THE ACCOUNTING REVIEW
Vol. 100, No. 1
January 2025
pp. 291–315

American Accounting Association
DOI: 10.2308/TAR-2023-0094

Enterprise Resource Planning (ERP) System Implementations and Corporate Misconduct

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ABSTRACT: This study examines whether enterprise resource planning (ERP) implementations are associated with reductions in corporate misconduct. Specifically, we study the relation between staggered facility-level rollouts of ERP systems and facility-level regulatory violations across a large sample of U.S. firms. Our results indicate that facility-level ERP adoptions are associated with substantial reductions in local violations and penalties. Additional analyses suggest that the effects are more pronounced among facilities incorporating advanced analytics into their systems and among workforces that are less resistant to technology change. Overall, our results suggest that ERP systems generate indirect effects that enhance compliance outcomes across a wide range of violations.

JEL Classifications: M40, M41

Keywords: corporate misconduct; compliance; information technology; ERP systems.

I. INTRODUCTION

Firms increasingly rely on information technology (IT) to improve their operations and enhance their competitive edge. In this study, we examine the spillover effects associated with one popular type of IT investment: enterprise resource planning (ERP) systems. An ERP system is a large-scale information system that integrates information from a wide spectrum of business activities subject to regulations, thus making it relevant for a broad array of compliance issues. We examine the relation between staggered facility-level rollouts of ERP systems and facility-level violations across a large sample of U.S. firms.

ERP systems are generally implemented for operational purposes (e.g., Grabski, Leech, and Schmidt 2011). For example, companies frequently install ERP systems to boost productivity, reduce costs, or increase customer satisfaction. Our central prediction is that such implementations can also have *indirect* benefits for a firm's compliance outcomes through at least two channels. First, an ERP system can enhance managerial monitoring, as it reduces the cost of accessing and processing information by centralizing information and producing standardized reports with actionable insights (e.g., Bloom, Garicano, Sadun, and Van Reenen 2014; Dorantes, Li, Peters, and Richardson 2013). As noted by Chapman and Kihn (2009), an ERP system provides managers with more "hierarchical visibility," which enables them to identify risks early. For example, consider a factory manager who might be concerned about ensuring that equipment is maintained in a timely fashion. ERP systems provide management with reports on the operational efficiency and maintenance requirements of such equipment (SAP 2022). This information can help managers adhere to maintenance schedules and ultimately reduce workplace accidents and safety violations.

We thank Shane S. Dikolli (editor) and two anonymous reviewers for helpful and constructive feedback. This paper has also benefited from the suggestions of Braiden Coleman, Caspar David Peter (discussant), Chris Ittner, Gordon S. Potter (discussant), and workshop participants at Cass University, the 2023 Barcelona Accounting Summer Workshop, the 2022 Columbia Junior Accounting Research Conference, Free University Berlin, The Hong Kong University of Science and Technology, the 2022 International Corporate Governance Society at University of Miami, The Pennsylvania State University, the 2023 MAS Midyear Meeting, New York University Shanghai, Rice University, Southwestern University of Finance and Economics, and Temple University. We also thank Christopher Johnson, Tony Liu, and Aiqi Sun for excellent research assistance. The authors of this publication have no conflicts of interest related to this research.

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Editor's note: Accepted by Shane S. Dikolli, under the Senior Editorship of W. Robert Knechel.

Submitted: February 2023
Accepted: July 2024
Early Access: September 2024

The second channel through which ERP systems can generate spillover effects on compliance outcomes relates to their ability to constrain employee behavior through process standardization (e.g., Orlikowski 1991; Sotto 1997). ERP systems help guide employees and alleviate agency problems by mapping out each employee's area of responsibility and by limiting choice alternatives (e.g., Boudreau and Robey 2005). For example, an ERP system can impose constraints on handling hazardous materials and reduce employee autonomy through imposing training and documentation requirements, as well as access and storage restrictions, thus reducing environmental violations (Panjwani 2022). Such constraints on employee behavior can ultimately reduce errors and improve compliance outcomes.

We note, however, that our prediction is not without tension. Various frictions may limit the ability of ERP systems to generate spillover effects for compliance, thus lending support for a null result. First, better information access may not enhance compliance if the information is difficult to process. For instance, many executives acknowledge challenges with interpreting the complex information provided by an ERP system (Agostino 2004), limiting the system's ability to enhance managerial monitoring.[1] Second, ERP systems may also be ineffective if end users do not use the system, as highlighted by models of user acceptance of new technology and prior ERP research (e.g., Beasley, Branson, Braumann, and Pagach 2023; Liang, Xue, and Wu 2012; Venkatesh, Morris, G. Davis, and F. Davis 2003). In such instances, employees are unwilling to follow system protocols, thus limiting the system's ability to constrain their behavior.

Examining the spillover effects of ERP systems poses several empirical challenges. First, ERP rollouts are typically unobservable across firms. We build on recent research in management and economics (e.g., Bloom et al. 2014; Forman, Goldfarb, and Greenstein 2012) and obtain detailed facility-level technology adoption data from Aberdeen's Computer Intelligence Technology Database (CiTDB). These data allow us to assess whether and at which point in time a facility implements an ERP system across facilities of a large sample of publicly traded firms.[2]

Second, extant research studying large-sample ERP adoption cannot examine decisions at the facility level. This unit of analysis allows us to provide a more complete analysis of ERP adoption effects within companies and also explore facility-level determinants of ERP adoption. Our main analyses employ a difference-in-differences (DiD) specification to exploit the staggered facility-level (i.e., within-firm) adoption of ERP systems across 5,982 facilities in the United States for the period 2005 to 2017. Given that firms typically roll out ERP systems in phases (Caldwell 2020), a facility-level analysis thus allows us to isolate the effects of technology adoption within a firm and better control for many time-varying firm effects that prior research is unable to account for.[3] Although this methodology cannot provide evidence on the causal effects of ERP systems, it can alleviate firm-level endogeneity and further our understanding of how ERP systems relate to compliance outcomes.

Finally, data on firm outcomes in general and compliance outcomes in particular are typically unavailable, requiring prior research to rely on questionnaires capturing *perceived* ERP benefits, which may be biased (e.g., Chapman and Kihn 2009). We assess the *realized* benefits of ERP systems using data from Violation Tracker. These data contain facility-level violations and penalties issued by federal agencies across a wide range of regulations for which ERP systems may offer benefits, such as those related to workplace safety, labor codes, or environmental requirements. Our final sample includes 12,505 violations, resulting in almost $16.9 billion in fines across our sample period. Our analyses assess how the number of violations and penalties change following ERP adoption at a facility.

Our initial analyses explore the determinants of ERP presence within a facility. Anecdotal evidence suggests that ERP systems are adopted for a variety of strategic and operational reasons that do not necessarily relate to compliance. We aim to capture these reasons by including proxies for competition, prior misconduct history, and the quality of local IT infrastructure, among other factors. We find that competitive pressures, as proxied by industry ERP adoption rates and Herfindahl-Hirshman indexes, strongly predict ERP adoption. In addition, companies appear to prioritize ERP adoption among closer facilities, where it is likely easier and more efficient to roll out an ERP system initially. Collectively, these results suggest that companies, on average, appear to install ERP systems for strategic reasons, further motivating our investigation of indirect compliance benefits associated with ERP systems.

Our main analyses examine the association between ERP system rollouts and compliance outcomes. Consistent with our main hypothesis, the results indicate that ERP rollouts are associated with reductions in both facility-level violations and penalties.

As discussed above, prior research suggests that ERP systems may indirectly enhance compliance outcomes through increasing managerial monitoring and imposing constraints on employees' actions. In our subsequent cross-sectional analyses, we provide additional evidence to help validate these channels.

[1] This idea is consistent with a long-standing body of literature examining the notions of bounded rationality (Simon 1955) and limited attention (e.g., Merton 1987).
[2] Facilities include distribution centers, factories, mines, stores, and warehouses, among others.
[3] Common ERP-implementation choices include "Big Bang," where the rollout occurs instantly across the firm; "Phased Rollouts," where change occurs over a longer period of time; and "Parallel Adoption," where both legacy and ERP systems run at the same time as users migrate over (Caldwell 2020).

We first explore the validity of the managerial monitoring mechanism by examining the role of advanced analytics, or tools that allow managers to derive additional insights from data. Such tools may enhance the efficacy of ERP systems in enabling managerial monitoring, as managers may be unable to process the wealth of data produced by the technology in the absence of such systems. We examine variation in the ERP rollout's inclusion of Business Intelligence and Data Warehousing (BI-DW) software, which is a common software deployed with ERP that helps managers process data and find patterns in the data that ERP systems collect. Prior academic studies and evidence from practice suggest that BI-DW is useful, as it "analyzes and contextualizes information…to generate actionable insights" and reduces information overload (e.g., Agostino 2004; D. Chou, Bindu Tripuramallu, and A. Chou 2005). Consistent with expectations, we find that our results are concentrated among facilities with ERP adoptions with BI-DW software. These findings suggest that the compliance benefits of ERP systems vary with managers' ability to easily use the information provided by the system to monitor employees.

Our second cross-sectional analysis validates the employee constraint channel. In these tests, we focus on frictions associated with end-user adoption. Prior studies note that ERP systems often face implementation challenges and fail, in part because workers are resistant to new technologies, and find ways to circumvent the constraints that the ERP system imposes on them (e.g., Aladwani 2001). We expect that ERP rollouts offer fewer compliance benefits for facilities with a more technology-resistant workforce because such employees' actions are less likely to be constrained by the ERP system. We construct two measures of technology resistance. The first is a local-level composite index based on known determinants of openness to technology, i.e., age and concentration of STEM jobs in a facility's locality (e.g., Bénabou, Ticchi, and Vindigni 2015, 2022). The second is a facility-level estimate of workforce age using data from Revelio Labs. Our results are concentrated in facilities that are likely to be more open to technology, suggesting that the compliance benefits of ERP systems vary with the system's ability to constrain employee behavior.

We conduct a large number of additional analyses, in part to address endogeneity critiques that a facility's ERP adoption is potentially correlated with local misconduct. First, we build on the findings of the determinants analysis and introduce an instrumental variable test based on the presence of connections to the Advanced Research Projects Agency Network (ARPANET), which is the predecessor of the internet. We follow Forman et al. (2012), who find that firms in counties with ARPANET nodes invest more in technology because the local infrastructure is better. The instrument is suitable for our setting, as it is unlikely that ARPANET nodes are endogenous to facility-level misconduct. Our results indicate that the instrumented ERP treatment continues to be associated with lower levels of misconduct.

In additional tests, we also show that our results are robust to the inclusion of various fixed effects accounting for other types of unobserved heterogeneity. Our results also hold using an entropy-balancing research design (Hainmueller 2012) as well as alternative sample-selection, measurement, and research-design choices. These analyses establish a stronger link between ERP adoption and misconduct and, collectively, help to alleviate endogeneity concerns.

We offer several caveats to our findings. First, our measurement of ERP adoption is potentially subject to measurement error. Although Aberdeen data have been used in prior studies in economics and finance, it is important to note that the data vendor uses both survey-based methodology and third-party sources. We conduct several robustness tests to alleviate measurement errors related to Aberdeen's methodology and also incorporate an alternative measure of ERP rollouts using labor market data from Revelio Labs. Second, our study is also unable to identify the causal effects of ERP systems. Instead, we can rule out many alternative explanations. In particular, given that ERP systems are not randomly assigned, we cannot fully alleviate the potential for selection effects or the potential for omitted time-varying facility factors to influence our findings. Nevertheless, our findings extend the literature by providing a comprehensive examination of both the determinants and consequences associated with ERP systems across the near universe of public companies.

Our study contributes to the literature across several dimensions. Our primary contribution is to the growing literature examining management control systems that help curtail corporate misconduct. We contribute to recent studies examining how control systems, such as compliance training, codes of conduct, management visits, and whistleblower programs, relate to misconduct (e.g., Heese and Pérez-Cavazos 2020; Kaptein and Schwartz 2008; Park 2020; Soltes 2020; Stubben and Welch 2020). Our findings suggest that ERP systems can generate benefits for compliance that extend beyond the operational benefits motivating their adoption.

Second, our findings complement a growing literature in accounting interested in examining compliance (e.g., An, Bushman, Kleymenova, and Tomy 2024; Charoenwong, Kowaleski, Kwan, and Sutherland 2024; Even-Tov, Su, and Wang 2024; Kowaleski, Sutherland, and Vetter 2024). For example, Charoenwong et al. (2024) examine how IT investments reduce customer complaints and misconduct in the broker-dealer industry, and Kowaleski et al. (2024) examine the effect of supervisors on employee misconduct in financial institutions. An et al. (2024) and Even-Tov et al. (2024) also examine compliance-related issues and spillover effects in the financial services sector. Our study contributes to this literature by documenting compliance-related spillover effects related to ERP systems. We show that ERP system implementation is associated with reductions in misconduct across a wide range of violations in a large sample of firms operating in many industries.

Third, our study extends the accounting literature examining determinants and potential benefits of ERP systems. Although prior research provides some evidence to suggest that ERP systems enhance financial reporting outcomes and performance (e.g., Baxter, Bedard, Hoitash, and Yezegel 2013; Brazel and Dang 2008; Dorantes et al. 2013), the effects of ERP systems on nonfinancial outcomes are less explored.[4] Our study complements this line of research by demonstrating how ERP systems enhance nonfinancial and compliance outcomes, which is an important, but understudied, area (Ittner and Larcker 2001).[5] Moreover, we show that the indirect compliance benefits of an ERP system depend on the system's ability to improve managerial monitoring and constrain employee choice (e.g., Chapman and Kihn 2009). Our determinants analyses also complement Baxter et al. (2013), who study the factors associated with enterprise risk management (ERM) adoption in financial services firms. Finally, our results are also broadly relevant to researchers examining the benefits of higher-quality internal information (e.g., Gallemore and Labro 2015; Hope, Wang, Yue, and Zhao 2022; Labro, Lang, and Omartian 2023).

II. RELATED LITERATURE AND HYPOTHESIS

Management Control Systems and Compliance

Determining the efficacy of management control systems to curtail misconduct within an organization has been the focus of a long line of research in accounting. As Merchant and Van der Stede (2007) note, management control systems ensure that employees act in accordance with the organization's objectives. As "almost everything in the organization is included as part of the overall control system" (Merchant and Otley 2006, 785), the challenge lies in determining which practices work and how they interact with each other (Grabner and Moers 2013).

A subset of this literature focuses on designing management control systems to prevent employees from exposing the organization to excessive risk (e.g., Campbell, Datar, and Sandino 2009; Sandino 2007). A recent stream of studies focuses on specific control systems that help deter misconduct. For example, Heese and Pérez-Cavazos (2020) examine the effects of management oversight on misconduct and show that site visits reduce violations. Stubben and Welch (2020) conduct a descriptive analysis of whistleblowing systems using proprietary data on nearly two million whistleblowing reports and show that a larger volume of internal reports is associated with fewer fines and lawsuits. Similarly, Park (2020) documents that compliance training can change employee behavior.

At the same time, the extant literature also suggests that there are limitations to existing compliance mechanisms. For example, Soltes (2020) finds that the whistleblowing hotlines of many firms have impediments that prevent the reporting of misconduct, and Dey, Heese, and Pérez-Cavazos (2021) show that firms often retaliate against employee whistleblowers. Similarly, Park (2020) demonstrates that compliance trainings only generate short-term benefits, and Kaptein and Schwartz (2008) suggest that codes of conduct are often ineffective.

We extend this literature by focusing on the potential for IT investments to generate unexpected benefits for control. Such investments may improve monitoring and reduce compliance risk. In particular, we examine the potential compliance benefits associated with ERP systems, which represent a significant IT investment for many firms.

ERP as a Management Control System

Prior research in accounting and information systems literature has long been interested in understanding the potential benefits of ERP systems, given their ability to centralize information in an organization. For example, Nicolaou (2004) demonstrates that firms with ERP systems exhibit better performance, and Tian and Xu (2015) show that ERP systems reduce earnings volatility. Announcements of ERP systems generally also lead to positive market reactions (Hayes et al. 2001; Hendricks, Singhal, and Stratman 2007; Ranganathan and Brown 2006), suggesting that ERP systems enhance firm value.

Several studies focus on how ERP systems affect financial outcomes, with a focus on financial reporting quality and accounting performance. These studies generate mixed findings. For example, Brazel and Dang (2008) show that ERP adoption leads to increases in absolute discretionary accruals or lower financial reporting quality, in part because ERP

[4] Prior studies also show that ERP systems generate firm-level benefits, such as improved profitability (e.g., Hayes, Hunton, and Reck 2001; Ranganathan and Brown 2006; Tian and Xu 2015).

[5] In their review of the management accounting literature, Ittner and Larcker (2001) find that senior executives rate customer relations, operational performance (such as safety), public image, environmental compliance, and employee relations as important drivers of their firms' long-term success. They also argue that information technologies—in particular, ERP systems—have important effects for the management of these nonfinancial value drivers.

implementations are associated with reductions in traditional control systems. On the other hand, two studies also provide evidence consistent with ERP systems improving financial reporting quality. Morris (2011) finds that ERP systems help to reduce the likelihood of internal control weaknesses. Dorantes et al. (2013) examine the benefits of ERP systems for management forecast production and find that firms that adopt these systems issue more accurate forecasts. Baxter et al. (2013) study the factors associated with ERM programs in financial services firms and also show that ERM quality is associated with improved accounting performance.

Understanding the nonfinancial benefits of ERP systems is also important, given Masli, Richardson, Sanchez, and Smith's (2011) claim that "the most important IT benefits are not financial." For example, prior IT research suggests that nonfinancial benefits associated with ERP adoption may include improved customer satisfaction or stronger supplier relationships (e.g., Sambamurthy, Bharadwaj, and Grover 2003; Smith and Wright 2004). Ittner and Larcker (2001) review the management accounting literature and also emphasize the potential importance of information technologies in helping firms manage nonfinancial value drivers. In particular, they highlight the importance of ERP systems, as such systems may contain data-mining capabilities that allow companies to better manage nonfinancial performance measures.

More broadly, our study is also related to the accounting literature examining the role of information technology in improving internal controls and managing enterprise risk. For example, Masli, Peters, Richardson, and Sanchez (2010) show that firms that implemented internal control monitoring technology in response to the internal control requirements of the Sarbanes-Oxley Act had a lower likelihood of internal control failures. More recently, Lawrence, Minutti-Meza, and Vyas (2018) find that operational control risks are leading indicators of financial reporting problems.[6] In light of the growing importance of information technology, studies have also begun studying how such technology can strengthen external control mechanisms, including auditors and analysts (e.g., Ashraf, Michas, and Russomanno 2020; Coleman, Merkley, and Pacelli 2022).[7]

Recent studies have also begun to examine compliance-related issues in accounting. For example, Charoenwong et al. (2024) examine Regulatory Technology, or RegTech, and assess how financial firms respond to new internal control requirements. They find that affected firms increase their investments in ERP and hardware and that such investments reduce customer complaints and misconduct in the broker-dealer industry. With respect to spillover effects, An et al. (2024) examine bank supervisors' enforcement decisions and orders (EDOs) and show that EDO-imposed improvements in loan policies, governance, and training generate externalities that make it easier for minority borrowers to gain access to credit. Even-Tov et al. (2024) examine the effects of reducing information-processing costs on regulatory outcomes in the mortgage industry and show that disclosing enforcement actions on a centralized repository increases the probability of enforcement actions. Our study complements this literature by assessing the indirect effects of ERP systems on compliance outcomes.

Overall, our study adds to the extant literature by examining how ERP systems may indirectly enhance firms' compliance with regulations that are largely nonfinancial and operational in nature (e.g., safety-related, environment-related, consumer-protection-related, etc.). This focus allows us to extend the management accounting literature interested in understanding how ERP systems enhance operational decision making. For example, Chapman (2005) highlights the importance of ERP systems for managerial accounting, noting that ERP systems are "fundamentally bound up with the work of accounting, and have been seen to have transformative implications for the nature of organizational integration and control." Prior research provides some evidence on how ERP systems influence operations, but often relies on site or survey data from one organization. For example, Chapman and Kihn (2009) conduct a survey that suggests that ERP systems enable better control. A related set of field studies also provides some evidence suggestive of ERP systems affecting management practice and control (e.g., Dechow and Mouritsen 2005; Orlikowski 1991). In addition, these studies also argue that ERP systems can improve organizational control by improving managerial monitoring and constraining employees' actions (e.g., Chapman and Kihn 2009), but have not yet provided large-scale evidence consistent with these mechanisms. Our study contributes to this literature by providing a large-sample investigation of how ERP systems can potentially influence one specific management control outcome, i.e., compliance with nonfinancial regulation, and the mechanisms through which ERP systems can improve these compliance outcomes.

Hypothesis

Our central premise is that IT investments in general can have important externalities for compliance.[8] We focus on ERP systems, as such technology has the potential to significantly improve the usefulness of the information available to

[6] As noted by Lawrence et al. (2018), the Committee of Sponsoring Organizations of the Treadway Commission (COSO 2013) has long recognized that controls over operations and compliance (in addition to reporting controls) are part of a comprehensive view of internal controls.

[7] For example, Ashraf et al. (2020) find that auditors' IT expertise improves clients' financial reporting, and Coleman et al. (2022) find that information technology can improve analyst research.

[8] For a review of the broader IT literature, please see Masli et al. (2011).

managers and, therefore, improve monitoring (e.g., Bloom et al. 2014). For example, to articulate the benefits of ERP systems, Bloom et al. (2014) provide a simple illustration of how a unified computing system provided by an ERP system allows a plant manager to "easily access and compare data across a range of processes" and efficiently respond to "timely information at an unprecedented rate, empowering plant managers to make decisions on a wide range of activities" (see Bloom et al. 2014, Appendix A.1). Our study extends this argument to a compliance setting. Specifically, we argue that the information provided by an ERP system may also allow companies to identify and prevent potential regulatory infractions more effectively.

ERP systems are often implemented for operational purposes that are unrelated to compliance needs (e.g., Grabski et al. 2011). These include boosting productivity, reducing costs, or increasing customer satisfaction. We predict that ERP systems can generate spillover effects and indirectly improve compliance outcomes in an organization through several channels. First, an ERP system can enhance managerial monitoring, as it reduces the cost of accessing information. ERP systems centralize information and produce standardized reports with actionable insights, thus reducing information acquisition and processing costs (e.g., Bloom et al. 2014; Dorantes et al. 2013). Second, ERP systems can improve compliance outcomes by constraining employee behavior through process standardization (e.g., Orlikowski 1991; Sotto 1997). In doing so, the system can ensure that employees act in accordance with managerial objectives. Formally, we state our central hypothesis as follows:

Hypothesis: Facility-level ERP rollouts are associated with a reduction in facility-level violations and penalties.

Although the above discussion suggests that ERP systems can generate improvements for firms' regulatory compliance, we note that this relationship is not obvious *ex ante*. First, managers may still face information processing costs that impede decision making after an ERP system is implemented. Such costs stem from the idea that the ERP system produces a wealth of information that may be difficult to process. Second, ERP systems may be ineffective in constraining employee behavior if end users do not adopt the new technology. This is a common theme in models of user acceptance of new technology and prior ERP research (e.g., Davis, Bagozzi, and Warshaw 1989; Liang et al. 2012; Venkatesh et al. 2003).[9]

III. EMPIRICAL METHODOLOGY AND DATA

Data

Violation Tracker Data

We obtain data from two primary sources. First, we collect federal corporate misconduct data from Violation Tracker. This dataset is maintained by Good Jobs First, a nonprofit organization that focuses on promoting corporate and government accountability.[10] The dataset contains violations beginning in 2000 and is sourced from a large number of regulatory agencies responsible for a wide array of regulatory areas, including banking, consumer protection, environmental, health and safety, and workplace discrimination, among others. However, we restrict the Violation Tracker sample to violations imposed on public firms occurring after 2005 only, as the ERP data (discussed below) are only available beginning in that year.

We drop banking violations and violations by foreign companies and retain observations for all other facilities with a publicly traded parent company. We match the Violation Tracker data to the historical parent and match violations to the firm's headquarters when the location is ambiguous or unavailable.[11] In addition, since the Violation Tracker database only includes facilities with violations during our sample period, we focus on firms and facilities that have at least one violation.[12] We lose 641 additional firms due to missing firm-level control variables, singletons, and because either the firm or the facility included in Violation Tracker is not included in the Aberdeen dataset. Our final sample includes 12,505 violations with almost $16.9 billion in penalties sanctioned against 734 unique firms with 5,982 unique facilities.[13]

[9] Recent survey evidence by Beasley et al. (2023) also emphasizes the role of resistance within an organization as an important impediment towards better risk management.
[10] The Violation Tracker database can be found at https://www.goodjobsfirst.org/violation-tracker. A list of the agencies and the online locations of their data can be found at https://violationtracker.goodjobsfirst.org/pages/user-guide
[11] Our results are robust when we adjust for these research-design choices (see Section VI).
[12] In additional analyses, we also re-examine our primary results using a sample that also includes nonviolation facilities included in the Aberdeen database (see Section VI).
[13] The penalties represent the revised penalty amounts rather than those initially proposed to account for negotiations or adjustments. Observations with missing penalty amounts or amounts below $5,000 are not included in the sample.

TABLE 1

Sample

Panel A: Sample Composition

	Number of Violations (1)	Number of Firms (2)
Violation Tracker sample for public firms	37,291	1,518
Less: Banking violations and foreign firms	(10,199)	(143)
Less: Firms not included in Aberdeen	(264)	(34)
Less: Firms for which no facility in Aberdeen has a match in Violation Tracker	(13,276)	(152)
Less: Missing firm-level control variables and singletons	(1,047)	(455)
Final sample	12,505	734

This table presents the sample composition for the period 2005–2017.

Panel B: Sample Composition by Year

Year	Number of Violations	% of Total	Penalties ($M)	% of Total
2005	416	3.3	588.2	3.5
2006	451	3.6	1,720.0	10.2
2007	624	5.0	262.1	1.6
2008	605	4.8	120.5	0.7
2009	747	6.0	2,731.0	16.2
2010	1,569	12.5	1,031.9	6.1
2011	1,726	13.8	607.1	3.6
2012	1,571	12.6	2,163.0	12.8
2013	991	7.9	1,820.2	10.8
2014	1,041	8.3	840.0	5.0
2015	1,037	8.3	1,290.6	7.6
2016	918	7.3	2,090.1	12.4
2017	809	6.5	1,631.8	9.7
Total	12,505	100.0	16,896.6	100.0

This table presents the distribution of violations and penalties in our sample for the period 2005–2017 by year.

(continued on next page)

Table 1 describes our sample in more detail. Panel A describes the sample composition. In Panel B, we provide an overview of the number of violations and penalties by year. We observe meaningful variation in violations over time in terms of frequency and penalties. In Panel C, we describe the types of violations in our sample in more detail. Our data include a wide set of offense types related to issues such as workplace safety and labor relations violations. As discussed above, these represent areas in which an ERP system can help improve compliance. In terms of the number of violations, workplace safety violations are the most common offenses, accounting for approximately 63 percent of total violations. Environmental violations received the largest penalties among the three most common violations, representing 16.3 percent of all penalties.

ERP Data

Our second data source provides information on ERP systems and firms' IT investments. We follow prior studies and collect this data from Aberdeen's CiTDB (e.g., Bresnahan, Brynjolfsson, and Hitt 2002; Beaudry, Doms, and Lewis 2010; Bloom et al. 2014; Tambe, Hitt, and Brynjolfsson 2012; Tuzel and Zhang 2021).[14] Aberdeen is an international marketing intelligence company that collects detailed hardware and software information to sell to large information technology firms, like IBM and Cisco, to use for marketing related to firms' current and future IT needs (Bloom et al. 2014).

[14] This database was previously owned by Harte Hanks.

TABLE 1 (continued)

Panel C: Sample Composition by Offense Type

Offense Type	Number of Violations	% of Total	Penalties ($M)	% of Total
Workplace safety or health violation	7,874	63.0	145.6	0.9
Railroad safety violation	1,426	11.4	13.0	0.1
Environmental violation	1,121	9.0	2,753.6	16.3
Wage and hour violation	514	4.1	978.7	5.8
Aviation safety violation	445	3.6	116.5	0.7
Labor relations violation	355	2.8	98.7	0.6
Motor vehicle safety violation	113	0.9	4.9	0.0
Employment discrimination	100	0.8	210.1	1.2
False Claims Act violation	81	0.6	5,134.0	30.4
Other	476	3.8	7,441.5	44.0
Total	12,505	100.0	16,896.6	100.0

This table presents the sample composition for the period 2005–2017 by offense type.

Aberdeen utilizes both first-party and third-party signals to generate their data. Aberdeen's third-party signals rely on publicly available sources, such as job postings, documents, and news, to compile signals of tech installations at companies. Aberdeen also conducts internal random quality checks on its own data to help improve its accuracy (Bloom et al. 2014).[15] The Aberdeen data include detailed information on the hardware, software, storage, networking, and telecom IT investments that firms make, including firms' ERP systems.

We identify publicly listed firms in the Aberdeen dataset via name matching to Compustat. An advantage of the Aberdeen dataset is that it provides data for an individual facility within a large firm (i.e., the Aberdeen data include identifiers to match facilities to parent companies), including detailed information on the facility name, as well as location. We use these data to identify when exactly each facility within a publicly listed firm indicates that it adopted an ERP system.

The Aberdeen survey does not contain responses from all facilities each year. We thus make several adjustments to backfill missing data in our sample. To start, we set our ERP treatment variable to 1 for all future years once a facility first indicates the use of an ERP. We set missing observations for facilities that indicate that they do not have an ERP system both *prior* to and *after* the missing observation to 0. Missing observations for facilities that indicate that they do not have an ERP system *before* but do have an ERP system *after* the missing years are coded based on when the firm (not facility) first introduced an ERP system.

We match the Aberdeen data to our sample of facilities with at least one violation, as per the Violation Tracker dataset based on facility location and the facility's parent company.[16] We drop 34 firms that are not covered by Aberdeen in this matching process. In addition, we lose 152 firms because the facilities of these firms never responded to the Aberdeen survey.

Other Data Sources

We source control variables from a variety of different data sources, including Dun & Bradstreet DMI files (which include annual establishment information), Compustat, and the Bureau of Labor Statistics (BLS). From Dun & Bradstreet, we construct facility-level controls, including the number of employees per facility (*Employees_Facility*) and the total sales per facility (*Sales_Facility*). We include these variables to better account for time-varying facility-level factors that seem relevant to the ERP-misconduct relation. From Compustat, we construct firm-level controls, including a firm's total assets (*Size*), the ratio of debt to total assets (*Leverage*), and profitability (*ROA*). These variables are described in more detail in Appendix A. After requiring nonmissing data for variables of interest and controls and after including facility, state-year, and firm-year fixed effects, our sample contains 5,982 facilities and 57,402 facility-year observations.

[15] Unfortunately, Aberdeen does not provide a breakdown of how often the data are modeled versus obtained via surveys. We conduct several robustness tests tabulated in Table 8 to alleviate the concern that measurement errors related to Aberdeen affect our inferences.

[16] Facility addresses can differ across Aberdeen and Violation Tracker. In such instances, we match Aberdeen facilities to Violation Tracker facilities that are within the same 25-mile radius.

TABLE 2

Summary Statistics Facilities

	Facility-Years Sample (n = 57,402)				
Variable	**Mean**	**Std. Dev.**	**Min.**	**Median**	**Max.**
ERP	0.585	0.493	0	1	1
Number of Violations	0.218	2.366	0	0	224
Penalties (in thousands)	294	1,431	0	0	2,301,365
Employees_Facility	798	4,634	1	182	59,226
Sales_Facility (in thousands)	4,844	20,754	0.01	67	274,485
Size (in millions)	58,233	189,414	3.895	11,896	2,692,538
Leverage	0.304	0.168	0	0.288	3.635
ROA	0.042	0.092	−2.283	0.046	4.833

This table reports the summary statistics on an annual basis of the variables used in our analyses. Statistics for *Employees_Facility* and *Sales_Facility* are displayed for facilities that report employees or sales.
All variables are un-Winsorized and defined in Appendix A.

Empirical Methodology

Our baseline regression model examines how ERP adoption at the facility level relates to misconduct using the following generalized DiD framework:

$$Y_{i,j,t} = \beta ERP_{i,j,t} + Controls + \gamma_i + \delta_t + \varepsilon_{i,j,t}, \quad (1)$$

where *i* indexes a facility, *j* indexes a firm (to which the facility belongs), and *t* indicates year. The dependent variable is either the natural logarithm of 1 plus the number of violations (*Violations*) or the natural logarithm of 1 plus the penalty amounts (*Penalties*) in a facility year. The variable, *ERP*, is an indicator variable that takes the value of 1 after an ERP system is adopted by a facility and 0 prior to the adoption. The regression specification also controls for factors at the facility and firm level that may influence corporate misconduct (*Controls*). Facility factors include employees and sales, which both proxy for the size of the facility. At the firm level, we control for size, leverage, and profitability.[17] Our baseline specification includes facility fixed effects (γ_i) that account for time-invariant heterogeneity across facilities and year fixed effects (δ_t) that account for time-varying differences.[18] Standard errors are clustered by firm.[19]

Table 2 describes the sample with the most stringent fixed-effects combination used in our regression analyses in more detail. The table indicates that 58.5 percent of observations are associated with ERP adoptions. The average facility in our sample has approximately 0.22 violations per year and average penalties of $294,356. Facilities that report employees or sales, on average, employ 798 employees and generate $4.8 million in sales.

Determinants Analysis

Our determinants analysis examines regressions of *ERP* on a wide set of facility, firm, and local characteristics that proxy for strategic motives for installing an ERP system. First, we include the adoption ratio of ERP within a firm's industry (*Industry_ERP_Adoption*), defined as the percentage of firms in each SIC sector with ERP systems already in place at a point in time. Higher adoption ratios likely indicate more competitive pressure to install an ERP system as such practices become a norm in an industry. Second, we include an indicator set to 1 for facilities that are part of highly competitive industries, measured as those with a Herfindahl-Hirschman index (HHI) based on sales below the average HHI across industries in any of the past three years, and 0 otherwise (*Industry_HHI*). Third, we consider the quality of the local IT infrastructure, measured based on the presence of historical ARPANET nodes (*ARPANET*), which served as the foundational footprint of the internet. Facilities located in areas with ARPANET presence likely have fewer frictions when installing an ERP system, as such locations have a higher-quality local infrastructure and more available

[17] All continuous variables are Winsorized at the 1st and 99th percentiles.
[18] We also modify this model to include a wide set of additional fixed effects, including industry-year, firm-year, state-year, and county-year fixed effects.
[19] As described in Section VI, our results are robust to clustering by facility, by state, or by state and year.

expertise. Finally, we consider the distance of a facility from firm headquarters to proxy for strategic prioritization within a firm (*Distance*). It is presumably easier for companies to roll out ERP systems to facilities located closer to headquarters, as they can more easily share resources, knowledge, and expertise with the local facility. Conversely, facilities that are more distant from headquarters will only be prioritized if the firm motivates an ERP system for compliance initiatives, as such facilities are more difficult to monitor (Heese and Pérez-Cavazos 2020).

Our model also includes measures of both prior violations and fines as explanatory variables to examine whether prior misconduct drives ERP adoption. In addition, our determinants model controls for other factors that may explain ERP adoption, including proxies for growth (i.e., sales growth at the facility level, denoted *Growth_Facility*), firm complexity (number of facilities, denoted *Number_Facilities*), firm and facility size, leverage, and profitability. Finally, we include year fixed effects to account for any temporal trend in ERP adoption.

Table 3 presents the results from the determinants analysis. We load violations and fines separately (columns (1) and (2)) to account for the fact that both measures are highly correlated. Our results yield several insights. First, we find that all four proxies for strategic initiatives load significantly in the model. That is, companies with high industry

TABLE 3

Determinants of ERP Rollout

Dependent Variable	***ERP***	
Variables	**(1)**	**(2)**
$Penalties_{t-1}$	0.001	
	(0.007)	
$Number\_Violations_{t-1}$		−0.002
		(0.108)
Employees_Facility	0.005	0.005
	(0.013)	(0.013)
Sales_Facility	0.023**	0.023**
	(0.010)	(0.010)
Growth_Facility	0.001	0.001
	(0.001)	(0.001)
Number_Facilities	0.000	0.000
	(0.016)	(0.016)
Size	0.062***	0.062***
	(0.022)	(0.022)
Leverage	−0.312	−0.312
	(0.209)	(0.209)
ROA	0.695	0.694
	(0.742)	(0.739)
ARPANET	0.286***	0.286***
	(0.086)	(0.086)
Industry_ERP_Adoption	4.914***	4.913***
	(0.647)	(0.647)
Industry_HHI	0.162*	0.162*
	(0.096)	(0.096)
Distance	−0.060***	−0.060***
	(0.016)	(0.016)
Year FE	Yes	Yes
Pseudo R^2	0.088	0.088
Observations	52,314	52,314

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table examines the determinants of facility-level ERP systems using a Logit regression. The dependent variable *ERP* takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. The sample spans the period 2005–2017. Standard errors are clustered by firm. Standard errors are reported below the coefficients.
All variables are defined in Appendix A.

TABLE 4

ERP Systems and Facility-Level Misconduct

Dependent Variables		***Penalties***				***Number_Violations***			
Variables	**Pred.**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
ERP	–	−0.153***	−0.132**	−0.151**	−0.149**	−0.012***	−0.010**	−0.010**	−0.010*
		(0.056)	(0.057)	(0.066)	(0.066)	(0.004)	(0.004)	(0.005)	(0.005)
Employees_Facility		0.038***	0.038***	0.041***	0.042***	0.003***	0.003***	0.003***	0.003***
		(0.010)	(0.010)	(0.011)	(0.011)	(0.001)	(0.001)	(0.001)	(0.001)
Sales_Facility		−0.005	−0.003	−0.009	−0.010	−0.000	−0.000	−0.001	−0.001
		(0.008)	(0.008)	(0.008)	(0.008)	(0.001)	(0.001)	(0.001)	(0.001)
Size		0.226***	0.213***			0.017***	0.016***		
		(0.080)	(0.076)			(0.006)	(0.006)		
Leverage		−0.298	−0.245			−0.023	−0.019		
		(0.184)	(0.181)			(0.014)	(0.014)		
ROA		0.134	0.082			0.017	0.013		
		(0.312)	(0.314)			(0.024)	(0.024)		
Facility FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE		Yes	No	No	No	Yes	No	No	No
Year × State FE		No	Yes	No	Yes	No	Yes	No	Yes
Year × Firm FE		No	No	Yes	Yes	No	No	Yes	Yes
Adjusted R^2		0.109	0.111	0.133	0.133	0.146	0.147	0.164	0.164
Observations		62,192	62,192	57,411	57,402	62,192	62,192	57,411	57,402

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table reports our main results. The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (columns (1)–(4)) or the natural logarithm of 1 plus the number of violations per facility and year (columns (5)–(8)). Columns (1) and (5) report results with facility and year fixed effects. Columns (2) and (6) report results with facility and state-year fixed effects. Columns (3) and (7) report results with facility and firm-year fixed effects. Columns (4) and (8) report results with facility, state-year, and firm-year fixed effects. Our main explanatory variable is *ERP*, which takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. Please note that firm-level *Controls* are not included in columns (3) and (4) and (7) and (8) due to the inclusion of firm-year fixed effects. The sample spans the period 2005–2017. Standard errors are clustered by firm. Standard errors are reported below the coefficients. All variables are defined in Appendix A.

adoption ratios, facilities being part of more competitive industries, and facilities with stronger local IT infrastructure are more likely to install an ERP system, whereas facilities located further (closer) to headquarters are less (more) likely to install an ERP system. The results also suggest that facility size is strongly associated with the presence of an ERP system.[20] In addition, firm size is also positively associated with ERP presence, although it is absorbed in our main analyses, which include firm-year fixed effects. Finally, we do not find evidence that prior facility-level violations or penalties, facility growth, or the number of facilities are significantly associated with the presence of an ERP system. This result suggests that ERP rollouts within a firm in our sample appear to be driven by a certain strategic rationale.

IV. MAIN RESULTS

Table 4 provides the results from estimating Equation (1). In columns (1)–(4), we present the results for the natural logarithm of 1 plus the total dollar value of penalties (*Penalties*). In columns (5)–(8), we present the results for the natural logarithm of 1 plus the number of violations (*Number_Violations*). In each set of results, we first present results from the baseline model as expressed in Equation (1), which includes control variables and facility and year fixed effects (columns (1) and (4)). We then layer on state-year and firm-year fixed effects in subsequent columns.

[20] One potential limitation of this analysis is that Aberdeen may impute an ERP installation based on facility size and peer installations, rather than facility size and peer installations driving actual adoption. In untabulated robustness analyses, we repeat this analysis, but use an alternative dependent variable based on job postings from Revelio (discussed in Section VI). We generate similar inferences with this alternative specification, thus reducing this concern.

Consistent with our prediction, the results from Table 4 indicate a negative and significant coefficient on *ERP* in each specification. In terms of economic significance, we find that ERP adoption reduces the dollar value of penalties by approximately 15 percent (column (4)) and the number of violations by approximately 1 percent (column (8)). The stronger decline in penalties (in comparison to the decline in the number of violations) suggests that ERP systems help firms avoid more severe violations, i.e., those violations that result in larger penalties.[21] Overall, these results are consistent with ERP rollouts improving compliance in facilities, as both the number of violations and penalties decline after the rollout.

V. MECHANISMS

Prior research suggests that ERP systems can enhance compliance outcomes through increasing managerial monitoring and imposing constraints on employees' actions. We next conduct cross-sectional analyses to validate these two channels.

Our first cross-sectional analysis considers features of the ERP implementation that may increase information processing costs and thus limit its efficacy in enabling managerial monitoring. Specifically, we examine the role of additional software that can help process complex information produced by the ERP system. We focus on Business Intelligence and Data Warehousing (BI-DW) software, which are often included in ERP implementations. These software incorporate advanced data analytics that can potentially help managers find patterns in the data that ERP systems collect. We expect that ERP systems that roll out with BI-DW software reduce processing constraints that managers face in analyzing complex information provided by ERP systems.

To implement this test, we collect data from Aberdeen on facilities' adoption of BI-DW software in conjunction with their ERP system. We then test the effects of ERP system introduction with and without BI-DW software by bifurcating the ERP treatment into two variables: *ERP_with_BI-DW_Software* and *ERP_without_BI-DW_Software*.

The results from the BI-DW tests are provided in Table 5. We find a negative and significant coefficient on *ERP_with_BI-DW_Software* using either *Penalties* ($p < 0.01$) or *Number_Violations* ($p < 0.05$) as dependent variables. We also find that the coefficients on *ERP_without_BI-DW_Software* are statistically insignificant and have significantly smaller magnitudes than the coefficients on *ERP_with_BI-DW_Software* ($p < 0.10$). These findings suggest that the compliance benefits of ERP rollouts are concentrated in rollouts that include BI-DW software. Overall, these results suggest that data analytics help reduce the processing costs associated with interpreting information from an ERP system.

Our next cross-sectional analysis considers frictions related to end-user adoption. In particular, we explore how local resistance to technology may affect how facilities and users respond to ERP implementation and interface with the system. Indeed, a key challenge that firms face in ERP implementations relates to "change management," with technology resistance providing one common reason for an ERP failure. Prior research also suggests that social factors, such as user acceptance, have a strong effect on ERP system usage (Chang, Cheung, Cheng, and Yeung 2008). We thus expect that ERP adoptions have a reduced effect on compliance when tech resistance at the facility is high, as users will not adopt the technology or use it inappropriately (e.g., managers may not invest in training, or users do not follow the protocol specified by the system), limiting the system's ability to constrain employee behavior.

We construct a composite measure reflecting local resistance to technology using data from two sources. We obtain data on a county's population age from the American Community Survey—which is run by the U.S. Census Bureau—and data on STEM jobs from the Occupational Employment and Wage Statistics of the U.S. BLS. This measure is more likely to capture the characteristics of the workers (instead of facility managers), as workers are likely more reflective of the general population in an area. We then test the interactive effects of ERP system adoption and resistance to technology using a similar model to Equation (1). Specifically, we interact *ERP* with *High_Resistance*, which is set to 1 for facilities located in counties with a below-median number of STEM jobs per 1,000 people or above-median age, and set to 0 otherwise. We also consider an alternative definition of *High_Resistance* based on the seniority of a facility's workforce using data from Revelio Labs. In these models, we interact *ERP* with *High_Resistance*, which is an indicator variable set to 1 if the facility's seniority level is below the mean level of seniority (measured using the ratio of entry-level workers in a facility), and 0 otherwise.[22]

We tabulate the results in Table 6. In columns (1) and (3), we find a positive and significant coefficient on *ERP* × *High_Resistance* using either *Penalties* ($p < 0.05$) or *Number_Violations* ($p < 0.05$) as dependent variables. As the sum

[21] The adjusted R^2 ranges from roughly 11 to 16 percent in these models. Please note that the fixed effects offer substantial explanatory power, so the adjusted R^2 does not change much after including the ERP treatment variable. To further illustrate this point, we also conduct an additional analysis (untabulated), where we vary the inclusion of only *Size* as a control variable and show that this has a limited effect on the R^2. In the presence of stringent fixed effects, very few variables can increase the R^2.

[22] The sample for these tests is smaller because Revelio Labs does not provide workforce seniority data for all facilities in our sample.

TABLE 5

Advanced ERP System

Dependent Variables Variables		*Penalties* (1)	*Number_Violations* (2)
ERP_with_BI-DW_Software	β_2	−0.190***	−0.013**
		(0.070)	(0.005)
ERP_without_BI-DW_Software	β_1	−0.104	−0.006
		(0.075)	(0.006)
Employees_Facility		0.042***	0.003***
		(0.011)	(0.001)
Sales_Facility		−0.010	−0.001
		(0.008)	(0.001)
F-Test: $\beta_2 < \beta_1$		−0.086*	−0.007*
		[0.070]	[0.076]
Facility FE		Yes	Yes
Year × State FE		Yes	Yes
Year × Firm FE		Yes	Yes
Adjusted R^2		0.133	0.164
Observations		57,402	57,402

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table analyzes cross-sectional variation in the results of Table 4. *ERP_with_BI-DW_Software* equals 1 after a facility introduced an ERP system with Business Intelligence and Data Warehouse Software, and 0 otherwise. *ERP_without_BI-DW_Software* equals 1 after a facility introduced an ERP system without additional Business Intelligence and Data Warehouse Software, and 0 otherwise. The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (i.e., column (1)) or the natural logarithm of 1 plus the number of violations (i.e., column (2)). The sample spans the period 2005–2017. Standard errors are clustered by firm. Standard errors are reported below the coefficients.
All variables are defined in Appendix A.

of the coefficients on *ERP* and *ERP* × *High_Resistance* is statistically insignificant from 0, these results suggest that ERP rollouts are only effective in reducing violations when facilities are located in areas where users are open to technological change, as the ERP system is less effective in constraining employee behavior. In columns (2) and (4), we repeat this test using the alternative measure for *High_Resistance* and generate similar results.

VI. ADDITIONAL TESTS

In this section, we present a wide set of additional tests, primarily focused on assessing the robustness of our results and alleviating endogeneity concerns. In these tests, we consider instrumental variables, parallel trends, entropy balancing, and alternative research designs.

One potential concern with our primary results is that the relationship between the adoption of ERP systems and facility-level misconduct could be driven by some correlated omitted factor. More specifically, any omitted variable that explains within-firm adoption of ERP and correlates with misconduct is potentially a concern for our findings. We note that our analyses thus far address many forms of endogeneity. For example, the inclusion of firm-year fixed effects alleviates concerns related to a firm choosing to invest in an ERP system. The inclusion of facility fixed effects removes any time-invariant correlated omitted variables related to a facility. With that being said, we acknowledge limitations to our analyses, as we cannot perfectly account for selection effects or control for which facilities are prioritized within a firm. We next address this concern more systematically by introducing an instrument for ERP adoption.

Our instrument follows Forman et al. (2012) and utilizes the presence of historical ARPANET nodes per county. The ARPANET was established by the Advanced Research Projects Agency (ARPA) of the United States Department of Defense in 1969. ARPANET nodes represent a historical choice based on the connectivity preferences to the Department of Defense and universities (Law and Shen 2020). Forman et al. (2012) suggest that the presence of historical ARPANET nodes at the county level reflects local internet communication infrastructure and influences future IT investment (e.g., ERP adoption), which we demonstrate in our determinants analysis. At the same time, it is unlikely

TABLE 6

Resistance to Technology

Dependent Variables	***Penalties***		***Number_Violations***	
Variables	**(1)**	**(2)**	**(3)**	**(4)**
ERP × High_Resistance	0.227**	0.200**	0.016**	0.015**
	(0.093)	(0.094)	(0.007)	(0.007)
ERP	−0.302***	−0.282***	−0.020***	−0.020***
	(0.091)	(0.091)	(0.007)	(0.007)
High_Resistance	−0.140	−0.129	0.000	−0.010*
	(0.361)	(0.078)	(0.028)	(0.006)
Employees_Facility	0.042***	0.049***	0.003***	0.004***
	(0.011)	(0.014)	(0.001)	(0.001)
Sales_Facility	−0.010	−0.013	−0.001	−0.001
	(0.008)	(0.010)	(0.001)	(0.001)
Facility FE	Yes	Yes	Yes	Yes
Year × State FE	Yes	Yes	Yes	Yes
Year × Firm FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.133	0.130	0.164	0.156
Observations	57,402	40,227	57,402	40,227

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table analyzes cross-sectional variation in the results of Table 4. *High_Resistance* either equals 1 if the facility is located in a county with below median number of STEM jobs per 1,000 people or above median age, and 0 otherwise (columns (1) and (3)), or 1 if the facility's seniority level is below the mean level of seniority (measured using the ratio of entry-level workers in a facility), and 0 otherwise (columns (2) and (4)). The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (i.e., columns (1) and (2)) or the natural logarithm of 1 plus the number of violations (i.e., columns (3) and (4)). *ERP* takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. The sample spans the period 2005–2017. Standard errors are clustered by firm. Standard errors are reported below the coefficients.
All variables are defined in Appendix A.

that the presence of historical ARPANET nodes per county directly affects local misconduct (i.e., the exclusion restriction). Similar to Law and Shen (2020), we create an indicator set to 1 if the county has at least one ARPANET node in the year 2005 as a time-invariant proxy for the quality of the IT infrastructure in a county. As this measure is time-invariant, we run this test without facility fixed effects. Instead, we include firm-year and state-year fixed effects to control for firm-level and state-level changes over time.

Table 7 presents the results from the instrumental variable analysis. We find that the instrument is strongly associated with facilities' ERP adoption (see Table 7, column (1)). Again, the F-statistics from the first-stage regression passes the weak identification tests at the 1 percent level, and the Kleinberg-Paap statistics pass the associated underidentification tests. The results of the second stage IV regressions (see Table 7, columns (2) and (3)) are consistent with the main results reported in Table 4. Specifically, the results show that ERP adoption at the facility level results in fewer violations and lower penalties. These findings establish a more robust link between ERP adoption and compliance.

We next plot the effects of ERP adoption on penalties and the number of violations in event time in Figure 1 and Figure 2, respectively. For these figures, we use the same regression as for our main results tabulated in Table 4, columns (4) and (8). Figure 1 plots the coefficient on *ERP* (and the 90 percent confidence intervals) using the natural logarithm of the penalty amounts as the dependent variable in the ten-year window around the ERP adoption. Figure 2 plots the coefficient on *ERP* (and the 90 percent confidence intervals) using the natural logarithm of the number of violations as the dependent variable in the ten-year window around the ERP adoption. Both graphs suggest that there is some preexisting increase in misconduct. While these pre-trend coefficients are statistically not significantly different from 0, they could potentially raise concerns about selection. Both figures also suggest that the effect of an ERP system on violations and penalties appears immediately after its adoption and persists for up to five years.

Next, we examine the robustness of the results presented in Table 4 using entropy balancing (Hainmueller 2012). Table 8, Panel A presents the results. Consistent with our main results, we find that, after an ERP rollout, treated facilities have fewer penalties and violations. The economic magnitudes are similar to those reported in Table 4.

TABLE 7

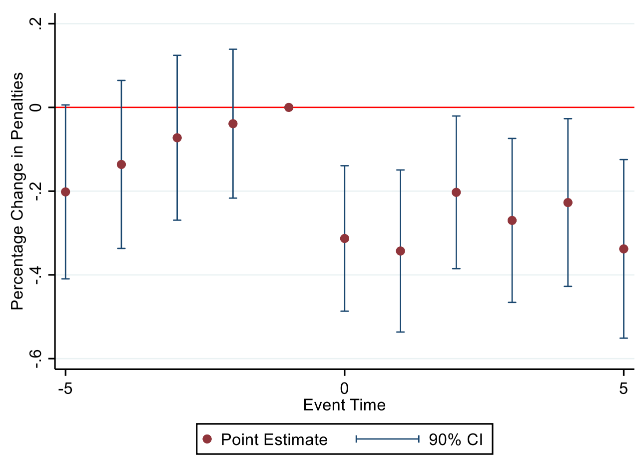
ARPANET Nodes as Instrumental Variables

	1st Stage	2nd Stage	
Dependent Variables	***ERP***	***Penalties***	***Number Violations***
Variables	**(1)**	**(2)**	**(3)**
ERP		−1.380**	−0.117**
		(0.562)	(0.045)
ARPANET	0.076***		
	(0.018)		
Controls	Yes	Yes	Yes
Firm-Year FE	Yes	Yes	Yes
State-Year FE	Yes	Yes	Yes
First-Stage F-Test	165.31		
p-value	<0.01		
Kleibergen-Paap LM Statistic	17.28		
p-value	<0.01		
Observations	54,581	54,581	54,581
Pseudo R^2	0.273		

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table examines the robustness to our primary results tabulated in Table 4 using ARPANET nodes as an instrumental variable. Column (1) reports the results from the first stage of the instrumental variable. In column (1), the dependent variable *ERP* takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. *ARPANET* is set to 1 if the county has at least one ARPANET node in 2005, and 0 otherwise. Columns (2) and (3) report results from the second stage of the instrumental variable, and the R^2 statistics are not reported because they have no statistical meaning in these models (Wooldridge 2012, 523). In columns (2) and (3), *ERP* is instrumented by *ARPANET*. The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (i.e., column (2)) or the natural logarithm of 1 plus the number of violations (i.e., column (3)). Violations and penalties that cannot be unambiguously assigned to a facility are excluded. *Controls* includes *Employees_Facility* and *Sales_Facility*. Standard errors are clustered by firm. Standard errors are reported below the coefficients.
All variables are defined in Appendix A.

FIGURE 1

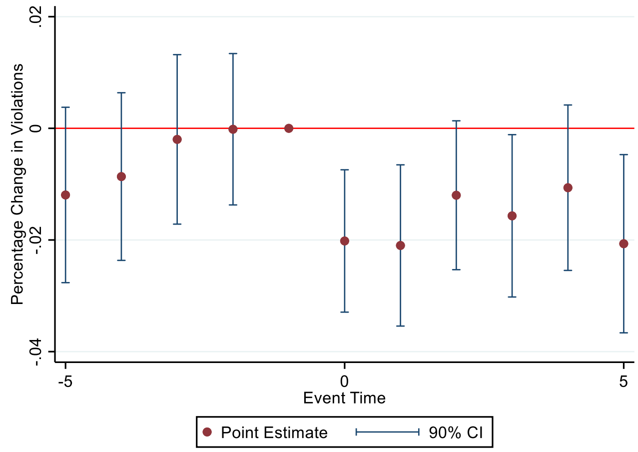
Parallel Trends—Penalties



This graph plots the coefficient on *ERP*, which takes the value of 1 after a facility adopted an ERP system (and the 90 percent confidence intervals), using the natural logarithm of 1 plus the penalty amounts as dependent variable around the ERP adoption. The coefficients are estimated using the same model as for Table 4, column (4).
(The full-color version is available online.)

FIGURE 2

Parallel Trends—Violations



This graph plots the coefficient on *ERP*, which takes the value of 1 after a facility adopted an ERP system (and the 90 percent confidence intervals), using the natural logarithm of 1 plus the number of violations as dependent variable around the ERP adoption. The coefficients are estimated using the same model as for Table 4, column (8).
(The full-color version is available online.)

TABLE 8

Additional Tests

Panel A: Entropy Balancing

Dependent Variables	***Penalties***	***Number_Violations***
Variables	**(1)**	**(2)**
ERP	−0.163**	−0.011**
	(0.066)	(0.005)
Controls	Yes	Yes
Facility FE	Yes	Yes
Year × State FE	Yes	Yes
Year × Firm FE	Yes	Yes
Adjusted R^2	0.141	0.173
Observations	57,402	57,402

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table examines the robustness of the results presented in Table 4 using entropy balancing. In column (1), the dependent variable, *Penalties*, is the natural logarithm of 1 plus the dollar amount of penalties per facility and year. In column (2), the dependent variable, *Number_Violations*, is the natural logarithm of 1 plus the number of violations per facility and year. Our main explanatory variable is *ERP*, which takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. *Controls* include *Employees_Facility* and *Sales_Facility*. The sample spans the period 2005–2017. Standard errors are clustered by firm. Standard errors are reported below the coefficients. All variables are defined in Appendix A.

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We next assess the sensitivity of our results to three alternative ERP measures. The first measure addresses potential concerns regarding how we backfill data on ERP rollouts. In our main analyses, we fill years with missing ERP data and consider ERP data from nearby facilities (as facilities may not respond to the Aberdeen survey every year). We thus consider a raw measure of ERP adoption, as provided by Aberdeen, to ensure that our choice to backfill missing years and using ERP data from nearby facilities does not drive the results. The second measure considers an alternative treatment based on the natural logarithm of 1 plus the number of modules included in the ERP implementation. The third measure

TABLE 8 (continued)

Panel B: Alternative ERP Measures

Dependent Variables	*Penalties*			*Number_Violations*		
ERP Measure	**Nonbackfill**	**Log Modules**	**Revelio ERP Measure**	**Nonbackfill**	**Log Modules**	**Revelio ERP Measure**
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ERP	−0.342***	−0.136*	−0.264*	−0.024**	−0.010*	−0.020*
	(0.126)	(0.075)	(0.151)	(0.009)	(0.005)	(0.012)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Facility FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.142	0.128	0.133	0.188	0.159	0.164
Observations	12,257	41,650	57,402	12,257	41,650	57,402

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table examines the robustness of our primary results tabulated in Table 4 using three alternative ERP measures. Columns (1) and (4) use the unadjusted information of ERP adoption as reported in Aberdeen from exact matches (labeled "Nonbackfill"). Columns (2) and (5) use the natural logarithm of 1 plus the number of ERP modules (labeled "Log Modules"). Columns (3) and (6) use information from Revelio Labs to identify facility-level ERP adoption (labeled "Revelio ERP Measure"). The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (columns (1)–(3)) or the natural logarithm of 1 plus the number of violations per facility and year (columns (4)–(6)). *Controls* includes *Employees_Facility* and *Sales_Facility*. The sample spans the period 2005–2017. The sample in columns (1) and (4) is smaller as ERP adoption information is missing in a number of facility years. The sample in columns (2) and (5) is smaller as information on ERP modules is only available as of 2010. Standard errors are clustered by firm. Standard errors are reported below the coefficients.
All variables are defined in Appendix A.

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utilizes an alternative treatment based on ERP signals from Revelio Labs, which aggregates employee resumes. Using these data, we identify employees with ERP-related skills on their resume and identify a facility as treated in the first year an employee with ERP-related skills is employed at the facility.[23] Table 8, Panel B reports the results. Our results hold.

We also consider the robustness of our main results to an alternative dependent variable, alternative controls, and alternative regression models, with a focus on better capturing the underlying distribution of our dependent variables. Specifically, we first rerun our results using *Misconduct*, an indicator set to 1 in years with a violation, as the dependent variable. As shown in Table 8, Panel C, column (1), the results hold. We also report results from robust regressions, in which we demean our variables by facility and include state-year fixed effects. As shown in Table 8, Panel C, columns (2) and (5), the results hold. Next, we also report robustness tests in Table 8, Panel C, columns (3) and (6) using Poisson pseudo maximum likelihood regressions as an alternative estimation technique to alleviate the concern that estimating linear regressions of log(1 + X) transformation can lead to biased estimates and standard errors (Cohn, Liu, and Wardlaw 2022). Our inferences remain unchanged.

Next, we acknowledge that a potential concern with our primary research design is that our estimated effects could be biased due to the observations that form the control group. We follow Baker, Larcker, and Wang (2022) and adjust for the use of prior treated units as effective comparison units by running stacked regressions. As shown in Table 8, Panel C, columns (4) and (7), our results hold using this alternative estimation technique.

Finally, we also acknowledge potential measurement error and bias in the facility control variables, which are based on data from Dun & Bradstreet. We construct an alternative measure of the number of facility-level employees using data from Revelio Labs. As shown in Table 8, Panel C, columns (5) and (8), our results hold. Overall, our results are robust to using alternative estimation techniques.

To further alleviate potential concerns that unobservable factors explain our results, we consider two alternative fixed-effects structures. First, we replace year fixed effects with industry-year fixed effects to control for changes at the industry level over time. Second, we replace year fixed effects with county-year fixed effects, exploiting the fact that

[23] We define ERP-related skills as those that include the following four keywords: "ERP," "Enterprise Resource Planning," "Enterprise Data Management," and "Enterprise Information System."

TABLE 8 (continued)

Panel C: Alternative Dependent Variables, Estimation Models, and Controls

Dependent Variables		*Penalties*				*Number_Violations*			
Estimation Models	**Misconduct OLS**	**Robust Regression**	**PPML Regression**	**Stacked Regression**	**Alternative Control**	**Robust Regression**	**PPML Regression**	**Stacked Regression**	**Alternative Control**
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
ERP	−0.014**	−0.030**	−0.369*	−0.185***	−0.147**	−0.002**	−0.261*	−0.015**	−0.010*
	(0.006)	(0.014)	(0.196)	(0.071)	(0.066)	(0.001)	(0.147)	(0.006)	(0.005)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Facility FE	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Year × State FE	Yes	Yes	No	No	Yes	Yes	No	No	Yes
Year × Firm FE	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Facility × Group FE	No	No	No	Yes	No	No	No	Yes	No
Year × Group FE	No	No	No	Yes	No	No	No	Yes	No
Adjusted R^2/Pseudo R^2	0.094	0.004	0.783	0.114	0.133	0.004	0.615	0.258	0.164
Observations	57,402	57,402	23,771	87,631	57,402	57,402	23,771	87,631	57,402

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.

This table examines the robustness of our primary results tabulated in Table 4 using an alternative dependent variable, alternative estimation models, and alternative controls. In column (1), the dependent variable *Misconduct* is an indicator set to 1 in years with a violation, as the dependent variable. In columns (2)–(9), the dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (columns (2)–(5)) or the natural logarithm of 1 plus the number of violations per facility and year (columns (6)–(9)). In column (1), results are from an OLS regression, and the adjusted R^2 is reported. In columns (2) and (6), results are from a robust regression, and the Pseudo R^2 is reported. In columns (3) and (7), results are from a Poisson Pseudo Maximum Likelihood (PPML) regression (and, hence, the dependent variables are not log transformed), and the Pseudo R^2 is reported. In columns (4) and (8), results are from a stacked regression, and the adjusted R^2 is reported. In columns (5) and (9), *Sales_Facility* is excluded, and *Employees_Facility* uses facility-level employee counts using data from Revelio Labs. *ERP* takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. In column (1), *Controls* includes *Employees_Facility* and *Sales_Facility*. In columns (2)–(4) and (6)–(8), *Controls* includes *Employees_Facility*, *Sales_Facility*, *Size*, *Leverage*, and *ROA*. In columns (5) and (9), *Controls* includes an alternative employee count based on Revelio data. Group marks each subsample for each ERP rollout year, which includes only not-yet-treated facilities as controls. The sample spans the period 2005–2017. Standard errors are clustered by firm. Standard errors are reported below the coefficients.

All variables are defined in Appendix A.

(continued on next page)

TABLE 8 (continued)

Panel D: Alternative Fixed Effects

Dependent Variables	***Penalties***		***Number_Violations***	
Variables	**(1)**	**(2)**	**(3)**	**(4)**
ERP	−0.158***	−0.139**	−0.012***	−0.010**
	(0.057)	(0.061)	(0.004)	(0.005)
Controls	Yes	Yes	Yes	Yes
Facility FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Year × Industry FE	Yes	No	Yes	No
Year × County FE	No	Yes	No	Yes
Adjusted R^2	0.115	0.027	0.152	0.063
Observations	61,936	52,636	61,936	52,636

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table examines the robustness of our primary results tabulated in Table 4 to different fixed effects. Columns (1) and (3) report results with industry-year fixed effects. Columns (2) and (4) report results with county-year fixed effects. *ERP* takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (i.e., columns (1) and (2)) or the natural logarithm of 1 plus the number of violations (i.e., columns (3) and (4)). *Controls* includes *Employees_Facility*, *Sales_Facility*, *Size*, *Leverage*, and *ROA*. The sample spans the period 2005–2017. Standard errors are clustered by firm. Standard errors are reported below the coefficients.
All variables are defined in Appendix A.

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facilities operating in the same county adopt ERP systems at different points in time. The sample for the latter test is slightly smaller; in some instances, only one facility operates in a county.

Table 8, Panel D provides the results from our alternative fixed-effects analyses. Columns (1) and (2) provide the results for *Penalties*, and columns (3) and (4) provide the results for *Number_Violations*. As shown in columns (1) and (3), our results remain robust with industry-year fixed effects. In columns (2) and (4), we include county-year fixed effects and also find that our inferences continue to hold. Overall, the results from our alternative fixed-effects analysis provide further evidence that our findings do not appear to be influenced by unobservable local or industry-level heterogeneity. It is also notable that the coefficients remain rather stable across our specifications and are comparable in magnitude to our main results.

Next, we examine the robustness of our main results to six research-design choices related to our sample (discussed above). First, we remove violations with ambiguous or unavailable location information. Second, we include facilities without violations. Third, we remove observations from facilities that do not experience a violation for a sustained period of time. Fourth, we exclude industry-specific violations. Fifth, we exclude facilities that do not have an ERP system by the end of the sample period, albeit they belong to a firm that rolled out an ERP system. Sixth, we assess the potential for Aberdeen to have greater imputing biases for large facilities and facilities operating in industries with many peer installations.

To examine the robustness of our main results to the first design choice, we remove all violations with ambiguous or unavailable location information. This reduces the number of violations to 8,705 and penalties to approximately $1.7 billion. As shown in Table 8, Panel E, columns (1) and (8), the results continue to hold using this alternative sample.

To examine the robustness of our main results to the second design choice, we add 95,123 facilities without violations and more than ten employees included in the Aberdeen database. We estimate our primary model using the sample of violation and nonviolation facilities, resulting in a much larger panel of 656,737 observations. As shown in Table 8, Panel E, columns (2) and (9), we find a negative and significant coefficient on *ERP* in both models. In terms of economic magnitude, the results indicate that ERP introduction decreases the dollar penalties and the number of violations in treated facilities by approximately 1.6 percent and 0.1 percent.

To examine the robustness of our main results to the third design choice, we exclude facility-year observations that had no violations in the last three years, reducing our sample size to 24,702 observations. As shown in Table 8, Panel E, columns (3) and (10), the results hold, and the economic magnitudes are larger. In particular, after the introduction of an ERP system, penalties decrease by 36.9 percent and the number of violations by 2.6 percent.

To examine the robustness of our main results to the fourth design choice, we exclude industry-specific violations (i.e., aviation safety, employment discrimination, motor vehicle safety, and railroad safety violations). As shown in Table 8, Panel E, columns (4) and (11), the results hold.

TABLE 8 (continued)

Panel E: Alternative Sample

Dependent Variables	*Penalties*							*Number_Violations*						
Sample	**No Ambiguous Violations**	**With No Violation Facilities**	**Fewer Nonviolation Years**	**No Hard-To-Monitor Violations**	**No Facilities without ERP**	**Small Facilities**	**Few Peers with ERP**	**No Ambiguous Violations**	**With No Violation Facilities**	**Fewer Nonviolation Years**	**No Hard-To-Monitor Violations**	**No Facilities without ERP**	**Small Facilities**	**Few Peers with ERP**
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
ERP	−0.123**	−0.016*	−0.369***	−0.131*	−0.147**	−0.144**	−0.356***	−0.010*	−0.001*	−0.026**	−0.009*	−0.010*	−0.010*	−0.026**
	(0.059)	(0.009)	(0.129)	(0.070)	(0.070)	(0.068)	(0.134)	(0.006)	(0.001)	(0.010)	(0.005)	(0.005)	(0.005)	(0.011)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Facility FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year × State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year × Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.046	0.183	0.212	0.117	0.133	0.037	0.178	0.234	0.213	0.251	0.150	0.159	0.061	0.220
Observations	57,402	656,737	24,702	50,600	46,667	42,744	20,839	57,402	656,737	24,702	50,600	46,667	42,744	20,839

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.

This table examines the robustness of our primary results tabulated in Table 4 to different samples. Columns (1) and (8) report results excluding violations and penalties that cannot be unambiguously assigned to a facility. Columns (2) and (9) report results including facilities without violations. Columns (3) and (10) exclude facility-year observations that had no violations in the last three years. Columns (4) and (11) exclude hard-to-monitor violations (i.e., aviation safety violations, employment discrimination violations, motor vehicle safety, and railroad safety violations). Columns (5) and (12) exclude facilities that do not have an ERP system by 2017 (albeit they belong to a firm that rolled out an ERP system). Columns (6) and (13) report results from the subset of facilities with fewer employees than the average facility in their industry. Columns (7) and (14) report results from the subset of facilities operating in industries with few ERP installations compared to the average industry. *ERP* takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (i.e., columns (1)–(7)) or the natural logarithm of 1 plus the number of violations (i.e., columns (8)–(14)). *Controls* includes *Employees_Facility* and *Sales_Facility*. The sample spans the period 2005–2017. Standard errors are clustered by firm. Standard errors are reported below the coefficients.

All variables are defined in Appendix A.

(continued on next page)

TABLE 8 (continued)

Panel F: Alternative Clustering

Dependent Variables	*Penalties*			*Number_Violations*		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ERP	−0.149**	−0.149**	−0.149**	−0.010**	−0.010*	−0.010*
	(0.064)	(0.067)	(0.062)	(0.005)	(0.005)	(0.005)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Facility FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year × Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered by	Facility	State	State and Year	Facility	State	State and Year
Adjusted R^2	0.133	0.133	0.133	0.164	0.164	0.164
Observations	57,402	57,402	57,402	57,402	57,402	57,402

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table examines the robustness of our primary results tabulated in Table 4 to different clustering of standard errors. Columns (1) and (4) report results with standard errors clustered by facility. Columns (2) and (5) report results with standard errors clustered by state. Columns (3) and (6) report results with standard errors two-way clustered by state and year. *ERP* takes the value of 1 after the introduction of an ERP system, and 0 in the years prior to the introduction of an ERP system. The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per facility and year (i.e., columns (1)–(3)) or the natural logarithm of 1 plus the number of violations (i.e., columns (4)–(6)). *Controls* includes *Employees_Facility* and *Sales_Facility*. The sample spans the period 2005–2017. Standard errors are reported below the coefficients.
All variables are defined in Appendix A.

Panel G: Firm-Level Analysis

Dependent Variables	*Penalties_Firm*			*Number_Violations_Firm*		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ERP	−0.513	−0.618*	−0.642*	−0.067**	−0.082**	−0.071**
	(0.337)	(0.350)	(0.389)	(0.032)	(0.034)	(0.036)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	No	Yes	No	No
Year × State FE	No	Yes	Yes	No	Yes	Yes
Year × Industry FE	No	No	Yes	No	No	Yes
Adjusted R^2	0.261	0.256	0.254	0.413	0.409	0.414
Observations	7,881	7,834	7,722	7,881	7,834	7,722

*, **, *** Indicate significance at the two-tailed 10 percent, 5 percent, and 1 percent levels, respectively.
This table examines the robustness of our primary results tabulated in Table 4 to a firm-level analysis. *ERP* is the percentage of a firm's facilities that introduced an ERP system in a given year. The dependent variable is either the natural logarithm of 1 plus the dollar amount of penalties per firm and year (i.e., columns (1)–(3)) or the natural logarithm of 1 plus the number of violations (i.e., columns (4)–(6)). *Controls* includes *Size*, *Leverage*, and *ROA*. The sample spans the period 2005–2017. Standard errors are reported below the coefficients and are clustered by firm.
All variables are defined in Appendix A.

To examine the robustness of our main results to the fifth design choice, we exclude facilities that do not have an ERP system by the end of the sample period, albeit they belong to a firm that implemented an ERP system. As shown in Table 8, Panel E, columns (5) and (12), the results hold, and the economic magnitudes are similar to our main results.

Finally, we assess the possibility that Aberdeen may have greater imputation accuracy for small facilities and facilities operating in industries with few ERP installations. Results for the subset of small facilities and facilities operating in industries with a lower ERP adoption ratio than the average industry are shown in Table 8, Panel E, columns (6), (7), (13), and (14). As shown, the results hold across all partitions, suggesting that our findings are unlikely to be influenced by a size bias created by Aberdeen's imputation process. Overall, our results hold using different sampling choices.

In our primary tests, we cluster the standard errors by firm. We also reexamine our main tests clustering by facility, state, or state and year. As shown in Table 8, Panel F, we find consistent results using these alternative clustering approaches. Collectively, our results suggest that ERP adoptions have a robust effect on misconduct.

Finally, we examine the effect of ERP rollouts at the firm level. For these tests, we aggregate penalties and number of violations included in our sample at the firm level (denoted *Penalties_Firm* and *Number_Violations_Firm*) and include firm as well as year, state-year, or both state-year and industry-year fixed effects.[24] *ERP* is measured as the percentage of a firm's facilities with an ERP system. As shown in Table 8, Panel G, the coefficient on *ERP* is negative and significant in all specifications, except for column (1). These results suggest that an ERP rollout is associated with a reduction in violations across the firm.

Overall, the results from our robustness analyses help document a stronger link between facility-level ERP adoption and compliance benefits. Our analyses suggest that unobservable heterogeneity at various levels is unlikely to explain our results and show that our results are robust to various alternative research-design choices.

VII. CONCLUSION

We examine the spillover effects of IT investments on corporate misconduct. Using the staggered rollout of ERP systems across U.S. firms, we find a decrease in facility-level violations and penalties following ERP adoption. In addition, we show that the compliance benefits of ERP systems depend on the system's ability to improve managerial monitoring and constrain employee choice. In particular, our findings suggest that ERP adoptions reduce misconduct only when such systems provide more decision-useful information relevant to compliance, thus enhancing managerial monitoring. In addition, ERP systems are more effective when facilities exhibit less resistance to new technologies, thus ensuring that employees' choices are constrained. Our results thus suggest that investments in ERP systems can indirectly benefit firms by enhancing their compliance outcomes and reducing corporate misconduct. Although ERP systems are a key element of firms' information technology, companies are also increasingly using more advanced and novel technologies, such as artificial intelligence applications. Future research could examine the potential compliance benefits of these technologies. Research may also examine the extent to which artificial intelligence enhances or complements ERP applications. In addition, future research can further explore the potential mechanisms underlying ERP system efficacy, such as why employees sometimes resist new technology.

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APPENDIX A

Variable Definitions

The following variables are constructed using data from Violation Tracker's dataset of corporate misconduct [VT], data on facilities from Dun & Bradstreet DMI files [D&B], Compustat [C], data on a county's population age structure from the American Community Survey [ACS], data on STEM jobs from the Occupational Employment and Wage Statistics of the U.S. BLS [STEM], data on ARPANET from Forman et al. (2012) [FORMAN], data on the seniority of a facility's employees from Revelio Labs [REVELIO], and data on facilities' IT investments from Aberdeen's CiTDB [CiTDB].

Variables of Interest	
Penalties	The natural logarithm of 1 plus total penalties for misconduct per facility and year Winsorized at the 1st and 99th percentile. [VT]
Number_Violations	The natural logarithm of 1 plus the number of violations per facility and year Winsorized at the 1st and 99th percentile. [VT]
ERP	Indicator variable that is set to 1 in the years following a facility's ERP adoption, and 0 in the years prior to the adoption. If facility-level information on ERP adoption for a *specific* year is missing (as the facility most likely did not respond to the Aberdeen survey), we use facility- and firm-level information from other years. [CiTDB]
ERP_with_BI-DW_Software and *ERP_without_BI-DW_Software*	Indicator variable that is set to 1 after a facility introduced an ERP system with (without) Business Intelligence and Data Warehouse Software, and 0 otherwise. [CiTDB]
High_Resistance	Indicator variable that is either set to 1 if the facility is located in a county with below median number of STEM jobs (i.e., engineering, math, and science occupations) per 1,000 people or above median age, and 0 otherwise, or set to 1 if the ratio of entry-level workers (as defined by Revelio Labs) at a facility is below the mean, and 0 otherwise. [ACS + STEM + REVELIO]
ARPANET	Indicator variable that is set to 1 if the facility is located in a county with ARPANET node, and 0 otherwise [FORMAN].
Industry_ERP_Adoption	The percentage of firms in each SIC sector with ERP systems already in place per year [CiTDB].
Industry_HHI	Indicator variable that is set to 1 if the facility is part of a competitive industry measured as those industries with a HHI based on sales below the average HHI across industries in any of the past three years, and 0 otherwise [C].
Distance	The natural logarithm of the distance between a facility and a firm's headquarters [C + VT].
Controls	
Employees_Facility	The natural logarithm of 1 plus the number of employees per facility. Missing values are set to 0. [D&B]
Sales_Facility	The natural logarithm of 1 plus sales per facility (in thousands of dollars). Missing values are set to 0. [D&B]
Growth_Facility	The change in sales per facility. Missing values are set to 0. [D&B]
Number_Facilities	The natural logarithm of 1 plus the number of facilities per firm. [D&B]
Size	The natural logarithm of the firm's asset size (in millions of dollars). [C]
Leverage	The ratio of debt to total assets. [C]
ROA	Net income scaled by total assets. [C]