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Retail inventory shrinkage, sensing weak security breach signals, and organizational structure

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management research and one of the top contributors to the field of operations management, according to published sources. His research is supported by grants totaling more than US$295,000 and CAD$1,400,000, with his 55+ publications related to quality management, mass customization, and supply chain disruptions and relationships having appeared in top academic and business journals. His current research focuses on attributes, triggering events, performance consequences, and mitigation of supply disruptions. Rungtusanatham has also co-authored two introductory operations management textbooks and five teaching cases.

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ABSTRACT

Retail inventory shrinkage, resulting primarily from employee theft and shoplifting, costs retailers nearly $70 billion annually. With brick-and-mortar retailers today confronting increased competition and low future growth expectations, reducing inventory shrinkage is becoming even more critical to becoming profitable. This paper analyzes a unique dataset that combines both primary survey and objective archival data from a Fortune 500 retailer to test a theoretical model associating retail inventory shrinkage, the capacity of a retail store to sense weak security breach signals, centralization of decision-making, and formalization of security breach management. The analysis builds on insights from High Reliability Organization theory and the literature on organizational structure. Results reveal that as a retail store increases its capacity to sense weak security breach signals, it observes decreases in store-level inventory shrinkage, with this negative association amplified (dampened) when the retail store has formalized procedures and protocols for managing security breaches (has centralized decision-making within the retail store). Moreover, while the establishment of formalized procedures and protocols for managing security breaches bolsters the capacity of a retail store to sense weak security breach signals, centralizing decision-making has the opposite effect. Our findings contribute to the retail operations literature by introducing a new store-level organizational capability to guard against theft-based retail inventory shrinkage and by offering novel insights into how and why organizational structure at the level of a retail store deters or facilitates the capacity to sense weak security breach signals. From a practical perspective, these findings advise retailers to develop the capability to become

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aware of and to mitigate security breaches. Further, to support this capacity, retailers are urged to decentralize decision-making to retail store personnel and to invest in formalizing procedures and protocols for managing security breaches in order to deter retail thefts that shrink retail store inventory.

Keywords: retail inventory shrinkage, sensing weak signals, retail thefts, formalization, centralization

INTRODUCTION

Inventory shrinkage for a retailer is the value of lost inventory due to theft or administrative error (Howell and Proudlove, 2007). A typical retailer loses 1.5% to 2% in sales due to inventory shrinkage (Langton and Hollinger, 2005). Recent statistics from the National Retail Federation reports that retailers in 2018 lost approximately US$51 billion in sales from inventory shrinkage. Inventory shrinkage for Walmart, for example, is at least $3 billion annually, which is equivalent to 1% of its revenue (Matthews, 2015).

One major component of retail inventory shrinkage is theft by employees and customers. The National Retail Federation reports that inventory shrinkage attributed to retail theft was as high as 72.5% in 2015. For 2017, this percentage, while lower than in previous years (66.5%), continues to impact financial performance negatively. Home Depot, a case in point, attributes its 0.5% profit margin decline from 14.5% (in 2017) to 14% (in 2018) to inventory shrinkage due to retail thefts (Boyle, 2019). European retailers are not better off, with Bamfeld (2004) estimating that retail theft accounting for 77% of the €31 billion in inventory shrinkage. Given these statistics, it is not surprising for Michael Creedon, Vice President of Retail Sales and Operations at Tyco Integrated Security, to advise: ". . . It's important for retailers to take a look at this statistic and evaluate [their] security strategies accordingly . . ." (Hollinger and Adams, 2011).

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In this paper, we conceptualize retail thefts as manifestations of security breaches. In a retail store setting, security breaches allow for the intentional and unauthorized removal of retail inventory. Minimizing retail thefts from stores, as such, requires ongoing attention to subtle threats of security breaches and leads to our first research question, namely, *how and why does the capacity of a retail store to sense weak security breach signals contribute to preventing and/or detecting security breaches manifesting as retail thefts and, hence, to lowering its inventory shrinkage?* Additionally, we note that the capacity to sense weak signals, in general, relates to the framing and processing of relevant information. Since organizational structure influences information framing and processing (Simons, 1991), we ask a second follow-up research question – i.e., *how does the organizational structure within a retail store, specifically the two dimensions of centralization and formalization, hinder or facilitate the deployment of appropriate controls to realize the benefits from the capacity to sense weak security breach signals?*

To answer these questions, we draw on High Reliability Organization theory (Roberts, 1990; Roberts and Bea, 2001; Schulman, 1993; Weick and Sutcliffe, 2001) and hypothesize a direct and negative association between the capacity of a retail store to sense weak security breach signals and its store-level inventory shrinkage. We also leverage insights about organizational structure to hypothesize, foremost, that the extent to which decision-making is centralized within a retail store (the degree to which rules and procedures regarding management of security breaches are formalized) is negatively associated (positively associated) with the capacity of a retail store to sense weak security breach signals. Moreover, we argue and posit that centralized decision-making positively moderates (i.e., weakens) the negative association between the capacity of a retail store to sense weak security breach signals and its store-level inventory shrinkage, whereas formalized security breach management negatively moderates (i.e., strengthens) this association.

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We examine these hypotheses empirically with a unique dataset pertaining to retail stores for a Fortune 500 US retailer. The dataset combines (i) objective retail store shrinkage data, (ii) survey responses from multiple key informants employed by retail stores, and (iii) retail store attribute data provided directly by the corporate headquarter and extracted from publicly available secondary sources. Results from analyzing the data support our hypotheses and affirm complex effects between the capacity of a retail store to sense weak security breach signals and its organizational structure attributes of centralization of decision-making and formalization of security breach management on store-level inventory shrinkage. As a retail store increases its capacity to sense weak security breach signals, it observes decreases in store-level inventory shrinkage. This negative association is amplified (dampened) when the retail store has formalized procedures and protocols for managing security breaches (has centralized decision-making within the retail store). Moreover, while the establishment of formalized procedures and protocols for managing security breaches bolsters the capacity of a retail store to sense weak security breach signals, centralizing decision-making has the opposite effect.

Our findings contribute to the retail operations literature by introducing a new store-level organizational capability to guard against theft-based retail inventory shrinkage and by offering novel insights into how and why organizational structure at the level of a retail store deters or facilitates detection and mitigation of theft-based retail inventory shrinkage. Pragmatically, these findings advise retailers to develop the capability to become aware of and to mitigate security breaches, with one unit of increase in the capacity to sense weak security breach signals reducing inventory shrinkage by 7.89% on average. Retailers should also support this capacity by decentralizing decision-making to retail store personnel and by investing in formalizing procedures and protocols for managing security breaches.

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RETAIL INVENTORY SHRINKAGE: RELEVANT LITERATURE

Retail operations has attracted much interest from operations and supply chain management scholars, including the creation of research submission departments in disciplinary journals. Research related to retail operations has delved into varied questions, with one thrust being the role of employees working in retail stores. Chase and Tansik (1983) and Soteriou and Chase (1998), for example, examined the impact that retail store personnel has on store-level productivity. Reiner et al. (2013) demonstrated that employees spend 40% of their time on logistics tasks and that streamlining in-store logistics improves store performance. Ton (2009) emphasized the role that retail store personnel play in driving sales through execution quality. Many others have looked into the effects of store-level personnel scheduling on store profits (e.g., Mani et al., 2015; Van den Bergh et al., 2013). For example, Mani et al. (2015) derived an optimal store staffing level based on queuing theory and archival data from a retailer.

Research on retail operations has also sought to better understand retail inventory shrinkage. Because retail inventory shrinkage is defined as the loss value of inventory from administrative errors or retail thefts (Howell and Proudlove, 2007) and, hence, excludes loss from fraud, robbery, and burglary (Bamfield, 2004), research to date has focused on how inventory record inaccuracy as a type of administrative error and theft by retail store personnel contribute to retail inventory shrinkage.

Regarding the former, DeHoratius and Raman (2008), for example, identified factors such as audit frequency and product variety that are associated with inventory record inaccuracy. Chuang et al. (2016), likewise, identified the increased frequency of auditing by third parties as a mechanism to improve the accuracy of inventory records. The number of full-time retail store personnel is also associated with inventory record inaccuracy (Chuang and Oliva, 2015). Some scholars have suggested curbing supplier delivery errors and product

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misplacements as effective practices against inventory record inaccuracy (e.g., Rekik et al., 2008). Others have examined the role of technological solutions (e.g., radio-frequency identification devices or RFID) to track inventory accurately in the supply chain (e.g., Fan et al., 2015). More recently, Choi et al. (2019) found vendor-managed inventory contracts to be more effective than scan-based trading contracts in ensuring the accuracy of retail inventory records.

Regarding the latter, prior research has associated employee-level demographic factors and personality traits with retail-store employee theft. Studying two department stores, Levine and Jackson (2002), for example, reported that age, gender, agreeableness, and neuroticism influenced employee theft. Avery et al. (2012), likewise, found older employees to be less likely to commit retail-store employee theft. Lau, Au and Ho (2003) found weak associations between employee job satisfaction, tenure, and the likelihood to steal. Bailey (2006), applying the theory of planned behavior, identified factors such as moral norms as influencing employee intentions to commit retail theft. Indeed, how well-compensated employees are has also been linked to employee theft (Chen and Sandino, 2012).

Prior research has also delved into factors associated with retail theft, beyond employee-level attributes. For example, analyzing store-level objective data from a large U.S. retailer, Howell and Proudlove (2007), revealed that (i) monitoring technologies such as CCTV and presence of security personnel do not deter retail theft, (ii) stores located in high crime neighborhoods experience greater retail theft, and (iii) stores with large stockrooms report higher retail theft. Survey responses from 161 retail stores reported that well-lit premises deter retail theft (Kajalo and Lindblom, 2011). Similarly, interviews with offenders noted that store layout and likelihood to steal are associated (Carmel-Gilfilen, 2013).

In summary, the literature relevant to retail operations has probed factors associated with retail inventory shrinkage attributed either to inventory record inaccuracy or to retail

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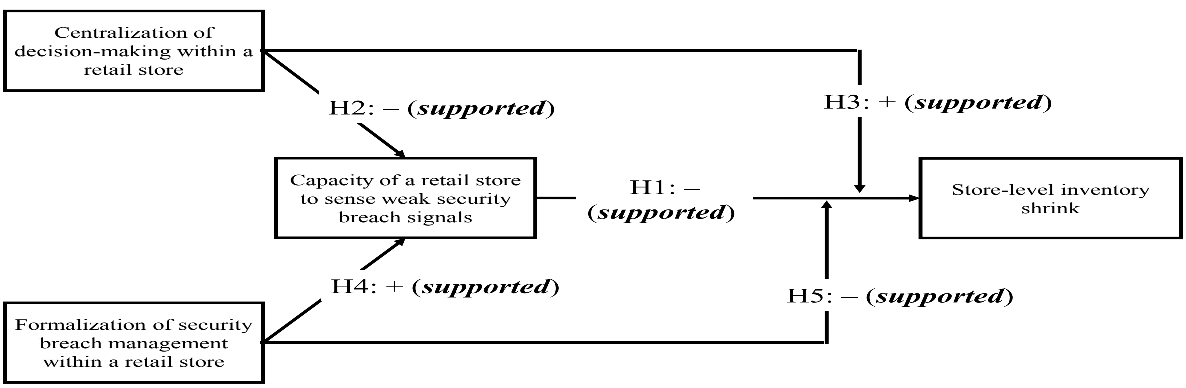
thefts. Our paper concerns the latter, augmenting the literature by theorizing and empirically investigating the complex effects between (i) the capacity of a retail store to sense weak security breach signals and (ii) centralization and formalization, constituent dimensions of organizational structure, on retail inventory shrinkage.

HYPOTHESES DEVELOPMENT

Figure 1 depicts the five hypotheses we develop and analyze in our conceptual model and indicates whether or not these hypotheses are empirically supported. Note that in Figure 1 moderators are posited as both an antecedent of an independent variable and as moderators of the association between the independent variable and the dependent variable. Such models are not uncommon (e.g., Auh and Menguc, 2007; Carbonell and Escudero, 2016; de Bérail et al., 2019; Diamantopoulos et al., 2019; Hassan et al., 2016). In fact, our conceptual model is structurally identical to that proposed by Auh and Menguc (2007), except that our independent variable is *capacity of a retail store to sense weak security breach signals* (versus customer orientation) and our dependent variable is *store-level inventory shrinkage* (versus firm performance).

Figure 1. Hypothesized Model and Empirical Results



The *Capacity to Sense Weak Security Breach Signals* and Retail Inventory Shrinkage

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High Reliability Organization theory posits that in organizations with complex interdependent processes, accidents and errors are preventable when they develop a heightened sense of attentiveness to subtle changes (Roberts, 1990; Roberts and Bea, 2001; Schulman, 1993; Su, 2017; Weick and Sutcliffe, 2001). This attentiveness to subtle changes reflects the capacity of an organization to sense weak signals regarding emerging threats, with such capacity being essential to reducing errors, lowering the probability of accidents, and achieving reliable performance (Bigley and Roberts, 2001; Schulman, 1993). Like other theories about organizations and organizational activities (e.g., principal-agent theory (Jensen and Meckling, 1976), theory of re-adaptative organizations (Lawrence and Dyer, 1983), resource-based view of the firm (Barney, 1991), structural inertia theory (Hannan and Freeman, 1977), etc.), High Reliability Organization theory is akin to a "grand theory" that may be applicable to many settings.

In this paper, we follow Su and Linderman (2016) and deem the capacity to sense weak signals to be ". . . the ability to become aware of . . . undesirable situations earlier through vigilant attention to changes in . . . [the] situated context . . . in which an organization resides" (p. 9). This capacity level reveals the state of alertness to situational changes that an organization possesses, with the concept of alertness defined in the literature as *proactive attentiveness* to information about the environment (Zaheer and Zaheer, 1997). Organizations with high capacity to sense weak signals have a heightened comprehension as to what is actually going on in the situated context (e.g., day-to-day retail operations) rather than what ought to be going on (McDaniel et al., 2003). The elevated situational comprehension, in turn, facilitates anticipation of errors (Ramanujam and Goodman, 2003; Rybowiak et al., 1999) and their detection (See et al., 1995). By being more capable at identifying anomalies and deviations from routine operations, organizations are, therefore, able to safeguard

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planned performance (Kennedy, 2016; Roth, 1997; Vogus and Sutcliffe, 2007; Wildavsky, 1991).

Applying these insights to the context of a retail store and inventory shrinkage due to retail thefts, we formally define the *capacity of a retail store to sense weak security breach signals* as its overall state of alertness towards potential security breaches in retail operations. Retail stores whose capacity to sense weak security breach signals is at a high level are continually alert to small details and are vigilant to potential security breaches. Elevated alertness and vigilance, arguably, permits retail stores to minimize damages from retail thefts by making needed operational adjustments to deter retail thefts from occurring, to detect them when they do occur, and/or to react more responsively to their occurrences. In conclusion, our arguments collectively suggest the following hypothesis:

H1: *The capacity of a retail store to sense weak security breach signals is negatively associated with its store-level inventory shrinkage.*

Role of Organizational Structure

Organizational structure points to the ". . . properties of organizations per se that cannot be reduced to or deduced from properties of . . . [their] . . . members. . . ." (Aiken et al., 1980, p. 634). Our focus on organizational structure is motivated by research associating structural properties of organizations to how they process information and influence individual decision-making (c.f. Simon, 1997). More specifically, the attention-based view of the firm (Ocasio, 1997) posits that how an organization is structured affects the allocation and distribution of attentional resources. As attentional resources vary in allocation and distribution across organizations, attentiveness to environmental signals by organizational members also varies, along with their response to such signals (Joseph and Ocasio, 2012; Rerup, 2009).

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Among properties of organizational structure, the three most prominent are centralization, formalization, and specialization (Fry and Slocum Jr, 1984). Centralization reveals the locus of decision-making authority within an organization (Pugh et al., 1968; Damanpour, 1991) and the role of hierarchy in the making of organizational decisions (Fry and Slocum Jr, 1984). Formalization refers to the presence of written and codified rules and procedures (Pugh et al., 1968, p. 75), as well as the exercise of control through these formalized rules and procedures (Fry and Slocum Jr, 1984). Specialization reflects the specificity of work within organizations and their completion by workers with specific skills (Dewar and Hage, 1978; Hage and Aiken, 1967). In tandem, these three organizational properties determine not only how organizations make decisions and consciously disperse resources to achieve goals (Child, 1972; Fredrickson, 1986; Fry and Slocum Jr, 1984) but also how they exert control over actions in achieving desired outcomes (Jaworski, 1988).

For this paper, we focus on *centralization* and *formalization*. These two organizational properties relevantly influence how organizational members frame, process, and respond to relevant information about the environment in which they operate. That is, they influence the level of situational awareness and alertness of organizational members to changes within an organization, which is de facto the capacity to sense weak signals.

For example, centralization (of decision-making) limits member participation in the decision-making process, with such limitation influencing how issues are framed (Auh and Menguc, 2007). Moreover, centralization constrains communication, hampering the amount, frequency, and scope of information that organizational members can process (Cardinal, 2001; Sheremata, 2000). Jansen et al. (2012) further posits that organizations with centralized decision-making are more likely to be slower in their response to market opportunities.

Formalization of rules and procedures ensure that ". . . roles, authority relations, communications, norms, sanctions, and procedures . . ." are properly defined (Jaworski and

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Kohli, 1993, p. 56). In doing so, they reduce the potential for ambiguity in the development and execution of activities and provide specific directives for organizational members as to how to behave and respond (Adler and Borys, 1996; Fredrickson, 1986). In this regard, the establishment of formalized rules and procedures serves to provide a problem-solving structure for organizational members to follow and, in turn, affect how organizational members interpret and overcome challenges and issues they face. Battilana et al. (2015), for example, found that formalized rules and procedures foster collaboration among organizational members while confronting internal tensions.

Centralization of Decision-Making: Direct and Moderating Effects

Centralized decision-making within a retail store impedes communication, reduces the quality and quantity of information processed by members, and hinders diffusion of information (Auh and Menguc, 2007; Cardinal, 2001; Sheremata, 2000). Relevant information, having to flow top-down, is subject to transmission delays since authorization is necessary for dissemination. Moreover, information flowing downwards is open to potentially varying interpretations at lower levels and consequently degrades in quality. These constraints imposed by centralized decision-making hinder employee attentiveness to, awareness of, and comprehension of the retail situational context. Such hindrance, importantly, deters timely detection of security breaches (i.e., anomalies) and the storewide sharing of instances of security breaches. Research in innovation highlights a parallel phenomenon, namely that organizations with highly centralized decision-making are less likely to become aware of new solutions that deviate from norms (Damanpour, 1991; Jansen et al., 2006). Hence, we posit that:

H2: The degree to which decision-making is centralized within a retail store and its capacity to sense weak security breach signals is negatively associated.

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Besides a direct effect, we also posit that the negative association between the capacity of a retail store to sense weak security breach signals and retail inventory shrinkage depends on the extent to which decision-making is centralized. When decision-making is centralized, employees have less discretion to act and react. The diminished discretion reduces the sense of control employees have about their work (Atuahene-Gima, 2003) and, more relevantly, lengthens the time to respond to not only opportunities but also threats (Jansen et al., 2006; Tsai, 2002; White, 1986). Even though the capacity to sense weak security breach signals is high (i.e., security breaches are readily identified), employees in retail stores with centralized decision-making are less able to curtail retail inventory shrinkage since formal approval is necessary for actions to be taken. Hence, we posit that:

H3: The negative association between the capacity of a retail store to sense weak security breach signals and its store-level inventory shrinkage becomes less negative as decision-making becomes more centralized.

Formalization of Security Breach Management: Direct and Moderating Effects

For this research context, we equate *formalization* to denote specifically the degree to which rules and procedures regarding management of security breaches are documented and written down to regular, monitor, and guide the behavior of retail store personnel (Cardinal, 2001). These formalized rules and procedures establish security management routines to help in identifying warning signals (Weick et al., 1999) that support efficient detection of potential security breaches and the consequent deployment of remedial actions to recover from security breaches.

Relatedly, the quality management literature has noted the importance of established formalized rules and procedures for detection and correction (Anderson et al., 1995; Kaynak, 2003; Samson and Terziovski, 1999). The implementation and practice of statistical process control, for instance, represents the systematic deployment of ". . . statistical and problem-solving tools to facilitate process monitoring, to aid in decisions related to the adjustment of

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process parameters, and to identify opportunities for process improvement. . . .” (Rungtusanatham et al., 1997, p. 118).

Similarly, by establishing formalized rules and procedures for managing security breaches, a retail store signals organizational commitment to store security; reduces employee stress regarding their role in the management of security breaches; and fosters their cognitive involvement on tasks to detect, avoid, and correct security breaches (Michaels et al., 1988). The formalization of rules and procedures regarding the management of security breaches ensures that retail store personnel are minimally distracted by other less-important concerns (Delmar and Shane, 2003). Retail store personnel are then able to legitimately focus their attention on the issue of security breaches (Adler and Borys, 1996; Boisot and Child, 1999; Campbell, 1988; Vlaar et al., 2006). Hence, we posit that:

H4: The degree to which rules and procedures for managing security breaches are formalized within a retail store and its capacity to sense weak security breach signals is positively associated.

Moreover, the negative association between the capacity of a retail store to sense weak security breach signals and retail inventory shrinkage depends on the establishment of formalized rules and procedures for managing security breaches. Once established, they embody a standardized process to efficiently flow information about detected security breaches throughout the retail store and improve decision speed regarding containment actions (Baum and Wally, 2003). By lowering ambiguity, post-detection of security breaches, retail store personnel have increased attentional resources (Levinthal & Rerun, 2006; Ocasio & Joseph, 2005) to devote to responding more quickly and effectively to minimize the negative effects of security breaches. Hence, we also posit that:

H5: The negative association between the capacity of a retail store to sense weak security breach signals and its store-level inventory shrinkage becomes more negative as rules and procedures for managing security breaches become more formalized.

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RESEARCH CONTEXT AND MEASURES

Research Context and Sample

We collected archival and primary survey data from a Fortune 500 retailer headquartered in the U.S. Midwest to test our hypotheses at the retail-store level. This retailer sells consumer electronics products through 1,000+ stores across the USA, with all retail stores deploying similar resources (alarm systems, closed-circuit televisions, digital recording systems, and security guards). Confining our analyses to retail stores of a single retailer removes confounding factors due to differences across retailers. In total, 1,047 retail stores comprise the sample for hypothesis testing.

Relevant Measures

Table 1 summarizes the relevant measures to test our hypotheses, as well as the source of data for the measures.

Dependent and Independent Variables

Store-level inventory shrinkage (SHRINK) is computed by the retailer as the ratio of merchandise loss due to employee theft, shoplifting, and administrative errors in a given year (in dollars) to total store sales in the same year (in dollars). This ratio is expressed by the retailer as a negative percent. A store with $15,000 in merchandise loss and $1,000,000 in sales, therefore, reports its store-level inventory shrinkage as –1.5%. To improve the interpretation of analytical results, we converted the negative *store-level inventory shrinkage* percentage values into

Table 1. Relevant measures

Measure		
SENSING (*Capacity to Sense Weak Security Breach Signals)*	In this store,	
	SEN1	Store employees generally report potential security breaches that coul serious consequences
4-item measurement scale,	SEN2	Store employees take potential signs of security breaches seriously

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adapted from Su and Linderman (2016)	SEN3	We actively look for something that deviates from what is expected in ordinary daily activities
	SEN4	We often update our procedures after experiencing a security breach
		(5-point, Likert response scale, anchored from “strongly disagree” to “strongly agree”)
CENTRALIZATION (*Centralization of Decision-Making)* 5-item measurement scale, adapted from Hage and Aiken (1967)	CEN1	There can be little action taken here until a manager approves a decisio
	CEN2	A person who wants to make his own decisions would be quickly disco
	CEN3	Even small matters have to be referred to someone higher up for a fina decision
	CEN4	Unit members need to ask their manager before they do almost anythin
	CEN5:	Most decisions people make here have to have their manager’s approv
		(5-point, Likert response scale, anchored from “strongly disagree” to “strongly agree”)
FORMALIZATION (*Formalization of Security Breach Management)* 4-item measurement scale, adapted from Desphandé and Zaltman (1982)	FOR1	Whenever a security breach (shoplifting, theft, burglary, product tamp etc.) arises in our store, written procedures are available for dealing wi
	FOR2	Rules and procedures occupy a central place in our store for preventin security breaches
	FOR3	We have standardized rules and procedures in dealing with security br
	FOR4	We have a formal process to decide what practice or procedure to impl in order to increase the level of security in our store
		(5-point, Likert response scale, anchored from “strongly disagree” to “strongly agree”)

Table 1. Relevant measures (Continued)

Measure	
SHRINK	Ratio of merchandise loss due to employee theft, shoplifting, and administrative errors in a given year (in dollars) for a retail store to its total store sales in the same year (in dollars), and expressed by as a negative percent
SHRINK-1	SHRINK for a retail store in the prior year
TERRITORY	Categorical variable to indicate which of 8 US sales region a retail store belongs
SIZE	Square footage of a retail store
AGE	Length of time a retail store has been in operation
LOCATION	The extent to which a retail store is situated in an urban versus rural area, computed as the total number of sister retail stores (i.e., those of the same US retailer) clustered within a 10-mile radius of the longitude and latitude of the specific retail store in question
CAP Index	Risk of crime for a location in which a retail store is situated, expressed relative to (the national average) such that a value below

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	(above) 100 means that an area is below (above) the national average

positive percentage values by taking the absolute value. This approach is consistent with Hollinger and Adams (2011) and allows comparisons to be made across retail stores. To reduce the influence of extreme values, we then take the natural logarithm of these values.

The *capacity of retail store to sense weak security breach signals* (SENSING) is measured with a 4-item measurement scale, adapted from Su and Linderman (2016). Each measurement item is paired with a 5-point, Likert-response scale, anchored from 1 (strongly disagree) to 5 (strongly agree).

Centralization of decision-making (CENTRALIZATION) is measured with the 5-item measurement scale for "hierarchy of authority" from Hage and Aiken (1967). Each measurement item is paired with a 5-point, Likert-response scale, anchored from 1 (strongly disagree) to 5 (strongly agree).

Formalization of security breach management (FORMALIZATION) is measured with a 4-item measurement scale for "degree of formalization" from Desphandé and Zaltman (1982). Each measurement item is paired with a 5-point, Likert-response scale, anchored from 1 (strongly disagree) to 5 (strongly agree).

Control Variables

Six store-level control variables are considered for our analyses. Our analyses control for the inventory shrinkage of a retail store in the prior year (SHRINK-1). Including this variable in our analyses accounts for heterogeneity among retail stores that is associated with inventory shrinkage and controls for other unobservable store-level characteristics that may influence inventory shrinkage (e.g., demographic characteristics of store employees) (Greene, 2003; Maddala, 1983; Wooldridge, 2010).

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TERRITORY is a categorical variable to indicate the sales region to which a retail store belongs. It is included as a control since managerial practices and incentive systems may differ across sales regions. Since the retailer splits the US into 8 sales regions, 7 dummy variables are, therefore, included during analyses.

SIZE represents the square footage of a retail store. Larger stores experience higher inventory shrinkage (Howell and Proudlove, 2007). Compared to smaller stores, they typically have higher operational complexity (e.g., more SKUs, higher customer traffic, greater inventory, and security monitoring challenges, etc.) that potentially influences thefts and administrative errors.

Also included during analyses is AGE (i.e., how long a retail store has been in operation). Compared to newer stores, older stores are likely to have different layouts, different lighting quality, and different models of security monitoring technologies. These differences may associate with effectiveness of security breach detection.

LOCATION indicates the extent to which a retail store is situated in an urban versus rural area. Retail stores in urban settings tend to experience higher inventory shrinkage according to Howell and Proudlove (2007). Relative to those in more rural areas, retail stores in urban settings typically serve a broader customer base and have higher customer traffic. These aspects of retail stores expose them to more potential thefts. To compute this value, we determine the total number of sister retail stores (i.e., those of the same US retailer) clustered within a 100-mile radius of the longitude and latitude of the specific retail store in question. The higher the value, the greater the urban nature of the area in which the retail store in question is located. This value, computed in this manner, is consistent with the corporate philosophy of opening more stores in urban areas where estimated customer traffic is high.

Finally, our analyses also control for the risk of crime for a location in which a retail store is situated using the CAP Index. The CAP Index (see https://capindex.com/) determines

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the risk of crime surrounding a location along such categories as robbery, burglary, larceny, and motor vehicle theft. It is expressed relative to 100 (the national average) such that a value below (above) 100 means that an area is below (above) the national average. Retail stores situated in areas with a high crime rate are more prone to shoplifting than their counterparts situated in areas with a low crime rate.

DATA SOURCES

Archival Data

Data for the dependent variable and all controls, including the CAP Index, come from digital printouts provided by the corporate headquarter of the US retailer. The "time stamp" for such data is generically designated as YEAR 1. A confidentiality agreement signed with the Fortune 500 US retailer who provided access to data, however, prevents us from revealing exact dates, since such revelation enables the identity of this retailer to be determined from publicly-available sources such as the National Retail Federation dataset on inventory shrinkage.

Primary Survey Data

Data for the three independent variables were collected using a web-based survey instrument. The web-based survey was administered over a two-month period for the year prior to the year for which we extracted data for *store-level inventory shrinkage* (i.e., YEAR 0). This ensures a temporal separation between data collected for independent variables and data collected for the dependent variable (i.e., a lag of at least one year).

The corporate headquarter of the US retailer facilitated the administration of the web-based survey by promoting store-level employee participation in the web-based survey in its internal newsletters. These internal communications serve to pre-notify and publicize the web-based survey (Rogelberg and Stanton, 2007). We also contacted store managers directly

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to encourage retail personnel participation. In addition, we sent email reminders during the two-month data collection period to encourage response (Rogelberg and Stanton, 2007).

To increase the response rate and, at the same time, mitigate against social desirability bias, we sent the email invitation to retail store personnel directly, with corporate providing email contacts for these individuals. The email invitation emphasized anonymity in responses (Nederhof, 1985; Rogelberg and Stanton, 2007; Simsek and Veiga, 2000), explaining that (i) individual responses are not accessible to corporate or to stores where employees work and (ii collected responses are stored at a university site and password-protected. To reinforce the latter, when employees click the embedded link to the web-based survey in the email invitation, they are redirected to a website hosted by university where we work and showing the university logo and domain.

In total, 4,387 email invitations were sent to informants across 1,047 retail stores. 3,221 informants completed the web-based survey, corresponding to a response rate of 73.4%. Table 2 provides demographic details about these informants.

Aggregation of Retail Store Personnel Responses

Our hypotheses and the unit of analysis refer to retail stores; the data for independent variables, however, are collected by surveying employees within a retail store. A necessary preparatory step before hypothesis testing is, therefore, to determine whether nor not it is appropriate to aggregate employee-level responses for a retail store to the store-level. We make this determination by evaluating the reliability within-group index (r_{wg}) for SENSING, CENTRALIZATION, and FORMALIZATION. Theoretically, r_{wg} ranges from 0 (no agreement)

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Table 2. Key informant demographics

Age	Frequency	Percentage	Tenure with Retail Store	Frequency	Percentage
18 or under	11	0.34%	Under 6 months	51	1.58%
19 - 22	316	9.81%	Between 6 and 12 months	149	4.63%
23 – 30	1315	40.83%	Between 1 and 2 years	263	8.17%
31 – 40	891	27.66%	Between 2 and 5 years	963	29.90%
41 or over	688	21.36%	Over 5 years	1795	55.73%
Position	Frequency	Percentage	Tenure in Position	Frequency	Percentage
Manager	702	21.79%	Under 3 months	135	4.19%
Supervisor	1263	39.21%	Between 3 and 6 months	260	8.07%
Sales support	779	24.19%	Between 6 and 12 months	554	17.20%
Sales team	477	14.81%	Between 1 and 2 years	751	23.32%
			Over 2 years	1,521	47.22%

to 1 (complete agreement), with 0.70 being an acceptable lower-bound value according to Glick (1985) and James et al. (1984). The r_{wg} values for SENSING (0.84), CENTRALIZATION (0.84), and FORMALIZATION (0.86) support aggregating employee survey responses to the level of the retail store. To aggregate, we average the employee responses to each measurement item and assign the average score for the measurement item to the retail store.

Composite Reliability, Convergent Validity, and Discriminant Validity

To assess measurement quality of the SENSING, CENTRALIZATION, and FORMALIZATION measurement scales (i.e., composite reliability, convergent validity, and discriminant validity), we fitted a three-factor, orthogonal measurement model to store-level scores via Confirmatory Factor Analysis (CFA). Model fits statistics for this measurement suggest good fit to data, as CFI = 0.98 is greater than the 0.90 cutoff value (Hu and Bentler,

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1999), SRMR = 0.03 is less than the cutoff value of 0.08 (Hu and Bentler, 1999), and RMSEA = 0.04 is less than the 0.08 cutoff value (Browne and Cudeck, 1992).

Table 3A summarizes factor loadings and composite reliability values from CFA, with these results supporting convergent validity. Measurement items loaded onto their *prior* factors as expected, with all factor loadings, ranging between 0.72 and 0.92, being significant at $p < 0.001$ and twice the magnitude of their respective standard errors (Anderson & Gerbing, 1988). Composite reliability for SENSING (0.83), CENTRALIZATION (0.92), and FORMALIZATION (0.89) also indicate that each factor explains more than 80% of the constituent measurement item variance (Fornell and Larcker, 1981). Last, the AVE (average variance extracted) for SENSING (0.59), CENTRALIZATION (0.71), and FORMALIZATION (0.66) exceed the recommended cutoff value of 0.50 (Hair et al., 2006).

As for discriminant validity, Table 3B reveals that the 95% confidence intervals for inter-factor correlations do not include 1.00 (Anderson & Gerbing, 1988). Moreover, the square root of AVE of each factor is greater than its correlations with the other two factors (Fornell and Larcker, 1981). These results conclude in support of discriminant validity.

Common Method Bias

Data for independent variables are based on web-based surveys of retail store personnel. Data for dependent variables are extracted from printouts provided by the corporate headquarter. Given the different sources and methods for collecting data for independent versus dependent variables, common method bias does not appear to be a methodological concern (Podsakoff et al., 2003).

ANALYTICAL RESULTS

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For hypothesis testing, we analyze weighted factor scores from CFA for SENSING, CENTRALIZATION, and FORMALIZATION. Compared to scores based on averaging across

Table 3A. Convergent validity: Factor loadings and composite reliability

Factor	Item	Composite Reliability	AVE	Factor Loading	S.E.	$p < 0.001$?
SENSING	SEN1	0.83	0.59	0.78	0.028	Yes
	SEN2			0.80	0.028	Yes
	SEN3			0.75	0.026	Yes
	SEN4			0.72	0.031	Yes
CENTRALIZATION	CEN1	0.92	0.71	0.80	0.013	Yes
	CEN2			0.77	0.015	Yes
	CEN3			0.87	0.010	Yes
	CEN4			0.92	0.011	Yes
	CEN5			0.83	0.016	Yes
FORMALIZATION	FOR1	0.89	0.66	0.77	0.016	Yes
	FOR2			0.86	0.013	Yes
	FOR3			0.84	0.015	Yes
	FOR4			0.79	0.018	Yes

Table 3B. Inter-factor correlations, 95% confidence intervals, and $\sqrt{\text{AVE}}$

	Inter-Factor Correlation [95% Confidence Interval]		
	SENSING	CENTRALIZATION	FORMALIZATION
SENSING	$\sqrt{\text{AVE}} = 0.76$		
CENTRALIZATION	–0.11 [–0.17, –0.05]	$\sqrt{\text{AVE}} = 0.84$	
FORMALIZATION	0.62 [0.58, 0.65]	–0.08 [–0.14, –0.02]	$\sqrt{\text{AVE}} = 0.81$

constituent measurement items, factor scores tend to have more symmetrical distributions and do not require strong assumptions about psychometric properties (Calantone et al., 2017; Edwards and Wirth, 2009). Table 4 summarizes descriptive statistics and bivariate correlations for variables for our analyses.

Estimation Approach and Results

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Our data has a nested structure, with multiple stores clustered within U.S. states and unobserved effects at the state level (e.g., differences in economic conditions, state laws, tax policies, law enforcement, etc.). A linear fixed-effects model appropriately controls for unobserved heterogeneity across states (Cameron and Trivedi, 2009; Rabe-Hesketh and Skrondal, 2008). The linear model, moreover, has the advantage of reducing omitted variable concerns at the higher cluster (i.e., state) level (Greene, 2003). Last, Hausman test results ($\chi^2 = 32.6$, $p = 0.008$) reveal that a fixed-effects model is more appropriate than a random-effect model.

Table 5 presents the results from estimating linear fixed-effects models for hypotheses with SHRINK as the dependent variable (i.e., H1, H3, and H5). Table 6 summarizes linear models with fixed-effects estimation results for H2 and H4 with SENSING as the dependent variable.[2] For all models in Tables 5 and 6, we report cluster-robust standard errors to ensure consistency of inference and, moreover, to guard against biased standard errors, given the possibility of estimated standard errors of stores from the same state being correlated

Table 4. Descriptive statistics and correlations[%, &]

	Mean	s.d.	(1)	(2)	(3)	(4)	(5)	(6)
(1) SHRINK	–1.13	0.45						
(2) SHRINK-1	–1.19	0.51	0.510***					
(3) SIZE	37588.35	9242.93	0.151***	0.142***				
(4) AGE	9.09	5.03	0.049*	0.087**	0.555***			
(5) LOCATION	29.94	22.23	0.194***	0.129***	0.204***	0.042		
(6) CAP Index	166.70	156.97	0.174***	0.109***	0.093**	–0.026	0.116***	

[2] Model 1 in Table 6 includes only control variables in estimating SENSING. Since we fit a linear fixed-effects model to address unobserved heterogeneity across states, the small R^2 value of 0.026 indicates that these control variables explain only a small portion of the variance of SENSING *across stores within states*. Substantively, the small R^2 reveals that such store-level attributes as SIZE, AGE, LOCATION, and CAP Index do not explain differences in SENSING across stores within states. Importantly, SENSING is better explained by CENTRALIZATION and FORMALIZATION, per Model 2 in Table 6, with the Model 2 R^2 improving to 0.397.

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(7) SENSING	0.008	0.451	–0.089**	–0.114***	0.030	–0.005	0.022	0.036
(8) CENTRALIZAITON	–0.001	0.638	0.035	0.034	0.014	0.016	0.011	0.017
(9) FORMALIZATION	0.006	0.514	–0.022	–0.064*	0.023	–0.016	0.004	0.017

[%] Note that weighted average factor scores from CFA are reported in the Mean column. Compared to scores based on averaging across constituent measurement items, factor scores tend to have more symmetrical distributions and do not require strong assumptions about psychometric properties (Calantone et al., 2017; Edwards and Wirth, 2009).

[&] The correlation between CENTRALIZATION and FORMALIZATION is negative and significant. Jansen et al. (2006), likewise, observed a negative correlation between these two organizational structure dimensions in their research into innovation and performance.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5. Linear models with fixed-effects estimation results for SHRINK[%, &, #]

Dependent variable	Model 1 SHRINK	Model 2 SHRINK	Model 3 SHRINK	Model 4 SHRINK	Model 5 SHRINK
SHRINK-1	0.336***	0.331***	0.334***	0.331***	0.334***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
SIZE	0.000**	0.000*	0.000**	0.000*	0.000*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
AGE	0.003	0.003	0.003	0.003	0.003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
LOCATION	0.003*	0.003*	0.003*	0.003*	0.003*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CAP Index	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TERRITORY	Included	Included	Included	Included	Included
SENSING		–0.076*	–0.085*	–0.087*	–0.094**
		(0.04)	(0.03)	(0.03)	(0.03)
CENTRALIZATION		0.016	0.011	.015	0.011
		(0.02)	(0.02)	(0.02)	(0.02)
FORMALIZATION		0.049	0.053*	0.042	0.046
		(0.03)	(0.03)	(0.03)	(0.03)
SENSING ×CENTRALIZATION			0.098*		0.095*
			(0.04)		(0.04)
SENSING ×FORMALIZATION				–0.079***	–0.075**
				(0.02)	(0.03)
R^2	0.230	0.235	0.243	0.240	0.247
AIC	673.982	672.408	663.960	668.235	660.404
N	1019	1019	1019	1019	1019

[%] Coefficients are small but not unexpected given the small range over which SHRINK varies (cf.,

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Cohen et al. 2003).
[&] Some territories are significant but not shown for brevity.
[#] Cluster-robust standard errors reported in parentheses.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ (two-tail).

Table 6. Linear models with fixed-effects estimation results for SENSING[%, &, #]

Dependent variable	Model 1 SENSING	Model 2 SENSING
SIZE	0.000 (0.00)	0.000 (0.00)
AGE	–0.003 (0.00)	–0.000 (0.00)
LOCATION	0.001 (0.00)	0.000 (0.00)
CAP Index	0.000 (0.00)	0.000 (0.00)
TERRITORY	Included	Included
CENTRALIZATION		-0.049^{*} (0.02)
FORMALIZATION		0.535^{***} (0.02)
R^2	0.026	0.397
AIC	1227.398	728.796
N	1047	1047

[%] Model 1 in Table 6 includes only control variables in estimating SENSING. Since we fit a linear fixed-effects model to address unobserved heterogeneity across states, the small R^2 value of 0.026 indicates that these control variables explain only a small portion of the variance of SENSING *across stores within states*. Substantively, the small R^2 reveals that such store-level attributes as SIZE, AGE, LOCATION, and CAP Index do not explain differences in SENSING across stores within states. Importantly, SENSING is better explained by CENTRALIZATION and FORMALIZATION, per Model 2 in Table 6, with the Model 2 R^2 improving to 0.397.
[&] Some territories are significant but not shown for brevity.
[#] Cluster-robust standard errors reported in parentheses.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$ (two-tail).

(Cameron and Trivedi, 2009). While the effect sizes (i.e., coefficients) are small, these are not unexpected since SHRINK varies over a small range (cf., Cohen et al, 2003).

Note that CENTRALIZATION (and FORMALIZATION) is hypothesized to be associated with SENSING and, at the same time, to moderate the association between SENSING and SHRINK. The correlation between CENTRALIZATION and SENSING (and

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between FORMALIZATION and SENSING), therefore, may present a multi-collinearity problem when analyzing SHRINK, particularly when the two-way interaction terms are included in Model 5. To confirm the absence of multicollinearity, we computed the variance inflation factor (VIF) for variables in Model 5, noting that all VIFs are below the recommended threshold of 3.0 (Hair et al., 2006) and, specifically, that the VIF for the SENSING×CENTRALIZATION and the SENSING×FORMALIZATION interaction terms are 1.03 and 1.09 respectively. Multi-collinearity, therefore, does not present a challenge to interpreting Table 5.

Interpreting Table 5, we note the consistently significant positive associations across Models 1-5 between SHRINK and SHRINK-1, SHRINK and SIZE, SHRINK and LOCATION, and SHRINK and CAP Index. Inventory shrinkage for a retail store appears to be positively associated with its shrinkage in the previous year. Larger retail stores, those situated in more urban locations, and those in relatively higher-crime areas also tend to experience higher inventory shrinkage. Models 2-5 reveal consistently negative association between SENSING and SHRINK, with estimation results directly supporting H1 given by Model 2 results ($b = –0.076$, $p < 0.05$). As the *capacity of a retail store to sense week security breach signals* increase, its inventory shrinkage decreases. Model 3 provides evidence to support H3, namely that the negative association between SENSING and SHRINK becomes weakened as the degree of CENTRALIZATION increases. The SENSING×CENTRALIZAITON interaction term ($b = 0.098$) is significant at $p < 0.05$. H5 is also supported, with Model 4 revealing that the negative association between SENSING and SHRINK becomes amplified as rules and procedures for managing security breaches become more formalized. The SENSING×FORMALIZATION interaction term ($b = –0.079$) is significant at $p < 0.001$. Model 5 demonstrates consistent findings when including all the independent variables and interaction terms.

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Table 6 reveals that SIZE, AGE, LOCATION, and CAP Index are not significant for SENSING (Model 1). CENTRALIZATION is negatively associated with SENSING ($b = -0.049$, $p < 0.05$); FORMALIZATION, on the other hand, is positively associated with SENSING ($b = 0.535$, $p < 0.001$). H2 and H4 are, therefore, supported, respectively. Moreover, between CENTRALIZATION and FORMALIZATION, the latter appears to have a stronger association with SENSING than the former.

Addressing Endogeneity Concerns

Omitted Variable Bias and Reverse Causality

We guarded against endogeneity due to simultaneity or reverse causality of SENSING, CENTRALIZATION, and FORMALIZATION by ensuring a temporal separation between when data are collected for independent variables and when data are extracted for the dependent variable (Zaefarian et al., 2017). In discussing our data sources, we noted that the time lag between data collected for SENSING, CENTRALIZATION, and FORMALIZATION and that for SHRINK is at least one year.

To guard against endogeneity due to omitted variable bias, we included appropriate theoretically-driven controls when estimating linear fixed-effects models to test our hypotheses (Keele et al., 2020; Miller et al. 2020). Miller et al. (2020) notes that endogeneity due to omitted variable bias decreases when hypothesized associations of interest are anchored in theory and when empirical results derive from analyses including theoretically-driven control variables. The linear fixed-effects models we fitted to data, for example, included SHRINK-1 since past performance likely correlates with both present performance (i.e., SHRINK) and unobserved omitted variables. By doing so, the correlations between the disturbance term (from fitting linear fixed-effects models to data) and SENSING, between the disturbance term and CENTRALIZATION, and between the disturbance term and FORMALIZATION are, therefore, reduced (Angrist and Pischke, 2009).

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Verifying SENSING to be Exogenous

Because SENSING is core to our five hypotheses, we conducted an additional Durbin-Wu-Hausman test to verify its exogeneity. Evidence in support of SENSING being exogenous ensures that our estimation of linear fixed-effects models produces consistent parameter estimates (Antonakis et al., 2010; Hamilton and Nickerson, 2003). To conduct a Durbin-Wu-Hausman test, we followed a four-step procedure: (a) identify variables to serve as potential instruments (IVs), (b) justify the identified variables as potential instruments, (c) verify that selected variables are strong instruments satisfying the relevance and the exclusion conditions, and (d) evaluate the Durbin-Wu-Hausman endogeneity test statistic and draw conclusion.

For Step (a), we identified three potential IVs. The three IVs identified correspond to three single-item indicators in the web-based survey instrument that ask retail store personnel about (i) their *commitment* to containing security breaches (i.e., “Employees are committed to containing all kinds of security breaches that may arise”), (ii) their level of *trust* with one another (i.e., “Employees here demonstrate trust in each other”), and (iii) their perspective regarding *expertise* to handle security breaches (i.e., “Expertise and experience appear to be more important than hierarchical position when there is a security breach”). All three single-item indicators are paired with a 5-point, Likert response scale anchored from 1 (strongly disagree) to 5 (strongly agree). As with other store-level measures from the web-based survey instrument, we aggregated employee-level responses to the store-level after verifying satisfactory r_{wg} values (0.72, 0.71, and 0.82, respectively).

For Step (b), we justified the selection of the three potential IVs by providing literature support associating the IVs to proactive behaviors. Parker, Williams, and Turner (2006), for example, reported that trust among employees facilitates such proactive behaviors as actively searching for potential problems. Thomas, Whitman, and Viswesvaran (2010)

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revealed that proactive behavior is associated with employee commitment to certain goals. Roberts (1990) observed that employee respect for residential expertise enables timely organizational search and response to potential problems. Empirically, we also confirmed that the correlations between the IVs and SHRINK are small (*commitment*-SHRINK: –0.065; *trust*-SHRINK: –0.097; *expertise*-SHRINK: –0.064). These small correlations reduce the likelihood of the IVs being correlated with the error term when SHRINK is regressed on SENSING in Step (c).

For Step (c), we verified that the three IVs are strong instruments, satisfying both the relevance condition (i.e., *strongly correlated* with SENSING) and the exclusion condition (i.e., *not correlated with the error term* from regressing SHRINK on SENSING). With respect to the relevance condition, the Stock-Yogo weak identification test assesses whether the F-statistic of the first-stage regression is high enough to justify the relevant condition of the instruments (Stock & Yogo 2005). The test statistic (Cragg-Donald F-statistic of 39.893) is above the Stock-Yogo's critical value (Cragg and Donald, 1993; Stock and Yogo, 2005), indicating that the IVs are relevant. Moreover, the more robust Rank Lagrange Multiplier test for testing weak instruments under heteroscedasticity (Kleibergen and Paap, 2006) also rejects the null hypothesis that the three IVs are irrelevant ($\chi^2 = 57.324$, $p = 0.000$). With respect to the exclusion condition, the Sargan-Hansen over-identification test (i.e., Hansen J statistic) fails to reject the null hypothesis that the linear combination of the three IVs is exogenous and uncorrelated with the error term ($\chi^2 = 0.764$, $p = 0.682$) (Cameron and Trivedi, 2009).

Finally, for Step (d), we evaluated the Durbin-Wu-Hausman endogeneity test statistic corresponding to the null hypothesis that SENSING is exogenous (Baum et al., 2003; Davidson and MacKinnon, 1993). With $\chi^2 = 2.290$ ($p = 0.132$). The null hypothesis is not rejected and leads to the conclusion that SENSING is exogenous.

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Table 7. SEM results for structural paths corresponding to hypotheses%

	Coefficient	*p*	95% Confidence Interval
Structural Paths Corresponding to Hypotheses			
H1: SENSING→SHRINK	–0.094 (0.032)	0.003	[–0.157, –0.032]
H2: CENTRALIZATION→SENSING	–0.049 (0.021)	0.017	[–0.090, –0.009]
H3: SENSING×CENTRALIZATION→SHRINK	0.095 (0.036)	0.009	[0.023, 0.166]
H4: FORMALIZATION→SENSING	0.534 (0.024)	0.000	[0.487, 0.582]
H5: SENSING×FORMALIZATION→SHRINK	–0.075 (0.025)	0.003	[–0.124, –0.026]

% Robust standard errors reported in parentheses.

Assessing Robustness of Results

We assessed how robust reported results are by evaluating Figure 1 via structural equation modeling (SEM) with territory dummies and maximum-likelihood estimation. Table 7 documents the SEM estimation results most directly comparable to the linear models with fixed-effects estimation results from Tables 5 and 6. SENSING is negatively associated with SHRINK (b = –0.094, p = 0.003), CENTRALIZATION is negatively associated with SENSING (b = –0.049, p = 0.017), FORMALIZATION is positively associated with SENSING (b = 0.534, p = 0.000), the SENSING×CENTRALIZATION interaction term is positive (b = 0.095, p = 0.009), and the SENSING×FORMALIZATION interaction term is negative (b = –0.075, p = 0.003). These SEM results are consistent with those from the fixed-effects linear models.

Post-Hoc Analyses

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As post-hoc, we conducted two additional analyses: (i) “retail store theft” as a random proportion of SHRINK and (ii) the presence of indirect effects of CENTRALIZATION and FORMALIZATION on SHRINK.

“Retail Store Theft” as a Random Proportion of Store-Level Inventory Shrink

Thefts by employees and customers constitute a large percentage of store-level inventory shrinkage. Indeed, the Fortune 500 US retailer we analyzed estimates its retail inventory shrinkage due to retail thefts to range from 30% to 80%. Developing our hypotheses, we argued foremost that the *capacity of a retail store to sense weak security breach signals* is negatively associated with store-level inventory shrinkage due to thefts by employees and customers.

An ideal assessment of this argument involves re-running our analyses by replacing SHRINK with “retail store theft” as the dependent variable. However, the US retailer that served as our research context was unable to decompose its retail inventory shrinkage data into theft versus non-theft components. To overcome this constraint, we multiplied SHRINK with a random % value drawn from a uniform distribution anchored between 0.3 and 0.8 and then replicated Model 5 in Table 5 via a Monte Carlo simulation with 1,000 runs. Table 8 summarizes these results. Substituting SHRINK with “retail store theft” yielded an identical pattern of associations involving SENSING, CENTRALIZATION, FORMALIZATION, and their interactions (i.e., SENSING×CENTRALIZATION and SENSING×FORMALIZATION). These results provide some support to our argument that the *capacity of a retail store to sense weak security breach signals*, along with its interactions with centralization of decision-making within stores and formalization of security breach management, reduce store-level shrinkage due to employee thefts and customer shoplifting incidents.

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Table 8. Monte Carlo simulation results for "retail store theft" as the dependent variable[%]

Dependent variable	Retail Store Theft (Mean Coefficient)	95% Confidence Interval
SHRINK-1	0.335	[0.333, 0.336]
SIZE	0.000	[0.000, 0.000]
AGE	0.002	[0.002, 0.002]
LOCATION	0.003	[0.002, 0.002]
CAP Index	0.0002	[0.00019, 0.00020]
TERRITORY	Included	Included
SENSING	–0.095	[–0.097, –0.094]
CENTRALIZATION	0.010	[0.009, 0.011]
FORMALIZATION	0.095	[0.093, 0.096]
SENSING×CENTRALIZATION	0.046	[0.045, 0.048]
SENSING×FORMALIZATION	–0.074	[–0.075, –0.072]

[%] Some territories are significant but not shown for brevity.

Indirect Effects of CENTRALIZATION and FORMALIZATION on SHRINK

The hypothesized model depicted in Figure 1 suggests that CENTRALIZATION and FORMALIZATION may have indirect effects on SHRINK through SENSING. Moreover, the indirect effects of CENTRALIZATION and of FORMALIZATION are, themselves, self-moderated – i.e., the indirect effect of CENTRALIZATION (or FORMALIZATION) on SHRINK through SENSING is moderated by CENTRALIZATION (or FORMALIZATION). To evaluate these indirect effects, we followed procedures described in Hayes (2017) to test for conditional indirect effects via bootstrapping.

Table 9 reports the conditional indirect effects of CENTRALIZATION on SHRINK through SENSING for low (25 percentile), median (50 percentile), and high (75 percentile) degrees of CENTRALIZATION. At a low degree of CENTRALIZATION, for example, the indirect effect is 0.006 (p = 0.080, non-significant at the α = 0.05 level) with the 95% confidence interval and bias-corrected 95% confidence intervals both including 0.000 (Lau

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and Cheung, 2010; MacKinnon et al., 2004). The indirect effect of CENTRALIZATION on SHRINK through SENSING is similarly non-significant at median and high levels of CENTRALIZATION. CENTRALIZATION, as a property of organizational structure, does not have an indirect effect on SHRINK through SENSING. In tandem, these results suggest that changes in SHRINK are due to changes in SENSING that do not stem from changes in CENTRALIZATION. Relative to the negative association between SENSING and SHRINK, CENTRALIZATION merely lessens this negative association as a moderator (based on empirical results supporting H3).

Table 9 reveals, on the contrary, that the conditional indirect effects of FORMALIZATION on SHRINK through SENSING are significant at low, median, and high levels of FORMALIZATION. For example, at a low level of FORMALIZATION, the indirect effect is –0.040, significant at $p = 0.033$, with the 95% confidence interval and bias-corrected 95% confidence intervals both excluding 0.000. FORMALIZATION, as a property of organizational structure, has indirect effects on SHRINK through SENSING at varying levels of FORMALIZATION. In tandem, these results suggest that changes in SHRINK are due to changes in SENSING that stem from changes in FORMALIZATION, with increased levels of FORMALIZATION further strengthening the negative association between SENSING and SHRINK (based on empirical results supporting H5).

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Table 9. Conditional indirect effects of CENTRALIZATION and FORMALIZATION on SHRINK through SENSING

Condition		Coefficient	Bias	Bootstrap Standard Error	*p*	Percentile Confidence Interval
Conditional Indirect Effect of CENTRALIZATION on SHRINK through SENSING						
CENTRALIZATION	Low	0.006	0.000	0.004	0.080	[0.000, 0.015]
	Median	0.004	–0.000	0.003	0.096	[0.000, 0.012]
	High	0.003	–0.000	0.002	0.159	[–0.000, 0.008]
Conditional Indirect Effect of FORMALIZATION on SHRINK through SENSING						
Condition		Coefficient	Bias	Bootstrap Standard Error	*p*	Percentile Confidence Interval
FORMALIZATION	Low	–0.040	–0.000	0.019	0.033	[–0.077, –0.002]
	Median	–0.051	–0.000	0.018	0.005	[–0.084, –0.011]
	High	–0.063	–0.000	0.019	0.001	[–0.102, –0.026]

DISCUSSION

For retailers, inventory shrinkage attributed to theft, whether by employees or by customers, is an ongoing concern with substantial financial penalties. Our findings contribute novel theoretical insights and pragmatic advice to minimize theft-based retail inventory shrinkage. These insights and advice also suggest future research opportunities to pursue.

Theoretical Contributions

Prior research into theft-based retail inventory shrinkage has examined its associations with employee attributes (e.g., age, moral norms, etc.), preventive technologies (e.g., CCTV), and store-level design factors (e.g., location, square footage, lighting, etc.). Our findings add to

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this literature, by being the first to introduce and advocate for the *capacity of a retail store to sense weak security breach signals*, a new store-level organizational capability to guard against theft-based retail inventory shrinkage. This capability draws conceptually from High Reliability Organization theory (Roberts, 1990; Roberts and Bea, 2001; Schulman, 1993; Weick and Sutcliffe, 2001). Our findings reveal how and why retail inventory shrinkage decreases when retail stores foster and possess elevated organizational attentiveness to the presence of potential employee thefts and customer shoplifting incidents. Introducing a new explanatory factor and being the first to report findings related to a new factor are relevant theoretical contributions, as explained in Whetten (1989) and Kohli (2011).

Moreover, how successful efforts by retail stores to develop this capability depend on two properties of organizational structure that influence how relevant information is framed, processed, and acted upon. Our findings uncover disadvantages to theft-based retail inventory shrinkage from centralized decision-making within retail stores. This practice constrains efficient flow of relevant information, hindering, as a result, not only alertness and attentiveness to employee thefts and customer shoplifting incidents but also discretion to act in prevention of or in response to such incidents. In addition, our findings emphasize the criticality of formalizing rules and procedures for managing security breaches, with this practice not only heightening alertness to employee thefts and customer shoplifting incidents but also efficiently providing guidance to prevent or to react to such incidents. These findings augment the literature with novel insights into how and why organizational structure in the context of a retail store deters or facilitates detection and mitigation of theft-based retail inventory shrinkage. They are relevant theoretical contributions because they reveal ". . . what we otherwise had not seen, known, or conceived [in the literature] . . ." (Corley and Gioia, 2011, p. 17). Moreover, as theoretical contributions, these findings identify boundary

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conditions for the observed association between the *capacity of a retail store to sense weak security breach signals* and retail inventory shrinkage (Busse et al., 2017; Whetten, 1989).[3]

Managerial Implications

> *"I can walk into a store, talk to some of the employees, and accurately estimate the level of shrink at that store . . ."*
>
> *Quote from a corporate asset protection manager for a US-based retailer*

As the quote reveals, the Fortune 500 US retailer suspects that retail-store employees have an important role to play in reducing inventory shrinkage due to employee thefts and customer shoplifting incidents. Our findings verify this suspicion. The financial loss that is avoidable from improving SENSING is non-trivial. For this US retailer, with average sales per retail store of \$28.8 million and the average store-level inventory shrinkage being 0.35%, and with the coefficient of SENSING being –0.076 (from Model 2 in Table 5), a one-unit improvement in the *capacity of a retail store to sense weak security breach signals* (i.e., SENSING), ceteris paribus, reduces inventory shrinkage per retail store by an average of 7.89% (i.e., $(e^{(-\text{Effect})} - 1)\times 100 = (e^{(0.076)} - 1)\times 100$). In monetary terms, this reduction equates to an annual savings of approximately \$7,953.00 per retail store (0.35% × \$28.8 million × 7.89% = \$7,953.12). With more than 1,000 retail stores, the average annual savings to the Fortune 500 US retailer is at least \$7.95 million.[4]

Table 10 delves further into the practical significance of SENSING, revealing the expected % reduction and annual dollar savings in inventory shrinkage attributed to

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[3] Tangentially, research invoking High Reliability Organization theory as a theoretical lens has focused on establishing how and why raising employee awareness and alertness prevents employee mistakes. Our results suggest that High Reliability Organization theory may be extended to explain how raising employee awareness and alertness can prevent *third parties* from engaging in undesirable behavior that harms an organization.

[4] Note that we do not interpret the percentage reduction or dollar savings in inventory shrinkage attributed to CENTRALIZATION and FORMALIZATION since Model 2 in Table 5 reports their direct effects on SHRINK to be non-significant.

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SENSING under different levels of CENTRALIZATION, FORMALIZATION, and combination levels of CENTRALIZATION and FORMALIZATION. By improving SENSING and adjusting CENTRALIZATION and/or FORMALIZATION, this US retailer can expect to reduce its average store-level inventory shrinkage between 4.5% and 16.58% and to save between $4.53 million and $16.71 million.

To improve the *capacity of a retail store to sense weak security breach signals*, our findings offer several specific pieces of advice. One, besides hiring the right personnel and adopting preventive technologies,[5] retailers should also invest consciously in fostering an elevated alertness and attentiveness to employee thefts and customer shoplifting incidents. The Retail Loss Prevention Training Manual from TRC Solutions (see https://www.trc-solutions.com/wp-content/uploads/2016/09/REI-Guide-to-Loss-Prevention.pdf) highlights the

Table 10. Expected annual percent reduction and savings in inventory shrinkage from a one-unit improvement in SENSING[%, &, #]

CENTRALIZATION	FORMALIZATION	Average Marginal Effect	Average % Reduction in Inventory Shrinkage (Per Store)	Average Inver (Fo
Mean	Mean	–0.076	7.89%	
Low	Mean	–0.130	13.87%	
High	Mean	–0.063	6.50%	
Mean	Low	–0.075	7.79%	
Mean	High	–0.118	12.52%	
Low	Low	–0.111	11.74%	
Low	High	–0.153	16.58%	
High	Low	–0.044	4.50%	
High	High	–0.087	9.06%	

[%] Recall that we analyze weighted average factor scores from CFA for CENTRALIZATION, FORMALIZATION, and SENSING. For CENTRALIZATION, Mean = 0, Low = –0.372, and High = 0.331; for FORMALIZATION, Mean = 0, Low = –0.254, and High = 0.315.
[&] Average % reduction in inventory shrinkage = $(e^{(-\text{Effect})} - 1)\times 100$.
[#] Average Annual Savings = 1000 stores×average *store-level inventory shrinkage* (0.35%)×average

[5] A recent survey by the National Retail Federation found that retailers invest more in technological solutions than in retail store personnel to address security risks. The survey results are available from https://nrf.com/research/national-retail-security-survey-2020.

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sales per store ($28.8 million)×average % reduction. The average *store-level inventory shrinkage* of 0.35% and average sales per store of $28.8 million are reported by the US retailer.

importance of raising awareness regarding employee thefts and customer shoplifting. For example, investments in visual displays of theft incidents and regular reporting of such incidents (e.g., newsletter) raise alertness by flowing information continually to retail store personnel, reinforcing the need to be attentive to these security breaches. Also worthy of consideration are investments in training programs to help retail store personnel identify potential procedural gaps that enable security breaches leading to thefts by employees and/or customers or for them to recognize behavioral cues associated with theft incidents. Such behavior cues include avoidance of eye contact, oversized bags, and meaningless conversations (see Retail Loss Prevention Training Manual from TRC Solutions). Likewise, incentivizing store personnel to be proactively visible to customers or to speak out when an anomaly is suspected are also worthy considerations.

Two, if procedures and protocols to prevent and mitigate security breaches are not yet defined, then retailers should place a high priority on doing so. The 2020 National Retail Federation survey finds that only 40% of retailers have formal in-store loss prevention committees (see https://nrf.com/research/national-retail-security-survey-2020). Formalizing security breach management not only helps with raising alertness about employee thefts and customer shoplifting incidents but also ensures that loss from security breaches is minimized through quick response. To formalize these procedures and protocols, a wise approach, consistent with advice on defect detection from the quality management literature (cf., Bushe, 1988; Rungtusanatham et al., 1997), is to seek input and feedback from "the front-line" – that is, from retail store personnel who have to enforce and follow the established procedures and protocols. Doing so begins the "buy-in" process that facilitates implementation and, importantly, empowers retail store personnel. Formalizing security breach management

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procedures and protocols may lead to creation of a checklist of activities (e.g., ensuring high-value items are in locked cabinets, checking working conditions for security cameras, etc.) to be performed by retail store personnel as part of their hourly or daily routines. Delegating these routines widely, as opposed to just "security guards," elevates alertness to potential and actual security breaches.

Third, retailers should delegate decision-making down to retail store personnel, especially decisions relating to preventing, detecting, and responding to security breaches. Such delegation reinforces attention on security breaches emphasized through employee training or information sharing and supports the roll-out of formalized procedures and protocols to prevent and mitigate security breaches.

In tandem, the advice offered through our findings deters the ignoring of warning signals about security breaches and any pretense that all is well. Ignoring warning signals is not an atypical organizational phenomenon (Watkins and Bazerman, 2003). Retail store personnel, therefore, should no longer fail to notice emerging threats of, or emerging loss from, thefts by employees and/or customers.

Limitations and Future Research

No research is without limitations, and ours is no exception. Foremost, we acknowledge that we only analyzed data about multiple stores of one Fortune 500, US-headquartered retailer that specializes in consumer electronics products. This research design choice controls for unobserved retailer-to-retailer differences but, at the same, may not permit our findings to extend to non-US-headquartered retailers or those retailing other types of products (e.g., grocery; furniture; personal effects like shoes, clothing, and accessories). As such, replicating this research in future endeavors by analyzing other retailers selling other types of products, within the US and/or globally, is worth consideration.

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Additionally, our research does not consider the investment costs to retailers for developing their capacity to sense weak security signals nor does it consider the challenges associated with switching from centralized decision-making to decentralized decision-making. We, therefore, encourage investigation of these issues as additional antecedents and/or moderators of the associations analyzed in this research.

Moreover, many factors, other than organizational structure, potentially influence how able retail stores are to sense weak security signals. Theoretical arguments and, to a lesser extent, the cost of primary data collection, constrained our focus to one factor. Other organizational factors such as communication channels and the vision and strategic focus of top management teams are worthwhile investigating since these also affect distribution of attentional resources within organizations (Koryak et al., 2018). Likewise, factors external to an organization (e.g., environmental uncertainty or competition level) are likely to alter the attentional focus within organizations (Jansen et al. 2006) and are, as such, opportunities for future research.

Also, how effective retail stores are at sensing weak security breach signals requires retail store personnel to be highly attentive to anomalies in their task environments while also fulfilling their responsibilities for day-to-day work activities. Our analyses at the store-level do not take into consideration (and arguably do not need to consider) individual attributes that may hinder or ease attentiveness to security breaches. Pragmatically, this issue is relevant since it has implications for hiring, as risk-averse individuals are likely to have already been more attuned to anomalies such as security breaches. Future research, therefore, may wish to delve into what effects employee attributes, attitudes, and values have on reported findings.

Retail store personnel are required to perform routine work activities. Our findings further encourage them to, at the same time, stay alert and react to security breaches. These activities, however, likely tap the same pool of scarce attentional resources, with this scarcity

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leading to within-person tension (Ocasio and Joseph, 2005). How a retail store is structured in terms of decision-making and formalization of procedures and protocols for managing security breaches, ideally, should help to lessen this tension. Our research, however, does not formally evaluate this implication. As such, to what extent does organizational structure add or reduce this tension is a worthy research focus, as are questions pointing to infrastructural and technological solutions that may improve the capacity to sense weak security breach signals through the overcoming of this tension.

Finally, in developing our hypotheses regarding centralization of decision-making and formalization of security breach management, we focused on their individual roles as antecedents of the *capacity of a retail store to sense weak security breach signals* and as moderators of the negative association between this capability and retail inventory shrinkage. In this paper, we did not delve into the plausibility of a three-way interaction effect, in which CENTRALIZATION (FORMALIZATION) moderates the moderation effect of FORMALIZATION (CENTRALIZATION) on the association between SENSING and SHRINK, in part because of our focus to first establish the theoretical but individual roles of CENTRALIZATION and FORMALIZATION as it pertains to SENSING and the association of SENSING to SHRINK and, in part, because of page limitations. We encourage future research to theorize these moderated moderation effects formally and to provide empirical assessments of these effects in the context of minimizing retail inventory shrinkage.

CONCLUSIONS

For retailers, losses from theft-based inventory shrinkage continue to be an ongoing concern. Research into retail theft has delved into characteristics and behavior of retail store personnel (e.g., Avery et al., 2012), store attributes (e.g., Kajalo and Lindblom, 2011), and monitoring technologies (e.g., Howell and Proudlove, 2007). Adding to this body of work, our paper

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finds theoretical and empirical support for retail stores to develop and/or enhance a new organizational capability (i.e., the *capacity of a retail store to sense weak security breach signals*) to deter and respond to security breaches contributing to theft-based inventory shrinkage and for retailers to formalize procedures and protocols to manage security breaches while decentralizing decision-making to retail store personnel. These findings reinforce the importance of organizational structure in driving desired behavioral and operational performance outcomes.

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