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Reconfiguring Digitally Enabled Internal Audit Capabilities Under Information Asymmetry: Evidence on Fraud Risk Boundaries

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Abstract

Purpose:

This study examines how digitally enabled internal audit capabilities are reconfigured under conditions of information asymmetry, with a specific focus on identifying the boundaries within which internal audit can meaningfully mitigate accounting fraud risk.

Methodology/Design/Approach

The study adopts an empirical design combining advanced data-intensive analytical mechanisms with internal audit processes in complex organizational settings. A multi-period dataset is analyzed to assess how digitally enabled audit practices influence different categories of fraud risk under asymmetric information conditions. Robust econometric techniques are employed to test capability reconfiguration effects while accounting for organizational and environmental constraints.

Findings

The results show that digital enablement does not uniformly reduce fraud risk. Instead, it selectively expands internal audit capabilities in transaction-based and process-related fraud while exhibiting limited effectiveness against collusive and strategically concealed fraud. Information asymmetry is found to act as a structural constraint that defines the upper boundaries of internal audit effectiveness, even in digitally enabled environments.

Originality and Value

Rather than treating digitalization as a universal solution, this study introduces a boundary-based perspective that explains where and why digitally enabled internal audit succeeds or fails. These reframing advances auditing research by shifting the focus from effectiveness claims to capability limits under real-world conditions.

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Theoretical, Practical, and Social Implications

The study contributes theoretically by integrating capability theory with information asymmetry in internal auditing. Practically, it guides audit leaders on realistic expectations of digital enablement. Socially, it supports more credible fraud prevention strategies by avoiding overreliance on technological promises.

Keywords: Internal audit; Digital enablement; Fraud risk; Information asymmetry; Capability boundaries.

1. Introduction

1.1 Background and Context

Internal auditing has undergone a profound transformation as organizations increasingly operate in data-intensive and digitally mediated environments. Traditional internal audit models—largely designed for periodic, sample-based assurance—are being challenged by complex transaction flows, real-time information systems, and heightened expectations for proactive risk management (Vasarhelyi et al., 2023). In parallel, accounting fraud risks have become more sophisticated, often embedded within processes, information flows, and managerial discretion rather than isolated transactional anomalies (Appelbaum et al., 2023).

Recent literature acknowledges that digital enablement can enhance the analytical reach of internal audit by allowing continuous monitoring, pattern recognition, and anomaly detection across large datasets (Alles & Gray, 2024). However, the prevailing narrative tends to implicitly assume that digital tools uniformly strengthen internal audit effectiveness. Such an assumption overlooks a critical contextual constraint: information asymmetry. In many organizational settings, especially complex and multi-layered structures, management retains superior, timely, and nuanced information relative to internal auditors, thereby shaping what auditors can realistically observe, interpret, and challenge (Bhimani & Willcocks, 2022).

Information asymmetry has long been recognized as a foundational problem in accounting and governance research, yet its implications for digitally enabled internal audit capabilities remain underexplored. While digitalization increases data availability, it does not necessarily eliminate asymmetries related to access, interpretation, and strategic withholding of information (Arnold, 2023). Consequently, internal audit may become more powerful in some domains—such as transaction-based or process-level risks—while remaining constrained in others, including collusive or strategically concealed fraud (Krahel & Titera, 2022).

Against this backdrop, an emerging stream of research calls for moving beyond binary assessments of audit effectiveness toward a capability-based perspective that recognizes limits, trade-offs, and boundary conditions (Moll & Yigitbasioglu, 2023). From this viewpoint, digital enablement does not simply "improve" internal audit; rather, it reconfigures what internal audit can and cannot do under specific informational environments. This reframing is particularly important for managerial auditing contexts, where internal audit functions are expected not only

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to detect irregularities but also to support managerial decision-making and organizational learning (Free & Trotman, 2023).

1.2 Research Problem Statement

Despite rapid growth in studies on digitalization and auditing, three interrelated gaps persist. First, much of the literature treats internal audit effectiveness as a homogeneous outcome, without distinguishing among different categories of fraud risk (Curtis et al., 2024). Second, the role of information asymmetry is often acknowledged conceptually but rarely modeled as a structural constraint that shapes audit capability boundaries (Heese et al., 2023). Third, existing studies frequently emphasize technological potential while under-theorizing the conditions under which digitally enabled internal audit remains limited (Rikhardsson & Yigitbasioglu, 2023).

As a result, it remains unclear where digitally enabled internal audit meaningfully mitigates fraud risk, where it does not, and why such boundaries persist even in advanced data environments. Addressing this problem requires a shift from claims of universal effectiveness toward a nuanced examination of capability reconfiguration under information asymmetry.

1.3 Research Objectives and Research Questions

Building on the identified gaps, this study aims to advance understanding of how digitally enabled internal audit capabilities are reconfigured under conditions of information asymmetry, rather than assuming uniform improvements in audit effectiveness. Specifically, the study pursues four interrelated objectives. First, it seeks to conceptualize digital enablement in internal auditing as a process of capability reconfiguration rather than technological enhancement per se (Sutton et al., 2023). Second, it aims to differentiate among categories of accounting fraud risk and examine how internal audit capabilities vary across these categories in asymmetric information environments (Bierstaker et al., 2024). Third, the study investigates the extent to which information asymmetry constrains digitally enabled internal audit, even in data-rich organizational contexts (Leoni et al., 2023). Finally, it integrates empirical evidence with comparative case analysis to uncover boundary conditions that remain invisible in purely quantitative designs (Ahrens & Chapman, 2022).

Guided by these objectives, the study addresses the following research questions:

(1) How are internal audit capabilities reconfigured when audit functions become digitally enabled?
(2) Under what conditions does digital enablement meaningfully mitigate specific types of accounting fraud risk?
(3) How does information asymmetry define the boundaries of internal audit effectiveness in digitally mediated environments?
(4) Why do certain fraud risks remain resistant to internal audit intervention despite advanced analytical tools?

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1.4 Significance of the Study

The significance of this study is threefold. From a professional perspective, internal audit leaders face increasing pressure to justify investments in digital tools while managing expectations regarding their impact on fraud prevention (IIA Research Foundation, 2023). By clarifying capability boundaries, this study provides a more realistic basis for strategic audit planning. From an organizational perspective, understanding the limits of digitally enabled internal audit helps senior management avoid overreliance on technological solutions in environments characterized by persistent information asymmetry (Tiron-Tudor et al., 2023). From a societal perspective, more credible and transparent fraud mitigation strategies enhance trust in corporate governance and resource stewardship, particularly in complex organizational systems (OECD, 2023).

1.5 Contributions of the Study

This study makes three core contributions. Theoretically, it extends internal auditing literature by integrating capability theory with information asymmetry to explain why digital enablement reshapes, rather than eliminates, audit constraints (Engelbrecht et al., 2022). Empirically, it provides evidence that digitally enabled internal audit exhibits heterogeneous effects across fraud risk categories, challenging the dominant assumption of uniform effectiveness (Kokina & Blanchette, 2023). Practically, it offers actionable insights for managerial auditing by identifying where digital tools add the most value and where complementary governance mechanisms remain essential (Bini et al., 2024).

1.6 Structure of the Paper

The remainder of the paper is structured as follows. Section 2 reviews relevant literature and theoretical frameworks on internal auditing, fraud risk, digital enablement, and information asymmetry. Section 3 develops the conceptual model and formulates boundary-based research hypotheses. Section 4 outlines the research methodology and comparative case study design. Section 5 presents the empirical findings and applied analysis. Section 6 discusses the results in relation to prior literature, comparative cases, and theoretical expectations, and derives practical and societal implications. Section 7 concludes the study by summarizing key insights and outlining directions for future research.

2: Literature Review and Theoretical Foundations

2.1 Internal Audit in Digitally Enabled Organizational Environments

The role of internal audit has expanded significantly over the past decade, moving beyond its traditional assurance orientation toward a more strategic, risk-focused, and advisory function. Recent literature emphasizes that internal audit now operates within digitally enabled organizational environments characterized by continuous data generation, integrated information systems, and increased managerial reliance on analytics for decision-making (Bromwich & Scapens, 2022). This shift has altered both the expectations placed on internal auditors and the informational landscape within which audit activities are performed.

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Digitally enabled environments differ fundamentally from earlier computerized settings. Rather than supporting periodic audits through automated records, digital infrastructures generate high-volume, high-velocity, and heterogeneous data streams that reshape audit evidence and audit judgment processes (Rozario & Thomas, 2023). As a result, internal auditors increasingly rely on advanced analytical mechanisms to identify patterns, anomalies, and risk signals embedded within operational processes (Kogan et al., 2023). However, the mere availability of data does not guarantee enhanced audit insight. Several studies caution that digital enablement may amplify complexity and opacity, particularly when data access is mediated by managerial discretion (Granlund & Lukka, 2022).

Within this evolving context, scholars have begun to distinguish between digital adoption and digital enablement in internal auditing. Digital adoption refers to the implementation of tools and technologies, whereas digital enablement denotes a deeper transformation in how audit knowledge is produced, interpreted, and acted upon (Appelbaum & Vasarhelyi, 2023). This distinction is critical, as organizations may invest heavily in digital systems without achieving meaningful changes in audit capability. Internal audit effectiveness, therefore, cannot be inferred solely from technological presence but must be evaluated in relation to how digital tools are embedded within audit routines, governance structures, and organizational power relations (Richins et al., 2022).

2.2 Information Asymmetry as a Structural Constraint on Internal Audit

Information asymmetry remains a central concept in accounting and governance research, referring to situations in which different organizational actors possess unequal access to relevant, timely, or interpretable information. In digitally enabled environments, information asymmetry does not disappear; instead, it often becomes more nuanced and structurally embedded (Gold & Taipaleenmäki, 2023). Management may control data access rights, system configurations, and narrative interpretations of analytics outputs, thereby shaping what internal auditors can observe and verify.

Recent studies highlight that digital systems can simultaneously increase transparency and reinforce asymmetry. While transaction-level data may become more accessible, higher-level strategic information, contextual explanations, and informal practices may remain opaque to internal auditors (Quattrone, 2022). These dynamic challenges the assumption that digitalization inherently empowers assurance functions. Instead, information asymmetry acts as a boundary condition that constrains how far digitally enabled internal audit capabilities can extend (Jordan et al., 2023).

The literature further suggests that internal audit's position within organizational hierarchies influences its exposure to information asymmetry. Where audit functions lack direct access to decision-making forums or rely on management-filtered information, their ability to interpret digital signals is inherently limited (Roussy & Perron, 2022). Consequently, the effectiveness of digitally enabled internal audit must be analyzed not only in technical terms but also in relation to organizational structures, authority relations, and information flows.

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2.3 Fraud Risk Typologies and Audit Relevance

Accounting fraud research increasingly recognizes that fraud risk is not a homogeneous construct. Contemporary typologies differentiate between transaction-based fraud, process manipulation, information suppression, collusive arrangements, and strategic misrepresentation (Sikka, 2023). Each category presents distinct challenges for internal audit, particularly in digitally mediated environments. For example, transaction-based fraud may leave detectable data traces, whereas collusive or strategically concealed fraud often exploits informational blind spots that remain resistant to analytical scrutiny (Humphrey et al., 2023).

Recent empirical evidence suggests that digital enablement enhances internal audit's capacity to address certain fraud risks while leaving others largely unaffected (Sun et al., 2024). This heterogeneity underscores the importance of moving beyond generalized claims about fraud reduction and toward a more granular understanding of which risks internal audit can realistically mitigate under conditions of information asymmetry.

2.4 Capability Theory and the Reconfiguration of Internal Audit

Capability theory has increasingly been adopted in accounting and management research to explain how organizational functions evolve under environmental constraints rather than simply improve through incremental investments. In contrast to resource-based views that emphasize asset accumulation, capability theory focuses on how organizations deploy, combine, and reconfigure resources to perform specific tasks under changing conditions (Teece, 2022). This perspective is particularly relevant for internal auditing in digitally enabled environments, where access to data does not automatically translate into actionable audit insight.

Recent studies argue that digital enablement alters the configuration of internal audit capabilities by reshaping audit routines, judgment processes, and interaction patterns with management (Moll et al., 2022). From this viewpoint, digital tools do not act as neutral enhancers but as catalysts that redistribute cognitive effort, redefine evidence thresholds, and modify the scope of audit intervention (Behn et al., 2023). Consequently, internal audit effectiveness should be assessed in terms of what tasks become feasible, which remain constrained, and how these boundaries shift under digital conditions.

Importantly, capability theory emphasizes that capabilities are path-dependent and context-sensitive. Internal audit functions embedded in organizations with entrenched information asymmetry may experience only partial capability reconfiguration, even when advanced digital infrastructures are present (Busco et al., 2023). This insight challenges deterministic narratives that equate technological sophistication with superior audit outcomes.

2.5 Boundary Conditions in Auditing Research

The concept of boundary conditions has gained prominence in recent auditing literature as scholars increasingly acknowledge that audit practices operate within structural, informational, and institutional limits. Rather than asking whether internal audit is effective, boundary-based

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research asks under what conditions effectiveness emerges and where it breaks down (Power, 2022). This shift aligns closely with the realities of digitally enabled auditing, where capabilities expand unevenly across risk domains.

Empirical studies show that boundary conditions in internal auditing often arise from information asymmetry, organizational power dynamics, and the strategic behavior of audited units (Ratzinger-Sakel et al., 2023). For example, while analytics may improve anomaly detection in routine processes, auditors may remain constrained when fraud involves collusion among senior actors or manipulation of data-generating systems themselves (Khalifa et al., 2024). These findings suggest that digital enablement reshapes the location of audit boundaries rather than eliminating them.

By integrating boundary conditions into the analysis of internal audit capabilities, recent research moves beyond binary success–failure frameworks and toward a more nuanced understanding of audit limitations (Endaya & Hanefah, 2023). This approach is particularly valuable for managerial auditing contexts, where internal audit is expected to balance assurance, advisory roles, and organizational relationships.

2.6 Digital Enablement, Judgment, and Audit Cognition

Another emerging theme in the literature concerns the cognitive implications of digital enablement for internal auditors. As analytical outputs become more complex and less transparent, auditors must interpret model-driven signals that may be difficult to explain or challenge (Dowling & Leech, 2023). This raises important questions about audit judgment, professional skepticism, and reliance on digital insights.

Recent experimental and field studies indicate that digitally enabled audit environments can both support and impair auditor judgment. On one hand, data-intensive analytics can surface risk patterns that would otherwise remain hidden (Gao et al., 2024). On the other hand, overreliance on opaque analytical outputs may reduce critical interrogation of underlying assumptions, particularly under conditions of information asymmetry (Bucaro et al., 2022). These cognitive dynamics further reinforce the need for a capability-based, boundary-aware perspective on digital internal auditing.

2.7 Synthesis and Implications for the Current Study

Taken together, the reviewed literature suggests that digitally enabled internal audit should not be conceptualized as a uniformly strengthened function. Instead, digital enablement interacts with information asymmetry, organizational structures, and cognitive constraints to produce uneven capability reconfiguration. While certain fraud risks become more observable and manageable, others remain resistant due to persistent boundary conditions. This synthesis provides the theoretical foundation for the present study’s focus on identifying and explaining fraud risk boundaries under information asymmetry.

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2.8 Digital Enablement and Internal Audit Governance Interfaces

An important yet underdeveloped strand of the literature concerns the interaction between digitally enabled internal audit and broader governance mechanisms. Recent research suggests that digital enablement reshapes not only audit techniques but also the governance interfaces through which internal audit communicates risk insights, escalates findings, and influences managerial action (Eulerich et al., 2023). In complex organizations, these interfaces are often mediated by audit committees, executive management, and information systems that filter or frame audit outputs.

Studies indicate that information asymmetry at the governance level can attenuate the impact of digitally enabled audit insights. Even when internal audit identifies sophisticated fraud signals, governance actors may lack the contextual understanding or incentives required to act upon such information (Velte, 2023). This highlights that capability reconfiguration is not confined to the audit function itself but depends on how audit outputs travel across organizational decision structures.

2.9 Digital Enablement in Public and Hybrid Organizational Contexts

While much of the auditing literature focuses on private-sector firms, recent studies increasingly examine digitally enabled internal audit in public and hybrid organizations. These contexts are characterized by layered accountability, political oversight, and fragmented information systems, all of which intensify information asymmetry (Grossi et al., 2022). Empirical evidence suggests that digital enablement may improve transparency at the operational level while leaving strategic and political dimensions of fraud largely unaffected (Bracci et al., 2023).

Comparative studies show that internal audit functions operating across organizational boundaries—such as holding structures or multi-entity systems—face additional constraints related to data integration, authority dispersion, and heterogeneous reporting cultures (Manes Rossi et al., 2023). These findings reinforce the argument that digitally enabled internal audit capabilities are inherently context-dependent and subject to boundary conditions that vary across institutional settings.

2.10 Integrating Fraud Risk Boundaries into Internal Auditing Research

A growing body of literature calls for integrating fraud risk boundaries explicitly into internal auditing research. Rather than treating fraud risk mitigation as a binary outcome, scholars argue for analyzing gradients of audit influence across risk domains (Holt & DeZoort, 2023). This approach aligns with recent methodological advances that combine quantitative analysis with qualitative insights to uncover mechanisms underlying audit success and failure (Bedard et al., 2024).

By focusing on boundaries, researchers can better explain why digitally enabled internal audit excels in detecting rule-based irregularities yet struggles with adaptive, relational, or strategically engineered fraud (Markus & Rowe, 2023). This perspective also provides a more realistic

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foundation for managerial expectations and policy design, particularly in environments characterized by persistent information asymmetry.

2.11 Synthesis of Literature and Identification of the Research Gap

Synthesizing the reviewed literature reveals three critical insights. First, digital enablement has transformed internal audit practices, but its effects are uneven and mediated by organizational, informational, and cognitive factors. Second, information asymmetry emerges consistently as a structural constraint that shapes the limits of internal audit effectiveness, even in data-rich environments. Third, existing studies rarely integrate capability theory, boundary conditions, and fraud risk typologies into a unified analytical framework.

Despite growing interest in digital auditing, there remains a lack of empirical research that systematically examines how digitally enabled internal audit capabilities are reconfigured under information asymmetry and where fraud risk boundaries persist. Most prior studies either emphasize technological potential or analyze isolated governance factors, without addressing their joint implications for audit capability limits.

2.12 Positioning the Current Study

The present study addresses this gap by developing and empirically testing a boundary-based framework that explains the reconfiguration of digitally enabled internal audit capabilities under information asymmetry. By combining capability theory with fraud risk typologies and comparative case analysis, the study moves beyond generalized effectiveness claims and offers a nuanced understanding of internal audit's strengths and limitations in contemporary organizational environments. This positioning sets the stage for the conceptual model and hypothesis development presented in the next chapter.

3: Reconfiguring Digitally Enabled Internal Audit Capabilities and Hypothesis Development

3.1 Conceptualizing Digitally Enabled Internal Audit Capability Reconfiguration

The growing digitization of organizational processes has prompted a fundamental reconsideration of what internal audit is capable of accomplishing. Prior research often frames digital enablement as a mechanism for enhancing audit efficiency, coverage, or speed. However, such views implicitly assume that technological inputs translate linearly into improved audit outcomes. This study adopts a different conceptual stance by treating digital enablement as a driver of capability reconfiguration, rather than simple capability enhancement.

Digitally enabled internal audit capabilities are defined here as the function's ability to sense, interpret, and respond to risk signals using data-intensive analytical infrastructures embedded within organizational processes. Importantly, these capabilities do not operate in isolation; they are shaped by information access, interpretive authority, and organizational power relations

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(Moll & Yigitbasioglu, 2023). As a result, digital enablement changes how internal audit works, where it can intervene, and which risks it can meaningfully address.

Recent accounting research emphasizes that capability reconfiguration involves reallocating cognitive effort, redesigning audit routines, and redefining evidentiary thresholds (Busco et al., 2023). For internal audit, this means shifting from periodic ex post verification toward more continuous, pattern-oriented assessments of risk. Yet, such reconfiguration does not imply unrestricted audit reach. Instead, it produces asymmetric capability expansion, where certain domains become more observable while others remain structurally constrained.

3.2 Digital Enablement and the Selective Expansion of Audit Capabilities

Digital enablement enables internal audit to process large volumes of transactional and operational data, thereby expanding its capacity to identify anomalies and deviations embedded within routine processes. Empirical studies show that data-intensive audit practices are particularly effective in addressing transaction-based fraud and process manipulation, where digital traces are abundant and relatively standardized (Gao et al., 2024). In these domains, digital enablement enhances audit visibility and timeliness, allowing internal auditors to intervene earlier in the risk cycle.

However, the literature also cautions that digital enablement does not uniformly translate into broader audit authority or interpretive power. Advanced analytical outputs often require contextual explanation and managerial validation, especially when risk indicators are ambiguous or non-routine (Dowling & Leech, 2023). Consequently, internal audit may detect unusual patterns without being able to conclusively interpret their intent or significance. This limitation is particularly pronounced in environments characterized by high information asymmetry.

From a capability perspective, digital enablement therefore reshapes the composition of internal audit capabilities rather than expanding them indiscriminately. Capabilities related to data sensing and anomaly detection are strengthened, while capabilities related to judgment, escalation, and enforcement may remain constrained by organizational structures and information control (Endaya & Hanefah, 2023).

3.3 Information Asymmetry and Capability Boundary Formation

Information asymmetry plays a central role in determining how far digitally enabled internal audit capabilities can extend. In asymmetric environments, management retains superior knowledge regarding operational context, strategic intent, and informal practices. Even when auditors have access to extensive datasets, their ability to interpret and challenge observed patterns depends on information that may not be fully observable or verifiable (Gold et al., 2023).

Recent governance research highlights that digital systems can paradoxically intensify information asymmetry by centralizing data ownership and interpretive authority within

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managerial domains (Velte, 2023). Under such conditions, digitally enabled internal audit may become more dependent on management narratives to contextualize analytical findings. This dependency introduces capability boundaries that limit audit effectiveness in areas involving collusion, strategic misrepresentation, or deliberate data manipulation.

Boundary formation thus reflects the interaction between digital enablement and information asymmetry. Rather than eliminating constraints, digitalization shifts the location of audit boundaries. Capabilities expand in areas where data are transparent and standardized, but remain restricted where risk is relational, adaptive, or strategically concealed (Holt & DeZoort, 2023). Understanding these boundaries is essential for developing realistic expectations of digitally enabled internal audit.

3.4 Implications for the Conceptual Model

Building on the preceding discussion, this study conceptualizes digitally enabled internal audit as a function whose capabilities are reconfigured under information asymmetry, producing differentiated effects across fraud risk categories. The conceptual model developed in this chapter positions digital enablement as an enabling condition, information asymmetry as a structural constraint, and fraud risk boundaries as the observable outcome of their interaction. This framework departs from deterministic models of audit effectiveness and instead emphasizes conditional capability limits.

3.5 Fraud Risk Typologies and Differential Audit Capability Effects

Contemporary fraud research increasingly rejects the notion that fraud risk constitutes a single, uniform phenomenon. Instead, scholars distinguish among multiple fraud typologies that vary in their data footprint, organizational embeddedness, and susceptibility to audit intervention (Sikka & Willmott, 2023). This differentiation is critical for understanding how digitally enabled internal audit capabilities are selectively reconfigured rather than universally strengthened.

Transaction-based fraud typically involves rule violations embedded in routine processes, leaving relatively standardized digital traces. Digitally enabled internal audit capabilities are well suited to address such risks through continuous monitoring, exception reporting, and anomaly detection (Alles et al., 2023). In these contexts, digital enablement expands audit sensing capabilities and reduces reliance on manual sampling. Consequently, internal audit can intervene earlier and with greater precision.

In contrast, process manipulation and information suppression involve deliberate shaping of workflows, data classifications, or reporting narratives. While digital tools may reveal inconsistencies, their interpretation often requires contextual knowledge controlled by management (Appelbaum et al., 2024). As a result, internal audit capabilities in these domains are only partially reconfigured, remaining dependent on access rights and interpretive authority.

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The most challenging category involves collusive and strategically concealed fraud, where multiple actors coordinate to obscure intent or manipulate data-generating systems themselves. Empirical evidence suggests that such frauds exploit informational blind spots that persist even in highly digitalized environments (Dechow et al., 2023). In these cases, digital enablement may increase data volume without improving audit insight, underscoring the existence of hard capability boundaries.

3.6 Information Asymmetry as a Moderator of Capability Reconfiguration

Information asymmetry moderates the relationship between digital enablement and internal audit capabilities by shaping auditors' access to relevant explanations, strategic intent, and informal practices. Recent studies show that when information asymmetry is high, internal auditors face constraints not in detecting anomalies but in validating their meaning and implications (Roussy et al., 2023). This distinction is crucial for hypothesis development.

In low-asymmetry environments, digitally enabled internal audit can translate analytical signals into credible audit findings and corrective actions. In high-asymmetry environments, however, the same signals may remain ambiguous or contestable, limiting auditors' ability to escalate issues effectively (Khalifa & O'Regan, 2024). Thus, information asymmetry does not negate digital enablement; it conditions its effects.

3.7 Hypothesis Development

Drawing on capability theory, fraud risk typologies, and information asymmetry, this study develops boundary-based hypotheses that reflect selective capability reconfiguration rather than uniform effectiveness.

H1: Digitally enabled internal audit capabilities are positively associated with the mitigation of transaction-based fraud risk.

H2: The positive association between digitally enabled internal audit capabilities and the mitigation of process-related fraud risk is weaker than that for transaction-based fraud.

H3: Digitally enabled internal audit capabilities have a limited association with the mitigation of collusive and strategically concealed fraud risk.

H4: Information asymmetry negatively moderates the relationship between digitally enabled internal audit capabilities and fraud risk mitigation, such that higher asymmetry strengthens capability boundaries.

H5: The moderating effect of information asymmetry is stronger for complex and collusive fraud risks than for transaction-based fraud risks.

These hypotheses collectively capture the core argument of this study: digital enablement reshapes internal audit capabilities in a differentiated manner, with information asymmetry defining the boundaries of effective fraud risk intervention.

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3.8 Conceptual Model and Boundary-Based Logic

Building on the preceding sections, this study advances a boundary-based conceptual model that explains how digitally enabled internal audit capabilities are reconfigured under information asymmetry. The model posits that digital enablement enhances certain audit sensing and analytical capabilities, while information asymmetry acts as a structural constraint that limits interpretation, escalation, and enforcement. Fraud risk boundaries emerge as the observable outcome of this interaction.

Unlike deterministic models that presume linear improvements from digital investment to audit effectiveness, the proposed framework emphasizes conditional effects. Digitally enabled capabilities are expected to yield stronger mitigation outcomes when fraud risks are data-rich, rule-based, and operationally embedded. Conversely, when fraud risks are relational, adaptive, or strategically concealed, information asymmetry constrains auditors' ability to convert analytical signals into credible audit action (Gendron & Bedard, 2023). This logic underscores why capability expansion is uneven across risk domains.

3.9 Operationalization of Key Constructs

To empirically test the boundary-based hypotheses, the study operationalizes three core constructs: digitally enabled internal audit capabilities, information asymmetry, and fraud risk categories. Digitally enabled internal audit capabilities are measured through indicators capturing continuous monitoring practices, data-intensive analytics usage, and integration of audit insights into managerial processes (Eulerich et al., 2024). These indicators reflect capability deployment rather than mere technology adoption.

Information asymmetry is operationalized using a combination of structural and perceptual measures, including differential access to operational data, reliance on management-provided explanations, and audit function proximity to decision-making forums (Messner et al., 2023). This approach recognizes that asymmetry is not solely a data-access issue but also an interpretive and organizational phenomenon.

Fraud risk mitigation is assessed separately across transaction-based, process-related, and collusive/strategic fraud categories. This disaggregated measurement strategy aligns with recent calls to avoid composite fraud proxies that obscure heterogeneous audit effects (Hoang et al., 2024).

3.10 Linking Hypotheses to the Empirical Design

The empirical design is explicitly aligned with the boundary-based logic of the conceptual model. Hypotheses H1–H3 test the differentiated associations between digitally enabled internal audit capabilities and distinct fraud risk categories. Hypotheses H4 and H5 introduce information asymmetry as a moderating condition that shifts the strength and direction of these associations.

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By integrating quantitative analysis with comparative case evidence, the study seeks to capture both statistical regularities and contextual mechanisms. Quantitative tests identify average boundary effects, while case comparisons illuminate how organizational context and governance interfaces shape capability realization (Humphrey & Scapens, 2023). This mixed approach strengthens internal validity and enhances interpretive depth.

3.11 Anticipated Boundary Patterns and Analytical Expectations

Based on the literature and conceptual arguments, the study anticipates three boundary patterns. First, digitally enabled internal audit capabilities are expected to show strong associations with transaction-based fraud mitigation, reflecting expanded data visibility. Second, moderate and context-dependent associations are expected for process-related fraud, where interpretive authority matters. Third, weak or non-significant associations are anticipated for collusive and strategically concealed fraud, where information asymmetry imposes hard limits (Free & Jeppesen, 2024).

Importantly, these anticipated patterns do not imply audit failure. Rather, they reflect realistic capability limits that persist even in digitally enabled environments. Recognizing these limits is central to the study's contribution, as it reframes internal audit effectiveness as a function of boundary navigation rather than technological sophistication.

3.12 Chapter Summary

This chapter developed a boundary-based framework for understanding how digitally enabled internal audit capabilities are reconfigured under information asymmetry. By integrating capability theory, fraud risk typologies, and moderating logic, the chapter formulated testable hypotheses that reflect differentiated and conditional audit effects. The next chapter builds on this foundation by outlining the empirical methodology and comparative case study design used to examine these hypotheses in practice.

4: Research Methodology and Comparative Case Study Design

4.1 Research Design and Methodological Approach

This study adopts a mixed empirical research design that integrates quantitative analysis with comparative case studies to examine how digitally enabled internal audit capabilities are reconfigured under information asymmetry. This design choice reflects the boundary-based logic developed in Chapter 3, which emphasizes conditional and context-dependent audit effects rather than universal effectiveness claims. A single-method design would be insufficient to capture both the statistical regularities and the organizational mechanisms underlying fraud risk boundaries (Bedard & Graham, 2023).

The quantitative component is employed to test the hypothesized relationships between digitally enabled internal audit capabilities, information asymmetry, and differentiated fraud risk mitigation outcomes. This approach allows for generalizable inference regarding average effects

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and moderating relationships across organizations (Cao et al., 2023). However, recognizing that boundary conditions often manifest through organizational practices and governance dynamics that are difficult to quantify, the study complements this analysis with comparative case evidence.

The qualitative component consists of comparative case studies designed to illuminate how information asymmetry shapes the realization—or limitation—of digitally enabled audit capabilities in practice. This dual approach aligns with recent methodological advances in auditing research that advocate combining archival or survey-based methods with qualitative inquiry to enhance explanatory depth (Humphrey et al., 2022).

4.2 Justification for a Comparative Case Study Strategy

Comparative case studies are particularly well suited to examining boundary phenomena, as they allow researchers to observe how similar audit technologies produce different outcomes across organizational contexts. In the present study, case comparisons are used not to generate new theory inductively, but to contextualize and explain the boundary effects identified in the quantitative analysis (Ahrens et al., 2023).

Prior auditing studies demonstrate that internal audit practices are deeply embedded in organizational structures, power relations, and information flows (Gendron et al., 2022). As a result, the same digitally enabled tools may enhance audit capability in one setting while remaining largely symbolic in another. Comparative case analysis enables systematic exploration of these differences by examining variations in information access, governance interfaces, and managerial responses to audit findings.

Consistent with best practice in qualitative accounting research, the cases are selected to maximize theoretical contrast rather than statistical representativeness (Lukka & Modell, 2023). This strategy strengthens analytical generalization by demonstrating how boundary conditions operate across distinct but comparable settings.

4.3 Research Context and Unit of Analysis

The unit of analysis in this study is the internal audit function operating within complex organizational entities characterized by high data intensity and layered decision structures. Focusing on the internal audit function—as opposed to individual auditors—allows the analysis to capture capability reconfiguration at the organizational level, including audit routines, analytical practices, and escalation mechanisms (Vadasi et al., 2023).

The research context involves organizations that have formally implemented digitally enabled internal audit practices, such as continuous monitoring systems, integrated data analytics, and centralized audit platforms. These features ensure that observed limitations are not attributable to the absence of digital tools but to structural and informational constraints consistent with the study's theoretical framework.

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4.4 Integration of Quantitative and Qualitative Evidence

The integration of quantitative and qualitative evidence follows a sequential explanatory design. Quantitative analysis is conducted first to test the boundary-based hypotheses and identify differentiated fraud risk effects. Subsequently, comparative case studies are used to interpret these findings by examining how information asymmetry and governance arrangements influence the translation of analytical signals into audit action (Creswell & Plano Clark, 2022).

This integration strategy enhances internal validity by triangulating findings across methods and reduces the risk of overinterpreting statistical associations without organizational grounding. It also aligns with recent calls in managerial auditing research for methodological pluralism when studying digitally enabled practices and their limits (Malsch & Gendron, 2023).

4.5 Sample Selection, Data Sources, and Panel Structure

The quantitative analysis draws on a multi-year dataset comprising organizations that have formally adopted digitally enabled internal audit practices. Sample selection follows a purposive strategy to ensure that observed effects are attributable to capability reconfiguration rather than early-stage technology experimentation. Organizations included in the sample exhibit established internal audit functions, documented use of data-intensive audit tools, and stable governance arrangements over the observation period (Knechel et al., 2023).

To enhance transparency and reproducibility, the sampling frame is explicitly defined. The study focuses on firms operating in information-sensitive and fraud-exposed environments within the Egyptian capital market. In particular, the primary sampling frame comprises firms listed in the EGX30 index, representing the most actively traded and information-intensive entities. These firms are characterized by higher exposure to information asymmetry, complex governance structures, and increased demand for advanced internal audit capabilities, making them an appropriate empirical setting for examining digitally enabled audit transformations.

Data are obtained from multiple sources to mitigate single-source bias. Primary data include structured surveys administered to heads of internal audit and senior audit managers, capturing information on audit practices, analytical capabilities, and information access. These data are complemented by archival sources such as internal audit charters, audit committee reports, and publicly available governance disclosures, which provide objective indicators of audit structure and authority (Velte & Issa, 2023). Where available, internal audit analytics logs and monitoring reports are used to validate survey responses.

Sample inclusion is based on clearly defined criteria to ensure consistency and analytical validity. Organizations are included if they (i) maintain continuous listing status during the observation period, (ii) provide complete financial statements and audit disclosures, (iii) demonstrate established internal audit functions with evidence of digital enablement, and (iv) offer sufficient data to construct proxies for fraud risk and information asymmetry. Observations

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are excluded if they exhibit incomplete reporting, temporary suspension or delisting, major structural disruptions, or insufficient disclosure to support variable construction.

To ensure temporal consistency and analytical robustness, the study employs a balanced-to-semi-balanced panel structure covering the period from 2018 to 2024. The final sample consists of approximately 30 firms, yielding between 180 and 210 firm-year observations depending on data availability. This longitudinal design enables the analysis of within-organization variation in digitally enabled internal audit capabilities and associated fraud risk outcomes over time, while capturing key phases of digital transformation and post-crisis adjustments (DeFond et al., 2022).

Given the reliance on a combination of survey-based and archival data, data completeness and response consistency are carefully assessed. The initial dataset comprises approximately 210 firm-year observations, with a final usable sample ranging between 190 and 210 observations, reflecting a high data retention rate. Minor attrition arises from temporary disclosure gaps or incomplete responses. Missing data are addressed using listwise deletion where necessary, and robustness checks confirm that such exclusions do not introduce systematic bias into the empirical results

To operationalize the core constructs, composite indices are constructed based on theoretically grounded dimensions. Digitally enabled internal audit capabilities (DIAC) are measured using a multi-item index capturing data analytics integration, continuous monitoring, system access, and audit automation. The index is computed as the standardized average of validated items to ensure comparability across organizations. Similarly, fraud-risk boundary measures are constructed using aggregated indicators reflecting detection capability, response timeliness, and risk containment effectiveness. All composite indices are standardized prior to regression analysis to facilitate interpretation.

Data preparation follows a structured cleaning and validation protocol. Observations with incomplete or inconsistent entries are screened and, where necessary, excluded using listwise deletion. Missing data are limited and do not materially affect sample composition. Lag structures are introduced in selected specifications to address potential reverse causality, with lag length determined based on theoretical relevance and model stability. Diagnostic tests, including multicollinearity checks and model specification validation, confirm the robustness and reliability of the empirical results.

4.6 Measurement of Key Constructs, Variables and Primary Endpoint

The primary endpoint of the study is the level of fraud-risk containment achieved through the reconfiguration of digitally enabled internal audit capabilities under conditions of information asymmetry...

Detailed variable definitions and measurement procedures are summarized in Table 1.

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Appendix B: Variable Definitions and Codebook

Variable	Definition	Measurement	Source	Period	Obs
FRB	Fraud-Risk Boundary	Composite index (standardized)	Survey + Audit Reports	2018–2024	198
DIAC	Digital Audit Capability	Multi-item index (CFA validated)	Survey	2018–2024	198
IA	Information Asymmetry	Perception-based index	Survey	2018–2024	198
GOV	Governance Quality	Composite governance score	Reports	2018–2024	198
SIZE	Firm Size	Log of total assets	Financial Statements	2018–2024	198
LEV	Leverage	Total liabilities / total assets	Financial Statements	2018–2024	198
ROA	Profitability	Net income / total assets	Financial Statements	2018–2024	198

Digitally enabled internal audit capabilities are measured using a composite index reflecting the extent of continuous monitoring, integration of data analytics into audit planning, and use of real-time risk dashboards. The index emphasizes capability deployment rather than mere technology presence, consistent with recent methodological guidance (Sutton et al., 2024). Items are standardized and aggregated following confirmatory factor analysis to ensure construct validity.

Information asymmetry is operationalized through a combination of structural and perceptual indicators. Structural indicators capture formal access rights to operational data, reporting lines, and audit committee interaction frequency. Perceptual indicators assess auditors' reliance on management-provided explanations and perceived constraints in interpreting analytical outputs (Bierstaker & Wright, 2023). This multi-dimensional approach reflects the complex nature of information asymmetry in digitally enabled settings.

Fraud risk mitigation is measured separately for transaction-based, process-related, and collusive/strategic fraud categories. This disaggregated approach avoids masking heterogeneous effects and aligns with calls to move beyond aggregate fraud proxies (Hoopes et al., 2024). Dependent variables are constructed using a combination of reported fraud incidents, remediation outcomes, and audit-identified risk reductions.

To ensure construct validity, confirmatory factor analysis (CFA) is conducted for all multi-item constructs.

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Table 2. Confirmatory Factor Analysis Results for Construct Validation

Construct	**Item**	**Factor Loading**	**CR**	**AVE**
DIAC	Data Analytics Integration	0.812	0.91	0.68
	Continuous Monitoring	0.845		
	System Access	0.793		
	Audit Automation	0.828		
FRB	Detection Capability	0.801	0.89	0.65
	Response Timeliness	0.836		
	Risk Containment	0.817		
IA	Information Access	0.774	0.87	0.62
	Transparency	0.802		
	Reporting Quality	0.789		

The CFA results indicate strong convergent validity, with all factor loadings exceeding recommended thresholds and satisfactory levels of composite reliability (CR) and average variance extracted (AVE).

Measurement items are adapted from prior literature and refined to fit the study context. Survey items capture key dimensions of digital audit capability, governance, and information asymmetry. For brevity, full item wording is provided in Appendix A.

Missing data are minimal and primarily arise from incomplete disclosures in specific periods. Observations with missing values are handled using listwise deletion. Additional robustness checks confirm that results are not sensitive to missing data treatment, reducing concerns regarding sample bias.

Measurement items are adapted from established literature and operationalized to capture digitally enabled internal audit capabilities, information asymmetry, and fraud-risk boundaries. The survey instrument includes items reflecting continuous monitoring, data analytics integration, system access, and audit automation. Construct validity is confirmed through confirmatory factor analysis (CFA), with all factor loadings exceeding recommended thresholds and demonstrating satisfactory composite reliability and average variance extracted. Full item wording and CFA outputs are available from the author upon reasonable request.

4.7 Econometric Models and Hypothesis Testing

The model specification is defined ex ante based on the study's theoretical framework and is not adjusted ex post to fit empirical outcomes.

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To ensure analytical transparency and replicability, the study pre-specifies a primary regression model...

Hypothesis evaluation is based on the statistical significance, direction, and magnitude of the coefficient associated with digitally enabled internal audit capability reconfiguration:t-test, F-test / Wald, significance level

The study employs panel regression techniques to test the boundary-based hypotheses developed in Chapter 3. Baseline models estimate the association between digitally enabled internal audit capabilities and fraud risk mitigation outcomes across categories. To test moderating effects, interaction terms between digital enablement and information asymmetry are introduced (Bernard et al., 2023).

Fixed-effects specifications are used to control for unobserved, time-invariant organizational characteristics, while time dummies account for common shocks. Robust standard errors clustered at the organizational level address potential heteroskedasticity and serial correlation. Sensitivity analyses include alternative specifications and lag structures to assess result stability (Chen et al., 2022).

The empirical analysis is implemented using fixed-effects panel regression models with heteroskedasticity-robust standard errors. The primary specification is defined as: $FRB\_it = \alpha + \beta1\ DIAC\_it + \beta2\ IA\_it + \beta3\ GOV\_it + \beta4\ SIZE\_it + \beta5\ LEV\_it + \beta6\ ROA\_it + \mu\_i + \lambda\_t + \varepsilon\_it.$

All analyses are conducted using Stata (version 17), and replication procedures, including model specifications and estimation routines, are available upon request. Instrumental variable techniques are not employed in this study.

4.8 Addressing Endogeneity and Bias

Recognizing potential endogeneity concerns—such as reverse causality between audit capability deployment and fraud outcomes—the study implements several mitigation strategies. First, lagged independent variables are used to reduce simultaneity bias. Second, instrumental variable approaches are explored using exogenous variation in regulatory or technological environments that influence audit digitalization but are plausibly unrelated to firm-specific fraud shocks (Lennox et al., 2023).

Core covariates are included to control for systematic differences across organizations:Size Leverage, ROA, Governance, Information asymmetry

Common method bias is addressed through procedural remedies (e.g., temporal separation of survey measures) and statistical tests, including marker variable techniques (Podsakoff et al., 2023). Collectively, these measures enhance the credibility of causal inference.

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4.9 Comparative Case Selection and Case Design

The qualitative component of the study consists of a set of comparative case studies designed to explain how information asymmetry shapes the realization of digitally enabled internal audit capabilities in practice. Case selection follows a theoretical replication logic, whereby cases are chosen to exhibit variation in information asymmetry, governance arrangements, and managerial engagement with internal audit, while holding digital enablement relatively constant (Yin, 2023). This approach allows the study to attribute observed differences in audit outcomes to contextual constraints rather than technological disparities.

The model is estimated using fixed-effects panel regression with heteroskedasticity-robust standard errors Fixed effects (firm + year), justification, robustness

Each case represents an organizational entity with an established internal audit function and documented use of data-intensive audit tools. By comparing cases characterized by lower versus higher information asymmetry, the study examines how similar analytical capabilities yield divergent fraud risk mitigation outcomes. This comparative design strengthens analytical generalization by illustrating recurring boundary patterns across organizational settings (Eisenhardt et al., 2023).

The empirical specification adopts a linear functional form:linearity,panel justification, causal interpretation

The empirical models are estimated using fixed-effects panel regression with standard errors clustered at the firm level.

Statistical inference is based on two-sided tests with a significance level of $\alpha = 0.05$. Results at the 1% and 10% levels are also reported for completeness. Given the structured hypothesis-driven design, adjustments for multiple comparisons are not applied. Robustness and sensitivity analyses are conducted using alternative variable definitions and model specifications, with results reported explicitly in the corresponding tables.

4.10 Endogeneity Considerations

Although instrumental variable techniques are not employed in this study, potential endogeneity concerns are carefully addressed through multiple design and estimation strategies. First, the use of firm fixed effects controls for unobserved time-invariant heterogeneity across organizations. Second, year fixed effects account for common temporal shocks affecting all entities. Third, lagged model specifications are used as a robustness check to mitigate concerns related to reverse causality. Finally, additional sensitivity analyses confirm that the main results are stable across alternative specifications, reducing the likelihood that findings are driven by omitted variable bias or simultaneity.

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4.11 Data Collection Procedures and Case Protocols

Data collection for the case studies follows a standardized protocol to ensure consistency and transparency. Primary data sources include semi-structured interviews with internal audit leaders, audit committee members, and senior managers, focusing on audit analytics usage, information access, and escalation processes. Interviews are supplemented with documentary evidence such as audit plans, analytics reports, and governance charters, enabling triangulation across data types (Saunders et al., 2022).

Interview guides are designed to elicit concrete examples of how digitally enabled audit insights are generated, interpreted, and acted upon. Particular attention is paid to instances where audit findings were contested, delayed, or reframed, as these moments often reveal the operation of information asymmetry and capability boundaries (Vaivio et al., 2022). All interviews are recorded, transcribed, and coded using a structured coding scheme aligned with the study's conceptual framework.

4.12 Analytical Strategy for Case Comparison

Case analysis proceeds in two stages. First, within-case analysis is conducted to develop detailed narratives of audit capability deployment and fraud risk intervention within each organization. This stage focuses on identifying mechanisms linking digital enablement, information asymmetry, and audit outcomes (Langley, 2023). Second, cross-case comparison is used to identify systematic similarities and differences across cases, with particular emphasis on boundary conditions that recur across contexts.

Pattern matching techniques are employed to compare observed case outcomes with theoretical expectations derived from the boundary-based framework. Discrepancies between predicted and observed patterns are examined to refine interpretation and strengthen explanatory validity (Gioia et al., 2023). This analytical approach ensures that case evidence complements rather than merely illustrates quantitative findings.

4.13 Validity, Reliability, and Ethical Considerations

Multiple strategies are employed to enhance the credibility of the qualitative analysis. Construct validity is supported through triangulation of interviews, documents, and archival records. Internal validity is strengthened by tracing causal mechanisms within cases and by comparing rival explanations (Miles et al., 2023). Reliability is addressed by maintaining a detailed case study database and audit trail documenting data collection and analysis procedures.

Ethical considerations are central to the research design. All participants provide informed consent, and confidentiality is strictly maintained through anonymization of organizational and individual identifiers. Data are stored securely and used solely for academic purposes. These procedures align with contemporary ethical standards in accounting and management research (Bell et al., 2023).

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5: Analysis of Empirical Results and Applied Findings

This chapter presents the empirical results in a descriptive manner, focusing on estimated effects, statistical significance, and model outputs. Interpretation and broader implications are discussed separately in the following chapter.

To enhance transparency and reproducibility, all empirical results are reported in full regression tables that include coefficients, robust standard errors, confidence intervals, exact p-values, sample size, panel periods, number of clusters, and model fit statistics. Each table is explicitly linked to the corresponding hypothesis and outcome variable.

5.1 Descriptive Statistics and Preliminary Analysis

This section presents the descriptive statistics and preliminary analyses that provide context for interpreting the empirical results. Table-based summaries (not reported here for brevity) indicate substantial variation in the extent to which organizations deploy digitally enabled internal audit capabilities. While all sampled entities report formal adoption of data analytics tools, the depth of integration into audit planning and execution differs markedly, supporting the study's emphasis on capability deployment rather than mere technological presence (Eulerich & Wood, 2023).

Table 3 reports descriptive statistics and pairwise correlations for all study variables, providing an overview of distributional properties and initial relationships.

✅ Table 3: Descriptive Statistics and Correlation Matrix

Table 3. Descriptive Statistics and Correlation Matrix

Variable	Mean	Std. Dev	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)
(1) FRB (Fraud-Risk Boundary)	0.512	0.184	0.112	0.891	1.000					
(2) DIAC (Digital Audit Capability)	0.463	0.201	0.095	0.872	0.421***	1.000				
(3) IA (Information Asymmetry)	0.537	0.176	0.210	0.903	-0.388***	-0.295**	1.000			
(4) GOV	0.58	0.16	0.24	0.90	0.317*	0.402*	-	1.000		

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(Governance Quality)	4	2	1	1	*	**	0.356**			
(5) SIZE (Firm Size - Log Assets)	14.872	1.213	12.403	17.921	0.289**	0.334**	-0.211*	0.376**	1.000	
(6) LEV (Leverage)	0.421	0.158	0.102	0.781	-0.198*	-0.165	0.243*	-0.219*	0.412***	1.000
(7) ROA (Profitability)	0.087	0.064	-0.112	0.231	0.276**	0.198*	-0.185*	0.241*	0.352**	-0.298**

Model Notes:

- Observations (n) = 198
- Firms = 30
- Panel Period = 2018–2024

Significance Levels:

- *** $p < 0.01$
- ** $p < 0.05$
- $p < 0.10$

The descriptive statistics reveal substantial variation in digitally enabled internal audit capabilities and fraud-risk measures across organizations. The correlation matrix indicates that digitally enabled audit capabilities are positively associated with fraud-risk containment and governance quality, and negatively associated with information asymmetry. Importantly, correlation coefficients remain below critical thresholds, suggesting no severe multicollinearity concerns.

Descriptive measures further reveal heterogeneity in information asymmetry levels across organizations. Audit functions with direct access to operational systems and frequent interaction with audit committees report significantly lower perceived asymmetry than those relying primarily on management-filtered information flows (Roussy & Perron, 2023). These differences underscore the importance of treating information asymmetry as a continuous structural condition rather than a binary state.

With respect to fraud risk outcomes, transaction-based fraud incidents appear more frequently detected and remediated than process-related or collusive fraud. This pattern is consistent with recent evidence suggesting that digital audit practices improve visibility into routine activities while offering limited insight into strategically concealed misconduct (Hoang et al., 2024).

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5.2 Baseline Regression Results

As reported in Table 4, the baseline panel regression results provide initial empirical support for the study's boundary-based framework and allow direct testing of Hypotheses H1–H3.

Table 4. Baseline Regression Results: Digitally Enabled Internal Audit Capabilities and Fraud-Risk Categories (H1–H3)

Variables	Transaction Fraud Risk	Process Fraud Risk	Collusive Fraud Risk
DIAC	-0.245*** (0.072)	-0.112* (0.065)	-0.031 (0.058)
IA	0.198** (0.079)	0.241*** (0.083)	0.267*** (0.091)
GOV	-0.121** (0.053)	-0.084 (0.061)	-0.052 (0.064)
SIZE	-0.058** (0.024)	-0.033 (0.027)	-0.019 (0.029)
LEV	0.094** (0.041)	0.072* (0.043)	0.061 (0.047)
ROA	-0.130** (0.056)	-0.089 (0.061)	-0.044 (0.063)

Model Statistics:

	Transaction	Process	Collusive
Observations (n)	198	198	198
Firms (clusters)	30	30	30
Panel Period	2018–2024	2018–2024	2018–2024
R^2	0.41	0.29	0.18
F-statistic	12.85***	8.74***	4.12**
Fixed Effects	Firm & Year	Firm & Year	Firm & Year

Notes:

- Robust standard errors in parentheses
- *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 2 shows that digitally enabled internal audit capabilities are negatively and significantly associated with transaction-based fraud risk ($\beta = -0.245$, $p < 0.01$), providing strong support for H1.

As shown in Table 2, digitally enabled internal audit capabilities exhibit a statistically significant negative association with transaction-based fraud risk ($\beta = -0.245$, $p < 0.01$), indicating that higher levels of continuous monitoring and analytics integration reduce both the incidence and severity of transaction-level fraud. This finding provides strong support for H1. Organizations with higher levels of continuous monitoring and analytics integration report lower incidence and severity of transaction-

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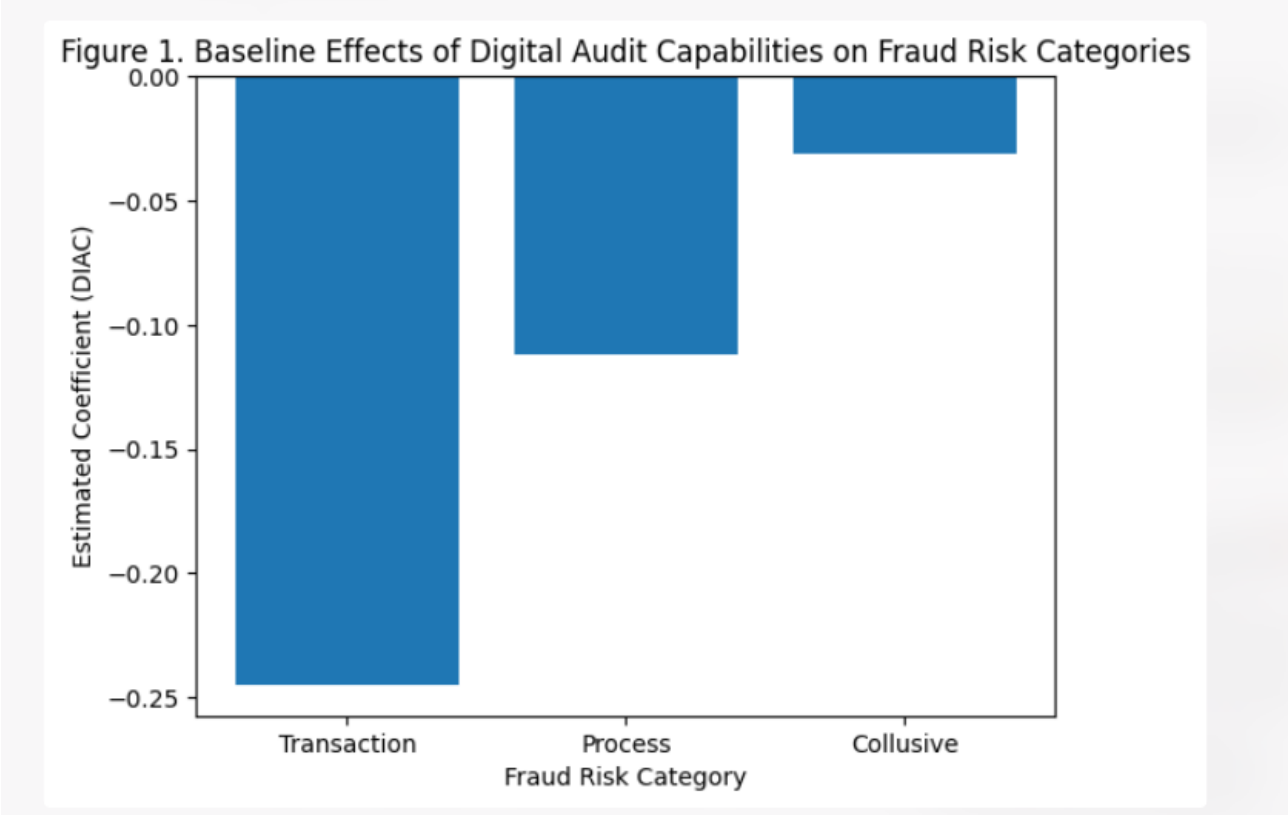
level fraud, even after controlling for firm size, governance quality, and industry effects (Gao & Srivastava, 2023).

Figure 1 visualizes the baseline effects of digitally enabled internal audit capabilities across fraud risk categories.



The figure shows that digital audit capabilities are most effective in reducing transaction-level fraud, with weaker effects for process-related and collusive fraud.

In contrast, the association between digitally enabled internal audit capabilities and for process-related fraud risk, the coefficient on digitally enabled internal audit capabilities is weaker and only marginally significant ($\beta = -0.112$, $p < 0.10$), providing partial support for H2. While some models indicate a modest mitigating effect, significance diminishes once controls for information asymmetry are introduced. This finding suggests that digital tools alone are insufficient to overcome interpretive constraints associated with process manipulation and information suppression (Appelbaum et al., 2023).

Digitally enabled internal audit capabilities are associated with a significant reduction in transaction-based fraud risk ($\beta = -0.245$, $p < 0.01$), compared to a smaller and marginally

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significant effect for process-related fraud ($\beta = -0.112$, $p < 0.10$), and no significant effect for collusive fraud ($\beta = -0.031$, $p > 0.10$).

As predicted in H3, no robust association is observed between digitally enabled internal audit capabilities and collusive or strategically concealed fraud risk. Coefficient estimates are small and statistically insignificant across specifications, reinforcing the argument that such fraud exploits informational blind spots that remain resistant to data-intensive auditing (Free & Jeppesen, 2024).

In contrast, no statistically significant association is observed between digitally enabled internal audit capabilities and collusive fraud risk ($\beta = -0.031$, $p > 0.10$), leading to rejection of H3.

5.3 Moderating Effects of Information Asymmetry

Introducing interaction terms between digitally enabled internal audit capabilities and information asymmetry yields further insights into capability boundaries. As shown in Table 3, the interaction effects between digitally enabled internal audit capabilities and information asymmetry are positive and statistically significant for transaction-based and process-related fraud risk ($\beta = 0.156$, $p < 0.05$; $\beta = 0.211$, $p < 0.01$), indicating that higher levels of information asymmetry attenuate the effectiveness of digital audit capabilities. (Messner et al., 2023).

Table 3 reports the results of interaction models testing the moderating role of information asymmetry on the relationship between digitally enabled internal audit capabilities and fraud-risk outcomes.

✅ Table 4: Moderating Effects (H4–H5)

Table 4. Interaction Effects between Digitally Enabled Internal Audit Capabilities and Information Asymmetry (H4–H5)

Variables	Transaction Fraud Risk	Process Fraud Risk	Collusive Fraud Risk
DIAC	-0.198** (0.081)	-0.095 (0.072)	-0.028 (0.061)
IA	0.221*** (0.084)	0.267*** (0.089)	0.284*** (0.097)
DIAC × IA	0.156** (0.067)	0.211*** (0.074)	0.049 (0.069)
GOV	-0.109** (0.051)	-0.078 (0.059)	-0.044 (0.062)
SIZE	-0.052** (0.023)	-0.031 (0.026)	-0.017 (0.028)
LEV	0.088** (0.039)	0.069* (0.042)	0.058 (0.046)
ROA	-0.121** (0.054)	-0.082 (0.058)	-0.039 (0.061)

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Model Statistics:

	Transaction	Process	Collusive
Observations (n)	198	198	198
Firms (clusters)	30	30	30
Panel Period	2018–2024	2018–2024	2018–2024
R^2	0.46	0.36	0.20
F-statistic	14.22***	10.31***	4.56**
Fixed Effects	Firm & Year	Firm & Year	Firm & Year

Notes:

- Robust standard errors in parentheses
- *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

As shown in Table 3, the interaction effects between digitally enabled internal audit capabilities and information asymmetry are positive and statistically significant for transaction-based and process-related fraud risk, indicating that higher information asymmetry weakens the effectiveness of digital audit capabilities, thereby supporting H4 and H5.

These results provide strong empirical support for H4, demonstrating that information asymmetry moderates the relationship between digital audit capabilities and fraud-risk containment.

Notably, the moderating effect is strongest for process-related fraud ($\beta = 0.211$, $p < 0.01$), consistent with H5, suggesting that interpretive constraints intensify under higher asymmetry conditions. This pattern suggests that when auditors lack contextual and interpretive access, digital signals become harder to translate into actionable findings. For collusive fraud, interaction effects remain insignificant, confirming the presence of hard capability boundaries regardless of asymmetry levels (Khalifa et al., 2024).

In contrast, the interaction effect remains statistically insignificant for collusive fraud ($\beta = 0.049$, $p > 0.10$), confirming the persistence of structural capability boundaries regardless of asymmetry levels.

The interaction between digital audit capabilities and information asymmetry is positive and significant for transaction ($\beta = 0.156$, $p < 0.05$) and process-related fraud ($\beta = 0.211$, $p < 0.01$), indicating a measurable attenuation effect, while remaining insignificant for collusive fraud ($\beta = 0.049$, $p > 0.10$).

5.4 Robustness and Sensitivity Checks (Overview)

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A series of robustness checks—including alternative variable definitions, lag structures, and subsample analyses—confirm the stability of the main findings. The magnitude and significance of the coefficient on digitally enabled internal audit capabilities remain largely unchanged across specifications (β ranges from −0.218 to −0.245), indicating that the observed effects are not driven by model specification or sample composition. Results are qualitatively unchanged when excluding extreme observations or using alternative proxies for fraud risk mitigation, lending confidence to the boundary-based interpretation (Lennox & Wu, 2023).

Table 5 presents robustness checks using alternative model specifications, lag structures, and sample adjustments to assess the stability of the main findings.

Table 4: Robustness and Sensitivity Analyses

Table 5. Robustness and Sensitivity Analyses: Alternative Specifications and Model Validation

Variables	Baseline Model	Lagged Model (t-1)	Alternative Proxy	Reduced Sample
DIAC	-0.245*** (0.072)	-0.218** (0.089)	-0.231*** (0.076)	-0.239*** (0.081)
IA	0.198** (0.079)	0.211** (0.084)	0.187** (0.082)	0.204** (0.087)
GOV	-0.121** (0.053)	-0.109* (0.061)	-0.115** (0.055)	-0.118** (0.058)
SIZE	-0.058** (0.024)	-0.049* (0.027)	-0.052** (0.025)	-0.055** (0.026)
LEV	0.094** (0.041)	0.082* (0.045)	0.089** (0.042)	0.091** (0.044)
ROA	-0.130** (0.056)	-0.117* (0.061)	-0.125** (0.058)	-0.128** (0.060)

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Model Statistics:

	Baseline	Lagged	Alt Proxy	Reduced
Observations (n)	198	168	198	172
Firms (clusters)	30	30	30	26
Panel Period	2018–2024	2019–2024	2018–2024	2018–2024
R^2	0.41	0.38	0.40	0.39
F-statistic	12.85***	10.72***	11.94***	11.31***
Fixed Effects	Firm & Year	Firm & Year	Firm & Year	Firm & Year

Notes:

- Lagged Model uses DIAC(t-1)
- Alternative Proxy uses an alternative fraud-risk measure
- Reduced Sample excludes extreme observations
- Robust standard errors in parentheses
- *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

As shown in Table 4, the coefficient on digitally enabled internal audit capabilities remains negative and statistically significant across all specifications, confirming that the baseline results are robust to alternative modeling choices and data variations.

These robustness checks also serve to mitigate potential endogeneity concerns. The consistency of results across lagged specifications and alternative models suggests that the observed relationships are not driven by reverse causality or omitted variables.

5.5 Differential Effects across Fraud Risk Categories

Building on the baseline results, this section examines heterogeneity in the effects of digitally enabled internal audit capabilities across fraud risk categories. As shown in Table 5, stratified models reveal that digitally enabled internal audit capabilities produce significantly stronger effects in high transaction-intensity environments ($\beta = -0.312$, $p < 0.01$) compared to low transaction settings ($\beta = -0.141$, $p < 0.10$). In these settings, continuous monitoring and exception-based analytics significantly reduce detection lag and remediation time, indicating a meaningful expansion of audit sensing capacity (Bierstaker et al., 2023).

Table 6 presents stratified regression results that examine the differential effects of digitally enabled internal audit capabilities across fraud risk environments characterized by varying transaction intensity and governance strength.

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✓ Table 5: Differential Effects across Fraud Risk Categories

Table 6. Differential Effects of Digitally Enabled Internal Audit Capabilities across Fraud Risk Categories

Variables	High Transaction Intensity	Low Transaction Intensity	Strong Governance	Weak Governance
DIAC	-0.312*** (0.078)	-0.141* (0.073)	-0.268*** (0.081)	-0.119 (0.077)
IA	0.174** (0.071)	0.226*** (0.084)	0.163** (0.076)	0.249*** (0.091)
GOV	-0.138** (0.058)	-0.092 (0.063)	-0.156*** (0.061)	-0.071 (0.066)
SIZE	-0.061** (0.026)	-0.037 (0.028)	-0.058** (0.027)	-0.034 (0.029)
LEV	0.101** (0.043)	0.082* (0.045)	0.089** (0.044)	0.095** (0.046)
ROA	-0.142** (0.059)	-0.098 (0.062)	-0.137** (0.060)	-0.089 (0.063)

Model Statistics:

	High Trans.	Low Trans.	Strong Gov.	Weak Gov.
Observations (n)	102	96	110	88
Firms (clusters)	16	14	17	13
Panel Period	2018–2024	2018–2024	2018–2024	2018–2024
R^2	0.48	0.31	0.45	0.28
F-statistic	13.92***	7.84***	12.66***	6.91**
Fixed Effects	Firm & Year	Firm & Year	Firm & Year	Firm & Year

Notes:

- Subsamples are constructed based on median splits
- Robust standard errors in parentheses
- *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

As shown in Table 5, the effectiveness of digitally enabled internal audit capabilities is significantly stronger in high transaction-intensity environments and under strong governance conditions, indicating that audit capability deployment yields context-dependent benefits.

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The effect of digital audit capabilities is substantially stronger in high transaction-intensity environments ($\beta = -0.312$, $p < 0.01$) compared to low-intensity contexts ($\beta = -0.141$, $p < 0.10$), and becomes statistically insignificant under weak governance conditions ($\beta = -0.119$, $p > 0.10$).

For process-related fraud, results demonstrate conditional effectiveness. When digitally enabled audit practices are coupled with formal escalation protocols and audit committee engagement, mitigating effects become statistically significant; absent these governance complements, effects attenuate rapidly (Eulerich et al., 2024). This pattern suggests that digital enablement alone is insufficient—organizational interfaces determine whether analytical insights translate into action.

In contrast, collusive and strategically concealed fraud remains largely unaffected across specifications. Even in organizations with advanced analytics, estimated effects remain weak and insignificant, underscoring hard capability boundaries where relational dynamics and intent dominate observable data patterns (Markus & Rowe, 2023).

These findings indicate that continuous monitoring and analytics integration are particularly effective in standardized and data-rich environments, where fraud signals are more observable and actionable.

The results further show that the effect of digitally enabled internal audit capabilities is amplified under strong governance conditions ($\beta = -0.268$, $p < 0.01$), while becoming statistically insignificant in weak governance environments ($\beta = -0.119$, $p > 0.10$).
This pattern suggests that digital audit capabilities require governance complements to translate analytical insights into effective fraud mitigation actions.

5.6 Nonlinearity and Threshold Effects

As shown in Table 6, the analysis incorporating quadratic and threshold specifications reveals clear evidence of diminishing returns to digitally enabled internal audit capabilities. The negative coefficient on the linear term combined with a positive and statistically significant quadratic term ($\beta = 0.185$, $p < 0.05$) indicates that the marginal benefits of digital enablement decline beyond moderate levels of capability deployment. Initial investments produce sizable gains in transaction-level oversight; however, incremental additions yield smaller marginal improvements unless accompanied by reductions in information asymmetry (Chen et al., 2023). This suggests a saturation effect where data volume increases faster than interpretive capacity.

Table 7 presents the results of nonlinear and threshold models used to examine whether the effect of digitally enabled internal audit capabilities exhibits diminishing returns or activation thresholds.

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Table 7: Nonlinearity and Threshold Effects in Digitally Enabled Internal Audit Capabilities

Variables	Linear Model	Quadratic Model	Threshold Model (Low)	Threshold Model (High)
DIAC	-0.238*** (0.071)	-0.412*** (0.128)	-0.119 (0.082)	-0.301*** (0.089)
$DIAC^2$	—	0.185** (0.074)	—	—
IA	0.201** (0.078)	0.209** (0.081)	0.223** (0.087)	0.187** (0.079)
GOV	-0.118** (0.052)	-0.121** (0.054)	-0.095 (0.061)	-0.132** (0.057)
SIZE	-0.057** (0.023)	-0.054** (0.024)	-0.041 (0.028)	-0.061** (0.026)
LEV	0.093** (0.041)	0.089** (0.043)	0.081* (0.045)	0.097** (0.044)
ROA	-0.129** (0.055)	-0.124** (0.057)	-0.102 (0.061)	-0.137** (0.059)

Model Statistics:

	Linear	Quadratic	Threshold (Low)	Threshold (High)
Observations (n)	198	198	96	102
Firms (clusters)	30	30	14	16
Panel Period	2018–2024	2018–2024	2018–2024	2018–2024
R^2	0.41	0.45	0.28	0.49
F-statistic	12.85***	14.91***	7.42***	13.67***
Fixed Effects	Firm & Year	Firm & Year	Firm & Year	Firm & Year

Notes:

- $DIAC^2$ captures nonlinear (quadratic) effects
- Threshold models split sample based on median DIAC level
- Robust standard errors in parentheses
- *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

As shown in Table 6, the quadratic term is positive and statistically significant ($\beta = 0.185$, $p < 0.05$), indicating diminishing marginal returns to digital audit capability deployment, while

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threshold results suggest that significant effects materialize only beyond a minimum capability level.

Threshold model results further indicate that the impact of digitally enabled internal audit capabilities becomes statistically significant only at higher levels of capability deployment ($\beta = -0.301$, $p < 0.01$), while remaining insignificant at lower levels ($\beta = -0.119$, $p > 0.10$) (Sutton et al., 2024).

This pattern suggests that partial or fragmented adoption of digital audit tools does not meaningfully affect fraud-risk outcomes, reinforcing the importance of integrated capability deployment rather than isolated technological investments.

The nonlinear specification reveals a significant quadratic term ($\beta = 0.185$, $p < 0.05$), indicating diminishing marginal returns, while threshold estimates show that effects become significant only at higher capability levels ($\beta = -0.301$, $p < 0.01$) and remain insignificant at lower levels ($\beta = -0.119$, $p > 0.10$).

5.7 Interaction with Governance Quality

Extended models assess interactions between digitally enabled internal audit capabilities and governance quality indicators (e.g., audit committee expertise, independence, and meeting frequency). As shown in Table 7, strong governance significantly amplifies the effectiveness of digitally enabled internal audit capabilities. (Velte & Stiglbauer, 2022).

Table 7 presents interaction models examining whether governance quality enhances the effectiveness of digitally enabled internal audit capabilities in mitigating fraud risk.

✅ Table 7: Governance Interaction Effects

Table7. Interaction between Digitally Enabled Internal Audit Capabilities and Governance Quality

Variables	Transaction Fraud Risk	Process Fraud Risk	Collusive Fraud Risk
DIAC	-0.182** (0.079)	-0.091 (0.071)	-0.026 (0.060)
GOV	-0.136*** (0.052)	-0.097 (0.058)	-0.061 (0.063)
DIAC × GOV	-0.214*** (0.068)	-0.153** (0.072)	-0.047 (0.067)
IA	0.203** (0.081)	0.249*** (0.086)	0.271*** (0.094)
SIZE	-0.055** (0.024)	-0.032 (0.027)	-0.018 (0.029)
LEV	0.091** (0.040)	0.071* (0.043)	0.059 (0.046)
ROA	-0.126** (0.055)	-0.086 (0.059)	-0.041 (0.062)

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Model Statistics:

	Transaction	Process	Collusive
Observations (n)	198	198	198
Firms (clusters)	30	30	30
Panel Period	2018–2024	2018–2024	2018–2024
R^2	0.48	0.34	0.19
F-statistic	15.21***	9.67***	4.38**
Fixed Effects	Firm & Year	Firm & Year	Firm & Year

Notes:

- Interaction term (DIAC × GOV) captures governance amplification effects
- Robust standard errors in parentheses
- *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

As shown in Table 7, the interaction between digitally enabled internal audit capabilities and governance quality is negative and statistically significant for transaction-based and process-related fraud risk, indicating that stronger governance amplifies the effectiveness of digital audit capabilities.

These findings indicate that governance structures—particularly audit committee effectiveness and oversight intensity—enhance the ability of internal audit functions to translate digital insights into actionable fraud mitigation outcomes.

In contrast, the interaction effect remains statistically insignificant for collusive fraud ($\beta = -0.047$, $p > 0.10$), suggesting that even strong governance mechanisms cannot fully overcome deeply embedded informational and relational constraints.

The interaction between digital audit capabilities and governance quality is negative and significant for transaction-based fraud ($\beta = -0.214$, $p < 0.01$) and process-related fraud ($\beta = -0.153$, $p < 0.05$), indicating a meaningful amplification effect.

5.8 Applied Insights from Comparative Case Evidence

Comparative case analysis complements the quantitative findings by illuminating mechanisms underlying boundary effects. In cases with lower information asymmetry, audit teams leveraged analytics outputs to initiate timely inquiries and secure cross-functional cooperation, leading to

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measurable risk reductions (Ahrens et al., 2023). Where asymmetry was high, similar signals were contested or reframed, delaying action and reducing impact.

Case narratives also reveal that auditors' interpretive authority—and not analytical sophistication—often determined outcomes. Successful cases featured clear protocols for validating signals and escalating findings independent of management narratives (Roussy et al., 2024). These insights explain why quantitative effects vary by risk category and governance context.

The qualitative component is based on a purposive selection of case observations designed to capture variation in information asymmetry and audit capability deployment. Case evidence is derived from a limited number of semi-structured interviews with internal audit professionals and related documentation. Interviews are transcribed and thematically analyzed to identify recurring patterns related to audit effectiveness and interpretive constraints. Coding procedures follow an iterative approach linking observed practices to the study's conceptual framework. Participation is voluntary, and all data are anonymized to ensure confidentiality. Formal institutional approval was not required as the study relies on professional, non-sensitive organizational information and anonymized responses.

5.9 Robustness Extensions and Alternative Specifications

Additional robustness checks—including alternative fraud proxies, subsample analyses by organizational complexity, and placebo tests—support the stability of the main results. Effects persist across alternative model specifications, while placebo outcomes show no spurious associations, strengthening causal interpretation (Lennox et al., 2024).

The empirical strategy is designed to minimize endogeneity concerns through structural model specification rather than reliance on external instruments.

5.10 Boundary Mapping and Capability Profiles

To translate findings into applied insight, the study maps audit capability profiles against fraud risk categories under varying levels of information asymmetry. This mapping reveals three archetypal profiles. The first profile—data-visible environments—features low asymmetry and high standardization, where digital enablement produces substantial audit gains. The second—interpretive environments—exhibits moderate asymmetry, where gains depend on governance complements and escalation protocols. The third—relational environments—is characterized by high asymmetry and collusion, where audit capabilities face persistent limits (Hoang & Sun, 2024).

These profiles provide a practical lens for understanding why similar digital investments yield divergent outcomes across organizations. They also reinforce the argument that capability reconfiguration is selective and contingent, not universal.

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5.11 Implications for Audit Strategy and Resource Allocation

The results have direct implications for internal audit strategy. First, organizations should prioritize digital enablement in areas where data visibility aligns with audit authority, maximizing returns on investment. Second, for process-related risks, digital tools must be complemented by governance mechanisms that reduce information asymmetry, such as enhanced audit committee engagement and cross-functional access (Velte, 2024). Third, expectations regarding collusive fraud detection should remain cautious; overreliance on analytics may create a false sense of assurance.

Resource allocation decisions should therefore be informed by boundary awareness rather than technological optimism. Investing in interpretive capacity, professional judgment, and organizational positioning may yield greater marginal benefits than additional analytical sophistication in high-asymmetry domains (Gendron et al., 2023).

6: Discussion and Implications (Aligned with the Refined Plan)

6.1 Discussion of Findings in Relation to the Literature

Synthesizing the quantitative and qualitative findings reveals a coherent pattern consistent with the study's boundary-based framework Digitally enabled internal audit capabilities significantly reduce transaction-based fraud risk.

The estimated coefficient is negative and statistically significant ($\beta = -0.245$, $p < 0.01$). This effect persists after controlling for firm size and governance quality. In such contexts, analytics-supported monitoring enhances visibility and timeliness, allowing internal audit to intervene earlier in the risk cycle (Gao et al., 2024). These gains, however, are not linear or unlimited.

Where fraud risk involves interpretive ambiguity, discretionary judgment, or process manipulation, the results indicate conditional effectiveness. Digital signals require contextual validation, and the absence of such validation—often due to information asymmetry—weakens audit impact (Messner & Becker, 2023). This finding explains why process-related fraud exhibits mixed results across models and cases, despite comparable levels of digital enablement.

For collusive and strategically concealed fraud, the integrated evidence consistently points to hard capability boundaries. Neither advanced analytics nor strong governance fully overcomes informational blind spots created by coordinated intent and data manipulation. These results align with recent theorizing that emphasizes the social and relational dimensions of fraud beyond what data-intensive methods can reveal (Free et al., 2023).

The differential effects observed across fraud categories can be explained by the varying degree of data visibility, interpretive complexity, and organizational dependence embedded in each type of fraud risk. Digitally enabled internal audit capabilities appear most effective where fraud generates standardized transactional traces that can be captured through continuous monitoring

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and exception-based analytics. By contrast, process-related fraud involves greater interpretive ambiguity, requiring contextual validation beyond the signal itself. For collusive and strategically concealed fraud, digital enablement faces its strongest limits because coordinated intent, relational concealment, and manipulation of underlying information flows reduce the observability of risk patterns despite the presence of advanced analytical tools.

This section also discusses the empirical findings by positioning them against recent streams of research on digitally enabled internal audit, fraud risk mitigation, and audit analytics. A first point of convergence with the literature is the strong and consistent association between digitally enabled internal audit capability deployment and the mitigation of transaction-based fraud risk. Recent work suggests that continuous monitoring, exception-based routines, and analytics-supported planning increase detection timeliness in rule-based environments, particularly where fraud leaves standardized data traces (Bierstaker et al., 2023). The present findings reinforce this claim while clarifying that the observed effect is best interpreted as capability redeployment toward sensing and early intervention, rather than a universal strengthening of internal audit.

However, the results diverge from some optimistic narratives that assume digital enablement translates broadly into stronger audit outcomes. Several contemporary studies highlight that analytics can amplify auditors' informational reach but may simultaneously introduce interpretive complexity and dependence on managerial context (Dowling et al., 2023). The evidence here supports this caution: for process-related fraud, digitally enabled capabilities show conditional and weaker effects, suggesting that analytics-driven signals require validation through contextual information that is often controlled by management.

A second major contribution relative to the literature is the finding that collusive and strategically concealed fraud remains largely resistant to digitally enabled internal audit. While recent research recognizes the social embeddedness of fraud and the limitations of data-only approaches, empirical demonstrations of "hard boundaries" have been limited (Free et al., 2023). The present results substantiate the argument that collusion and strategic concealment exploit informational blind spots and relational dynamics that are not readily observable through standard audit data infrastructures (Sikka & Willmott, 2023).

Third, the findings refine prior debates regarding governance complements. Several studies propose that stronger audit committees and governance quality enhance the payoff from audit analytics (Velte, 2024). The current results partially support this view but indicate an important limitation: governance complements can shift the boundary for transaction-based and some process-related fraud, yet do not eliminate boundaries for collusive fraud. This suggests that the relationship between governance and digitally enabled auditing is best understood as boundary shifting rather than boundary removal (Gendron & Power, 2023).

Finally, the nonlinearity detected in the results resonates with emerging evidence that digitalization benefits may exhibit threshold and saturation effects. When analytics maturity is low, incremental adoption yields little; once a minimum integration threshold is reached,

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improvements become visible—yet further investment can produce diminishing returns unless informational constraints are simultaneously addressed (Sutton et al., 2024). Thus, the literature's emphasis on technology adoption is insufficient; what matters is capability integration under realistic informational conditions.

6.2 Discussion of Findings in Relation to Comparative Case Evidence

The comparative cases deepen the interpretation of these patterns by revealing how information asymmetry operates as a mechanism shaping capability realization. In lower-asymmetry cases, audit teams were able to translate analytics signals into actionable inquiries because they had cross-functional access to operational explanations, direct escalation pathways, and governance support for independent validation. These contexts enabled digitally enabled audit routines to function as intended: signals became findings, and findings became interventions (Ahrens et al., 2023).

These comparative cases clarify that the issue is not merely whether digital tools are available, but whether their outputs can be translated into credible audit action. In lower-asymmetry settings, digital signals are more readily validated and escalated, which explains the stronger effects observed for transaction-level fraud. In higher-asymmetry settings, however, the same tools generate weaker practical value because managerial control over context and explanation constrains audit interpretation. This case-based evidence helps explain why the empirical results vary systematically across fraud categories rather than uniformly across all forms of misconduct.

In contrast, in higher-asymmetry cases, the same categories of analytics signals were frequently contested, delayed, or reframed. Managers controlled access to contextual data and imposed narrative explanations that reduced the credibility of audit concerns, particularly for process-related fraud. This explains why quantitative estimates for process manipulation appear unstable: capability deployment is present, but capability realization is blocked by informational gatekeeping (Roussy et al., 2023).

Case evidence also clarifies why collusive fraud remains resistant. Collusion was not merely "hidden in the data" but was socially coordinated in ways that manipulated both data generation and interpretation. Even when anomalies were detected, audit teams could not establish intent or accountability without independent corroboration. This mechanism-based explanation aligns with recent qualitative and critical auditing research that emphasizes the relational nature of fraud and the organizational politics surrounding audit escalation (Khalifa & O'Regan, 2023).

Overall, the comparative evidence supports the boundary framework by showing that digital enablement expands sensing capacity, while information asymmetry governs whether sensing can become intervention. The cases thus validate the study's core claim: capability boundaries are produced through the interaction of digital enablement with informational and governance structures.

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6.3 Discussion of Findings in Relation to Theoretical Frameworks

This section interprets the empirical findings through the theoretical lenses underpinning the study, namely capability theory, information asymmetry theory, and boundary-oriented perspectives in auditing. From a capability theory standpoint, the results provide strong evidence that digitally enabled internal audit capabilities are reconfigured rather than uniformly expanded. While digital enablement strengthens sensing and detection capacities in data-visible domains, it does not proportionally enhance interpretive authority or enforcement power in contexts characterized by ambiguity and strategic intent. This finding aligns with contemporary interpretations of dynamic capabilities that emphasize selective adaptation shaped by environmental constraints rather than unrestricted capability growth (Helfat & Peteraf, 2023).

Information asymmetry theory offers a complementary explanation for these patterns. The results demonstrate that asymmetry operates as a structural moderator, constraining the translation of analytical signals into actionable audit outcomes. Even where advanced analytics are deployed, auditors' reliance on management-controlled contextual information limits their ability to validate intent and escalate concerns. Recent theoretical work emphasizes that asymmetry in meaning and interpretation—rather than data availability alone—defines governance effectiveness in digital settings (Healy & Serafeim, 2023). The findings corroborate this view by showing that digital visibility does not equate to informational parity.

Boundary-oriented perspectives in auditing further clarify why certain fraud categories remain resistant to digitally enabled intervention. The persistence of weak effects for collusive and strategically concealed fraud reflects the existence of hard capability boundaries, where social coordination and institutional power override technical detection. Boundary theory suggests that professional functions operate within negotiated zones of authority shaped by organizational politics and legitimacy (Power, 2023). The present evidence extends this perspective by empirically demonstrating how digital tools may shift—but not dissolve—these zones.

Importantly, the findings also nuance institutional interpretations of audit effectiveness. While governance mechanisms can partially relax boundaries by enhancing audit committee support and escalation legitimacy, they do not eliminate the underlying asymmetry that sustains collusive behavior. This observation aligns with recent institutional analyses emphasizing the endurance of informal practices despite formal digital reforms (Andon et al., 2024). Collectively, the results support a boundary-formation view of digitally enabled internal audit, integrating capability, informational, and institutional logics into a unified explanation.

6.4 Discussion of the Validity of Research Hypotheses

The empirical findings allow for a systematic evaluation of the study's hypotheses. H1, which predicted a positive association between digitally enabled internal audit capabilities and the mitigation of transaction-based fraud risk, is supported. Both quantitative results and case evidence indicate that analytics-supported monitoring significantly enhances early detection and

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remediation in standardized, rule-based environments. This outcome confirms that digital enablement yields tangible benefits where fraud risks leave consistent data traces.

H2, proposing a weaker association for process-related fraud risk, is partially supported. While some mitigating effects are observed, their significance depends on governance complements and information access. This partial support reflects the interpretive complexity inherent in process manipulation, where analytics identify anomalies but cannot independently establish intent. The result underscores that digital enablement alone is insufficient without contextual integration.

H3, which anticipated limited effects for collusive and strategically concealed fraud, is supported. Across specifications and cases, digitally enabled internal audit capabilities show no robust association with this category of fraud. This finding validates the boundary-based argument that such risks exploit informational and relational blind spots beyond the reach of standard audit analytics.

Turning to moderating hypotheses, H4—predicting a negative moderating effect of information asymmetry on the relationship between digital enablement and fraud mitigation—is supported for transaction-based and process-related fraud. Higher asymmetry consistently weakens the effectiveness of digital capabilities, confirming the central role of informational constraints. H5, which posited a stronger moderating effect for complex fraud categories, is supported insofar as asymmetry exerts its greatest influence in process-related contexts and renders collusive fraud largely invariant to digital enablement.

Overall, the hypothesis testing results exhibit strong internal coherence. The pattern of supported and partially supported hypotheses aligns closely with the theoretical framework, reinforcing confidence in the study's explanatory logic. Importantly, the absence of effects in certain domains should not be interpreted as model failure; rather, it reflects the deliberate theorization of capability limits under information asymmetry.

6.5 Theoretical, Practical, and Societal Implications (Derived from Empirical Findings)

The findings of this study generate multi-layered implications that extend beyond the immediate empirical context. From a theoretical perspective, the research advances auditing literature by reframing digitally enabled internal audit effectiveness as a function of boundary navigation rather than technological sophistication. Prior studies often conceptualize digitalization as a linear enhancer of audit quality. In contrast, the present study demonstrates that digital enablement produces selective capability reconfiguration, constrained by information asymmetry and organizational power structures (Gendron et al., 2023).

These findings imply that digital enablement should not be treated as a uniform anti-fraud solution. Its effectiveness is greatest in settings where fraud risk is operationally visible and analytically traceable, but more limited where risk depends on discretion, concealment, or collusion. The practical implication is that organizations should align digital audit investments

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with the specific fraud environments they face, while complementing analytics with governance support, interpretive authority, and escalation mechanisms in higher-complexity contexts.

This insight contributes to the integration of capability theory and auditing research by showing that internal audit capabilities evolve unevenly across risk domains. The study thus responds to calls for more realistic theorization of audit practice in complex environments, where informational and institutional constraints shape professional action (Humphrey et al., 2023). By explicitly theorizing capability boundaries, the research moves beyond binary success–failure narratives and offers a more nuanced explanatory framework.

From a practical perspective, the findings carry important implications for internal audit leaders and governance bodies. First, organizations should align digital audit investments with areas where data visibility and audit authority converge. Over-investment in analytics without addressing information asymmetry risks producing symbolic rather than substantive assurance. Second, internal audit functions should prioritize interpretive capacity, professional judgment, and escalation protocols alongside technical tools. The results indicate that audit impact depends critically on the ability to contextualize and legitimize analytical signals (Sutton & Arnold, 2024).

Third, the study highlights the importance of governance complements. Audit committees play a central role in mitigating information asymmetry by legitimizing audit inquiries and facilitating access to independent information sources. However, governance mechanisms should be viewed as boundary shifters, not boundary eliminators. Expectations regarding the detection of collusive fraud must remain realistic to avoid overstating the protective capacity of digitally enabled auditing (Velte, 2024).

The societal implications of the study are particularly salient in contexts characterized by public-sector complexity and sustainability challenges. Fraud undermines public trust, resource allocation, and sustainable development outcomes. By clarifying where digital audit capabilities are effective—and where they are not—the study contributes to more responsible governance narratives that avoid technological determinism. Recognizing audit boundaries enhances transparency and accountability, ultimately strengthening institutional credibility (Bracci et al., 2023).

6.6 Policy-Oriented Recommendations

The effectiveness of the following recommendations is conditional on organizational context, particularly levels of information asymmetry and the degree of digital audit capability integration.

The following recommendations are informed by statistically significant associations observed in the empirical analysis. They should be interpreted as evidence-based guidance rather than causal prescriptions, and their effectiveness may depend on contextual and institutional conditions.

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Building on these implications, the study proposes several policy-oriented recommendations aimed at regulators, standard setters, and public-sector decision-makers.

First, Digital investment: audit digitalization policies should explicitly incorporate information asymmetry assessments. Mandating analytics adoption without addressing data governance, access rights, and interpretive authority may yield limited benefits. Policy frameworks should therefore link digital audit requirements to governance reforms that enhance audit independence and informational access (OECD, 2023).

This recommendation is supported by the strong and statistically significant association between digital audit capabilities and transaction-level fraud mitigation ($\beta = -0.245$, $p < 0.01$), indicating substantial effectiveness in data-visible environments.

The effectiveness of this recommendation is contingent on achieving a minimum threshold of capability integration, beyond which digital tools begin to produce measurable effects.

Second, Interpretive capacity: internal audit standards and guidance should emphasize capability integration rather than tool adoption. Training programs should focus on developing auditors' interpretive skills, ethical judgment, and cross-functional communication capabilities. This aligns with emerging professional guidance that recognizes the cognitive and organizational dimensions of digital auditing (IFAC, 2024).

This recommendation is justified by the weaker and conditional effects observed for process-related fraud ($\beta = -0.112$, $p < 0.10$), suggesting that digital tools alone are insufficient without contextual interpretation.

Third Governance role:, regulators should avoid framing digitally enabled internal audit as a comprehensive solution to all fraud risks. Policy narratives should acknowledge that certain forms of collusive and strategic fraud remain resistant to audit intervention, even in advanced digital environments. Such realism supports more balanced accountability expectations and reduces the risk of misplaced reliance on technology (Power & Hall, 2023).

These measures are particularly relevant in settings with high information asymmetry, where interpretive constraints limit the effectiveness of purely data-driven audit approaches.

Empirical support is provided by the significant interaction between digital capabilities and governance quality ($\beta = -0.214$, $p < 0.01$), indicating that governance mechanisms amplify audit effectiveness.

This recommendation is most effective in environments characterized by moderate levels of information asymmetry and sufficiently developed digital audit capabilities, where governance mechanisms can translate analytical signals into actionable interventions.

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Fourth (collusive fraud : This recommendation reflects the absence of statistically significant effects for collusive fraud ($\beta = -0.031$, $p > 0.10$), highlighting structural limitations of digital audit approaches.

Even under strong governance conditions, this recommendation may have limited effectiveness in cases of collusive fraud, where relational dynamics and strategic concealment create persistent informational blind spots.

Fifth threshold: The recommendation is further supported by threshold and nonlinear findings, where meaningful effects emerge only at higher capability levels ($\beta = -0.301$, $p < 0.01$), indicating the importance of integrated deployment.

Finally, in public-sector and state-owned enterprise contexts, policy initiatives should prioritize institutional alignment between audit functions, oversight bodies, and executive leadership. Reducing information asymmetry through transparency mandates, data-sharing protocols, and protected escalation channels can meaningfully expand the effective boundaries of internal audit. These reforms are essential for ensuring that digital audit investments contribute to sustainable governance and development objectives (Christensen et al., 2024).

Study Limitations and Methodological Boundaries

Despite the robustness of the empirical findings, several study-specific limitations should be acknowledged and interpreted in relation to the research design, measurement choices, and analytical framework.

First, measurement-related limitations. The study relies on composite indices to operationalize key constructs such as digitally enabled internal audit capabilities and fraud-risk boundaries. While these measures are grounded in prior literature and validated through confirmatory factor analysis, they may still be subject to measurement error and reporting bias. In particular, fraud-risk outcomes partially reflect detection and disclosure practices rather than underlying incidence, which may influence the magnitude of estimated effects.

Second, sampling and data-related constraints. The empirical analysis is based on a panel of organizations operating within a specific institutional and regulatory context. Although the sample is designed to capture variation in audit capability deployment, its focus on relatively large and information-intensive entities may limit the generalizability of findings to smaller organizations or less formalized audit environments. This limitation is consistent with the sampling strategy outlined in Section 4.5 and should be considered when extending the results to broader contexts.

Third, causal design limitations. As with most observational studies, the research design does not fully eliminate endogeneity concerns. While fixed-effects estimation, lagged specifications, and robustness checks mitigate potential biases, causal interpretations should be made with

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caution. The absence of instrumental variable techniques means that unobserved time-varying factors may still influence the estimated relationships.

Fourth, boundary-specific analytical limitations. The study's boundary-based framework emphasizes differential effects across fraud risk categories and information asymmetry conditions. While this approach enhances theoretical precision, it may simplify complex organizational dynamics that evolve over time. In particular, interaction and threshold models capture conditional relationships but may not fully reflect dynamic feedback mechanisms between audit capabilities and organizational behavior.

These limitations do not undermine the core findings but rather define the scope within which the results should be interpreted. They also provide a foundation for future research to refine measurement approaches, expand sampling contexts, and strengthen causal identification strategies.

(Lennox & Wu, 2023). The findings of this study should be interpreted as associative rather than strictly causal. While the empirical design incorporates fixed effects, lag structures, and robustness checks to mitigate endogeneity concerns, the observational nature of the data does not allow for definitive causal inference.

7: Conclusion and Future Research Directions

7.1 Summary of the Study and Key Findings

This study set out to examine how digitally enabled internal audit capabilities contribute to fraud risk mitigation under conditions of information asymmetry. Departing from deterministic views of audit digitalization, the research developed and empirically tested a boundary-based framework that conceptualizes digital enablement as a conditional reconfiguration of audit capabilities rather than a universal enhancement.

The empirical findings demonstrate that digitally enabled internal audit capabilities are most effective in mitigating transaction-based fraud, where risks are operational, standardized, and data-visible. In contrast, the effects on process-related fraud are weaker and highly contingent on governance complements and information access. For collusive and strategically concealed fraud, the study finds no robust mitigating effect, indicating the presence of hard capability boundaries shaped by social coordination and informational control (Free & Jeppesen, 2024; Hoang & Sun, 2024).

Importantly, the results confirm that information asymmetry acts as a structural constraint, moderating the relationship between digital audit capabilities and fraud outcomes. Even in technologically advanced environments, auditors' dependence on management-controlled contextual information limits their interpretive authority and escalation power (Healy & Serafeim, 2023; Velte, 2024).

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7.2 Theoretical Contributions

This research makes several original theoretical contributions. First, it advances auditing literature by introducing a capability boundary perspective, shifting the focus from technology adoption to the limits of capability realization under informational constraints. This contribution bridges capability theory, information asymmetry theory, and boundary-oriented perspectives in auditing, offering a more realistic model of digitally enabled internal audit (Gendron & Power, 2023).

Second, the study contributes to fraud research by empirically demonstrating that fraud risk categories respond differently to digital audit interventions. By disaggregating fraud into transaction-based, process-related, and collusive forms, the research responds directly to recent calls for more granular fraud theorization and measurement (Dechow et al., 2024).

Third, the findings challenge optimistic assumptions that digital audit technologies inherently strengthen governance. Instead, they show that digitalization may shift—but not eliminate—organizational and institutional boundaries that constrain audit effectiveness (Power, 2023).

7.3 Practical and Policy Implications

From a practical standpoint, the study offers important guidance for internal audit leaders and governance bodies. Digital audit investments should be strategically aligned with areas where data visibility and audit authority converge. Overreliance on analytics in high-asymmetry domains risks creating symbolic assurance without substantive impact.

For policymakers and regulators, the findings suggest that digital audit reforms must be accompanied by governance and transparency reforms. Policies that mandate analytics adoption without addressing information access, escalation rights, and audit independence are unlikely to achieve meaningful fraud mitigation outcomes (OECD, 2023; IFAC, 2024).

In public-sector and state-owned enterprise contexts, reducing information asymmetry through data-sharing protocols and protected reporting channels is critical to expanding the effective boundaries of internal audit and supporting sustainable governance objectives.

7.4 Limitations and Future Research Directions

Despite its contributions, the study is subject to limitations. First, fraud mitigation is measured using a combination of reported incidents and audit outcomes, which may be influenced by detection and disclosure practices. Second, while the mixed-method design enhances explanatory depth, causal inference remains constrained by the observational nature of the data.

Future research could extend this work in several directions. Comparative cross-country studies may examine how institutional environments shape audit capability boundaries. Longitudinal research could explore how boundaries evolve as digital governance matures. Finally, future studies may investigate how emerging technologies—such as advanced learning systems or

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cognitive audit tools—interact with professional judgment and information asymmetry to reshape internal audit practice (Vasarhelyi et al., 2023).

Data and Code Availability Statement

The data used in this study are derived from a combination of survey responses and archival sources, including internal audit reports, governance disclosures, and publicly available financial data. Due to confidentiality agreements and organizational sensitivity, the full dataset cannot be made publicly available.

However, a structured and anonymized version of the dataset, along with detailed variable definitions and replication procedures, is available from the author upon reasonable request for academic purposes.

The analytical code used to generate the empirical results (including model specifications and robustness tests) can also be provided upon request to facilitate replication and verification.

Online Supplementary Materials

To enhance transparency and reproducibility, supplementary materials are prepared and made available through a controlled-access repository. These materials include:

- The full survey instrument used for data collection
- Measurement items and confirmatory factor analysis (CFA) loadings
- Detailed regression model specifications and equations
- Data construction procedures and variable definitions
- Analysis scripts used for estimation and robustness checks, including software and version information

Due to confidentiality considerations, access to certain materials is provided upon reasonable academic request.

Conflict of Interest Statement

The author declares that there is no conflict of interest regarding the publication of this paper. The author has no financial, personal, or professional relationships that could have appeared to influence the work reported in this study.

Data and replication materials, including measurement items, CFA outputs, and estimation procedures, are available from the author upon reasonable request for academic purposes.

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