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Published in:
International Journal of Production Economics

DOI:
[10.1016/j.ijpe.2018.09.027](https://doi.org/10.1016/j.ijpe.2018.09.027)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2018

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Tong, X., Chen, J., Zhu, Q., & Cheng, T. C. E. (2018). Technical assistance, inspection regime, and corporate social responsibility performance: A behavioural perspective. *International Journal of Production Economics*, 206, 59-69. <https://doi.org/10.1016/j.ijpe.2018.09.027>

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Technical assistance, inspection regime, and corporate social responsibility performance: A behavioural perspective

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ARTICLE INFO

Keywords:

Corporate social responsibility
Buyer-supplier relationship
Technical assistance
Inspection
Behavioural
Multi-period

ABSTRACT

Corporate social responsibility (CSR) issues in suppliers can affect the reputation of buyers or even result in supply chain disruption. Thus, buyer and supplier firms are urged to comply with CSR codes in a coordinated manner. In other words, multinational buyers are expected to extend CSR practices to their suppliers in emerging countries. This is particularly crucial when suppliers' CSR performance is screened under a regulatory agency's inspection regime. To this end, this study formulates an analytical model to understand the effects of buying firms' supportive schemes, i.e., technical assistance programmes, on their partner suppliers' CSR performance. Specifically, we develop a multi-period behavioural model to simulate a system consisting of multiple buyers and suppliers where the government regularly conducts inspections on suppliers' CSR performance. The results from the agent-based simulation analysis shed light on (1) how the dyadic risk preferences of suppliers and buyers affect suppliers' CSR performance; (2) how the gap between the perceived and actual CSR levels in a supplier interacts with the regulatory agency's tactics to influence suppliers' CSR performance; (3) the extent to which the overall suppliers' CSR performance improvement is attributable to the buyers' technical assistance programmes under the regulatory agency's inspection regime. This research contributes to the socially responsible supply chain management literature and provides innovative managerial insights for policy makers (e.g., CSR regulators) to promote CSR practices among suppliers.

1. Introduction

Corporate social responsibility (CSR) issues have long been recognized in the supply chain and operations management (SCOM) literature (Babich and Tang, 2012; Chen and Lee, 2016; Dhanorkar et al., 2018; Lampikoski et al., 2014; Porteous et al., 2015; Wilhelm et al., 2016) whereas one stream of research focused on whether and how CSR practice implementation could lead to superior corporate operational performances (Chen et al., 2015; Flammer, 2015; McWilliams and Siegel, 2000; Tang et al., 2012) and identifying critical contingency factors (e.g., corporate characteristics and external pressures) that may influence such linkage (Arora and Dharwadkar, 2011; Saeidi et al., 2015; Torugsa, O'Donohue and Hecker, 2012). Despite the disagreement on the effectiveness of CSR practice implementation on corporate operating performance, in the modern business world, no corporate needs to be convinced that maintaining CSR at an acceptable level is deemed legitimate for trading in domestic and international markets

(Banguera et al., 2018; Tseng et al., 2018; Matten and Moon, 2008). This is because stakeholders such as regulators and customers increasingly require firms to maintain a certain level of CSR within their operations and across their extended supply chains. Otherwise, the publicity of the corporate socially irresponsible accidents (such as harsh employee working conditions and pollution to the environment) may lead to corporate image damage, which can eventually cause a boycott of the brand by customers, reduction in order from downstream partners, server penalties imposed by regulators, and so on. For instance, the disaster of the 2013 garment factory collapse in Bangladesh suggested that the absence of the basic safety and health management for employees in the Rana Plaza led to more than 1000 deaths. The multinationals that outsourced their products in that building were blamed for failing to mandate that suppliers' operations complied with socially responsible codes (Disaster at Rana Plaza, *The Economist*, 2 May 2013).

Despite a large body of research on CSR in SCOM, according to Hull and Rothenberg (2008), some recent studies have begun to investigate

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<https://doi.org/10.1016/j.ijpe.2018.09.027>

Received 5 July 2018; Received in revised form 2 August 2018; Accepted 21 September 2018

Available online 26 September 2018

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how the buyer and its partnered supplier manage CSR in a coordinated fashion (Huq et al., 2016; Plambeck and Taylor, 2015). In practice, many multinational buyer firms concern about supplier firms' possible CSR violations as they may indirectly cause reputation damages to the sourcing firm, i.e., multinational buyers. To mitigate potential CSR violations in suppliers, buyers have begun to adopt the inspection mechanism (e.g. regularly audit supplier facilities) (Babich and Tang, 2012), deferred payment mechanism (e.g., a buyer only pays after no CSR violation occurred during the contracted period) (Babich and Tang, 2012; Chen et al., 2008), technical assistance (TA) programmes (e.g., provide expert recommendations on CSR improvement to suppliers) (Dhanorkar et al., 2018). It has become popular that buyer firms tend to use various tactics in developing capabilities of managing CSR in their extended supply chains, among which TA has been increasingly adopted by buyers as a means to improve suppliers' CSR performance. For instance, *Daikin Industries, Ltd* claimed that it continuously helps their raw material suppliers create and maintain environmental management systems by providing technical assistance (*Helping Suppliers Build Environmental Management Systems*, Daikin, 2018) whereas technical assistance serves as one of the core practices to ensure legal compliance of CSR codes in their extended supply chains.

While TA has become an effective means adopted by the buyer firms in promoting CSR to their suppliers, under varying circumstances, the extent to which buyers would engage in the TA largely remains underexplored. In reality, a buyer firm's engagement in TA may depend on the risk preference upon the supplier's CSR performance. Hence, a model that accounts for the buyer's risk preference, i.e., risk-taking or risk-averse behaviour, can shed light on a behavioural view of buyer firm's responses to the supplier's CSR level. Similarly, upon the receipt of the buyer's TA programme, supplier's dedication to the actual implementation of TA may also be stimulated by its own risk preference towards the benefits and potential losses. Also, *absorptive capabilities* may distinguish the extent to which the supplier is able to implement CSR improvements recommended by the buyer. These behavioural perspectives and supplier learning capability-related variables have been largely neglected in the literature. Consequently, in light of the decision-making process regarding buyer firm's supportive tactic, i.e., TA, on supplier's CSR improvement behaviours, it is critical to developing a framework considering both buyer and supplier's risk preferences and capabilities of implementing CSR improvements.

Uncertainties in the marketplace exist between a buyer and a supplier to affect the implementation of TA programmes whereas numerous studies assert that information asymmetry results in ambiguity for buyer firms to identify the actual level of CSR in their partnered suppliers (Govindan et al., 2016; Ojha et al., 2018; Srinivasan et al., 2011). Accordingly, information asymmetry in regard to the gap between buyer's perceived CSR and supplier's actual CSR performance may affect the extent to which a TA programme will be initiated and implemented in the suppliers. On the other hand, uncertainties resulted from the behavioural adaptations over time among buyers and suppliers in the marketplace may also influence the implementation of a TA programme. Specifically, although the regulatory agency (e.g., the environmental protection agency) conducts inspections regularly, the efforts of maintaining CSR in suppliers may still be subject to opportunistic behaviours. For instance, a supplier is likely to spontaneously decrease the CSR efforts to some extent over time due to cost consideration. Moreover, the deterrence effect (from possible inspection) imposed on a supplier may diminish right after a recent inspection that took place in the corresponding supplier. In other words, the focal supplier may tend to believe that the probability of being spot-checked again shortly tends to be significantly low, triggering an opportunistic behaviour, i.e., to decrease CSR efforts, towards improving or maintaining the current CSR efforts.

Drawing on the CSR literature and a behavioural perspective of buyer and supplier' efforts towards CSR management, this study investigates the following research question:

What is the impact of buyers' supportive scheme, i.e., TA, on suppliers' CSR performance considering both supplier and buyer's adaptive behaviours triggered by various uncertainty factors under the regulatory agency's inspection regime?

This study aims at exploring the impact of buyer firm's TA programme on supplier's CSR performance in a multi-period setting considering the deterrence effect, i.e., possible penalties from the regulatory agencies, and buyer-supplier interactions from an adaptive view.

2. Literature review

2.1. CSR literature in general

Previous studies on CSR have extensively focused on the conceptualizations and applications of CSR in the broad management disciplines including strategic management (Bansal, 2005), organizational behavioural studies (Marquis and Qian, 2013), and international business studies (Husted and Allen, 2006). The conceptualizations of CSR and discussion on the potential applications of CSR practices in these domains have provided insightful theoretical and managerial implications for SCOM researchers. As such, SCOM researchers have benefited from these pioneering research by incorporating critical elements related to CSR concepts and practices into decision models in formulating SCOM problems (Krass et al., 2013; Rezaei et al., 2016; Zhu et al., 2016; Zhu and Zhang, 2015). One major CSR research category in the SCOM domain concerns the relationship between CSR practice adoption and focal firm's operational performance (Arora and Dharwadkar, 2011; Cochran and Wood, 1984; Pava and Krausz, 1996; Saeidi et al., 2015; Torugsa et al., 2012). This line of research provides inconsistent findings regarding whether or not CSR efforts made by companies can lead to positive corporate financial performance, which further introduces ongoing debates on this linkage. However, there is little doubt that CSR implementation has evolved as a liability for firms to fulfill under pressure from various stakeholders. Hence, firms increasingly convey their positive attitudes to CSR engagement to better align with institutional norms (Marano et al., 2017).

2.2. The role of regulators in promoting CSR

While firms have noticed the importance of involving in CSR practices, as CSR improvement often comes at the expense of significant investments, firms can be reluctant to make sufficient efforts in implementation. To this end, a stream of recent research has focused on the regulatory agencies' role in promoting CSR implementation (Arya and Mittendorf, 2015; Buhmann, 2016; Dhanorkar et al., 2018; Wu et al., 2014). Several studies particularly investigated the role of the regulatory agency in mandating CSR practices for various supply chain partners (Dhanorkar et al., 2018; Jamali and Karam, 2018; Jamali and Neville, 2011). Yet promoting CSR improvements in focal firms from the outside (e.g., government agencies) can be difficult (Zolfagharini and Hafezi, 2018). As such, previous research has introduced various mechanisms that a regulatory agency could use to create the right external context that promotes CSR in firms. Specifically, local governments continuously monitor and promote implementation of CSR in firms and administer supportive (e.g., give monetary incentives to the leader firms) and punitive tactics (e.g., impose a penalty on suspected violation of CSR codes), articulating a state (or provincial) or national level vision in accordance with the triple bottom line model (Marquis and Qian, 2013). On the one hand, firms regard governance regimes on CSR as "social license to operate" because violations of CSR codes can result in strict penalties or shut down of business by the regulatory agencies (Buhmann, 2016). On the other hand, supportive schemes can timely provide expert assistance to firms enabling them to make efficient improvements in CSR practices (Aguilera and Jackson, 2003; Dhanorkar et al., 2018).

2.3. Buyer-supplier dyadic relationship in managing CSR

Another branch of the literature has begun to highlight the buyer-supplier dyadic relationship in CSR management. For instance, [Jamali and Karam \(2018\)](#) assert that previous studies tended to treat CSR as a simple phenomenon failing to account for contextual and multimodal variables “in collaboration with other inside and outside the corporation”. Extant research has suggested that specific relationships (e.g., candid relationship with suppliers and ethical perceptions of buyers) facilitate CSR extension from multinational buyers to suppliers ([Bendixen and Abratt, 2007](#)). In particular, some research has provided empirical evidence on the impact of certain facilitating mechanisms (e.g., monitoring or trust) on the diffusion of CSR practices from multinational buyers to their local suppliers ([Boström, 2015](#)). On the other hand, research also quantified the extent to which a buyer may hinder the extension of CSR to suppliers when incentive mechanisms are absent ([Plambeck and Taylor, 2015](#)). Recent works consider tradeoffs between investment costs and risks from a buyer's perspective investigating specific supportive schemes such as certification, technical support, etc. Moreover, risk sharing contracting schemes such as contingency payment are proposed to mitigate suppliers' potential risks caused by socially irresponsible operations and reduce buyers' financial burden ([Babich and Tang, 2012](#); [Hong and Guo, 2018](#); [Letizia and Hendrikse, 2016](#)). [Tong et al. \(2018\)](#) used an agent-based model to exam how costs of CSR implementation and government policies would affect CSR diffusion from multinational buyers to original equipment manufacturer suppliers in emerging countries.

2.4. Behavioural adaptations towards CSR management

Firms face ambiguity triggered by uncertainty factors in supply chain management. It has long been argued that organizations' decision making be bounded rational when encountering various uncertainties embedded in the business environment ([Foss and Weber, 2016](#); [Simon, 1982](#); [D. Y. Wu and Chen, 2014](#)). Numerous experimental research has documented that conventional optimization models could be biased due to bounded rationality in individuals' decision makings ([Bendoly et al., 2006](#); [Croson and Donohue, 2006](#); [Schweitzer and Cachon, 2000](#)). However, the underlying mechanisms and associated consequences regarding buyers to provide CSR supportive schemes under behavioural adaptations are underdeveloped in the literature. In addition, previous studies ([Klassen and McLaughlin, 1996](#); [Rezaei et al., 2016](#); [Yin and Zhang, 2012](#)) examining CSR implementation have adopted a static view, lacking a dynamic view of how decisions evolve in multi-periods.

Several features set our study apart from the extant literature. The contribution of our results is threefold. First, we propose a model that incorporates opportunistic behaviours of both a buyer and a supplier towards CSR practice implementation, which extends existing models only considering investment costs and potential risks associated with market indicators (e.g., market share). Second, we simulate a system consisting of multiple buyers and suppliers so a high level of dynamism and complexity can be taken into consideration. Hence, our research findings can be applied to explain more complex and dynamic systems in SCOM. Third, our multi-period assumption in the model allows us to investigate a system evolving over time, incorporating a longitudinal organizational learning and behavioural perspective.

3. Model description

In this section, we first provide background information for model development with explanation for assumptions and discussion of objectives of the model in Section 3.1. In Section 3.2, we formulate our analytical model to quantify the impact of the buyer's technical support on supplier's CSR performance, aiming to understand how technical support programmes affect supplier's CSR performance incorporating various behavioural variable in a multi-period setting.

3.1. Notations and model assumptions

We consider a system consisting of multiple buyers and suppliers where a buyer firm concerns the CSR performance of its partnered supplier (we assume one buyer is only partnered with a single supplier). In the meanwhile, a regulatory agency, i.e., the government, conducts spot-checks on suppliers' CSR performance, i.e., it selects suppliers for inspection on their CSR performance levels in a predetermined period. The government sets a threshold to split suppliers in the marketplace into *Laggards* and *Do-no-harm firms* ([Cottrill, 1990](#); [Muller and Kolk, 2009](#)). That is, in each period, the threshold is regarded as the “passing criterion” or “reference point” where a below-threshold assessment result leads to penalties imposed on the supplier. By contrast, the supplier passes the inspection with an above-threshold assessment result. This threshold continuously evolves over time as the government adjusts it based on the overall CSR level from time to time.

The decision-making process of the buyer (Buyer j) and the partnered supplier (Supplier i) in Period t is formulated as follows.

1. We denote the actual CSR level in Supplier i and the Buyer j 's perceived CSR level in Supplier i in Period t as CSR_{it} and $\widehat{CSR}_{ijt}$, respectively. We use $(\widehat{CSR}_{ijt} - CSR_{it})$ to measure the gap between Buyer j 's perceived CSR and Supplier i 's actual CSR performance in Period t (abbreviated as BP-SA-CSR-Gap hereafter). The risk preference of Supplier i and Buyer j is denoted as ρ_i and θ_j , both of which range from 0 to 1 (inclusive), indicating the extent to which the firm would take a risk (a larger value suggests a higher preference to take a risk).
2. Similarly, we use ϕ_i ranging from 0 to 1 (inclusive), to represent the *absorptive capability* of Supplier i . We assume that a greater ϕ_i indicates a higher absorptive capability for implementing CSR improvements upon Buyer j 's technical support.
3. We consider a multi-period setting where in Period t , Buyer j compares its perceived CSR performance in Supplier i , i.e., $\widehat{CSR}_{ijt}$, against the threshold in Period $t-1$ (denoted as $CSR_{i,t-1}^*$, which serves as the reference point for decision making in Period t). We use the lagged reference point because in reality, Buyer j appears to rely on the most recent past reference point in the marketplace. Period t is the decision making phase where Buyer j determines whether or not it would provide TA depending on its risk preference. Also, Supplier i makes decisions in Period t regarding to what extent it would implement CSR improvements (based on its own risk preference ρ_i) upon the recipient of the TA provided by Buyer j .
4. We assume that there is a tendency (proportional to ρ_i) that Supplier i opts to decrease its CSR level and oppositely, a probability measured as $(1 - \rho_i)$ that Supplier i decides to increase its CSR level. As such, we use δ_{it} and ε_{it} , both of which lie within the range $[0, 1)$, to denote the proportion of the amount of CSR efforts that Supplier i decides to decrease or increase in Period t .
5. Herein, all the above-mentioned decisions are made in Period t but the consequences manifest in the subsequent period, i.e., Period $t + 1$, meaning that Buyer j and Supplier i estimate the costs and risks associated with CSR improvements in Period $t + 1$. Therefore, we are able to consider the behavioural adaptations of buyers and suppliers in a sequential manner. [Fig. 1](#) depicts the multi-period evolving mechanism in our model. Note that we label periods $t-1$, t , and $t + 1$ as the *reference period*, *decision-making period*, and *performance period*, respectively.

3.2. Model description

This section develops the model and specifies how Buyer j makes a decision in Period t under different scenarios. As discussed previously, whether Buyer j provides TA to Supplier i depends on its risk preference against the gap between the perceived CSR level of Supplier i , i.e.,

Fig. 1. Multi-period decision-making under regulatory agency's inspection regime and buyer-supplier interactions.

$\widetilde{CSR}_{ij}$, and the reference point in Period $t-1$, i.e., CSR_{t-1}^* . Hence, Buyer j 's decision in Period t can be either to *provide* TA (Providing TA) or *not-to-provide* TA (No TA) to Supplier i . The decision is triggered by a tradeoff between investment costs and future potential risks. More importantly, our model incorporates various behavioural variables that were rarely considered in previous studies. Below, we quantify the costs and risks under Scenario I (Providing TA) and Scenario II (No TA), respectively.

3.2.1. Scenario I (providing TA)

Cost consideration: when $\widetilde{CSR}_{ij} < CSR_{t-1}^*$, Buyer j will provide TA to Supplier i , and the associated cost is $\alpha \cdot (1 - \theta_j) \cdot (CSR_{t-1}^* - \widetilde{CSR}_{ij})$, where α is the unit cost per CSR improvement. In this case, Supplier i 's *actual* CSR improvement is $\phi_i \cdot (1 - \theta_j) \cdot (CSR_{t-1}^* - \widetilde{CSR}_{ij})$. Please note that in $\phi_i \cdot (1 - \theta_j) \cdot (CSR_{t-1}^* - \widetilde{CSR}_{ij})$, ϕ_i is the absorptive capacity of Supplier i , which measures its capability of implementing CSR improvements upon receiving Buyer j 's technical support. To summarize, we denote Buyer j 's *perceived* CSR improvement in Supplier i as ΔCSR_{ij} . Thus,

$$\Delta CSR_{ij} = (1 - \theta_j) \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{ij}, 0).$$

On the other hand, the *actual* CSR improvement is $\phi_i \cdot \Delta CSR_{ij}$ and the associated cost is estimated by

$$\alpha \cdot (1 - \theta_j) \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{ij}, 0).$$

Risk consideration: Let $P_i(i)$ denote the probability that Supplier i is spot-checked by the government (selected for inspection on CSR level) in Period t . The risk of Buyer j can be estimated as

$$P_i(i) \cdot \beta \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{ij} - \phi_i \cdot \Delta CSR_{ij}, 0),$$

where β is the unit penalty per CSR deviation from the reference point in Period $t-1$, i.e., CSR_{t-1}^* . In the above, $(\widetilde{CSR}_{ij} + \phi_i \cdot \Delta CSR_{ij})$ is Buyer j 's estimated CSR level of Supplier i after providing TA. Thus, $\max(CSR_{t-1}^* - \widetilde{CSR}_{ij} - \phi_i \cdot \Delta CSR_{ij}, 0)$ measures the CSR insufficiency of Supplier i after receiving TA compared with the reference point CSR_{t-1}^* . $\beta \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{ij} - \phi_i \cdot \Delta CSR_{ij}, 0)$ is the penalty cost after inspection on Supplier i . Finally, $P_i(i) \cdot \beta \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{ij} - \phi_i \cdot \Delta CSR_{ij}, 0)$ is the expected penalty and we treat it as the risk in Scenario I.

3.2.2. Scenario II (No TA)

Cost consideration: When $\widetilde{CSR}_{ij} \geq CSR_{t-1}^*$, Buyer j will not provide TA to Supplier i so the associated cost for Buyer j is 0, and Supplier i 's CSR improvement will be 0 as well.

Risk consideration: The risk in this situation can be estimated as follows:

$$P_i(i) \cdot \beta \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{ij}, 0).$$

Similar to Scenario I, $\max(CSR_{t-1}^* - \widetilde{CSR}_{ij}, 0)$ is Buyer j 's estimated amount of Supplier i 's CSR level below the reference point.

$\beta \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{ij}, 0)$ is the penalty cost after inspection on Supplier i and $P_i(i) \cdot \beta \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{ij}, 0)$ is the expected penalty, i.e., risk, considered for Scenario II.

In addition, we quantify the CSR performance level in Supplier i in the subsequent period, i.e., Period $t+1$, which is a collective result of whether Buyer j has provided TA on Supplier i and whether Supplier i has been spot-checked by the government in the preceding period, i.e., Period t . In other words, we endeavor to quantify the magnitude of change in CSR performance level due to Buyer j and Supplier i 's adaptive behaviours towards costs and risks in managing CSR. We define the *transitional rule* from Period t to Period $t+1$ as follows. There are four cases in total in the transition.

Case 1: No TA and CSR not spot-checked in Period t . We assume that $CSR_{t+1,i} = CSR_{ti} \cdot (1 + \varepsilon_{ii})$ with a probability of $(1 - \rho_i)$ and $CSR_{t+1,i} = CSR_{ti} \cdot (1 - \delta_{ii})$ with a probability of ρ_i . δ_{ii} and ε_{ii} lie within the range $[0, 1)$, representing the proportions of the amount of CSR that Supplier i decides to decrease and increase in Period t , respectively (refer to the assumption aforementioned). Hence, we have

$$CSR_{t+1,i} = \begin{cases} CSR_{ti} \cdot (1 + \varepsilon_{ii}) & \text{with probability } (1 - \rho_i) \\ CSR_{ti} \cdot (1 - \delta_{ii}) & \text{with probability } \rho_i \end{cases}$$

In the meanwhile, we assume that Buyer j 's perception in Period $t+1$ is identical to that in the preceding period as Buyer j did not provide TA and thus it relies on the perception in Period t . That is,

$$\widetilde{CSR}_{t+1,ij} = \widetilde{CSR}_{tij}.$$

Case 2: TA provided and CSR not spot-checked in Period t .

In this case, it is easy to obtain that

$$CSR_{t+1,i} = CSR_{ti} + \phi_i \cdot \Delta CSR_{ij}$$

$$\widetilde{CSR}_{t+1,ij} = \widetilde{CSR}_{tij} + \Delta CSR_{ij}$$

Case 3: No TA and CSR spot-checked in Period t .

In this case, if $CSR_{t-1}^* \geq CSR_{ti}$, then

$$CSR_{t+1,i} = (1 - \rho_i) \cdot (CSR_{t-1}^* - CSR_{ti}) + CSR_{ti}.$$

Otherwise (when $CSR_{t-1}^* < CSR_{ti}$)

$$CSR_{t+1,i} = \begin{cases} CSR_{ti} \cdot (1 + \varepsilon_{ii}) & \text{with probability } (1 - \rho_i) \\ CSR_{ti} \cdot (1 - \delta_{ii}) & \text{with probability } \rho_i \end{cases}$$

In addition,

$$\widetilde{CSR}_{t+1,ij} = CSR_{ti}$$

Case 4: TA provided and CSR spot-checked in Period t . Similar to Case 3, when $CSR_{t-1}^* \geq CSR_{ti} + \phi_i \cdot \Delta CSR_{ij}$, then

$$CSR_{t+1,i} = (1 - \rho_i) \cdot (CSR_{t-1}^* - CSR_{ti} - \phi_i \cdot \Delta CSR_{ij}) + CSR_{ti} + \phi_i \cdot \Delta CSR_{ij}.$$

Otherwise (when $CSR_{t-1}^* < CSR_{ti} + \phi_i \cdot \Delta CSR_{ij}$),

$$CSR_{t+1,i} = \begin{cases} (CSR_{ti} + \phi_i \cdot \Delta CSR_{ij}) \cdot (1 + \varepsilon_{ii}) & \text{with probability } (1 - \rho_i) \\ (CSR_{ti} + \phi_i \cdot \Delta CSR_{ij}) \cdot (1 - \delta_{ii}) & \text{with probability } \rho_i \end{cases}$$

Similarly, $\widetilde{CSR}_{t+1,ij} = CSR_{ti} + \Delta CSR_{ij}$

4. Agent-based simulation study

To capture the multi-period behavioural dynamics of the buyer-supplier system, we used the multi-agent based simulation method. In this simulation, there are two types of agents, i.e., a buyer firm and its partnered supplier. Each supplier has certain attributes such as risk preference, the current CSR level, and absorptive capacity. Similarly, each buyer firm has the attributes such as risk preference and the current perceived CSR level of its partnered supplier. Other than buyer and supplier firm agents, the CSR policies imposed by the regulator are treated as exogenous agent which influences the behavioural adaptations

of buyer and supplier agents. We made the following assumptions for our simulation study.

Assumptions:

Suppliers. To reduce analysis complexity, without loss of generality, each supplier has a risk preference to downgrade its CSR level with a constant decreasing percentage $(1 - \delta)$, i.e., we assume $\delta_{it} = \delta$ for all the suppliers in all periods. On the other hand, if the supplier does not take a risky move in one step in the simulation, it will upgrade its CSR level with a constant increasing percentage $(1 + \varepsilon)$, i.e., we assume $\varepsilon_{it} = \varepsilon$ for all the suppliers in all periods. δ and ε are parameters and they are tunable. Also, each supplier's knowledge absorptive capacity is known by its partnered buyer firm through previous TAs/interactions/communications, etc.

Buyer firms. Each buyer firm only has a single supplier partner in this study and maintains a perceived CSR level of its partnered supplier. The perceived CSR level can only be updated in following two scenarios. First, the partnered supplier has been inspected and its actual CSR level has been publicized by the regulator. Second, the buyer firm decides to provide TA for the partnered supplier and afterwards, the buyer firm would estimate the amount of CSR improvement of the partnered supplier and update the perceived CSR level.

The exogenous agent. The regulator conducts inspections with a fixed inspection rate, (e.g., 20%), i.e., in each step of the simulation, on average, 20% of suppliers would be inspected. As mentioned previously, $P_t(i)$ denotes the probability that Supplier i is spot-checked. We assume that $P_t(i)$ is equivalent to the inspection rate. Further, there is one CSR reference point set by the regulator, which is used as a threshold value to distinguish between Do-no-harm and laggard suppliers in terms of CSR levels. We assume that when a supplier is inspected and its actual CSR level is below the reference point, the supplier will be penalized and its partnered buyer firm would suffer from public reputation damage. Note that we assume that the regulator sticks to a fixed reference point (in percentile of the threshold value: CSR_t^*), which is assumed to be always the fixed percentile of the overall CSR level distribution at time t . Note that even through the percentile is fixed, the CSR threshold value may change from time to time as the estimated overall CSR performance level in the marketplace varies over time. Additionally, the unit cost per CSR improvement, i.e., α , which incurs buyer firm agent when TA is provided, is fixed in the simulation. Similarly, the potential unit loss of buyer firm per its associated supplier's CSR deviation from the threshold value, i.e., β , is fixed as well.

Simulation design:

We developed a multi-agent based simulation model by using Python agent-based simulation library, MESA. After several pilot analyses, we used the following parameter settings for simulation analyses.

- The number of buyer firm agents (supplier agents), N , is 1000;
- α is set to 1.0;
- β is set to 5.0;
- The value of δ ranges from 0.0% to 4.0% with step 1.0%, i.e., δ takes a value in the list [0.0%, 1.0%, 2.0%, 3.0%, 4.0%];
- The value of ε ranges from 0.0% to 4.0% with a step of 1.0%;
- The inspection rate (as well as $P_t(i)$) takes a value in the list [10.0%, 20.0%, 30.0%, 40.0%, 50.0%];
- The risk preference of Supplier i , ρ_i , follows a uniform distribution in the interval [0.0, 1.0], i.e., $U(0.0, 1.0)$. We call a supplier a **risk-averse supplier** if its risk preference falls in the interval [0.0, 0.5]. Oppositely, we call a supplier a **risk-taking supplier** if its risk preference attribute falls in the interval (0.5, 1.0);
- The absorptive capacity of Supplier i , ϕ_i , follows a uniform distribution in the interval [0.0, 1.0];
- The risk preference of Buyer firm j , θ_j , follows a uniform distribution in the interval [0.0, 1.0]. Similarly, we call a buyer a **risk-averse buyer** if its risk preference falls in the interval [0.0, 0.5] and a **risk-taking buyer** if its risk preference falls in the interval (0.5, 1.0);

Fig. 2. Simulation flowchart. Note: shadowed areas indicate a higher CSR performance than unshadowed areas. Fig. 3. (left) fixes suppliers as all risk-taking while Fig. 3 (right) fixes suppliers as all risk-averse.

- The percentile for CSR threshold value CSR_t^* , γ , takes a value ranging from 10.0% to 85.0% with a step of 5.0%.

Note that we call any parameter tuple $(N, \alpha, \beta, \delta, \varepsilon, P_t(i), \rho_i, \phi_i, \theta_j, \gamma)$ a parameter setting, e.g., $N = 1000$, $\alpha = 1.0$, $\beta = 1.0$, $\delta = 1.0\%$, $\varepsilon = 2.0\%$, $P_t(i) = 20.0\%$, $\rho_i \propto U(0.0, 1.0)$, $\phi_i \propto U(0.0, 1.0)$, $\theta_j \propto U(0.0, 1.0)$, $\gamma = 20.0\%$ is a particular parameter setting. In the simulation experiments, we use

one parameter setting for per simulation iteration and the number of steps per simulation iteration is set to 100. Fig. 2 gives the simulation flow chart.

5. Results

In this section, we discuss the following three major findings from simulation analyses related to the following questions: (1) How the dyadic risk preference in buyer-supplier affects suppliers' CSR performance; (2) how the inspection rate is related to the BP-SA-CSR-Gap; (3) to what extent the buyers' TA programme can help suppliers to enhance CSR at a system level. Collectively, the three findings provide insights into under what circumstances, TA programme and regulatory agency's inspection would be effective to promote a socially responsible supply chain. More specifically, how interactions between buyers' and regulatory agency's tactics can enhance the overall CSR performance in the market.

5.1. Dyadic risk preference relationship of supplier-buyer on CSR performance

First, we categorize supplier-buyer dyadic relationship in respect to risk preferences as follows (in the sequence of supplier-buyer): Risky-Averse (RA), Risky-Risky (RR), Averse-Risky (AR), and Averse-Averse (AA). We simulated the four scenarios by considering various values of suppliers' risk preferences, i.e., δ and ε , within a relatively small range (this assumption should be realistic because often, under regulatory agency's inspection regime, suppliers will neither be too risky nor too risk-averse). The performance metric is the suppliers' overall CSR level in the marketplace (which is a collective result of all agents' adaptive behaviours) in relative to the initial status of the simulation. In other words, we used the difference between the *prior*- and *post*- suppliers' average CSR performance in our simulation as the performance metric. We compared the overall CSR levels associated with differing values of δ and ε combinations under the scenarios of RA, RR, AR, and AA.

A negative value in the simulation results means the overall CSR performance has decreased compared with the initial status while a positive number indicates an overall improvement of CSR in suppliers. Intuitively, a dyad of AA (supplier-buyer) would result in better CSR performance than that of a dyad of RR. However, the CSR performance associated with the remaining two dyadic relationships, i.e., RA and AR, is unknown. In order to quantify the magnitudes of the overall CSR improvements under the RA, RR, AR, and AA. We compared the four scenarios in a systematic manner. That is, we compared when suppliers are risky: RA against RR and when suppliers are risk-averse: AR against

AA. The two sets of comparisons allowed us to determine two thresholds splitting the impact of risk preference dyadic relationship on CSR performance into two regions. Fig. 3 depicts how the dyadic risk preference of supplier-buyer relationship influences the CSR improvement in the marketplace. Specifically, Fig. 3 (left) demonstrates that it is generally true (given the portion of the area in the diagram) that when buyers are risk-averse, the CSR performance in suppliers can be improved (as shown in the shadowed area). However, there are certain circumstances that risk-taking buyers can even improve suppliers' CSR performance than that of risk-averse buyers. However, such circumstances require a relatively higher CSR increasing efforts, i.e., ε , and lower decreasing efforts, i.e., δ , by suppliers. Therefore, we provide the following Proposition to summarize the simulation results.

Proposition 1a. *A market consisting of risk-averse dyads of supplier-buyer would lead to significantly higher CSR performance than a market consisting of risk-taking dyads of supplier-buyer. While under certain circumstances, dyads of risk-taking buyer and risk-taking (or averse) supplier could enhance CSR performance, which, however, is subject to only when the suppliers in the dyads are sufficiently less risk-taking.*

Intuitively, risk-averse suppliers are likely to improve CSR performance to a greater extent than that of risk-taking suppliers. However, there remains one question regarding to what extent the overall CSR performance in the marketplace would differ between risk-averse and risk-taking suppliers. To this end, we compare and contrast the grand average of CSR performance among cases of RA, RR, AR, and AA to estimate the magnitudes of CSR improvement or decrease in suppliers. Interestingly, we found that when suppliers are risky (RA and RR), the decrease of the overall CSR performance in the market tends to be not symmetric to the amount of increase in the CSR performance in the opposing case (when suppliers are risk-averse: AR and AA). For example, in Fig. 4, RA is not worse off to the extent to which the magnitude of its counterpart case, i.e., AA. Accordingly, the asymmetric CSR performances between different scenarios, i.e., AA vs. RA and AR vs. RR, may indicate that at the system level, the deterrence effects imposed by the regulatory agency's inspection regime can enforce RA and RR dyads of buyer-supplier to be less opportunistic. For instance, even when the market is dominated by the RR dyads of supplier-buyer, the CSR performance would not become worse off to the extent to which the CSR increase from AA dyads of supplier-buyer.

Proposition 1b. *Regulatory agency's inspection regime is effective in promoting suppliers' CSR improvement when buyers have the option to provide TA to suppliers. Specifically, the inspection regime creates a deterrent environment to prevent the CSR performance from being too worse off in a market consisting of risk-taking suppliers and to trigger*

Fig. 3. Risk preference dyadic relationship of supplier-buyer on CSR performance. Note: Dyad in the sequence of supplier-buyer (e.g., Averse-Risky or AR means supplier is averse and buyer is risky).

Fig. 4. Comparison of CSR performance ($\underline{AA}$ vs. $\underline{RA}$ and $\underline{AR}$ vs. $\underline{RR}$). Note: A negative number of the “BP-SA-CSR-Gap” indicates a reduction of the gap (the difference between actual and perceived CSR level in a supplier).

superior CSR performance in a market consisting of dyads of risk-averse supplier-buyer.

5.2. The impact of inspection rate on BP-SA-CSR-Gap

The simulation results show that an increase in the inspection rate (from 10% to 50%) reduces the gap between the actual and perceived CSR in suppliers (see Table 1). Note that negative numbers in the table mean the gap (= perceived CSR level - actual CSR level in suppliers) is lessened. The reduced gap can be attributable to more exposure of actual CSR in suppliers due to the higher rate of CSR inspection on suppliers. In other words, a higher inspection rate set by the regulatory agency is likely to facilitate buyers to ascertain their partnered suppliers' actual CSR level, thus reducing the BP-SA-CSR-Gap. As such, a

reduced BP-SA-CSR-Gap can possibly enable buyers to be more efficient in determining whether or not they should provide TA to suppliers considering costs and the inspection rate. Table 1 also illustrates how a series of CSR inspection thresholds (see the columns) influence the buyer-supplier CSR gap. Surprisingly, we find that under each fixed inspection rate, an increase in the threshold will lead to an increase in the BP-SA-CSR-Gap. We provide brief discussion regarding this finding in Section 6.2. Fig. 5 depicts various scenarios of the impact of the inspection rate on the BP-SA-CSR-Gap. It can be seen that an increase in the inspection rate is associated with a decrease in the BP-SA-CSR-Gap, suggesting that regulatory agency could adjust the inspection rate to promote a more socially responsible supply chain. Hence, we provide the following Proposition.

Proposition 2. All others being equal, increasing the inspection rate can be used as an instrument by the regulatory agency to reduce the BP-SA-CSR-Gap, i.e., the gap between the buyer's perceived CSR level and its corresponding supplier's actual CSR level.

5.3. The impact of inspection threshold on CSR performance

Fig. 6 summarizes the trend of CSR improvement given differing CSR thresholds, i.e., CSR_{t-1}^* , set by the regulatory agency. We simulated a highly dynamic environment in which various dyadic supplier-buyer relationships were taken into consideration. Similar to the above simulation analyses in Section 5.2, we ran simulation in batches (e.g., set the range of $\delta = 0.00, 0.01, 0.02, 0.03$, and 0.04 , within each of these experiments, ε varies within the range of $(0.00, 0.01, 0.02, 0.03, 0.04)$). Consequently, we obtained results of CSR improvement at a system level. As can be seen, the level of the inspection threshold is positively associated with CSR performance. Notably, the CSR performance seems to follow an exponential function in respect of the CSR threshold, suggesting that a unit increase in CSR threshold could possibly

Table 1
The impact of the inspection rate and CSR threshold on the BP-SA-CSR-Gap.

Threshold (Col)/ Inspection rate (Row)	0.1	0.2	0.3	0.4	0.5	Grand average
0.1000	-0.0059	-0.0106	-0.0123	-0.0134	-0.0138	-0.0112
0.1500	-0.0056	-0.0103	-0.0124	-0.0132	-0.0135	-0.0110
0.2000	-0.0047	-0.0098	-0.0121	-0.0129	-0.0135	-0.0106
0.2500	-0.0041	-0.0094	-0.0120	-0.0126	-0.0136	-0.0103
0.3000	-0.0030	-0.0093	-0.0117	-0.0126	-0.0132	-0.0100
0.3500	-0.0020	-0.0086	-0.0112	-0.0126	-0.0130	-0.0095
0.4000	-0.0009	-0.0075	-0.0109	-0.0122	-0.0126	-0.0088
0.4500	0.0010	-0.0064	-0.0102	-0.0115	-0.0126	-0.0079
0.5000	0.0026	-0.0043	-0.0094	-0.0113	-0.0120	-0.0069
0.5500	0.0065	-0.0022	-0.0085	-0.0106	-0.0116	-0.0053
0.6000	0.0107	0.0003	-0.0073	-0.0099	-0.0116	-0.0036
0.6500	0.0161	0.0037	-0.0064	-0.0091	-0.0115	-0.0014
0.7000	0.0224	0.0082	-0.0040	-0.0077	-0.0108	0.0016
0.7500	0.0316	0.0142	-0.0017	-0.0062	-0.0093	0.0057
0.8000	0.0412	0.0208	0.0013	-0.0042	-0.0078	0.0103
0.8500	0.0563	0.0298	0.0050	-0.0017	-0.0062	0.0167
Grand average	0.0101	-0.0001	-0.0077	-0.0101	-0.0117	-0.0039

Note: A negative number means the BP-SA-CSR-Gap has been reduced. Shadowed cells indicate reduction of the BP-SA-CSR-Gap.

Fig. 5. The impact of CSR inspection rate on the BP-SA-CSR-Gap (gap between perceived CSR and actual CSR levels in suppliers).

Fig. 6. The impact of CSR threshold set by the regulatory agency on suppliers' CSR performance.

exponentially increase suppliers' CSR performance in the market.

To statistically validate the observed trend of exponential distribution of CSR performance based on differing inspection threshold levels, we log-transformed the CSR performance levels obtained from the simulation analysis to run a linear regression. The *goodness-of-fit* and beta statistics ($F(1, 14) = 298.25$, significant at $p = 0.000$, $\beta = 4.44$, significant at $p = 0.000$) show that the inspection threshold significantly predicts CSR performance in an exponential manner.

Proposition 3. *All others being equal, increasing the inspection threshold can be used as an instrument by the regulatory agency to enhance suppliers' CSR performance. Specifically, a unit increase in the inspection threshold may exponentially enhance suppliers' CSR performance.*

6. Concluding remarks

6.1. Contributions

Managing suppliers' CSR performance is critical to both buying firms and regulatory agencies. This study examines a specific supportive scheme, namely, *technical assistance* provided by the buyer firms aiming at improving their corresponding suppliers' CSR performance. Our results suggest that buyer-supplier dyadic risk preference towards managing CSR influences overall suppliers' CSR performance in the market. In particular, we take into account both buyer and supplier's behavioural adaptations (not necessarily in a completely mutual agreed manner on CSR management, see Tong et al., 2018) towards risks and costs in managing CSR. The analysis demonstrates that, regardless of

the level of buyer and supplier's risk preference, the inspection regime could effectively prevent the market from being too worse off (Proposition 1b). Furthermore, we show that the inspection rate and threshold could be leveraged by the regulatory agency to improve CSR performance in a complex system consisting of various differing dyadic risk preference between buyers and suppliers.

This research contributes to the existing literature on CSR/sustainability and behavioural supply chain management in several aspects. To begin with, to the best of our knowledge, our analytical model is the first one to adopt a systematic view incorporating regulatory agency and buyer-supplier dyadic risk preferences to understand how a specific supportive tactic, i.e., TA, could improve CSR performance. Increasingly, buyer firms concern suppliers' CSR performance, so they adopt various tactics to regulate or help improve suppliers' CSR performance. Our model quantifies the impact of a specific supportive scheme (see, e.g., Dhanorkar et al. (2018)) provided by buying firms on suppliers' CSR performance. More importantly, previous research largely ignores an interactive behavioural perspective that may exist in a buyer-supplier dyadic relationship in managing CSR. As such, this study not only accounts for risk preferences and the BP-SA-CSR-Gap (the gap between perceived and actual CSR performance) in a dyadic relationship, but also incorporates the absorptive capabilities of suppliers in dealing with the implementation of TA provided by the buyers. Thus, our model helps to understand how these behavioural variables collectively affect CSR performance in a systematic manner.

Second, while there are studies of buyers' role in suppliers' CSR/sustainability performance (Babich and Tang, 2012), most of them only considered a single phase context or a single buyer-supplier dyadic relationship, failing to account for system dynamics resulting from interactions among multi-agent and multi-phase in a sequential manner. To this end, our model provides a more comprehensive view on how agents evolve through learning by doing over time and the extent to which regulatory agency's policy, i.e., the inspection rate and threshold, affects CSR performance in the market. Due to the high complexity (e.g., multi-agent and multi-period) of the system simulated in this study, an optimal solution regarding the inspection rate and threshold may not be available. Nevertheless, we provide a holistic view on how dyadic buyer-supplier risk preferences influence CSR performance under the regulatory agency's inspection regime. The heuristic rules regarding how and under what circumstances CSR performance could be improved insights into the CSR and behavioural supply chain literature.

Last but not least, this study simultaneously investigates the

effectiveness of the regulatory agency's tactic and buyer's effort on suppliers' CSR performance. The dual tactics imposed on suppliers may create a synthesized regime in promoting a more socially responsible supply chain. As the simulation results suggest, the inspection regime turns out to be effective in various situations (e.g., differing dyadic buyer-supplier risk preference) when buyers have the option to provide TA to suppliers (e.g., Proposition 1b).

6.2. Limitations and future research directions

This study is subject to several limitations that offer future research opportunities. We only considered a punitive tactic adopted by the regulatory agency, i.e., inspection with possible penalties, it would be worthwhile to develop a framework in which punitive and supportive (e.g., a subsidy to do-no-harm firms) tactics adopted by regulatory agency interactively influence buyer's behaviour towards supplier's CSR performance. However, such framework would introduce a higher degree of system dynamics making it challenging to find patterns in simulations. Meanwhile, we could not provide a satisfactory explanation for why the BP-SA-CSR-Gap would increase as a result of an increase in the inspection threshold (see Section 5.2). We provide a partial mathematical proof of such a causal relationship (for Case 2 in the transitional rule) in the Appendix. However, the underlying mechanism is yet to be discovered either by extending the current model or conducting more simulation analyses. Hence, we believe that future research can extend our model to analyze the ways in which the regulatory agency can leverage various tactics for promoting CSR.

Acknowledgments

We appreciate many practical insights obtained from discussion with several senior managers in a world-leading automobile manufacturer and its suppliers, which we believe have substantially improved the practical relevance of the models in this paper. Chen was supported by the National Natural Science Foundation of China (71501126) and Programme of Shanghai Academic/Technology Research Leader (18XD1402100). Zhu was supported by the National Natural Science Foundation of China (71632007, 71690241, and 71472021). Tong was supported by a Tenure-track Assistant Professor fund (147120310) from SOM Research Institute, Faculty of Economics and Business, University of Groningen, Netherlands. Responsibility for any errors in this work remains at the authors' own.

Appendix 1. Partial proof on why CSR threshold increases “BP-SA-CSR-Gap”

Currently, it is difficult to explain why the “BP-SA-CSR-Gap” increases as the CSR threshold increases in a systematic way. However, we may show why it happens based on *Transition Rule* in Case 2.

$$CSR_{t+1,i} = CSR_{ti} + \phi_i \cdot \Delta CSR_{tij} \quad (1)$$

$$\widetilde{CSR}_{t+1,ij} = \widetilde{CSR}_{tij} + \Delta CSR_{tij} \quad (2)$$

Subtracts (2) by (1), we can get

$$\widetilde{CSR}_{t+1,ij} - CSR_{t+1,i} = \widetilde{CSR}_{tij} - CSR_{ti} + (1 - \phi_i) \Delta CSR_{tij}$$

$\widetilde{CSR}_{t+1,ij} - CSR_{t+1,i}$ is the “BP-SA-CSR-Gap” at time $t+1$ and $\widetilde{CSR}_{tij} - CSR_{ti}$ is the “BP-SA-CSR-Gap” at time t . $(1 - \phi_i) \Delta CSR_{tij} = (1 - \phi_i)(1 - \theta_j) \cdot \max(CSR_{t-1}^* - \widetilde{CSR}_{tij}, 0)$, it shows that as CSR_{t-1}^* increases $(1 - \phi_i) \Delta CSR_{tij}$ tends to increase, thus “BP-SA-CSR-Gap” tends to increase as well.

Appendix 2. Pseudo-code for the simulation

Require a parameter setting $(N, \alpha, \beta, \delta, \varepsilon, P(i), \rho_i, \phi_i, \theta_j, \gamma)$, the maximal step per simulation iteration, S .

Create Θ_b , the set of buyer firms and Θ_s , the set of suppliers. Create a list Γ to store the publicized CSR level for all suppliers.

```

for  $i = 1$  to  $N$  do
    Create a buyer firm with risk preference attribute sampling from  $U(0.0, 1.0)$ ;
    Create a supplier with risk preference attribute sampling from  $U(0.0, 1.0)$  and absorptive
    capacity sampling from  $U(0.0, 1.0)$ ;
    Couple the buyer and the supplier;
    Randomly generate a CSR level for the supplier and generate a perceived CSR level for the
    buyer based on its associated supplier's CSR level;
    Add the buyer to set  $\Theta_b$ , add the supplier to set  $\Theta_s$ ;
end for
for each supplier  $i$  in  $\Theta_s$  do
    Add Supplier  $i$ 's CSR level to the list  $\Gamma$ ;
end for
Calculate  $CSR_0^*$  based on the list  $\Gamma$  and the percentile  $\gamma$ .
for  $t = 1$  to  $S$  do
    for each buyer  $j$  in  $\Theta_b$  do
        Get buyer  $j$ 's associated supplier  $i$  from  $\Theta_s$ ;
        Buyer  $j$  makes the decision to provide TA or not for supplier  $i$ ;
        Randomly generate a value from  $U(0.0, 1.0)$  and if the value is small than  $P_t(i)$ , mark
        the supplier as inspected and update list  $\Gamma$  accordingly;
        if supplier  $i$  does not receive TA and is not spot-checked then
            Apply supplier's transition rule in case 1;
        end if
        if supplier  $i$  receives TA and is not spot-checked then
            Apply supplier's transition rule in case 2;
        end if
        if supplier  $i$  does not receive TA and is spot-checked then
            Apply supplier's transition rule in case 3;
        end if
        if supplier  $i$  receives TA and is spot-checked then
            Apply supplier's transition rule in case 4;
        end if
        Update buyer  $j$ 's perceived CSR level for supplier  $i$ ;
    end for
    Update the regulator's CSR threshold value  $CSR_t^*$ ;
end for

```

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