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Supply chain transparency: Consumer reactions to incongruent signals

Diane A. Mollenkopf | Simone T. Peinkofer | Yu (Jade) Chu

Abstract
In response to consumers’ growing interest in how products are sourced, produced, and distributed, organizations are increasingly transparent about their supply chain sustainability practices. Supply chain transparency (SCT) efforts are intended to signal positive information about the company to consumers but the benefits are often unclear, especially when consumers receive multiple, but mixed signals that include negative events. We draw on signaling theory to explore how consumers develop impressions of a company’s products based on different evaluative dimensions: the positive integrity signal of SCT and the negative capability signal of a product recall. The incongruent signal set creates ambiguity for consumers in assessing product quality and subsequent purchase decisions. We develop two scenario-based experiments to test aspects of interdimensional signal incongruence. Experiment 1 investigates the magnitude of signal incongruity by considering combinations of different levels of SCT and product recall severity. Experiment 2 investigates the temporal effect of the incongruent signals, considering the restorative effect of SCT after a product recall signal has been received. While product recall signals are salient for consumers in shaping perceptions of product quality and purchase intentions across both experiments, we demonstrate the strategic value of SCT as a positive integrity signal to consumers.

KEYWORDS
consumer perceptions, product recalls, signaling theory, supply chain transparency, sustainable operations

Highlights
- Disclosing sustainable supply chain initiatives to consumers can have a positive impact on building a relationship with consumers.
- This form of transparency helps at least partially shield firms from negative events such as a product recall.
- Firms should think about developing transparency about their sustainable supply chain practices as a strategic initiative to protect against, and recover from, adverse events (exemplified as a product recall in this research).
INTRODUCTION

Strong consumer pressure, aided by technology and social media, is fostering a transformation of organizational strategies from a sole focus on profit to pursuit of a broader set of sustainability outcomes (Nichols et al., 2019; Tang, 2018). In the food sector, large global companies such as Nestlé and Unilever have been pursuing a plethora of sustainability initiatives for many years that span their supply chains. For example, Nestlé publicizes its aim to “achieve sustainable, resilient food supply chains” (Nestlé 2021), and provides web-site evidence of responsible sourcing initiatives, support for regenerative agriculture, and water management, among other sustainability initiatives. Likewise, Unilever’s sustainable sourcing programs focus on high standards when sourcing from their network of suppliers, driving change through their supply base through continuous improvement policies, leading the transformation toward regenerative agricultural practices, and disclosing information about their sustainable sourcing practices to consumers (Unilever, 2021).

Unilever’s emphasis on disclosing their sustainability practices to consumers demonstrates that consumers are increasingly recognized as important stakeholders and constituents of firms’ supply chains (Kirchoff et al., 2017; Ta et al., 2015). The company explicitly states that communication to consumers is linked clearly to their brands, demonstrating that the company recognizes that consumers “care how the products they buy are sourced, produced, and brought to market” (Nichols et al., 2019, p. 536). Scholars have begun to address this supply chain-consumer relationship (Abbey et al., 2019; Akturk et al., 2018; Simpson et al., 2019; Ta et al., 2018), particularly within the realm of supply chain sustainability, addressing issues such as upstream supplier practices or internal operations, often focusing on the important relationship between sustainability practices and firm performance (Duan, Aloysius, & Mollenkopf, 2022; Duan, Hofer, & Aloysius, 2021; Goebel et al., 2018; Wiengarten et al., 2019; Wilhelm et al., 2016).

Proactively disclosing relevant information and engaging with consumers about upstream operations and the products sold to consumers embodies the practice of supply chain transparency (SCT) (Sodhi & Tang, 2019), which is considered an important facet of sustainable supply chain management (Carter & Easton, 2011; Carter & Rogers, 2008). Not surprisingly, food supply chains are a particularly important arena in which to develop SCT. Consumers’ concerns about ingredients, farming, and processing methods (e.g., organic, genetically modified organisms, pesticide and antibiotic use), and food safety heighten consumers’ interest in knowing more about the quality of the foods they consume. While some authors ascribe transparency as a builder of trust within consumer food chains (Roth et al., 2008), others assert that the benefits of disclosure remain unclear, especially in light of unanticipated or undesirable events which could lead to negative consumer reactions (Sodhi & Tang, 2019).

Firms that disclose information about their environmental and social practices indubitably do so with the intention of building trust with consumers, to further enhance their brand or organizational reputations. Patagonia, for example, exemplifies that disclosure of its sustainability practices leads to more positive consumer perceptions (Caniato et al., 2012) by signaling its commitment to sustainability (Sodhi & Tang, 2019). Yet, in this age of social media and internet-enabled news/information platforms, consumers receive a multitude of signals about firms, not all of which might be positive. Consumers’ perceptions of companies and their products are shaped by the mixed-signal sets they receive (Connelly et al., 2011; Plummer et al., 2016; Stern et al., 2014). Product recall news, for example, represents a negative signal. Such signals may interfere with a firm’s more positive, strategically designed SCT efforts (Connelly et al., 2011). The need for a recall suggests an operational failure on the part of the firm, which we purposefully contrast with the more strategic efforts a firm makes to disclose its sustainability efforts. Hence, in this research, we focus on intentionally disclosed positive information about a firm’s sustainability efforts (SCT), coupled with negative information about product recalls1 to understand how and when consumers respond to information about a firm’s sustainable supply chain processes and operations.

We build on recent work (Duan, Hofer, & Aloysius, 2021; Nichols et al., 2019) by focusing on the mechanism of SCT—that is, a firm’s intentional disclosure of information to its consumers about its sustainable supply chain practices, in the face of other conflicting information that consumers could receive. By using signaling theory as our theoretical foundation (Spence, 1973), we address contemporary thinking on consumers receiving competing, incongruent signals (Connelly et al., 2011; Paruchuri et al., 2021). By examining an incongruent signal set, we tease out the benefits of SCT as a controllable mechanism within the arsenal of strategic tools available to supply chain managers as they engage with external stakeholders such as consumers.

We conduct three pretests and two scenario-based experiments to assess consumer reactions to intentionally disclosed information about a dairy firm’s sustainability practices in light of a product recall. We employ middle-range theorization, using top–down theoretical
contextualization (Craighead et al., 2016; Stank et al., 2017) to explain how the positive signal of SCT and the negative signal of a product recall constitute an interdimensional set of incongruent signals that impacts consumers’ product quality perceptions and repurchase intentions. Signaling theory is well established in management research, and increasingly being employed in supply chain management research to explore sustainability issues (e.g., Duan, Aloysius, & Mollenkopf, 2022; Duan, Hofer, & Aloysius, 2021; Hofer et al., 2012; Jacobs, 2014; Ketchen et al., 2014; Thomas et al., 2021). Therefore, the sustainable supply chain context provides fertile ground for examining SCT as a mechanism for constructive engagement between firms and consumers. The pretests (detailed in the appendices) validate the primary theoretical arguments around consumers’ interpretation of different signals: first, that the intentional disclosure of sustainability-related supply chain information (SCT) acts as a positive product quality signal and second, that when combined with a product recall (a negative signal), the two signals create interdimensional signal incongruence (Paruchuri et al., 2021), in which the negative information of the product recall is weighted more than the positive information contained in the SCT signal.

Our two main experiments build on the theoretical notion of an interdimensional set of incongruent signals, in which we explore magnitude and temporal aspects of SCT and product recall signals. Experiment 1 investigates the impact of various levels of interdimensional signal incongruity by considering combinations of different levels of SCT and product recall severity. Hence, we provide insights into how the positive signal of SCT can shield companies from at least some of the negative effects of a negative product recall signal. Experiment 2 explores the temporal sequence of interdimensional signal incongruity—an important signaling theory extension that remains uninvestigated to date (Plummer et al., 2016; Taj, 2016). Specifically, this experiment sheds light on how the sequence of a negative signal followed by a positive signal leads to changes in consumer sentiments. We show that SCT serves as a strategic tool to regain positive product quality perceptions lost due to an operational capability failure.

2 | BACKGROUND

2.1 | SCT

Scholars are slowly coalescing around a clear and consistent definition of transparency (Bell et al., 2016; Egels-Zandén & Hansson, 2015; Mol, 2015; Pagell & Wu, 2009; Sodhi & Tang, 2019). Schnackenberg and Tomlinson (2016) have argued that the lack of a clear definition limits scholars’ ability to understand the role of transparency, particularly with respect to firm performance and relationships between firms and their stakeholders. They define organizational transparency as “the perceived quality of intentionally shared information from a sender” (p. 1788), suggesting that disclosure must be intentional, timely, and relevant, coherent and understandable to the receiver, and accurate (within the confines of the sender-receiver relationship). While the term is now generally thought of as “disclosure of information” (Mol, 2015, p. 154), concepts such as visibility and traceability also involve information sharing. For example, Pagell and Wu (2009) distinguish between traceability and transparency by emphasizing the nature of information shared internally (traceability) vis-à-vis information shared externally (transparency). More recently, researchers have clarified that visibility refers to information sharing within the firm or supply chain (with traceability being an aspect of visibility that relates to provenance) whereas transparency refers to information disclosure to external stakeholders, such as consumers or investors (Sodhi & Tang, 2019).

Two important themes emerge within the literature regarding SCT. The first theme is that focal attention to stakeholders is paramount. The focus on external stakeholders began with the “right-to-know” movements of the 1960s and 1970s in the United States, which resulted in legislation and changed business practices to reduce information asymmetries between firms and their stakeholders, thus holding organizations more accountable for their actions (Egels-Zandén & Hansson, 2015; Mol, 2015). Recent research demonstrates the growing accountability of firms to their consumers, as firms increasingly recognize consumers as active and strategically important participants in their supply chains (Esper et al., 2003; Esper & Peinkofer, 2017; Mena & Bourlakis, 2016; Peinkofer et al., 2015; Ta et al., 2015), and supply chain scholars address the impact of information disclosure on consumer responses (Allon & Bassamboo, 2011; Peinkofer et al., 2016; Ta et al., 2018).

The second theme relates to sustainability. Supply chain strategy has become highly focused on sustainability, due to recognition of supply chain managers’ key role in impacting a firm’s environmental and social performance, in addition to the more traditional focus on economic performance (Carter & Easton, 2011). As such, transparency has been receiving attention as a key facet of sustainable supply chain management (Carter & Rogers, 2008; Sodhi & Tang, 2019). This is particularly important as firms increasingly address issues of how to become more sustainable (Castillo et al., 2018; Pagell et al., 2013).
Sustainable supply chain management has long employed a stakeholder lens to support the rationale that firms should care about environmental and social outcomes (Carter & Jennings, 2004; Hofer et al., 2012; Sarkis et al., 2010). Such a values-laden approach emphasizes the link between business and ethics (Freeman, 1999), providing the basis for the introduction of supply chain integrity as an enabler of a firm’s ability to meet its sustainable supply chain objectives (Castillo et al., 2018). Fundamentally, supply chain integrity represents a values-culture blend that encompasses both moral and structural dimensions as firms employ sustainable supply chain strategies (Douglas et al., 2021). Importantly, transparency plays a key role in supporting a firm’s ability to communicate to stakeholders the consistency of its supply chain actions with stated sustainability objectives (Castillo et al., 2018).

Within the theoretical domain of signaling theory, the focus on supply chain integrity as an important antecedent to sustainable supply chain management practices (Castillo et al., 2018; Douglas et al., 2021) clearly positions SCT as an integrity signal. Management and social psychology researchers have established that stakeholders develop impressions of organizations along both integrity and capability dimensions (Connelly et al., 2016; Fiske et al., 2007; Paruchuri et al., 2021). The integrity dimension refers to an organization’s “adherence to accepted ethical, regulatory and normative principles” (Paruchuri et al., 2021, p. 563). Thus, communicating SCT to consumers can be considered an act of integrity, in which firms attempt to clearly signal their intent, actions, and consistency of working toward their stated sustainability goals.

### 2.2 Product recalls

Just as SCT can be considered an integrity signal, the issuance of a product recall can be considered within the capability dimension of signal types. Such signals indicate the “ability to perform” (Paruchuri et al., 2021, p. 563), which in the case of a product recall, would indicate a capability failure. A capability failure of this type not only has direct and immediate financial consequences (e.g., Thirumalai & Sinha, 2011; Zhao et al., 2013), but more broadly represents an unplanned supply chain disruption (Craighead et al., 2007) that “presents a serious threat to the normal course of business operations of the focal firm” (Bode & Macdonald, 2017, p. 838). Such events can lead to lost sales or stockouts in the immediate term (Hendricks & Singhal, 2005; Riddalls & Bennett, 2002), but recalls can also lead to lower brand reputation and equity (Dawar & Pillutla, 2000; Germann et al., 2014), lower consumer-perceived product quality, and reduced repeat purchase behaviors (Ahuwalia et al., 2000; Cleeren et al., 2008; Munyon et al., 2019).

In the face of a clear operational capability failure, scholars have identified different strategies to manage and mitigate consumers’ negative reactions. Strategies developed prior to a recall can protect a firm’s performance in the case of a product recall. Such pre-emptive strategies can have a positive spillover effect on consumer reactions in the case of a negative event. For instance, brand equity (Cleeren et al., 2008), commitment (Germann et al., 2014), and reputation (Grunwald & Hempelmann, 2010) have each been shown to mitigate a product recall’s negative impact on consumers. In contrast, strategies employed after an operational failure such as a recall can help a firm recover from negative consequences. Researchers have addressed brand advertising after a recall (Cleeren et al., 2013), as well as increased frequency, timing, and intensity of corporate social responsibility activities after a recall (Noack et al., 2019) as means to mitigate post-recall damages.

When considering the operational capability failure of a product recall, the negative consequences are well known. However, when a negative capability signal is coupled with integrity-based signal effects, the consequences remain unclear. Particularly important to identify is how SCT efforts—which reflect a firm’s intention to convey positive sustainability-related information to consumers—interact with the negative signals consumers receive about a product recall. Research on this topic is particularly timely given the value of consumer insights for deriving supply chain strategy (Esper & Peinkofer, 2017; Ta et al., 2015) around a firm’s sustainability efforts.

### 3 THEORETICAL FOUNDATION

#### 3.1 Overview

Signaling theory provides a framework to explain the behavior of two parties—the signaler and the receiver—under the condition of information asymmetry (Connelly et al., 2011; Spence, 1973, 2002). The signaler is the more informed party, possessing information not fully available to the receiver, who might find the information useful in the decision-making process (Stiglitz, 2002). To mitigate information asymmetry and convey its unobservable quality, the more informed party can send a signal to the receiver (Connelly et al., 2011). However, the signal’s effectiveness depends primarily on (1) observability and (2) credibility (Connelly et al., 2011; Gulati &
Observability refers to the extent to which a receiver can notice the signal (Connelly et al., 2011), and credibility refers to the potential for the sender’s experience of loss of standing (e.g., loss of reputation, monetary loss) should a wrong signal be sent (Boulding & Kirmani, 1993).

Signaling theory has been applied to explain a variety of phenomena in marketing (Moon & Shugan, 2018; Yim et al., 2019) and operations management (Dai et al., 2012; Hofer et al., 2012; Rao et al., 2018). For instance, Yan et al. (2020) used signaling theory to explain the role of supplier ties as signals in buyer-supplier relationships, and Rao et al. (2018) explored a retailer’s return policy leniency as a signal. Signaling theory has also been used to explain how signals can convey unobservable product quality under information asymmetry between a manufacturer and consumers (Kirmani & Rao, 2000), and subsequently affect consumer reactions such as purchase intentions (Wells et al., 2011) or willingness to pay (Rao et al., 2018). While the seller of the product (the brand owner/manufacturer, or the retailer, for example) possesses considerable information about the product, consumers lack that same level of information (Rao et al., 2018). Thus, consumers may have difficulty assessing a product’s quality prior to making a purchase. The seller can reduce information asymmetry by using observable and credible signals to convey the unobservable product quality to consumers (Kirmani & Rao, 2000; Rao et al., 1999). Consequently, consumers rely on such signals to make inferences about a product’s quality and to guide their purchasing decision process.

### 3.2 Signal sets

While signaling theory has traditionally focused on the transmission and reception of one signal (Connelly et al., 2011), in reality a receiver might be exposed to multiple signals simultaneously coming from the same or different senders. These could be signals from different departments within the same firm being directed at consumers, or could be signals from different organizations about a firm-related issue (e.g., a 3rd party organization might be reporting on a company’s sustainability efforts separately from the firm’s own messaging) (Connelly et al., 2011; Paruchuri et al., 2021). Recent research extends signaling theory by exploring how signal receivers process and interpret multiple signals (Plummer et al., 2016). A signal set can consist of signals that are either on the same (intradimensional) or different (interdimensional) evaluative dimensions (Paruchuri et al., 2021).

Considering a B2C context, consumers derive unobserved product quality perceptions based on multiple signals from their environment. Specifically, impression formation research suggests that integrity and capability are two fundamental dimensions which a person uses to formulate an impression (Mishina et al., 2012; Wojciszke et al., 1998). In this research, SCT forms the focal signal, constituting a positive signal along the evaluative dimension of integrity. To reduce the asymmetry between manufacturers and consumers and communicate the unobservable quality of products (Connelly et al., 2011; Kirmani & Rao, 2000; Rao et al., 1999; Spence, 2002), manufacturers can intentionally disclose supply chain sustainability information (e.g., on the firm’s website). Consumers can use this observable information to make inferences about product quality. However, considering that consumers are exposed to a multitude of signals in the marketplace, the effectiveness of the positive SCT signal will depend on additional signals from the environment. One specific concern companies have with providing SCT is the potential responses from consumers if a negative event should occur (Sodhi & Tang, 2019).

A product recall is the negative event of interest in this research and can be construed as a negative quality signal (Ketchen et al., 2014), essentially an operational failure along the capability dimension. Taken together, when a firm provides SCT to its consumers and experiences a capability failure in the form of a product recall, an interdimensional signal set is formed. Consumers receiving both signals will process this incongruent signal set in order to derive unobservable product quality. However, to date only limited research has examined the effect of interdimensional signal sets that include both positive and negative signals (Paruchuri et al., 2021; Plummer et al., 2016; Stern et al., 2014).

The impression formation view supplements our signaling theory lens to guide our theorization of how consumers will interpret this interdimensional set of incongruent signals. While impression formation literature suggests that a negative integrity signal is generally more diagnostic than a positive one and a positive capability signal is more diagnostic than a negative one (Mishina et al., 2012; Wojciszke et al., 1998), the diagnosticity of a signal is context dependent. Specifically, the extremity of a signal as well as the relevancy to one’s self-interest influences how much weight a person would assign to the signal (Fiske, 1980). In exploring the magnitude and temporal aspects of interdimensional signal sets, the experiments described in the following sections enable us to evaluate various conditions of a positive integrity signal coupled with a negative capability signal to better understand the diagnosticity of two
types of signals that consumers might receive regarding a firm's supply chain operations.

4 | THE MAGNITUDE OF INTERDIMENSIONAL SIGNAL INCONGRUITY

In Appendix B (Pretest 2) we establish that SCT as a positive integrity signal alone has a positive effect on consumers' product quality perceptions. However, consumers do not receive signals in isolation and hence, the effect of SCT might depend on additional signals that consumers receive from the environment. Mixed signals can produce various purchase intentions, depending on the magnitude of interdimensional signal incongruity created. Product recalls vary in severity (Craighead et al., 2007), ranging from low severity recalls unlikely to cause adverse health consequences (e.g., mislabeling of weights), to high severity recalls that are very likely to cause adverse health consequences (e.g., food-borne illnesses) (FDA, 2014). In our contextual setting, in which a product recall constitutes a negative event, consumers are expected to more heavily weigh the negative product recall signal over the positive SCT signal. This will be exacerbated for the high-severity recalls due to the direct impact on consumer well-being. Thus, the negative capability signal is likely to have a stronger impact on consumer reactions than the impact of the positive integrity signal (Coombs, 2007). When recall severity is high, interdimensional signal incongruity is elevated since the high expectations set forward by the positive SCT signal are incongruent with the recall severity signal indicating poor product quality. The positive signal of SCT coupled with the negative signal of high recall severity is likely to generate a high level of incongruence, making the interpretation of this interdimensional signal set ambiguous for consumers (Gioia & Chittipeddi, 1991). We expect consumers will pay more attention to the extreme negative capability signal (product recall) because it is highly relevant to the consumer's personal well-being. Essentially, the positive effect of SCT on quality perceptions and repurchase intentions will diminish if the negative signal outweighs the positive signal.

Conversely, a weak negative signal of low recall severity could indicate to consumers that the firm is concerned about the well-being of consumers (Germann et al., 2014; Ketchen et al., 2014) which would conform to the expectations set by the positive SCT signal. Hence, the weak negative signal of low recall severity is likely to generate less interdimensional incongruity with the positive signal of SCT, and the interpretation of this interdimensional signal set is likely to be less ambiguous (Gioia & Chittipeddi, 1991). Therefore, in the SCT/low severity recall set, we expect consumers to weigh the negative information less heavily than in the high severity recall scenario, such that the effect of SCT on quality perceptions and repurchase intentions will be stronger than in the high severity recall scenario.

H1. The positive effect of SCT on purchase intention through product quality is stronger for a low severity recall than for a high severity recall.

4.1 | Overview of research methodology

Following prior work (Abbey et al., 2017; Ball et al., 2018; Li et al., 2013; Peinkofer et al., 2015; Ta et al., 2018), we recruited participants from Amazon Mechanical Turk (MTurk) for our pretests and two main experiments. MTurk participants have been shown to provide reliable results (Goodman et al., 2013) and have also been shown to be more attentive than traditional subject samples (Hauser & Schwarz, 2016).

All participants were randomly assigned to one of the experimental scenarios and compensated with $0.70 for their participation. To ensure high data quality, we eliminated participants who missed the attention check question and, where applicable, we also removed participants who failed the memory recall manipulation check (Abbey & Meloy, 2017). Participants were limited to a single experiment and were excluded from future pools after initial participation. Given the nature of scenario-based experiments, we employed realism checks to ensure reliability of the experimental designs (Thomas et al., 2010). We used a two-item, 7-point Likert scale (1 = strongly disagree/7 = strongly agree) that (1) asked participants to assess whether the described shopping situation was realistic and (2) whether they had any difficulty imagining themselves in the shopping scenario. Table 1 summarizes the experimental procedures as well as the demographic profile of each sample.

Two factors carried through all our experiments: (1) SCT and (2) signal credibility. To develop our baseline experimental scenarios, we followed the guidelines of Runngtusanatham et al. (2011). In the pre-design stage, we conducted research on food supply chains. Because dairy products constitute a significant number of total food recalls (Maberry, 2018), dairy products became our focal product category. We visited multiple firms' websites to understand how they communicate supply chain sustainability information to consumers. As websites can be effective for communicating with consumers (Schlosser et al., 2006), we created a website for a fictional dairy product firm, DairyMade, mimicking websites that present supply chain
sustainability information. We developed common module statements (held constant across all experimental conditions) and developed the experimental module with varying statements, depending on the experimental condition of SCT and signal credibility.

High SCT (low SCT) was represented by abundant (limited) information about sustainable sourcing practices. The design element representing signal credibility was a certificate for the sustainable supply chain practices accompanied by a description of the certification process. High credibility was reflected by including a description of the significant amount of time, money, and resources invested to become certified, whereas low credibility was indicated by describing the certification process as neither time- nor resource-intensive.

We conducted three initial pretests (details of all pretests are provided in the appendices). Pretest 1 (Appendix A) ensured the validity of the experimental manipulations for SCT and signal credibility. High SCT (low SCT) was represented by abundant (limited) information about sustainable sourcing practices. The design element representing signal credibility was a certificate for the sustainable supply chain practices accompanied by a description of the certification process. High credibility was reflected by including a description of the significant amount of time, money, and resources invested to become certified, whereas low credibility was indicated by describing the certification process as neither time- nor resource-intensive.

We conducted three initial pretests (details of all pretests are provided in the appendices). Pretest 1 (Appendix A) ensured the validity of the experimental manipulations for SCT and signal credibility. All subsequent experiments were embedded within the high credibility context, in line with our theoretical lens of signaling theory. Pretest 2 (Appendix B) provided statistical evidence that high SCT leads to higher perceptions of product quality than does low SCT ($\beta_1 = .651$, $p = .001$). Pretest 3 (Appendix C) provided statistical evidence for our theoretical foundation that consumers weigh the negative information of a product recall (capability signal) more heavily than the positive SCT information (integrity signal). The coefficient of a product recall on perceived product quality is significantly larger than the coefficient for SCT with $F(1, 210) = 36.52, p < .001$. After testing and establishing these theoretical foundations, we proceeded with Experiment 1.

### 4.2 | Experiment 1

Experiment 1 constitutes a 2 (SCT: low vs. high) × 2 (recall severity: low vs. high) between-subjects design. In addition to using the manipulations for SCT employed in the pretests, we manipulated the recall severity. Participants in the low recall severity condition were informed that “DairyMade has issued a recall on one of its dairy products due to incorrect weight labeling on the milk bottles. The mislabeling of weight will NOT cause any harmful health consequences.” Participants in the high recall severity condition were informed that “DairyMade has issued a recall on one of its dairy products due to the toxin listeria monocytogenes being found in its dairy product. The contaminated product can cause harmful health consequences or even death for vulnerable consumers. Infected people may experience symptoms such as fever, stiff neck, confusion, weakness, vomiting, sometimes preceded by diarrhea.”

We measured recall severity with two 7-point Likert items asking participants to evaluate two statements: (1) “The recall issued by DairyMade is very severe” and (2) “The recall issued by DairyMade is very impactful.” To assess the validity of our manipulations, we ran a MANOVA using perceived amount of information disclosed and perceived recall severity as dependent variables
and SCT (using the same measures as in the pretests) and severity of recall (1 = high severity/0 = low severity) as independent variables. A significant main effect occurs for SCT with $F (1, 171) = 38.35, p < .001$, indicating that participants in the high SCT condition perceived that DairyMade had disclosed significantly more information ($M_{High\_SCT} = 5.10$) than did those in the low SCT condition ($M_{Low\_SCT} = 3.62$). Participants in the high severity recall condition perceived the recall as being more severe ($M_{High\_Severity} = 5.37$) than participants in the low severity recall condition ($M_{Low\_Severity} = 3.21$) with $F (1, 171) = 80.95, p < .001$. No significant cross effects or interaction effects were observed. Thus, the validity of our experimental manipulations is confirmed.

The variables of interest were perceived product quality and purchase intention. Perceived product quality was measured with a three-item, 7-point Likert scale adapted from Sprott and Shimp (2004) (Cronbach’s $\alpha = .926$). The scale items are provided in Appendix B. Purchase intention was measured with a binary outcome variable that asked participants whether they would purchase a DairyMade product:

$$y = \begin{cases} 
1 & \text{would purchase} \\
0 & \text{would not purchase}
\end{cases}$$

### 4.3 Analysis and results

Per best practices, we extracted the factor scores for quality perception using MPlus’s Bayesian estimator (Calantone et al., 2017). Factor scores are preferable to an average of respective scale items (Aiken et al., 1991) because factor scores allow indicators with larger factor loadings to have a greater impact on a participant’s latent variable scores (Calantone et al., 2017).

Regression results after running PROCESS Model 8 with 20,000 bootstrap samples (Hayes, 2017) are shown in Table 2. The factor score of perceived product quality was used as the mediator and purchase intention (binary) as our dependent variable. SCT (1 = high SCT/0 = low SCT) and recall severity (1 = high severity/0 = low severity) were used as independent variables.

While the conditional indirect effect for low severity is not significant (effect size = 0.351; CI[-0.516; 1.435]) the conditional indirect effect for high severity is significant (effect size = 1.505; CI[0.199; 3.384]). However, the index of moderated mediation is not significant (index = 1.154; CI[-0.452; 3.137], indicating that the respective conditional indirect effect sizes are not significantly different. Thus, $H1$ is not supported.

Contrary to expectations, the effect of SCT on purchase intention through quality perception does not depend on recall severity since adding the interaction between SCT and recall severity did not significantly improve the $R^2$ change ($\Delta = 0.0100, F = 2.05, df = 1, 171; p = .154$). We therefore conducted a post hoc analysis to more fully explore the relationship of the inter-dimensional signal incongruence of SCT and recall severity by estimating a simple mediation model (PROCESS Model 4), as presented in Table 3. The indirect effects suggest that regardless of the recall severity, participants...
in the high SCT condition are 2.55 times more likely to purchase a DairyMade product due to higher product quality perceptions (effect size = 0.936; CI[0.146; 2.076]; odds ratio = 2.55) than participants in the low SCT condition. Regardless of the level of SCT, in the event of a high severity recall participants are less likely to purchase a DairyMade product owing to lower perceived quality than when there is a low severity recall (effect size = −2.49; CI[−3.838; −1.400]; odds ratio = 0.09). In essence, participants are 11.112 times more likely to purchase a DairyMade product when there is a low severity recall than when there is a high severity recall.

We were unable to support our expectations that the positive effect of SCT would be stronger in a low severity recall scenario than in a high severity recall scenario due to the different level of interdimensional signal incongruence. Rather, our results suggest that the effect of SCT is not conditional on the severity of the recall, suggesting the level of interdimensional signal incongruity is perceived by consumers to be similar. In other words, in both the case of the SCT/low recall severity signal set and the SCT/high recall severity signal set, consumers assign more weight to the negative capability signal than to the positive integrity signal. Although the negative capability signal of a product recall can dampen perceptions of product quality and reduce purchase intentions, the positive effect of the positive integrity signal of SCT persists. This finding suggests that disclosing sustainability information to some degree preempt the negative outcomes associated with product recalls since consumers appear to downplay the negative information of the product recall signal, regardless of the level of signal incongruence. Recent work has highlighted that positive perceptions can cushion negative information, such as when stakeholders blame firms less for wrongdoing when they are known to be engaged in corporate social responsibility activities (Bundy & Pfarrer, 2015) or corporate philanthropy (Lungeanu et al., 2018).

5 TEMPORAL EFFECTS OF INTERDIMENSIONAL SIGNAL INCONGRUITY

While Experiment 1 considered the magnitude of interdimensional signal incongruence, Experiment 2 addresses the temporal effects of a negative capability signal (product recall) followed by a positive integrity signal (SCT)—a particularly important issue for companies seeking to mitigate the consequences of negative events such as a product recall. Therefore, Experiment 2 shifts the focus to interdimensional signal incongruity over time by theorizing within-subjects effects and adopting a within-subjects experimental design.

To test the temporal effects of the positive integrity signal (SCT) after a negative capability signal (recall event), we first establish the baseline impact of a recall on the change in consumers’ perceptions prior to SCT exposure. Thus, we theorize the within-subjects effect of the change in consumers’ quality perceptions due to low and high severity recalls. In establishing the baseline impact of both high and low severity recalls on consumer perceptions, we fall back on the logic presented in Experiment 1. A high severity recall situation constitutes a
more extreme negative capability signal than a low severity recall situation. Since more extreme information receives more weight and attention from consumers than less extreme information (Fiske, 1980), the high severity recall will be more diagnostic than the low severity recall. Thus, consumers are expected to have a greater decrease in their product quality perceptions in the case of a high severity than a low severity recall (Germann et al., 2014; Korkofingas & Ang, 2011).

**H2.** Consumers experiencing a high severity recall will have a greater decrease in quality perceptions than consumers experiencing a low severity recall.

We now theorize about the within-subjects effect of a consumer’s change in quality perceptions when the positive integrity signal of SCT is introduced, creating interdimensional signal incongruence. Prior research suggests that more salient signals are easier to recall and thus, will be integrated by consumers in their interpretation of a signal set (Drover et al., 2018). When introduced to a SCT signal after initially receiving a product recall signal, consumers will reevaluate the negative capability signal of a product recall in the context of the positive integrity signal of SCT. At that point in time the positive integrity signal of SCT will be more salient to consumers, having temporally followed the negative capability signal. Hence, in line with impression formation literature, the positive SCT signal should receive more attention from consumers. We therefore expect to see a reversal of the negative trend in quality perceptions (predicted in H2), regardless of recall severity.

**H3.** Regardless of the severity of the recall, SCT will lead to an increase in quality perceptions.

A high severity recall (negative) followed by SCT (positive) constitutes a sequence of interdimensional and incongruent signals in which the information is incompatible (Zhao & Zhou, 2011). Similarly, a low severity recall (weak negative) followed by SCT (positive) also forms a sequence of interdimensional and incongruent signals; however, in the latter scenario, consumers should perceive the information in the two signals as only minimally ambiguous (Gioia & Chittipeddi, 1991). Given the temporal sequence of the two signals, the initial decrease in product quality perceptions predicted in H2 should subsequently be disconfirmed (Oliver, 1981) by the positive signal of SCT, leading to higher product quality perceptions. In both recall severity scenarios, this increase should be larger the more transparent a firm is about its supply chain sustainability practices since the more information a firm discloses, the greater the signal’s observability, thus invoking stronger changes in product quality perceptions.

**H4.** Regardless of the severity of the recall, high SCT leads to greater increases in quality perceptions than does low SCT.

### 5.1 | Experiment 2

Experiment 2 constitutes a 2 (recall severity: low vs. high) x 2 (SCT: low vs. high) mixed factorial design. As in Experiment 1, we manipulated recall severity and SCT. However, the focus of this experiment was to explore the change in consumer perceptions over time with SCT as a positive integrity signal following a recall as a negative capability signal. Hence, all participants were first exposed to some general information about DairyMade and then asked to assess the quality of DairyMade’s products to get some baseline measures (Time 1). Next, participants were exposed to either a low or a high severity recall, after which they again indicated their quality perceptions (Time 2). Finally, DairyMade provided either low or high SCT signals to consumers. After the exposure to SCT, participants once more indicated their quality perceptions (Time 3) as well as their purchase intentions. We used the same manipulation check measures as in Experiment 1 and our manipulations worked as intended, supporting their validity. We adopted the same measures for product quality as in Experiment 1. We extracted the factor scores for product quality for the pooled data using MPlus’s Bayesian estimator (Calantone et al., 2017). This approach is in line with other work extracting factor scores for longitudinal data (Muir et al., 2019).

### 5.2 | Analysis and results

To test H2–H4, which focus on change over time and thus the within-subjects effect of quality perceptions, we ran a mixed effects model using the xtmixed command in STATA. We estimated a linear spline model with one knot at Time 2 and an unstructured covariance matrix. Linear spline models accommodate non-linear trends over time (Fitzmaurice et al., 2012), as we observed in our data. Linear spline models “divide the time axis into a series of segments and consider a model for the trend over time that is composed of piecewise linear trends, having different slopes within each segment but joined or
Overall, our results show that there is a significant decrease in consumer quality perception from Time 1 to Time 2 (timespline 1) \((\beta = -1.245, p < .001)\). As expected, the decrease of quality perceptions is significantly larger for a high severity than a low severity recall (contrast \(= -1.319, p < .001\)), supporting H2. Pairwise comparisons show that consumers experiencing a low severity recall indicate no significant decrease in quality perception from Time 1 to Time 2 (contrast \(= -0.106, p = .221\)). In comparison, consumers experiencing a high severity recall indicate a significant decrease in quality perception from Time 1 to Time 2 (contrast \(= -1.425, p < .001\)). For timespline 2 we observe a significant coefficient \((\beta = 1.178, p < .001)\) indicating a positive change in slope from the first time segment (Time1/Time2) to the second time segment (Time2/Time3) supporting H3. Furthermore, pairwise comparisons show that regardless of the recall severity, when SCT is low a significant change in quality perceptions occurs from Time 2 to Time 3 (contrast \(= 0.632, p < .001\)). Similarly, when SCT is high, a significant change occurs in quality perceptions from Time 2 to Time 3 (contrast \(= 0.755, p < .001\)). Results show that regardless of recall severity, the increase of quality perceptions due to low and high SCT is equal (contrast \(= 0.122, p = .253\)). Thus, H4 is not supported. Figure 1 illustrates the change of quality perception over time.

Our results show that consumers' quality perceptions decrease to a greater extent for a high severity recall than for a low severity recall. In line with our theorizing, this finding provides support for consumers weighting extreme negative capability information (high severity recall) more than less extreme negative capability information (low severity recall). Subsequently, a positive integrity signal (SCT) following a negative capability signal (product recall) serves as a strategic tool to regain positive product quality perceptions. This finding specifically shows that considering the temporal sequence of signals received, consumer will reevaluate the negative capability signal which was received first in the light of the positive integrity signal. Since the positive integrity signal (SCT) followed the negative capability signal (product recall), the former appears to be more salient in consumers’ minds and hence, will be weighted more, leading to a positive change in product quality perceptions. Thus, regardless of recall severity, a firm making an effort to disclose supply chain sustainability information will be positively evaluated by consumers, as demonstrated by the increase in consumer quality perceptions. Lastly, contrary to our predictions, the increase we observed in consumer quality perceptions does not differ

### Table 4 Experiment 2 linear spline model

<table>
<thead>
<tr>
<th>DV: Quality</th>
<th>Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
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<tr>
<td>(0.225)</td>
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<td>Timespline 1</td>
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<tr>
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<td></td>
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<tr>
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<tr>
<td>Low severity Time2</td>
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<td>.000</td>
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<tr>
<td>(0.135)</td>
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<tr>
<td>Timespline 2</td>
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<tr>
<td>(0.212)</td>
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<tr>
<td>Severity*Timespline2</td>
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<td></td>
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<tr>
<td>Low severity Time3</td>
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<tr>
<td>(0.163)</td>
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<td></td>
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<tr>
<td>High SCT Time2</td>
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<td>.062</td>
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<tr>
<td>(0.134)</td>
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<td></td>
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<tr>
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<tr>
<td>Low SCT Time3</td>
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<tr>
<td>SCT<em>Severity</em>Timespline2</td>
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<tr>
<td>High SCT High Severity</td>
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<td>.347</td>
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<tr>
<td>(0.189)</td>
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</tr>
<tr>
<td>Time 2</td>
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<tr>
<td>High SCT High Severity</td>
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<td>.545</td>
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<tr>
<td>(0.251)</td>
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<tr>
<td>Reml = -545.19, ( p = .000 )</td>
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</tr>
<tr>
<td>Wald Chi² (df = 9) = 329.91</td>
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<td></td>
</tr>
<tr>
<td>AIC = 1122.38</td>
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<td></td>
</tr>
</tbody>
</table>

Note: SE are presented in parentheses.
between providing low or high SCT. Therefore, low SCT is equally strong in positively impacting consumer sentiments after a recall occurs. From a theoretical perspective, this finding suggests that in our context consumers experienced similar interdimensional signal incongruity leading to equal increases in perceived quality.

6 | DISCUSSION AND IMPLICATIONS

6.1 | SCT as a strategic tool

Providing SCT to external stakeholders, such as consumers, is a challenging and difficult endeavor (Sodhi & Tang, 2019). Not only does a firm need to have sufficient internal visibility as a prelude to disclosure of any information to external parties, the costs and challenges of providing relevant and accurate information are not insignificant. While gaining consumers’ trust may be the ultimate rationale for providing transparency, the benefits of providing SCT are still not clearly established (Sodhi & Tang, 2019). This research begins to address that knowledge deficit, demonstrating the strategic value of providing sustainable supply chain information to consumers.

As demonstrated by the experimental approach employed in this research, we were able to isolate the causal effect of SCT on product quality perception and consumer purchase intentions. The experimental approach demonstrated the strategic value of SCT as a positive integrity signal to consumers, even when received with an incongruent negative product recall signal. Within the theoretical domain of signaling theory, the contextual specificity of sustainable supply chain practices provided an opportunity to better understand the mechanism by which SCT influences consumers’ perceptions. Thus, our middle range theory approach focusing on outcomes based on mechanisms within a specific context (Pawson & Tilley, 1997; Stank et al., 2017) enabled us to begin to address the knowledge gap identified by Sodhi and Tang (2019) regarding the benefits of SCT.

Growing pressure from consumers wanting to know more about the products they buy (Duan, Hofer, & Aloysius, 2021; Nichols et al., 2019), coupled with recalls demonstrate the need for firms’ disclosures to their consumers, often in complex situations in which incongruent signal sets may be received by consumers. Because transparency is considered an antecedent to organizational trustworthiness (Schnackenberg & Tomlinson, 2016), this research supports the strategic importance of managing disclosure about a firm’s sustainability initiatives. Disclosure to external stakeholders becomes an important aspect of relationship-building with stakeholders (in this case, consumers), and supports the importance of sustainable supply chain management as part of organizational strategy. Even when coupled with the operational failure of a product recall that could impact consumer well-being, the value of transparency was demonstrated as part of the overall relationship firms develop with their consumers. Not only did SCT help shield companies from consumers’ negative quality perceptions following a recall, but even low levels of SCT were found to help recover from negative perceptions when SCT followed a recall event. While these findings are encouraging, they do not suggest that SCT is a panacea for all that could go wrong in the supply chain. SCT, as a positive integrity signal, cannot simply be conjured up on the spot in the face of a crisis (exemplified in this research as a product recall). The ability to be transparent about sustainability efforts takes time and planning (Sodhi & Tang, 2019), suggesting the need to view sustainability efforts and related disclosure capabilities as part of a firm’s overall supply chain strategy. But more research needs to be conducted to understand issues related to how much and when to employ transparency efforts. For example, in Experiment 2, the transparency signal disclosing the firm’s sustainability efforts was effectively received immediately following a participant’s knowledge of the recall. In such an immediate sense, even low levels of SCT helped reverse participants’ product quality perceptions. How much SCT would be needed if the disclosure came sometime later, and at what point would such disclosure have no effect? In the rather simplified format of Experiment 2, these questions cannot be fully answered, but the results point out the need for further research to address more complex situations regarding how much SCT and over what timeframe SCT provides value for firms in product recall contexts.

More generally, the effectiveness of SCT in other contexts needs to be explored to identify the boundaries of the magnitude and timing effects we identified within a mixed signal set. Further research should focus on exploring the robustness and pervasiveness of incongruent signal set effects in different supply chain and operations management contexts to enhance theoretical understanding of the role and impact of signal sets. By recognizing that events that occur within the supply chain serve as signals to consumers who actively interpret those signals in determining how (whether) to interact with a firm, supply chain researchers can further explore a variety of signals that might be relevant to consumers. Importantly, the mix of signals consumers
receive, as well as their representation as integrity and/or capability characteristics, needs further attention by scholars. The complexity of mixed-signal sets, especially when signals are incongruent, provides an opportunity for researchers to further explore the firm-consumer relationship. In particular, future research needs to develop a broader theoretical understanding of the role of SCT as one of many signals consumers receive. Previous operations and supply chain management research has begun to examine the effect of information disclosure on consumer responses (Allon & Bassamboo, 2011; Peinkofer et al., 2016; Ta et al., 2018), and our research continues that trend by casting disclosure to consumers as a strategic sustainability initiative with broad implications for firm performance.

6.2 | Implications for signaling theory

Our research also augments recent advances in signaling theory (Paruchuri et al., 2021; Plummer et al., 2016; Stern et al., 2014) with insights from impression formation literature (Fiske, 1980; Maheswaran & Meyers-Levy, 1990; Skowronski & Carlston, 1989) to theorize how consumers process positive and negative information contained in signal sets. While signaling theory broadly supports the diagnostic superiority of integrity over capability dimensions (Paruchuri et al., 2021), the diagnostic value of SCT and product recall signals has not been explored previously. In our context, both the extremity and the relevancy of the signal to the well-being of the consumer determine the diagnosticy of the signal. Considering that a product recall can directly impact the well-being of a consumer, the negative signal of a capability failure received more weight from consumers than the positive SCT integrity signal. However, we expected differential outcomes based on the magnitude of the interdimensional signal incongruence between the SCT and product recall signals. Yet, in our setting, the positive effect of SCT persisted regardless of the level of recall severity.

In addition, while prior operations and supply chain management researchers have explored the role of one signal (Allon & Bassamboo, 2011; Aydinliyim et al., 2017; Park et al., 2020; Peinkofer et al., 2016), they have yet to develop theory regarding a supply chain management-related signal set. This research provides a timely attempt to address this theoretical knowledge gap. By exploring interdimensional signal incongruence, the relative importance of the integrity dimension (operationalized as supply chain transparency about the firm’s sustainability efforts) was demonstrated vis-à-vis the capability dimension (operationalized as a product recall, an operational failure). Our exploration of interdimensional signaling is an important step for supply chain researchers. We found that even a small integrity signal is sufficient to counteract a negative capability signal; this covers new ground in signaling theory. In contrast to Paruchuri et al. (2021) who considered a negative integrity signal with a positive capability signal, we considered the interdimensional set of a positive integrity signal (SCT) coupled with a negative capability signal (operational failure of a recall). We did this to better understand the diagnostic impact of integrity signals (Stellar & Willer, 2018; Wojciszke et al., 1998), which helps explain the positive change in product quality perceptions with even a low level of SCT. But further research is needed to more fully explore the context and mechanisms of SCT as a positive integrity signal. Magnitude effects as well as the interdimensional signal sets across a variety of supply chain contexts should be explored to further understand the boundary conditions of signaling theory for supply chain researchers.

We further contribute to signaling theory by theorizing about the temporal sequence of incongruent signals to better understand the impact of supply chain signaling on consumers’ perceptions over time. As signals are not necessarily received by consumers at the same time, understanding the impact of signals’ temporal sequence is important. Although the temporal sequence of multiple signals has been highlighted as an important theoretical extension to signaling theory (Plummer et al., 2016; Taj, 2016), the issue has been largely ignored in both the general signaling literature and the operations and supply chain management literature. Our research provides an initial effort to address this theoretical knowledge gap. Future research could explore the underlying nature of the relationship of a signal sequence on specified outcomes, which is especially interesting since our results suggest a nonlinear effect. Additionally, it would be important to explore different signal sequence compositions (such as a congruent vs. an incongruent signal sequence) over time.

6.3 | Managerial implications

Our research shows that how an organization manages its supply chains and communicates its supply chain sustainability practices to consumers can influence the organization’s relationship with its consumers. To enhance organizational trustworthiness, managers should consider SCT as a strategic initiative for fostering and managing customer relationships with the firm. Such efforts can be particularly important in the face of a supply chain failure, such as the need to recall products from the market. Firms that already have sufficient supply chain visibility to enable disclosure of their sustainability...
practices should recognize that their disclosure efforts may at least partially shield their companies from negative consumer reactions. Those firms not yet disclosing sustainability information to consumers may be able to do so as a means to reshape consumer perceptions in times of turbulence brought about by negative events (such as the product recalls in our research). This approach would be similar to the immediate signaling approach employed in our Experiment 2, where we demonstrated that even a little bit of SCT can go a long way in positively impacting consumer sentiments in the event of a product recall. Of course, such an effort requires sufficient supply chain visibility to be able to disclose relevant information in a credible manner. This requires a strategic focus on both sustainability and transparency efforts; our comments here are not intended to imply that SCT is nothing but a “quick public relations stunt” to distract consumers from a negative event.

Of particular importance when considering the value of disclosing sustainability information, is that companies cannot always control when, and which signals a consumer might receive. In the face of the product recall employed in this research, the underlying consistency of the sustainability signal had positive impact on consumers’ perceptions across various scenarios of magnitude and timing for the negative signal. Given the supply chain challenges being faced globally—due to the pandemic, political unrest, as well as the climate crisis—positive integrity signals such as the sustainability disclosure employed in the current research may contribute to a more resilient organization.

7 LIMITATIONS AND FUTURE RESEARCH

While experimental research designs provide strength in detecting causality and testing the underlying theoretical mechanisms, which align with the goals of this research, we traded internal validity for external validity. Thus, this research should only be evaluated within its boundaries. To overcome the limitations of the current research setting and to demonstrate a broader range and scope of the role of SCT across contexts and over time, future research could employ different methodological approaches to provide external validity. In addition, more research is needed to more fully explore signal sets as perceived by consumers. A sustainability signal that gets lost in the cacophony of signal noise would be a waste of effort, time, and money for managers. Hence, future research could integrate additional signals consumers might be exposed to in the signaling environment, such as product attributes, price, brand information, or firm reputation. Such an extension would further contribute to a broader stream of SCT research to complement our initial experimental findings and shed light on the role of SCT in a noisy signaling environment.

From a theoretical perspective, while the premises of signaling theory provided a foundation for our research, our theoretical approach and results suggest that incorporating aspects from impression formation literature (Fiske, 1980; Skowronski & Carlston, 1989) offers a promising avenue to build signaling theory in operations and supply chain management. Future research could integrate an impression formation approach to enhance the theoretical understanding of how and why consumers use operations and supply chain-related signals to develop quality perceptions.

Finally, while we were explicit about SCT being an intentional disclosure by the company, we did not ascribe ownership of the recall signal to the company itself. Future research needs to address situations in which the company explicitly controls the mixed signals to better understand how and when to disclose information to consumers. Duan, Hofer, and Aloysius (2021) acknowledge the important role that supply chain managers play in a firm’s ability to disclose relevant information accurately. But future research also needs to explore the difference in effectiveness of mixed signals when received from the same vs. different senders.

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ENDNOTES

1 Not all recalls are initiated or initially communicated by firms. The US Food & Drug Administration can and does initiate product recalls, forcing companies to comply with their recall mandates (FDA, 2021). Our focus is not on the initiator of the product recall messaging, but consumers’ reactions to mixed messaging.

2 Due to the mathematical characteristic of the invariance of the odds ratio, the reciprocal odds ratio for 0.09 is 11.11 (1/0.09).

3 As indicated in Table 1, we detected two outliers in the sample. These were eliminated for analysis purposes, but we also estimated our models including the two outliers and achieved similar results.

REFERENCES


**APPENDIX A: PRETEST 1**

**Purpose**: Establish validity of experimental manipulations: Supply Chain Transparency (SCT) and signal credibility.

**Design**: 2 (SCT: low vs. high) x 2 (signal credibility: low vs. high) between-subjects design. See Figure A1 for a visualization of the four basic scenarios. See Table A1 for a description of the Pretest 1 sample.

**Manipulation check measures**

SCT: is a one-item 7-point Likert scale (1 = strongly disagree/7 = strongly agree) asking participants to evaluate whether DairyMade provided a lot of information with regard to their supply chain sustainability practices (perceived amount of information disclosed).

Signal credibility: based on Wells et al. (2011), participants were asked to evaluate three statements on a 7-point Likert scale (1 = strongly disagree/7 = strongly agree).

**FIGURE A1** A visualization of the basic scenarios. A full set of all scenarios employed across all pretests and experiments is available from the authors on request
agree) (perception of the resource investment involved with having sustainability practices certified):

- “DairyMade must have invested significant effort to become part of the International Dairy Council Sustainability program.”
- “DairyMade must have invested a lot of time to become part of the International Dairy Council Sustainability program.”
- “DairyMade must have made a significant financial investment to become part of the International Dairy Council Sustainability program.”

**Manipulation check analysis**

MANOVA, using perceived amount of information disclosed and perception of the resource investment involved with having sustainability practices certified as our dependent variables.

ANOVA results:

- Participants in the low SCT condition perceived that DairyMade disclosed significantly less information (M_{Low,SCT} = 3.72) than participants perceived in the high SCT condition (M_{High,SCT} = 5.15) with F(1, 174) = 33.95, p < .001.
- Participants in the low signal credibility condition perceived significantly fewer costs with having sustainability practices certified (M_{Low,credibility} = 3.59) than participants in the high credibility condition (M_{High,credibility} = 5.80) with F(1, 174) = 82.29, p < .001.
- No significant interactions or cross effects were determined, ruling out confounding effects.

**APPENDIX B: PRETEST 2**

**Purpose:** To establish that SCT functions as a positive signal.

Hypotheses:

- H_A: When signal credibility is high, high SCT leads to higher perceived quality perceptions compared with low SCT.
- H_B: Perceived product quality mediates the effect between SCT and purchase intention.

**Design:** a single factor (SCT) with two levels: low versus high between-subjects design. Both experimental conditions are embedded in the high credibility context. See Table B1 for the description of the Pretest 2 sample.

**B.1. Dependent variables**

Perceived product quality was measured with a three-item, 7-point Likert scale adapted from Sprott and Shimp (2004). The scale items are provided in Table B2.

Purchase intention was measured with a binary outcome variable that asked participants whether they would purchase a DairyMade product:
Factor scores: We extracted the factor scores for perceived product quality using MPlus’s Bayesian estimator. Factor scores are preferable to an average of respective scale items (Aiken et al., 1991) because factor scores allow indicators with larger factor loadings to have a greater impact on a participant’s latent variable scores (Calantone et al., 2017).

Hypothesis testing: PROCESS Model 4 with 20,000 bootstrap samples (Hayes, 2017). PROCESS follows the ordinary least square regression path analysis and uses bootstrapping to test for direct and especially indirect effects (Hayes, 2017). The factor score of perceived product quality was used as the mediator and the binary outcome variable for purchase intention as the dependent variable. SCT (1 = high SCT/0 = low SCT) was used as the independent variable. Table B3 summarizes the regression results.

- **H_A**: High SCT leads to higher perceptions of product quality than does low SCT (β₁ = 0.651, p = 0.001). Thus, H_A is supported.
- **H_B**: Indirect effect shows that participants in the high SCT condition are 2.23 times more likely to purchase a DairyMade product owing to higher product quality perceptions than participants in the low SCT condition (effect size = 0.800, CI[0.258; 1.919]; odds ratio = 2.23). Hence, perceived product quality mediates the relationship between SCT and purchase intention. H_B is supported.

Summary: Pretest 2 establishes that consumers perceive higher product quality when a firm discloses higher
levels versus lower levels of credible information related to its supply chain sustainability practices. This finding suggests that high levels of information create an easier “signal” for consumers to observe. Our results also show that if SCT is perceived to be a credible signal, it is effective as an unobservable indicator of product quality. In addition, we show that product quality functions as an important mediator, positively affecting consumer purchase intentions when signal credibility is high.

APPENDIX C: PRETEST 3

Purpose: To establish that the negative capability signal (product recall) is weighted more than the positive capability signal (SCT).

C.1. Hypotheses

Hypothesis (HC): The magnitude of the effect of a product recall is larger than the magnitude of the effect of SCT.

Design: a 2 (SCT: low vs. high) x 2 (recall: present vs. absent) between-subjects design. In addition to the manipulation used in Pretest 2, we also manipulated whether a recall happened. Following Berry et al. (2015), participants in the recall condition were exposed to a newspaper headline stating, “Recall Alert: DairyMade has issued a recall on one of its dairy products.” Participants in the no-recall condition were exposed to the filler headline of “Identity theft laws have flaws” (Table C1).

C.2. Dependent variables

Perceived product quality was measured with a three-item, 7-point Likert scale adapted from Sprott and Shimp (2004). The scale items are provided in Table B2. Purchase intention was measured with a binary outcome variable that asked participants whether they would purchase a DairyMade product:

\[
y = \begin{cases} 
1 & \text{would purchase} \\
0 & \text{would not purchase} 
\end{cases}
\]

C.3. Analysis and results

Factor scores: We extracted the factor scores for perceived product quality using MPlus’s Bayesian estimator.

Hypothesis testing: PROCESS Model 4 with 20,000 bootstrap samples (Hayes, 2017). We used the factor score of perceived product quality as the mediator and purchase intention (binary) as our dependent variable. SCT (1 = high SCT/0 = low SCT) and recall (1 = recall/0 = no recall) were used as the independent variables. Table C2 summarizes the results.

- HC: To test H3, we used the “Test” command in STATA. Results suggest that the coefficient of recall on perceived product quality is significantly larger than the coefficient for SCT with F (1, 210) = 36.52, p < .001. Hence, HC is supported.

Summary: Pretest 3 provide insights into how consumers process a single set including a positive and a negative signal. While consumers ascribe more weight to the negative capability signal of a product recall than to the positive integrity signal of SCT, our results also show that the effect of the positive signal of SCT persists even in light of interdimensional signal incongruity.

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<tr>
<th>Recruits from Mturk</th>
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<tr>
<td>Compensation</td>
<td>$0.70</td>
<td>Average age (range)</td>
<td>35.89 (18–76)</td>
</tr>
<tr>
<td>Eliminations due to:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failed attention check</td>
<td>28</td>
<td>Female/Male/Other</td>
<td>42%/58%</td>
</tr>
<tr>
<td>Failed memory recall manipulation check</td>
<td>10</td>
<td>Median household income</td>
<td>$40–$49 k</td>
</tr>
<tr>
<td>Outliers</td>
<td>0</td>
<td>@ with some college</td>
<td>87.3%</td>
</tr>
<tr>
<td>Final sample size</td>
<td>213</td>
<td>Realism checks: ratings range</td>
<td>5.90–6.20</td>
</tr>
</tbody>
</table>
### TABLE C2  Pretest 3 process Model 4 results

| Predictors | Model 1 | | Model 2 | |  |
|---|---|---|---|---|
| | DV: Perceived quality | p-value | DV: Purchase intention | p-value |  |
| Constant | 0.385 | .003 | 2.658 | .000 |  |
| | (0.130) | (0.580) | (0.497) | .702 |  |
| SCT | 0.284 | .052 | 0.191 | .702 |  |
| | (0.146) | (0.497) | (0.497) | .702 |  |
| Recall | −0.960 | .000 | −0.871 | .111 |  |
| | (0.146) | (0.546) | (0.546) | .111 |  |
| Perceived quality | | | 2.813 | .000 |  |
| | | | (0.464) | .18 |  |
| F-value (df) | 23.54 | < .001 | -2LL = 109.01 | |  |
| | (2, 152) | (df = 3) | (df = 3) | |  |
| | p < .001 | p < .001 | p < .001 | |  |
| R² | .18 | | Pseudo R² = .70 | |  |

*Note: SE are presented in parentheses.*