 indicate a statistically significant negative association between operational leanness and audit lag (1% level), consistent with the view that leaner firms are audited more quickly. Column (2) shows that audit lag is positively associated with audit fees (1% level), implying that longer audits require more auditor time and resources. The Sobel test confirms that audit lag is a statistically significant mediator in the leanness–audit fee relationship, and mediation diagnostics reveal that audit lag accounts for approximately 8.3% of the total effect. These results highlight audit effort as an important transmission channel linking operational leanness to audit fees.

The evidence in Table 6 is consistent with the Audit Risk Model (Simunic, 1980), which posits that audit fees reflect both engagement risk and auditor effort. Lean firms, by simplifying workflows and standardizing processes, likely reduce both dimensions, leading to shorter audits and lower fees. From a Transaction Cost Economics perspective, lean operations minimize the number of verifiable transactions and coordination points, thereby reducing the auditor's information-processing burden (Williamson, 1981). This lower complexity is consistent with the observed reduction in audit lag and, ultimately, audit fees.

We next examine audit risk, proxied by inventory-related material weaknesses in internal control (Inventory-MWIC). Lean operations typically feature simplified inventory systems, real-time monitoring, and minimal excess stock, all of which reduce exposure to inventory misstatements. Accordingly, we expect leaner firms to be less likely to report inventory-related control weaknesses under Section 404 and, therefore, to be perceived as lower-risk by auditors. Consistent with Feng et al. (2015), we measure Inventory-MWIC by identifying Section 404 disclosures in firms' Form 10-K reports that indicate material weaknesses in internal control related to inventory. Inventory-MWIC is an indicator variable equal to 1 if such a weakness is reported in a given year, and 0 otherwise.

Results in Column (3) show a statistically significant negative association between operational leanness and Inventory-MWIC (1% level), indicating that lean firms are less

likely to report such weaknesses. Column (4) demonstrates that the presence of an inventory-related weakness is positively associated with audit fees (1% level). The Sobel test indicates that Inventory-MWIC partially mediates the relationship between leanness and audit fees, accounting for 2.0% of the total effect.

These findings are consistent with prior research showing that inventory-related internal control deficiencies predict operational inefficiencies, greater audit scrutiny, and higher audit fees (Feng et al., 2015; Rajgopal et al., 2021). By minimizing inventory exposure and strengthening control environments, lean firms lower the likelihood of such deficiencies and, in turn, lower audit risk. Viewed through the lens of Signaling Theory (Balsam et al., 2003; Armstrong et al., 2025), lean inventory practices send credible signals of managerial discipline and control consciousness to auditors and investors, further reducing perceived engagement risk and audit pricing.

Overall, the results in Table 6 provide empirical support for both channels. Operational leanness lowers audit fees (1) by reducing the time auditors need to complete the engagement, and (2) by decreasing audit risk through fewer material control weaknesses related to inventory.

(Insert Table 6 here)

4.4 Cross-sectional analysis

4.4.1 The Moderating Role of Auditor Industry Specialization

The cost-saving potential of lean operations (through reduced transaction volume and enhanced behavioral control systems) may not be equally visible to all auditors (Kristensen and Israelsen, 2014; van der Steen and Tillema, 2018). Although lean systems simplify internal processes and strengthen operational discipline, recognizing these features as indicators of lower audit risk and effort requires contextual expertise. This is particularly important in audit engagements, where fee-setting depends not only on observable financial metrics but also on auditors' ability to correctly interpret underlying operational structures.

Industry specialist auditors, with their deeper knowledge of sector-specific risks, reporting norms, and operational practices, are better positioned to tailor audit strategies, identify risk-reducing operational features, and form more accurate assessments of audit complexity (Balsam et al., 2003; Reichelt and Wang, 2010). Consequently, they are more likely to appreciate the governance and efficiency advantages embedded in lean systems and incorporate these insights into audit pricing decisions. In contrast, non-specialist auditors may adopt more generic or conservative risk assessments, overlooking some of the efficiency signals inherent in lean operations.

Consistent with this argument, prior research finds that auditors with greater contextual expertise more accurately anticipate audit quality risks and adjust their pricing accordingly (Rajgopal et al., 2021; Liu et al., 2021). Taken together, these insights suggest that the negative association between operational leanness and audit fees should be stronger when engagements are led by industry specialists, as these auditors are better able to translate operational efficiencies into lower risk assessments and reduced audit effort.

To explore the role of industry specialists, we construct two alternative proxies for industry specialization. The first is based on audit fee dominance, and the second on client sales dominance within a given industry-year, as defined by the Fama and French 48-industry classification. For each measure, an auditor is classified as an industry specialist if (i) it holds the largest market share in the industry (by audit fees or client sales, respectively), and (ii) its market share exceeds that of the second-largest auditor by at least 10 percent (Reichelt and Wang, 2010; Balsam et al., 2003; Jaggi et al., 2015). We assign a binary indicator equal to 1 if the auditor meets these criteria, and 0 otherwise. Untabulated robustness checks confirm that the two measures yield consistent results. For brevity, we report results using the client sales measure and make the results from the second available on request.

In Column (1) of Table 7, we examine whether the association between operational leanness and audit fees varies with auditor industry specialization. The coefficient on the interaction term is negative and statistically significant (at the 1% level), indicating that

the fee-reducing effect of leanness is stronger when a firm is audited by an industry specialist. This finding supports our expectation that industry experts are better positioned to recognize and price the efficiency and governance benefits of lean operations. Specialists are more likely to view lean systems as credible indicators of robust controls and lower engagement risk, resulting in greater audit fee discounts relative to non-specialist auditors.

This result is also consistent with Signaling Theory (Balsam et al., 2003; Armstrong et al., 2025), which emphasizes that the credibility of a signal depends on the receiver's ability to interpret it. In this setting, lean operations serve as a signal of operational discipline and control quality, but industry specialists are uniquely equipped to interpret and incorporate this information into their pricing decisions. From a Transaction Cost Economics perspective (Williamson, 1981), specialists can also more accurately evaluate the reduced coordination and verification costs embedded in lean firms, further lowering perceived engagement risk and required audit effort. Collectively, these findings underscore that the negative relationship between leanness and audit fees is amplified by auditor expertise, thereby reinforcing our main hypothesis that operational leanness reduces audit fees.

This result highlights the interpretive dimension of audit pricing: operational characteristics, such as leanness, do not speak for themselves but must be contextualized by the auditor. When such contextual knowledge is available, as is the case with industry specialists, the cost-saving benefits of operational efficiency are more accurately reflected in audit fees.

4.4.2 The Role of the Information Environment

As previously noted, the signaling effect of operational leanness (Armstrong et al., 2025; Balsam et al., 2003) is neither automatic nor uniformly interpreted across all firms. Its impact depends critically on the quality of the firm's broader information environment, which shapes whether auditors and other stakeholders view lean practices as credible indicators of strong governance, efficient operations, and disciplined management.

In high-quality information environments, where financial disclosures are transparent, reliable, and subject to external scrutiny, lean operational choices are more likely to be interpreted as genuine signals of reduced audit risk. These environments attenuate information asymmetry between the firm and the auditor, thereby allowing auditors to incorporate lean-related risk reductions into their pricing decisions with greater confidence. This perspective aligns with Kim et al. (2024), which finds that stronger board governance and disclosure quality increase demand for audit quality and enable more precise risk-based audit pricing.

Conversely, in low-transparency settings, auditors may be more skeptical of the efficiency and discipline implied by lean operations (Jha et al., 2021; Rajgopal et al., 2021). In such contexts, they are likely to adopt more conservative risk assessments and maintain higher audit effort levels, thereby dampening or even negating the fee-reducing effect of leanness.

To empirically test this moderating effect, we consider three established proxies for the quality of a firm's information environment in Table 7: (i) earnings quality (Column 2) capturing the credibility of reported performance or the degree of accrual earnings management, (ii) the absence of financial restatements (Column 3), capturing historical reporting reliability, and (iii) analyst following (Column 4), reflecting the degree of external monitoring and information production. Each proxy represents a distinct but complementary dimension of the transparency and scrutiny that condition the extent to which lean practices translate into lower perceived audit risk and, consequently, lower audit fees.

In Column (2) of Table 7, we examine whether earnings quality, as a measure of the quality of a firm's information environment, affects the link between leanness and audit pricing. Following prior studies, we use discretionary accruals from the Jones model (Jones, 1991) and multiply the values by negative one so that higher values represent higher earnings quality (Kim and Zhang, 2014; Dechow et al., 1995; Tunyi et al., 2024). High levels of discretionary accruals are generally associated with earnings manipulation or aggressive reporting, while lower levels indicate more credible earnings quality (Srinidhi

et al., 2011; Tunyi et al., 2024). The interaction term between operational leanness and earnings quality is negative and statistically significant, suggesting that lean firms with transparent earnings benefit more strongly from audit fee reductions. Auditors likely perceive the combination of efficient operations and reliable earnings reporting as a strong indicator of reduced inherent and control risk, which justifies a less intensive audit and, therefore, a lower fee.

In Column (3), we proxy for the quality of the information environment using a binary indicator equal to one if the firm has not restated its financial statements during the sample period. Restatements are widely viewed as red flags in the auditing literature, often signaling weaknesses in internal control or prior audit failures where material misstatements were not detected (Rajgopal et al., 2021; Francis et al., 2013). Consequently, firms without restatements are generally perceived as more reliable and better governed. The interaction between operational leanness and the no-restatement indicator is negative and statistically significant (at the 5% level), suggesting that auditors are more responsive to the efficiency signals of lean firms when there is no history of restatements. This finding implies that the audit fee-saving effect of leanness is amplified in settings where the absence of restatements signals stronger controls and fewer prior audit failures, thereby enhancing the credibility of lean signals.

Column (4) of Table 7 examines analyst following, measured by the number of financial analysts covering the firm, as an additional proxy for the information environment. Analyst coverage enhances transparency by generating independent information, increasing the visibility of managerial decisions and operational practices, and reducing asymmetry between the firm and external stakeholders, including auditors (Bhojraj et al., 2009). The interaction term between operational leanness and analyst following is negative and highly significant (at the 1% level), indicating that lean firms with greater analyst coverage receive larger audit fee discounts. This finding supports the view that when external monitors validate and disseminate information about operational efficiency, auditors can more confidently adjust their perceived risk downward, resulting in lower audit pricing.

Taken together, the results in Columns (2) to (4) of Table 7 provide compelling

evidence that the audit fee–reducing effect of operational leanness is conditioned by the firm's information environment. When firms operate in settings characterized by higher transparency—whether through an absence of restatements, greater analyst scrutiny, or higher-quality accruals—the signaling value of leanness becomes more salient and credible to auditors.

(Insert Table 7 here)

4.4.3 The Role of Operational Complexity

Firm-specific operational complexity represents a critical determinant of audit pricing because it directly shapes both engagement risk and audit effort. Complex firms often operate across multiple business lines, geographies, or regulatory environments, which increases the scope of audit procedures, the number of verification points, and the need for greater coordination between audit teams. From a Transaction Cost Economics perspective, complexity heightens coordination and monitoring costs, as auditors must expend more effort to reconcile diverse processes and control systems (Williamson, 1981). Similarly, the Audit Risk Model highlights that engagement risk rises when firms have intricate operations, as the likelihood of misstatements and control failures is higher in more fragmented environments. These factors jointly justify higher audit fees for complex firms.

Lean systems, however, may mitigate these challenges by streamlining workflows, reducing redundancies, and embedding standardized processes across business segments. By simplifying information flows and strengthening the reliability of internal controls, lean operations can reduce the auditor's information processing burden even in otherwise complex settings. Importantly, the value of lean practices may be especially salient in complex firms, where their simplifying effects are most visible to auditors.

To empirically examine this moderating role, we proxy for operational complexity using the natural logarithm of the number of business segments within the firm, consistent with prior literature (Hay et al., 2006). This measure captures the breadth of a firm's operations, which directly affects the scope of audit procedures and the resources required

to complete them. In Column (1) of Table 8, we find that the interaction between operational leanness and complexity is negative and statistically significant at the 1% level. This indicates that the audit fee discount associated with leanness is more pronounced in firms with greater operational complexity. One interpretation is that auditors perceive lean practices as a credible mechanism for reducing redundancies, standardizing controls, and integrating oversight across multiple segments, thereby lowering both audit effort and engagement risk. These results highlight that the benefits of leanness are not uniform; they depend on the firm's structural characteristics and are particularly valuable in environments where operational complexity would otherwise increase audit risk.

4.4.4 The role of CEO gender

The relationship between operational leanness and audit fees may also depend on leadership characteristics, particularly CEO gender. Prior studies show that female executives exhibit more conservative reporting, greater risk aversion, and stronger ethical orientations than their male counterparts (Francis et al., 2015; Srinidhi et al., 2011; Tunyi et al., 2023). These traits shape auditors' perceptions of managerial discipline and firm risk.

We argue that under female leadership, the signaling value of leanness is amplified. Lean systems already convey operational discipline and control strength. Coupled with the prudence and ethical orientation associated with female CEOs, this signal becomes more credible to auditors, reinforcing their confidence in governance and risk management. In turn, auditors may reduce substantive testing and apply lower risk premiums, translating into lower audit fees. This aligns with audit risk and signaling theories, which emphasize that external assurance providers incorporate both structural controls and managerial characteristics in their risk assessments (Balsam et al., 2003).

Column (2) of Table 8 confirms this expectation: the interaction between leanness and female CEO leadership is negative and significant at the 1% level, indicating that the audit fee discount from leanness is stronger in firms led by female CEOs. In other words, auditors appear to reward lean systems more when implemented under leadership

associated with prudent risk-taking and conservative reporting.

This finding complements governance research showing that gender-diverse leadership enhances transparency and reduces agency costs, both critical considerations in audit pricing (Kim et al., 2024). In this context, female CEOs act as a reinforcing mechanism that strengthens the credibility of lean operational structures.

(Insert Table 8 here)

4.4.5 The Role of Industry Type: Manufacturing versus Services

The impact of operational leanness on audit fees likely varies across industries depending on the centrality of inventory management. In manufacturing, where inventories of raw materials, work-in-progress, and finished goods are substantial, auditors must perform resource-intensive procedures such as walkthroughs, inspections, and reconciliations. Lean practices reduce the volume and complexity of inventory records and transaction flows, thereby lowering inherent and control risks and streamlining audit efforts (Kennedy and Widener, 2008; Fullerton et al., 2013; Hogan and Wilkins, 2008). Prior research confirms that inventory-related control weaknesses increase inefficiency and audit risk, and that deficiencies are more common in firms with complex inventory systems (Feng et al., 2015; Rajgopal et al., 2021). Together, these findings highlight inventory management as a key audit risk driver, making lean practices especially salient in manufacturing. Accordingly, auditors may view lean manufacturers as less costly to audit, leading to fee discounts.

By contrast, in the services sector, inventory is largely irrelevant. These firms depend on human capital, intangibles, or digital infrastructure and hold little or no stock. Auditors, therefore, place less weight on inventory systems when pricing engagements. While leanness may still signal discipline and efficiency, its audit relevance is muted, as risk in services is more often tied to judgment-intensive areas such as revenue recognition or intangible asset valuation.

We test this prediction in Columns (3) and (4) of Table 8. Column (3) reports the interaction between leanness and a dummy for manufacturing firms (SIC 2000–3999). The

interaction is negative and significant at the 1% level, indicating that the audit fee discount from leanness is stronger in manufacturing. This aligns with the expectation that the audit relevance of lean practices is amplified where inventory management and production processes are central. Column (4) examines the services sector (SIC 7000–8999). Here, the interaction is positive and significant at the 1% level, suggesting that the fee discount typically associated with leanness is attenuated in service-oriented firms. One interpretation is that auditors do not perceive lean operations in these firms as materially reducing risk or effort. Instead, audit complexity in services may be driven by other factors, such as the valuation of intangibles or the complexity of service delivery.

(Insert Table 8 here)

4.5 Robustness checks

Before drawing our conclusions, we conduct several robustness checks to ensure the reliability and validity of our main findings on the relationship between operational leanness and audit fees. In Column (1) of Table 9, we estimate the baseline model using firm fixed effects to control for time-invariant, firm-specific heterogeneity. The coefficient on operational leanness remains negative and statistically significant at the 1% level, supporting the main result that leaner firms are charged lower audit fees.

Column (2) of Table 9 addresses the potential concern that results may be driven by a dominant industry group. We exclude the top three industry sectors with the highest number of firm-year observations (Electronic equipment, Pharmaceutical Products, and Retail) in our sample and re-estimate the baseline model. The negative and significant coefficient on our leanness variable persists, suggesting that our findings are not an artifact of over-representation in a specific industry. Similarly, in Column (3), we test the sensitivity of our results to extreme macroeconomic shocks by excluding the financial crisis year of 2009 and the COVID-19 pandemic year of 2020. The results are unchanged, indicating that our findings are not driven by these abnormal periods.

Audit fee regressions typically exhibit high R-squared values (see, for example, Truong et al., 2020; Kim et al., 2024), partly due to the inclusion of highly explanatory variables

such as firm size, litigation indicator, and auditor's local presence. Column (4) presents results from a more parsimonious specification excluding these three variables. Although R-squared declines as expected, the coefficient on operational leanness remains negative and highly significant, thereby reinforcing the robustness of our core relationship.

In Column (5), we address potential reverse causality by using a one-year lagged measure of operational leanness. The result remains robust, with the lagged coefficient negative and significant at the 1% level, suggesting that operational leanness precedes, rather than is determined by, audit fees.

Finally, in Columns (6) and (7), we test the sensitivity of our operational leanness construct to alternative industry classifications. Following Hrazdil et al. (2013), we re-calculate leanness using industry medians based on 2-digit SIC codes Column (6) and 3-digit NAICS codes Column (7), instead of the Fama-French 48 industry groupings. In both cases, the coefficient on operational leanness remains negative and statistically significant, indicating that our results are not sensitive to the definition of industry benchmarks.

Overall, these robustness checks, in addition to earlier checks for endogeneity, confirm that our main finding—operationally leaner firms are charged lower audit fees—holds consistently across a range of model specifications, sample modifications, timing assumptions, and industry classification schemes.

(Insert Table 9 here)

5 Conclusion

This study examines whether and how operational leanness influences audit fees, utilizing a large panel of U.S.-Listed firms. Motivated by the idea that lean firms are likely to pose lower audit risk, involve less audit effort, and offer more transparent operational structures, we hypothesize that operational leanness is negatively associated with audit fees. Our baseline results, based on OLS regressions with industry and year fixed effects and clustered standard errors (at the firm-level), provide consistent evidence that leaner

firms pay significantly lower audit fees.

We explore two mechanisms underlying this relationship: reduced audit effort, proxied by shorter audit lags, and reduced audit risk, proxied by fewer inventory-related material control weaknesses. Mediation analysis confirms both channels, with audit effort explaining a larger share (over 8%) and audit risk contributing a smaller but significant role (about 2%) of the total effect.

We further demonstrate that the audit fee discount is more pronounced in firms with stronger audit quality and more transparent information environments, as measured by the presence of industry specialist auditors, the absence of restatements, higher analyst following, and high earnings quality. The effect is also stronger in manufacturing firms, where inventory is more operationally relevant, and in firms led by female CEOs, whose leadership traits may reinforce the credibility of lean signals.

These findings are consistent with the broader literature on audit pricing and risk assessment. For example, Rajgopal et al. (2021) emphasizes that audit deficiencies are more likely in firms with weak internal controls, while Feng et al. (2015) show that inventory-related control weaknesses impair operational efficiency and increase audit scrutiny. Our results suggest that lean firms, by minimizing such weaknesses, are perceived as less risky and more auditable. Moreover, from the signaling theory perspective (Balsam et al., 2003; Armstrong et al., 2025), lean operations, especially when combined with strong governance signals such as female leadership or high earnings quality, serve as credible indicators of managerial discipline and transparency.

This study makes three interrelated contributions by integrating the audit risk model, transaction cost economics, and signaling theory. First, we extend the audit pricing literature (Hay et al., 2006; Ferguson et al., 2003; Gul et al., 2009; Choi et al., 2008; Yuan et al., 2025) by introducing operational leanness—a concept rooted in operations and management research—as a novel and economically meaningful determinant of audit fees. We show that lean firms systematically reduce inherent and control risk, thereby narrowing the scope, timing, and intensity of audit procedures.

Second, we advance transaction cost economics in the audit context by demonstrat-

ing that lean operations lower transaction volume and complexity, reshaping the audit production function and reducing the cost of producing assurance. This perspective highlights how operational choices, often studied in supply chain or efficiency settings, directly influence audit effort and risk assessments.

Third, we refine signaling theory by positioning operational leanness as an externally observable and credible signal of managerial discipline and robust internal controls. Importantly, we identify contingencies, including auditor specialization, information transparency, industry setting, and CEO characteristics, that amplify or attenuate this signal.

To our knowledge, this is the first large-sample evidence linking operational leanness to audit fees. By bridging the operations management, corporate governance, and auditing literatures, we reconceptualize operational efficiency as a strategic attribute with direct implications for audit pricing, risk assessment, and practice.

Our findings have practical implications for multiple stakeholders. For managers, particularly in operational and finance roles, leanness offers not only efficiency gains but also measurable reductions in audit costs. For auditors, our results suggest that operational indicators can enhance risk assessment and engagement planning. Audit firms may benefit from incorporating leanness-related metrics into pricing models and resource allocation. For policymakers and regulators, encouraging lean practices through incentives or disclosures may enhance the transparency and reliability of financial reporting.

Finally, this study opens several avenues for further research. First, future studies could examine whether the leanness–audit fee relationship varies across countries with different institutional or regulatory environments. Second, scholars might examine whether leanness affects audit quality itself, rather than only its cost. Lastly, examining how leanness interacts with other forms of organizational capabilities (e.g., digital capabilities or sustainability practices) may yield valuable insights into modern audit risk assessments.

References

Alcácer, J. and Chung, W. (2007). Location strategies and knowledge spillovers. *Management Science*, 53(5):760–776.

Armstrong, D. M., Glaeser, S., and Hoopes, J. L. (2025). Measuring firm exposure to government agencies. *Journal of Accounting and Economics*, 79(1):101703.

Balsam, S., Krishnan, J., and Yang, J. S. (2003). Auditor industry specialization and earnings quality. *Auditing: A Journal of Practice & Theory*, 22(2):71–97.

Beatty, R. P. and Ritter, J. R. (1986). Investment banking, reputation, and the underpricing of initial public offerings. *Journal of Financial Economics*, 15(1-2):213–232.

Beck, M., Constance, P., and Li, C. (2025). Risky business: The impact of experience in auditing financially distressed clients. *Auditing: A Journal of Practice & Theory*, pages 1–26.

Becker, S. D. and Endenich, C. (2023). Entrepreneurial ecosystems as amplifiers of the lean startup philosophy: Management control practices in earliest-stage startups. *Contemporary Accounting Research*, 40(1):624–667.

Bell, G. G. (2005). Clusters, networks, and firm innovativeness. *Strategic Management Journal*, 26(3):287–295.

Bendig, D., Strese, S., and Brettel, M. (2017). The link between operational leanness and credit ratings. *Journal of Operations Management*, 52:46–55.

Bhojraj, S., Hribar, P., Picconi, M., and McInnis, J. (2009). Making sense of cents: An examination of firms that marginally miss or beat analyst forecasts. *The Journal of Finance*, 64(5):2361–2388.

Blanco, C. C. (2021). Supply chain carbon footprinting and climate change disclosures of global firms. *Production and Operations Management*, 30(9):3143–3160.

Blank, S. and Eckhardt, J. T. (2024). The lean startup as an actionable theory of entrepreneurship. *Journal of Management*, 50(8):3012–3034.

Chen, X., Li, M., Obiri-Yeboah, E., and Wu, Q. (2025). Reprint of: Rank-and-file employee stock options and audit pricing: Evidence from S&P 1500 firms. *The British Accounting Review*, 57(1):101556.

Choi, J.-H., Kim, J.-B., Liu, X., and Simunic, D. A. (2008). Audit pricing, legal liability regimes, and big 4 premiums: Theory and cross-country evidence. *Contemporary Accounting Research*, 25(1):55–99.

Dah, M. A., Frye, M. B., and Hurst, M. (2014). Board changes and CEO turnover: The unanticipated effects of the Sarbanes–Oxley Act. *Journal of Banking & Finance*, 41:97–108.

Datar, S. M., Feltham, G. A., and Hughes, J. S. (1991). The role of audits and audit quality in valuing new issues. *Journal of Accounting and Economics*, 14(1):3–49.

De Haan, J. and Yamamoto, M. (1999). Zero inventory management: facts or fiction? lessons from japan. *International Journal of Production Economics*, 59(1-3):65–75.

De Stefano, M. C. and Montes-Sancho, M. J. (2024). Complex supply chain structures and multi-scope ghg emissions: the moderation effect of reducing equivocality. *International Journal of Operations & Production Management*, 44(5):952–986.

Dechow, P. M., Sloan, R. G., and Sweeney, A. P. (1995). Detecting earnings management. *The Accounting Review*, pages 193–225.

Downes, D. H. and Heinkel, R. (1982). Signaling and the valuation of unseasoned new issues. *The Journal of Finance*, 37(1):1–10.

Eroglu, C. and Hofer, C. (2011). Lean, leaner, too lean? The inventory-performance link revisited. *Journal of Operations Management*, 29(4):356–369.

Feng, M., Li, C., McVay, S. E., and Skaife, H. (2015). Does ineffective internal control over financial reporting affect a firm's operations? evidence from firms' inventory management. *The Accounting Review*, 90(2):529–557.

Ferguson, A., Francis, J. R., and Stokes, D. J. (2003). The effects of firm-wide and office-level industry expertise on audit pricing. *The Accounting Review*, 78(2):429–448.

Firth, M. and Liau-Tan, C. K. (1998). Auditor quality, signalling, and the valuation of initial public offerings. *Journal of Business Finance & Accounting*, 25(1-2):145–165.

Francis, B., Hasan, I., Park, J. C., and Wu, Q. (2015). Gender differences in financial reporting decision making: Evidence from accounting conservatism. *Contemporary Accounting Research*, 32(3):1285–1318.

Francis, J. R., Michas, P. N., and Yu, M. D. (2013). Office size of big 4 auditors and client restatements. *Contemporary Accounting Research*, 30(4):1626–1661.

Fullerton, R. R., Kennedy, F. A., and Widener, S. K. (2013). Management accounting and control practices in a lean manufacturing environment. *Accounting, Organizations and Society*, 38(1):50–71.

Ge, W., Koester, A., and McVay, S. (2017). Benefits and costs of Sarbanes-Oxley Section 404 (b) exemption: Evidence from small firms' internal control disclosures. *Journal of Accounting and Economics*, 63(2-3):358–384.

Ghafran, C. and O'Sullivan, N. (2017). The impact of audit committee expertise on audit quality: Evidence from uk audit fees. *The British Accounting Review*, 49(6):578–593.

Gualandris, J., Branzei, O., Wilhelm, M., Lazzarini, S., Linnenluecke, M., Hamann, R., Dooley, K. J., Barnett, M. L., and Chen, C.-M. (2024). Unchaining supply chains: Transformative leaps toward regenerating social–ecological systems. *Journal of Supply Chain Management*, 60(1):53–67.

Gul, F. A., Fung, S. Y. K., and Jaggi, B. (2009). Earnings quality: Some evidence on the role of auditor tenure and auditors' industry expertise. *Journal of Accounting and Economics*, 47(3):265–287.

Hartlieb, S. and Eierle, B. (2024). Do auditors respond to clients' climate change-related external risks? evidence from audit fees. *European Accounting Review*, 33(3):1075–1103.

Hay, D., Knechel, R., and Li, V. (2006). Non-audit services and auditor independence: New zealand evidence. *Journal of Business Finance & Accounting*, 33(5-6):715–734.

Hogan, C. E. and Wilkins, M. S. (2008). Evidence on the audit risk model: Do auditors increase audit fees in the presence of internal control deficiencies? *Contemporary Accounting Research*, 25(1):219–242.

Hrazdil, K., Trottier, K., and Zhang, R. (2013). A comparison of industry classification schemes: A large sample study. *Economics Letters*, 118(1):77–80.

Jaggi, B., Mitra, S., and Hossain, M. (2015). Earnings quality, internal control weaknesses and industry-specialist audits. *Review of Quantitative Finance and Accounting*, 45:1–32.

Jha, A., Kulchania, M., and Smith, J. (2021). US political corruption and audit fees. *The Accounting Review*, 96(1):299–324.

Jones, J. J. (1991). Earnings management during import relief investigations. *Journal of Accounting Research*, 29(2):193–228.

Kennedy, F. A. and Widener, S. K. (2008). A control framework: Insights from evidence on lean accounting. *Management Accounting Research*, 19(4):301–323.

Kim, I., Kong, J. H., and Yang, R. (2024). The impact of board reforms on audit fees: International evidence. *Journal of Business Finance & Accounting*, 51(1-2):45–83.

Kim, J.-B. and Zhang, L. (2014). Financial reporting opacity and expected crash risk: Evidence from implied volatility smirks. *Contemporary Accounting Research*, 31(3):851–875.

Kinder, T. and Burgoyne, T. (2013). Information processing and the challenges facing lean healthcare. *Financial Accountability & Management*, 29(3):271–290.

Köhler, A. G. and Ratzinger-Sakel, N. V. (2012). Audit and non-audit fees in germany—the impact of audit market characteristics. *Schmalenbach Business Review*, 64(4):281–307.

Kristensen, T. B. and Israelsen, P. (2014). Performance effects of multiple control forms in a lean organization: A quantitative case study in a systems fit approach. *Management Accounting Research*, 25(1):45–62.

Lefebvre, V. (2024). Navigating challenges: lean inventory management and smes performance during the covid-19 crisis and beyond. *Small Business Economics*, 64:1–27.

Leland, H. E. and Pyle, D. H. (1977). Informational asymmetries, financial structure, and financial intermediation. *The Journal of Finance*, 32(2):371–387.

Liu, X., Lobo, G. J., and Yu, H.-C. (2021). Is audit committee equity compensation related to audit fees? *Contemporary Accounting Research*, 38(1):740–769.

Loughran, T. and McDonald, B. (2024). Measuring firm complexity. *Journal of Financial and Quantitative Analysis*, 59(6):2487–2514.

McGrath, R. G. (2024). Who learns fastest, wins: Lean startup and discovery driven growth. *Journal of Management*, 50(8):3162–3182.

Nakandala, D., Elias, A., and Hurriyet, H. (2024). The role of lean, agility and learning ambidexterity in industry 4.0 implementations. *Technological Forecasting and Social Change*, 206:123533.

Neukirchen, D., Köchling, G., and Posch, P. N. (2024). Do institutional investors care about operational leanness? *British Journal of Management*, 35(3):1632–1657.

New, S. (2010). The transparent supply chain. *Harvard Business Review*, 88(10).

Pankratz, N. M. and Schiller, C. M. (2024). Climate change and adaptation in global supply-chain networks. *The Review of Financial Studies*, 37(6):1729–1777.

Pratt, J. and Stice, J. D. (1994). The effects of client characteristics on auditor litigation risk judgments, required audit evidence, and recommended audit fees. *The Accounting Review*, 69(4):639–656.

Rajgopal, S., Srinivasan, S., and Zheng, X. (2021). Measuring audit quality. *Review of Accounting Studies*, 26(2):559–619.

Reichelt, K. J. and Wang, D. (2010). National and office-specific measures of auditor industry expertise and effects on audit quality. *Journal of Accounting Research*, 48(3):647–686.

Shah, R. and Ward, P. T. (2003). Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management*, 21(2):129–149.

Simunic, D. A. (1980). The pricing of audit services: Theory and evidence. *Journal of Accounting Research*, 18(1):161–190.

Sodhi, M. S. and Tang, C. S. (2019). Research opportunities in supply chain transparency. *Production and Operations Management*, 28(12):2946–2959.

Spence, M. (1973). Job market signaling. *Quarterly Journal of Economics*, 87:354–374.

Srinidhi, B., Gul, F. A., and Tsui, J. (2011). Female directors and earnings quality. *Contemporary Accounting Research*, 28(5):1610–1644.

Tang, C. S. (2018). Socially responsible supply chains in emerging markets: Some research opportunities. *Journal of Operations Management*, 57:1–10.

Titman, S. and Trueman, B. (1986). Information quality and the valuation of new issues. *Journal of Accounting and Economics*, 8(2):159–172.

Truong, C., Garg, M., and Adrian, C. (2020). Climate risk and the price of audit services: The case of drought. *Auditing: A Journal of Practice & Theory*, 39(4):167–199.

Tunyi, A. A. (2021). Revisiting acquirer returns: Evidence from unanticipated deals. *Journal of Corporate Finance*, 66:101789.

Tunyi, A. A., Areneke, G., Tob-Ogu, A., and Khalid, S. (2023). Doing more with more: Women on the board and firm employment. *Journal of Business Research*, 154:113385.

Tunyi, A. A., Yang, J., Agyei-Boapeah, H., and Machokoto, M. (2024). Takeover vulnerability and pre-emptive earnings management. *European Accounting Review*, 33(2):677–711.

van der Steen, M. P. and Tillema, S. (2018). Controlling lean manufacturing in multidivisional organisations: Highlighting local interests and constraints. *International Journal of Operations & Production Management*, 38(11):2149–2168.

Widmann, M., Follert, F., and Wolz, M. (2021). What is it going to cost? empirical evidence from a systematic literature review of audit fee determinants. *Management Review Quarterly*, 71(2):455–489.

Williamson, O. E. (1975). *Markets and hierarchies: Analysis and antitrust implications*. The Free Press.

Williamson, O. E. (1979). Transaction-cost economics: The governance of contractual relations. *The Journal of Law and Economics*, 22(2):233–261.

Williamson, O. E. (1981). The Economics of Organization: The transaction cost approach. *American Journal of Sociology*, 87(3):548–577.

Womack, J. P., Jones, D. T., and Roos, D. (1990). *The Machine that Changed the World*. Simon and Schuster, Illustrated edition.

Womack, J. P., Jones, D. T., and Roos, D. (2007). *The Machine that Changed the World: The story of lean production–Toyota's secret weapon in the global car wars that is now revolutionizing world industry*. Simon and Schuster.

Xue, B. and O'Sullivan, N. (2023). The determinants of audit fees in the alternative investment market (aim) in the uk: Evidence on the impact of risk, corporate governance and auditor size. *Journal of International Accounting, Auditing and Taxation*, 50:100523.

Yuan, R., Luo-Yang, L., and Xia, S. (2025). Stock market openness and audit fees: Evidence from the inclusion of china a-shares in the msci emerging markets index. *Accounting and Business Research*, 55(2):156–187.

Table 1 Sample derivation

Description	**Firm year observations**
All observations at the intersection of Compustat and Audit analytics data using CIK	160,044
Exclude:	
Financial firms (SIC codes 6000–6999)	(50,860)
Utilities (SIC codes 4900–4999)	(7,947)
Firm years in industries with less than 6 observations	(9)
Missing values	(42,949)
Final sample size in baseline regression	58,279

Notes: This table presents information about the sample selection.

Table 2 Data distribution by Fama & French 48 Industry groups

Industries	Frequency	Percent
Agriculture	307	0.53
Food Products	1405	2.41
Candy & Soda	267	0.46
Beer & Liquor	298	0.51
Tobacco Products	105	0.18
Recreation	618	1.06
Entertainment	905	1.55
Printing and Publishing	441	0.76
Consumer Goods	1226	2.10
Apparel	994	1.71
Healthcare	982	1.68
Medical Equipment	3628	6.23
Pharmaceutical Products	4792	8.22
Chemicals	2005	3.44
Rubber and Plastic Products	573	0.98
Textiles	255	0.44
Construction Materials	1465	2.51
Construction	641	1.10
Steel Works Etc	956	1.64
Fabricated Products	165	0.28
Machinery	2668	4.58
Electrical Equipment	1345	2.31
Automobiles and Trucks	1354	2.32
Aircraft	538	0.92
Shipbuilding, Railroad Equipment	146	0.25
Defense	205	0.35
Precious Metals	201	0.34
Non-Metallic and Industrial Metal Mining	349	0.60
Coal	290	0.50
Petroleum and Natural Gas	2261	3.88
Communication	1257	2.16
Personal Services	502	0.86
Business Services	4006	6.87
Computers	2231	3.83
Electronic Equipment	5195	8.91
Measuring and Control Equipment	1841	3.16
Business Supplies	668	1.15
Shipping Containers	246	0.42
Transportation	1496	2.57
Wholesale	2930	5.03
Retail	4286	7.35
Restaurants, Hotels, Motels	1428	2.45
Others	808	1.39
Total	58,279	100.00

Notes: This table reports the distribution of firm-year observations across Fama and French's 48 industry groups for the final sample used in the analysis. Industries are ordered by SIC codes. The sample comprises 58,279 firm-year observations from U.S. firms listed on the NYSE and NASDAQ between 2001 and 2024. Industry classifications follow the definitions provided by Kenneth French's data library. The frequencies and percentages are based on non-missing observations after applying all sample selection filters.

Table 3 Descriptive statistics

	N	Mean	SD	P1	P25	P50	P75	P99
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Dependent variable								
Audit fee	58,279	13.371	1.601	8.854	12.254	13.516	14.509	16.803
Audit fee to sales ratio	58,279	3.346	8.443	0.003	0.224	0.872	2.776	46.989
Panel B: Independent variables								
Operational leanness	58,279	0.371	1.204	-2.307	-0.385	0.207	0.978	4.332
Operational leanness standardised	58,279	0.294	0.927	-1.541	-0.355	0.194	0.826	3.157
Operational leanness dummy	58,279	0.520	0.500	0.000	0.000	1.000	1.000	1.000
Operational leanness lagged	52,396	0.330	1.169	-2.326	-0.402	0.185	0.930	4.064
Operational leanness SIC	58,279	0.356	1.177	-2.334	-0.387	0.194	0.942	4.271
Operational leanness NAICS	58,279	0.358	1.166	-2.380	-0.370	0.192	0.941	4.250
Panel C: Controls variables								
Leverage	58,279	0.260	0.337	0.000	0.020	0.187	0.366	1.708
Firm size	58,279	5.846	2.399	0.444	4.130	5.954	7.549	11.168
Profitability	58,279	-0.241	1.511	-5.033	-0.098	0.022	0.071	0.320
Loss dummy	58,279	0.408	0.491	0.000	0.000	0.000	1.000	1.000
Current ratio	58,279	2.734	2.800	0.077	1.265	1.963	3.170	15.008
Busy season	58,279	0.664	0.472	0.000	0.000	1.000	1.000	1.000
Litigation	58,279	0.345	0.475	0.000	0.000	0.000	1.000	1.000
Special items	58,279	0.989	0.106	0.000	1.000	1.000	1.000	1.000
Foreign income	58,279	0.656	0.475	0.000	0.000	1.000	1.000	1.000
Big 4 auditor	58,279	0.660	0.474	0.000	0.000	1.000	1.000	1.000
Auditor opinion	58,279	0.640	0.480	0.000	0.000	1.000	1.000	1.000
Auditor change	58,279	0.089	0.284	0.000	0.000	0.000	0.000	1.000
Auditor tenure	58,279	1.739	0.699	0.693	1.099	1.609	2.303	3.135
Auditor county presence	58,279	15.011	2.438	9.798	13.340	15.355	16.850	18.822
Auditor scale	58,279	4.503	9.398	1.000	1.000	1.500	3.500	55.500
Non-audit fee	58,279	9.958	4.580	0.000	9.473	11.369	12.836	15.831
Panel D: Moderating and Mediating variables								
Audit lag	58,021	4.171	0.368	3.135	4.007	4.143	4.357	5.529
Inventory-MWIC	42,192	0.011	0.106	0.000	0.000	0.000	0.000	1.000
Industry specialist	58,279	0.194	0.396	0.000	0.000	0.000	0.000	1.000
Lean firms in industry	58,279	0.439	0.373	0.000	0.000	0.400	0.727	1.000
No restatement	58,279	0.895	0.307	0.000	1.000	1.000	1.000	1.000
Analyst following	29,455	8.148	7.368	1.000	3.000	6.000	12.000	31.000
Earnings quality	58,174	-0.114	3.839	-14.373	-0.354	-0.041	0.113	15.943
Complexity	40,791	0.211	0.058	0.086	0.171	0.209	0.249	0.358
Female CEO	23,653	0.038	0.191	0.000	0.000	0.000	0.000	1.000
Manufacturing	58,279	0.613	0.487	0.000	0.000	1.000	1.000	1.000

Notes: This table presents descriptive statistics for the variables used in the analysis, based on 58,279 firm-year observations unless otherwise noted. Columns report the number of observations (N), mean, median (P50), standard deviation (SD), and the 1st and 99th percentiles (P1, P99). Panel A reports summary statistics for the dependent variable (audit fees), Panel B covers the main independent variables related to operational leanness, and Panel C presents control and interaction variables included in the regressions. All continuous variables are winsorized at the 1st and 99th percentiles. Detailed variable definitions are provided in Appendix A.

Table 4 Operational leanness and audit fees

	Audit fee			Audit fee to sales ratio		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
Operational leanness	-0.031***			-0.401***		
	(0.006)			(0.092)		
Operational leanness standardised		-0.051***			-0.446***	
		(0.008)			(0.105)	
Operational leanness dummy			-0.079***			-0.337**
			(0.013)			(0.131)
Firm size	0.418***	0.414***	0.418***	1.704***	1.717***	1.792***
	(0.005)	(0.005)	(0.005)	(0.099)	(0.102)	(0.105)
Leverage	0.050***	0.051***	0.049***	-0.217	-0.220	-0.236
	(0.015)	(0.015)	(0.015)	(0.161)	(0.162)	(0.163)
Profitability	-0.022***	-0.022***	-0.021***	-0.421***	-0.420***	-0.421***
	(0.003)	(0.003)	(0.003)	(0.035)	(0.035)	(0.036)
Loss dummy	0.108***	0.106***	0.106***	1.928***	1.923***	1.933***
	(0.010)	(0.010)	(0.010)	(0.118)	(0.118)	(0.118)
Current ratio	-0.033***	-0.033***	-0.033***	0.184***	0.185***	0.189***
	(0.002)	(0.002)	(0.002)	(0.033)	(0.033)	(0.033)
Busy season	0.097***	0.098***	0.096***	0.600***	0.589***	0.551***
	(0.015)	(0.015)	(0.015)	(0.159)	(0.160)	(0.159)
Litigation	0.001	-0.002	-0.003	-0.012	-0.096	-0.148
	(0.029)	(0.029)	(0.029)	(0.336)	(0.328)	(0.326)
Special items	0.004	0.003	0.003	0.698***	0.684***	0.680**
	(0.030)	(0.030)	(0.030)	(0.265)	(0.265)	(0.265)
Foreign income	-0.083***	-0.082***	-0.083***	1.104***	1.098***	1.078***
	(0.012)	(0.012)	(0.012)	(0.180)	(0.179)	(0.178)
Big 4 auditor	0.030	0.030	0.029	-1.211***	-1.217***	-1.231***
	(0.020)	(0.020)	(0.020)	(0.223)	(0.223)	(0.224)
Auditor opinion	-0.091***	-0.090***	-0.090***	-0.546***	-0.546***	-0.557***
	(0.008)	(0.008)	(0.008)	(0.094)	(0.094)	(0.094)
Auditor change	-0.128***	-0.128***	-0.128***	-0.100	-0.104	-0.097
	(0.015)	(0.015)	(0.015)	(0.159)	(0.159)	(0.159)
Auditor county presence	0.185***	0.185***	0.185***	0.016	0.016	0.018
	(0.005)	(0.005)	(0.005)	(0.032)	(0.032)	(0.032)
Auditor scale	-0.008***	-0.008***	-0.008***	0.054***	0.055***	0.054***
	(0.001)	(0.001)	(0.001)	(0.015)	(0.015)	(0.015)
Auditor tenure	-0.003	-0.004	-0.004	-0.264*	-0.272*	-0.269*
	(0.010)	(0.010)	(0.010)	(0.156)	(0.157)	(0.157)
Non-audit fee	0.016***	0.016***	0.016***	0.046***	0.046***	0.047***
	(0.001)	(0.001)	(0.001)	(0.013)	(0.013)	(0.013)
Constant	7.346***	7.364***	7.368***	-10.902***	-10.968***	-11.262***
	(0.134)	(0.134)	(0.135)	(1.229)	(1.231)	(1.245)
Observations	58,279	58,279	58,279	58,279	58,279	58,279
Adjusted R-squared	0.826	0.826	0.826	0.253	0.252	0.251
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports coefficient estimates from OLS regressions examining the relationship between operational leanness and audit fees. Columns (1) to (3) use the natural logarithm of audit fees as the dependent variable, and Columns (4) to (6) use audit fees scaled by total sales. Operational leanness is measured using three variants: continuous (Columns 1 and 4), standardized (Columns 2 and 5), and a binary indicator (Columns 3 and 6). All regressions include industry and year fixed effects. Firm-level clustered standard errors are reported in parentheses beneath the respective coefficients. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in Appendix A.

Table 5 PSM and 2 SLS

Variables	Audit fee (1)	Operational leanness (2)	Audit fee (3)
Operational leanness	-0.045***		-0.065***
	(0.007)		(0.016)
Lean firms in industry		1.052***	
		(0.026)	
Firm size	0.408***	-0.259***	0.407***
	(0.007)	(0.008)	(0.007)
Leverage	0.053**	0.056*	0.052***
	(0.023)	(0.028)	(0.015)
Profitability	-0.022***	0.008	-0.022***
	(0.004)	(0.005)	(0.003)
Loss dummy	0.119***	-0.014	0.106***
	(0.013)	(0.015)	(0.010)
Current ratio	-0.029***	-0.012***	-0.033***
	(0.002)	(0.003)	(0.002)
Busy season	0.095***	0.144***	0.103***
	(0.017)	(0.024)	(0.015)
Litigation	0.023	0.413***	0.016
	(0.034)	(0.059)	(0.030)
Special items	-0.004	0.072*	0.006
	(0.037)	(0.042)	(0.030)
Foreign income	-0.092***	0.075***	-0.080***
	(0.014)	(0.019)	(0.012)
Big 4 auditor	0.077***	0.051*	0.032
	(0.023)	(0.026)	(0.020)
Auditor opinion	-0.100***	0.031**	-0.089***
	(0.011)	(0.013)	(0.008)
Auditor change	-0.138***	-0.018	-0.128***
	(0.022)	(0.018)	(0.015)
Auditor county presence	0.178***	0.010*	0.185***
	(0.007)	(0.006)	(0.005)
Auditor scale	-0.008***	0.002	-0.008***
	(0.001)	(0.002)	(0.001)
Auditor tenure	-0.010	-0.010	-0.003
	(0.012)	(0.016)	(0.010)
Non-audit fee	0.017***	-0.003	0.016***
	(0.002)	(0.002)	(0.001)
Constant	7.309***	0.818***	7.405***
	(0.145)	(0.151)	(0.138)
Observations	30,720	58,279	58,279
Adjusted R-squared	0.751	0.465	0.826
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Panel B: Instrument validity tests for IV regression			
1. Underidentification test Kleibergen-Paap rk LM statistic (p-val)			887.335 (0.00)
2. Weak identification tests			
Cragg-Donald Wald F statistic			9236.706
Kleibergen-Paap rk Wald F statistic			1,655.409
Stock-Yogo weak ID test critical values: 10% maximal IV size			16.38

Notes: This table presents coefficient estimates from the regressions exploring the relationship between leanness and audit fees. All variables are fully defined in Appendix A. Firm-level clustered standard errors are reported in parentheses beneath the respective coefficients. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors are clustered at the firm level.

Table 6 Mediation analysis

Variables	Audit lag (1)	Audit fee (2)	Inventory-MWIC (3)	Audit fee (4)
Operational leanness	-0.015***	-0.028***	-0.325***	-0.034***
	(0.002)	(0.006)	(0.060)	(0.007)
Audit lag		0.173***		
		(0.016)		
Inventory-MWIC				0.161***
				(0.038)
Firm size	-0.060***	0.428***	-0.285***	0.415***
	(0.002)	(0.005)	(0.052)	(0.006)
Leverage	0.049***	0.043***	-0.035	0.067***
	(0.007)	(0.015)	(0.120)	(0.018)
Profitability	-0.003*	-0.022***	0.133**	-0.016***
	(0.002)	(0.003)	(0.060)	(0.003)
Loss dummy	0.067***	0.096***	0.502***	0.109***
	(0.004)	(0.010)	(0.130)	(0.012)
Current ratio	-0.010***	-0.031***	-0.064**	-0.032***
	(0.001)	(0.002)	(0.027)	(0.002)
Busy season	0.029***	0.092***	-0.157	0.053***
	(0.005)	(0.015)	(0.149)	(0.017)
Litigation	-0.025**	0.008	-0.138	-0.016
	(0.011)	(0.029)	(0.253)	(0.034)
Special items	-0.020*	0.005	0.441	0.053*
	(0.012)	(0.030)	(0.512)	(0.031)
Foreign income	0.013***	-0.085***	0.002	-0.066***
	(0.004)	(0.012)	(0.121)	(0.013)
Big 4 auditor	-0.024***	0.036*	-0.432**	0.044*
	(0.006)	(0.020)	(0.176)	(0.025)
Auditor opinion	-0.054***	-0.081***	-0.283**	-0.082***
	(0.004)	(0.008)	(0.121)	(0.010)
Auditor change	-0.027***	-0.125***	0.284*	-0.159***
	(0.006)	(0.015)	(0.171)	(0.018)
Auditor county presence	0.002	0.185***	0.071*	0.194***
	(0.001)	(0.005)	(0.043)	(0.007)
Auditor scale	-0.000	-0.008***	0.011	-0.008***
	(0.000)	(0.001)	(0.011)	(0.001)
Auditor tenure	-0.076***	0.009	-0.269**	-0.020*
	(0.004)	(0.010)	(0.132)	(0.012)
Non-audit fee	-0.003***	0.016***	-0.006	0.013***
	(0.000)	(0.001)	(0.013)	(0.002)
Constant	4.387***	6.583***	-1.416	7.043***
	(0.033)	(0.152)	(1.040)	(0.145)
Observations	58,021	58,021	41,695	42,192
Adjusted R-squared	0.351	0.827		0.825
Pseudo R-squared			0.107	
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Sobel test p values		0.000		0.001
Proportion of total effects mediated		0.083		0.020
Ratio of indirect to direct effect		0.091		0.020
Ratio of total to direct effect		1.091		1.020

Notes: This table reports coefficient estimates from regressions assessing the mediating role of audit effort (proxied by audit lag) and internal control risk (proxied by inventory-related material control weaknesses) in the relationship between operational leanness and audit fees. Columns (1) and (2) test the audit lag channel, while Columns (3) and (4) test the control weakness channel. All regressions include firm-level controls, as well as year and industry fixed effects. Firm-level clustered standard errors are reported in parentheses beneath the respective coefficients. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The Sobel test assesses the statistical significance of the mediation effect. The proportion of the total effect mediated, the ratio of indirect to direct effects, and the ratio of total to direct effects are reported at the bottom of the table. Variable definitions are provided in Appendix A.

Table 7 Moderating effects

	Audit fee			
	(1)	(2)	(3)	(4)
Operational leanness X Industry specialist	-0.065***			
	(0.014)			
Industry specialist	-0.020			
	(0.015)			
Operational leanness X Earnings quality		-0.001*		
		(0.000)		
Earnings quality		0.001		
		(0.001)		
Operational leanness X No restatement			-0.016**	
			(0.008)	
No restatement			-0.035***	
			(0.011)	
Operational leanness X Analyst following				-0.005***
				(0.001)
Analyst following				-0.010***
				(0.002)
Operational leanness	-0.020***	-0.031***	-0.017*	0.000
	(0.006)	(0.006)	(0.009)	(0.011)
Firm size	0.416***	0.418***	0.418***	0.465***
	(0.005)	(0.005)	(0.005)	(0.009)
Leverage	0.050***	0.050***	0.051***	0.017
	(0.015)	(0.015)	(0.015)	(0.038)
Profitability	-0.021***	-0.023***	-0.022***	-0.097***
	(0.003)	(0.003)	(0.003)	(0.022)
Loss dummy	0.108***	0.108***	0.108***	0.099***
	(0.010)	(0.010)	(0.010)	(0.014)
Current ratio	-0.033***	-0.033***	-0.033***	-0.037***
	(0.002)	(0.002)	(0.002)	(0.003)
Busy season	0.097***	0.097***	0.097***	0.107***
	(0.015)	(0.015)	(0.015)	(0.020)
Litigation	-0.000	0.001	0.001	-0.000
	(0.029)	(0.029)	(0.029)	(0.036)
Special items	0.004	0.003	0.004	-0.009
	(0.030)	(0.030)	(0.030)	(0.039)
Foreign income	-0.083***	-0.082***	-0.083***	-0.055***
	(0.012)	(0.012)	(0.012)	(0.014)
Big 4 auditor	0.044**	0.031	0.031	0.083***
	(0.020)	(0.020)	(0.020)	(0.030)
Auditor opinion	-0.089***	-0.091***	-0.091***	-0.072***
	(0.008)	(0.008)	(0.008)	(0.011)
Auditor change	-0.129***	-0.129***	-0.129***	-0.237***
	(0.015)	(0.015)	(0.015)	(0.027)
Auditor county presence	0.186***	0.184***	0.185***	0.156***
	(0.005)	(0.005)	(0.005)	(0.009)
Auditor scale	-0.008***	-0.008***	-0.008***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Auditor tenure	-0.004	-0.004	-0.003	-0.036**
	(0.010)	(0.010)	(0.010)	(0.015)
Non-audit fee	0.016***	0.016***	0.016***	0.017***
	(0.001)	(0.001)	(0.001)	(0.002)
Constant	7.316***	7.347***	7.383***	7.481***
	(0.132)	(0.134)	(0.135)	(0.190)
Observations	58,279	58,174	58,279	29,455
Adjusted R-squared	0.827	0.826	0.826	0.764
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes

Notes: This table presents coefficient estimates from the regressions exploring factors that moderate the relationship between leanness and audit fees. All variables are fully defined in Appendix A. Firm-level clustered standard errors are reported in parentheses beneath the respective coefficients. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors are clustered at the firm level.

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Table 8 Moderating effects

	Audit fee			
	(1)	(2)	(3)	(4)
Operational leanness X Complexity	-0.291***			
	(0.081)			
Complexity	2.135***			
	(0.132)			
Operational leanness X Female CEO		-0.120***		
		(0.040)		
Female CEO		0.015		
		(0.043)		
Operational leanness X Manufacturing			-0.057***	
			(0.010)	
Manufacturing			-0.003	
			(0.050)	
Operational leanness X Services				0.037***
				(0.012)
Services				0.040
				(0.058)
Operational leanness	0.025	-0.073***	-0.011	-0.043***
	(0.019)	(0.013)	(0.008)	(0.007)
Firm size	0.398***	0.424***	0.415***	0.416***
	(0.006)	(0.009)	(0.005)	(0.005)
Leverage	0.007	0.084*	0.052***	0.052***
	(0.018)	(0.044)	(0.015)	(0.015)
Profitability	-0.021***	-0.112***	-0.023***	-0.022***
	(0.003)	(0.020)	(0.003)	(0.003)
Loss dummy	0.063***	0.094***	0.108***	0.108***
	(0.012)	(0.015)	(0.010)	(0.010)
Current ratio	-0.030***	-0.045***	-0.032***	-0.033***
	(0.002)	(0.005)	(0.002)	(0.002)
Busy season	0.081***	0.112***	0.096***	0.097***
	(0.016)	(0.023)	(0.015)	(0.015)
Litigation	-0.002	-0.091**	-0.006	-0.008
	(0.032)	(0.044)	(0.029)	(0.029)
Special items	-0.009	-0.027	0.003	0.006
	(0.038)	(0.042)	(0.030)	(0.030)
Foreign income	-0.069***	-0.031**	-0.083***	-0.083***
	(0.013)	(0.016)	(0.012)	(0.012)
Big 4 auditor	0.038	0.005	0.032	0.031
	(0.024)	(0.038)	(0.020)	(0.020)
Auditor opinion	-0.074***	-0.067***	-0.091***	-0.091***
	(0.009)	(0.011)	(0.008)	(0.008)
Auditor change	-0.122***	-0.221***	-0.128***	-0.129***
	(0.017)	(0.035)	(0.015)	(0.015)
Auditor county presence	0.170***	0.154***	0.184***	0.185***
	(0.006)	(0.013)	(0.005)	(0.005)
Auditor scale	-0.008***	-0.005***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Auditor tenure	0.037***	-0.048***	-0.002	-0.004
	(0.014)	(0.017)	(0.010)	(0.010)
Non-audit fee	0.018***	0.028***	0.016***	0.016***
	(0.002)	(0.003)	(0.001)	(0.001)
Constant	7.194***	7.699***	7.356***	7.353***
	(0.145)	(0.263)	(0.135)	(0.134)
Observations	40,791	23,653	58,279	58,279
Adjusted R-squared	0.822	0.753	0.827	0.826
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes

Notes: This table presents coefficient estimates from the regressions exploring factors that moderate the relationship between leanness and audit fees. All variables are fully defined in Appendix A. Firm-level clustered standard errors are reported in parentheses beneath the respective coefficients. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors are clustered at the firm level.

Table 9 Robustness: Alternative measures, model specifications and lagged independent variables

	Audit fee						
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Operational leanness	-0.035***	-0.029***	-0.030***	-0.315***			
	(0.007)	(0.007)	(0.006)	(0.010)			
Operational leanness lagged					-0.035***		
					(0.006)		
Operational leanness SIC						-0.036***	
						(0.006)	
Operational leanness NAICS							-0.032***
							(0.006)
Firm size	0.316***	0.429***	0.419***		0.420***	0.416***	0.423***
	(0.009)	(0.006)	(0.005)		(0.005)	(0.005)	(0.005)
Leverage	0.018	0.044**	0.043***	0.147***	0.047***	0.050***	0.055***
	(0.013)	(0.018)	(0.015)	(0.028)	(0.016)	(0.015)	(0.015)
Profitability	-0.018***	-0.025***	-0.024***	0.076***	-0.023***	-0.022***	-0.023***
	(0.003)	(0.004)	(0.003)	(0.005)	(0.003)	(0.003)	(0.003)
Loss dummy	0.048***	0.107***	0.111***	-0.223***	0.113***	0.108***	0.109***
	(0.008)	(0.012)	(0.010)	(0.015)	(0.011)	(0.010)	(0.010)
Current ratio	-0.018***	-0.032***	-0.034***	-0.058***	-0.032***	-0.033***	-0.033***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Busy season	0.049	0.076***	0.102***	0.220***	0.101***	0.097***	0.102***
	(0.067)	(0.017)	(0.015)	(0.025)	(0.015)	(0.015)	(0.015)
Litigation		0.044	0.001		0.007	0.000	-0.005
		(0.037)	(0.030)		(0.031)	(0.029)	(0.021)
Special items	0.010	-0.010	-0.008	-0.010	0.014	0.005	0.010
	(0.022)	(0.033)	(0.031)	(0.047)	(0.031)	(0.030)	(0.030)
Foreign income	-0.036***	-0.073***	-0.082***	-0.270***	-0.077***	-0.083***	-0.076***
	(0.011)	(0.014)	(0.012)	(0.019)	(0.012)	(0.012)	(0.012)
Big 4 auditor	0.004	0.036	0.035*	1.168***	0.044**	0.031	0.031
	(0.030)	(0.023)	(0.020)	(0.025)	(0.022)	(0.020)	(0.019)
Auditor opinion	-0.046***	-0.085***	-0.092***	-0.085***	-0.091***	-0.091***	-0.092***
	(0.005)	(0.009)	(0.008)	(0.013)	(0.009)	(0.008)	(0.008)
Auditor change	-0.109***	-0.112***	-0.128***	-0.083***	-0.145***	-0.128***	-0.128***
	(0.015)	(0.017)	(0.015)	(0.021)	(0.015)	(0.015)	(0.015)
Auditor county presence	0.257***	0.176***	0.184***		0.182***	0.185***	0.183***
	(0.009)	(0.007)	(0.005)		(0.006)	(0.005)	(0.005)
Auditor scale	-0.005**	-0.007***	-0.008***	0.009***	-0.007***	-0.008***	-0.008***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Auditor tenure	-0.094***	0.009	-0.004	0.158***	-0.025**	-0.003	-0.005
	(0.016)	(0.012)	(0.010)	(0.016)	(0.011)	(0.010)	(0.010)
Non-audit fee	0.008***	0.018***	0.016***	0.062***	0.016***	0.016***	0.015***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Constant	6.994***	7.385***	7.364***	10.966***	7.353***	7.353***	7.297***
	(0.140)	(0.141)	(0.134)	(0.162)	(0.142)	(0.134)	(0.123)
Observations	58,279	44,006	53,679	58,279	53,199	58,279	58,279
Number of gvkey	6,495						
Adjusted R-squared	0.519	0.832	0.826	0.641	0.826	0.826	0.828
Firm fixed effects	Yes	No	No	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents coefficient estimates from the regressions exploring the relationship between leanness and audit fees. All variables are fully defined in Appendix A. Firm-level clustered standard errors are reported in parentheses beneath the respective coefficients. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors are clustered at the firm level.

Appendix A Definition of variables

Variables	Variable definition	Data source
Audit fee	Natural logarithm of audit fees paid to the external auditor.	Audit Analytics
Audit fee to sales ratio	Audit fees divided by sales.	Audit Analytics
Operational leanness	Measure of operational leanness as proposed by Eroglu and Hofer (2011).	Compustat
Operational leanness standardized	Studentized measure of operational leanness as proposed by Eroglu and Hofer (2011).	Compustat
Operational leanness dummy	A binary dummy variable equal to one if the Operational leanness value of the firm is greater than the median Operational leanness value of the industry in that year.	Compustat
Firm size	Natural logarithm of total assets.	Compustat
Leverage	Ratio of total liabilities to total assets.	Compustat
Profitability	Ratio of net income to total assets (ROA).	Compustat
Loss dummy	Indicator variable which equals one if ROA is negative, and zero otherwise.	Compustat
Current ratio	Current assets divided by current liabilities	Compustat
Busy season	Indicator variable which equals one if the fiscal year ends in December, and zero otherwise.	Audit Analytics
Litigation	Indicator variable which equals one if a client operates in a high litigation risk industry (4-digit SIC codes 2833-2836, 3570-3577, 3600-3674, 5200-5961, and 7370-7374), and zero otherwise.	Compustat
Special items	Indicator variable which equals one if the client reports special items, and zero otherwise.	Compustat
Foreign income	Indicator variable which equals one if clients have more than 50% of their pre-tax income attributed to foreign income, and zero otherwise.	Compustat
Big 4 auditor	Indicator variable which equals one if a client is audited by one of the Big 4 firms, and zero otherwise.	Audit Analytics
Auditor opinion	Indicator variable which equals one if the auditor issues an unqualified opinion, and zero otherwise.	Compustat
Auditor change	Indicator variable which equals one if the auditor has changed in the fiscal year, and zero otherwise.	Audit Analytics
Auditor county presence	Natural logarithm of the sum of audit fees paid to an auditor from clients in a county.	Audit Analytics
Auditor scale	This variable measures how large-scale the auditor is from an industry and county perspective. It is calculated by ranking auditors by the total number of clients they have in each Fama-French industry by county-year in percentile for each year. Finally, we divide it by 100.	Audit Analytics
Auditor tenure	Natural log of length of time an auditor has continuously provided audit services to a particular client.	Audit Analytics
Non-audit fee	Natural logarithm of non-audit fees paid to the external auditor.	Audit Analytics
Operational leanness SIC	Operational leanness measured by using two-digit SIC numbers for industry classification.	Compustat
Operational leanness NAICS	Operational leanness measured by using three-digit NAICS for industry classification.	Compustat
Lean firms in industry	Percentage of lean firms in each Fama-French industry in each county in a year. The lean firm is identified as the firm with Operational leanness greater than the median value of all firms in a particular year.	Compustat
Audit lag	Difference auditor signature date and fiscal year end date.	Audit Analytics
Inventory-MWIC	Material control weaknesses (as per Section 404) related to inventory extracted by following Feng et al. (2015). A dummy that takes a value of 1 for firms that report an inventory-related material weakness in internal control in year t, and 0 otherwise.	Audit Analytics
Industry specialist	Indicator variable which equals one if the ratio of total sale of firms audited by an auditor for the industry (Fama and French 48 sectors) to the total sales collected is the highest, and zero otherwise.	Audit Analytics
No-restatement	Indicator variable which equals one if the firm has no restatement, and zero otherwise.	Audit Analytics
Analyst following	Number of analysts following.	I/B/E/S (Institutional Brokers' Estimate System).
Earnings quality	Discretionary accruals calculated using Jones (1991) model and multiplied by -1.	Compustat
Complexity	Textual measure of business complexity from using 10-K reports.	Loughran and McDonald (2024)
Female CEO	Indicator variable which equals one if the CEO of the firm is a female, and zero otherwise.	Execucomp
Manufacturing	Binary dummy equal to 1 if SIC code greater than 2000 and less than 3999 (Bendig et al., 2017), and zero otherwise.	Compustat
Services	Binary dummy equal to 1 if SIC code greater than 7000 and less than 8999, and zero otherwise.	Compustat

Appendix B
Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Audit fee	1.00																
(2) Operational lean	-0.48*	1.00															
(3) Firm size	0.85*	-0.55*	1.00														
(4) Leverage	0.06*	0.03*	0.04*	1.00													
(5) Profitability	0.23*	-0.18*	0.32*	-0.24*	1.00												
(6) Loss dummy	-0.28*	0.23*	-0.40*	0.13*	-0.25*	1.00											
(7) Current ratio	-0.14*	-0.00	-0.12*	-0.25*	0.10*	-0.01	1.00										
(8) Busy season	0.10*	0.06*	0.06*	0.09*	-0.03*	0.09*	-0.04*	1.00									
(9) Litigation	-0.08*	0.07*	-0.11*	-0.05*	-0.04*	0.11*	0.08*	-0.11*	1.00								
(10) Special items	-0.02*	0.01*	-0.02*	0.00	-0.01	0.02*	0.01	-0.00	0.01	1.00							
(11) Foreign income	-0.29*	0.19*	-0.25*	0.02*	-0.09*	0.03*	0.00	-0.01*	0.02*	0.01	1.00						
(12) Big 4 auditor	0.57*	-0.36*	0.61*	0.01	0.19*	-0.24*	-0.04*	0.04*	-0.02*	0.00	-0.19*	1.00					
(13) Auditor opinion	0.02*	-0.02*	0.07*	-0.12*	0.17*	-0.13*	0.14*	-0.05*	-0.01	-0.00	-0.02*	-0.02*	1.00				
(14) Auditor change	-0.21*	0.11*	-0.20*	0.00	-0.09*	0.10*	-0.00	0.01	0.01*	-0.00	0.06*	-0.22*	-0.03*	1.00			
(15) Auditor county pres.	0.71*	-0.35*	0.63*	-0.00	0.21*	-0.19*	-0.04*	0.08*	0.01	-0.01	-0.23*	0.65*	0.02*	-0.21*	1.00		
(16) Auditor scale	0.13*	-0.02*	0.12*	-0.02*	0.02*	0.05*	0.06*	0.07*	0.15*	-0.01*	-0.04*	0.15*	-0.02*	-0.04*	0.33*	1.00	
(17) Auditor tenure	0.48*	-0.22*	0.44*	0.02*	0.12*	-0.21*	-0.03*	0.03*	-0.04*	-0.01	-0.15*	0.31*	0.11*	-0.47*	0.35*	0.05*	1.00
(18) Non-audit fee	0.43*	-0.32*	0.49*	-0.01*	0.19*	-0.21*	-0.06*	-0.01	-0.05*	-0.00	-0.15*	0.42*	0.00	-0.17*	0.35*	0.06*	0.20*
VIF		1.62	3.80	1.20	1.26	1.36	1.22	1.14	4.68	1.00	1.14	2.27	1.29	1.41	2.45	1.53	2.19

Note: Variance inflation factors (VIF) are presented at the bottom of the table. *** p<0.01, ** p<0.05, * p<0.10

Appendix C PSM diagnostics

Variable	Match	Treated	Control	%Bias	%Reduct	t-test	p-value	V(T)/V(C)
Firm size	U	4.731	7.038	-109.7		-132.30	0.000	1.08*
	M	5.9628	5.955	0.4	99.7	0.38	0.706	1.04*
Leverage	U	0.2596	0.2603	-0.2		-0.25	0.800	2.24*
	M	0.2522	0.2423	2.9	-1288.0	2.89	0.004	0.96*
Profitability	U	-0.4050	-0.0654	-22.9		-27.29	0.000	6.49*
	M	-0.1557	-0.1424	-0.9	96.1	-0.93	0.350	1.95*
Loss dummy	U	0.4937	0.3156	36.9		44.47	0.000	.
	M	0.3883	0.3876	0.1	99.6	0.13	0.898	.
Current ratio	U	2.7962	2.6678	4.6		5.54	0.000	1.76*
	M	2.9443	2.9822	-1.4	70.5	-1.11	0.265	1.62*
Busy season	U	0.6846	0.6429	8.8		10.66	0.000	.
	M	0.6691	0.6686	0.1	98.8	0.10	0.923	.
Litigation	U	0.3691	0.3187	10.6		12.81	0.000	.
	M	0.3401	0.3436	-0.7	93.0	-0.65	0.516	.
Special items	U	0.9892	0.9878	1.4		1.65	0.098	.
	M	0.9889	0.9890	-0.1	95.5	-0.05	0.956	.
Foreign income	U	0.7303	0.5774	32.6		39.36	0.000	.
	M	0.6391	0.6348	0.9	97.2	0.77	0.441	.
Big 4 auditor	U	0.5134	0.8161	-67.7		-81.34	0.000	.
	M	0.7079	0.7087	-0.2	99.7	-0.16	0.870	.
Auditor opinion	U	0.6485	0.6303	3.8		4.56	0.000	.
	M	0.6574	0.6620	-1.0	74.5	-0.85	0.393	.
Auditor change	U	0.1150	0.0608	19.2		23.10	0.000	.
	M	0.0826	0.0820	0.2	99.0	0.17	0.868	.
Auditor county presence	U	14.338	15.731	-59.9		-71.94	0.000	1.69*
	M	15.217	15.225	-0.3	99.4	-0.31	0.758	1.12*
Auditor scale	U	4.4674	4.5408	-0.8		-0.94	0.346	0.97*
	M	4.6007	4.646	-0.5	38.3	-0.41	0.682	0.96*
Auditor tenure	U	1.6101	1.8772	-38.9		-46.95	0.000	0.86*
	M	1.7425	1.7368	0.8	97.9	0.73	0.468	1.03
Non-audit fee	U	8.7357	11.265	-57.6		-69.32	0.000	1.43*
	M	10.019	10.064	-1.0	98.2	-0.90	0.370	0.96*

Notes: This table presents covariate balance diagnostics before (U = unmatched) and after (M = matched) propensity score matching (PSM). "Treated" refers to firms classified as operationally lean, and "Control" refers to matched non-lean firms. Columns report the mean values of each covariate for treated and control groups, standardized percentage bias, bias reduction after matching (%Reduct), two-sample t-test statistics and associated p-values for equality of means, and the ratio of variances of treated to control groups (V(T)/V(C)). A variance ratio close to 1 indicates homoscedasticity across groups. An asterisk (*) on V(T)/V(C) indicates an acceptable variance ratio (between 0.8 and 1.25). Missing values in V(T)/V(C) reflect binary variables. Variable definitions are provided in Appendix A. Matching is performed using nearest-neighbor matching without replacement and common support. All continuous variables are winsorized at the 1st and 99th percentiles.