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Multinational enterprise buyers' choices for extending corporate social responsibility practices to suppliers in emerging countries

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Multinational Enterprise Buyers' Choices of Extending Corporate Social Responsibility Practices to Suppliers in Emerging Countries: A Multi-Method Study

Abstract

When managing a global supply chain, one critical challenge encountered by multinational enterprises (MNEs) is the extension of corporate social responsibility (CSR) practices to suppliers in emerging countries. In this study, we use a multi-method approach to explore 1) the nature of suppliers' CSR heterogeneity based on the various components of CSR in emerging countries, and 2) the choices of MNEs for extending CSR to different types of suppliers in dynamic environments. We begin with a survey of Chinese original equipment manufacturers (OEMs) servicing MNEs to examine how these suppliers vary in CSR implementation based on cluster analysis results. To understand the choices made by MNE buyers for extending CSR to their OEM suppliers, we conduct an agent-based simulation study considering the dynamics of a system with multiple agents (i.e., MNE buyers, OEM suppliers, and the government). The cluster analysis results show that CSR practices implemented by Chinese OEMs differ significantly from one another and can be classified into three clusters (i.e., *Leader*, *Follower*, and *Laggard*). The simulation results provide insights into how the adaption costs (e.g., upgrade cost and cost saved by downgrading) and punitive (inspection with possible penalties) and supportive (subsidies) tactics adopted by the government affect the choices made by MNE buyers for extending CSR practices to suppliers in emerging countries. Moreover, we demonstrate when supportive tactics are more effective than punitive tactics under varying conditions and extend the model to investigate the consequences of switching between these two types of tactics in a sequential simulation.

Keywords: multinational enterprise buyer; original equipment manufacturer supplier; emerging country; extending corporate social responsibility; empirical analysis; multi-agent simulation

1. Introduction

With the globalization of production and market activities, multinational enterprises (MNEs) frequently source products and services from suppliers in emerging countries, thereby taking advantage of low costs of labor, production, and services (Aulakh et al. 2000, Asgary and Li 2016, Ruamsook et al. 2007). However, MNEs increasingly encounter difficulties in managing corporate social responsibility (CSR) in their global supply chains. They must extend CSR to their supplier partners in emerging countries, where the implementation levels and awareness of CSR are in their initial stages (Jamali and Karam 2016, Jamali and Neville 2011). Extending CSR to suppliers involves selecting suppliers with high levels of CSR implementation or assisting supplier partners in implementing CSR practices to avoid misconduct (particularly the violation of CSR codes) and enhancing the overall CSR performance with the supplier's involvement. CSR practices are adopted by enterprises that hope to reduce the external damages caused by their operations and create benefits valued by their stakeholders (Aguinis and

Glavas 2012). However, supplier deficiency in CSR practices can seriously damage an MNE's corporate reputation; for example, disclosure of worker suicide scandals, harsh working conditions, and low wages for workers in Foxconn factories, have led to the boycott of Apple products by media and customers (*Forbes*, August 22, 2016). Suppliers in emerging countries are liable to overlook CSR, which can result in socially irresponsible practices; publicity surrounding such adverse events can cause significant reputational and financial damages to MNEs that partner with suppliers in emerging countries.

While the value of CSR for overseas expansion is no longer in question for MNEs given the increasing frequency of outsourcing and offshoring operations in emerging countries, MNEs must understand the status of CSR implementation among suppliers in emerging countries and consider how and to what extent CSR should be extended to their global supply chain partners. In particular, MNE buyer firms must understand the various components (e.g., labor and environment) of CSR practices required for successful extension to upstream suppliers. If CSR is diffused to supply chains in emerging countries, the institutional environment concerning the disclosure and adoption of CSR could be ambiguous for MNEs compared with practices in their host countries. Furthermore, the administrative, geographical, and cultural differences, subsidiary sizes, and experiences of MNEs in their host countries can influence the process of CSR diffusion (Reimann et al. 2015). Previous studies have suggested a polarization of “*Do-Good*” or “*Do-Harm*” among firms in terms of their CSR implementation levels (Cottrill 1990, Muller and Kolk 2009). However, Jamali and Karam (2016, p.1) noted that “distinctive elements of CSR in developing countries” are “less formalized” and “more sunken.” Given that CSR implementation levels in emerging countries may differ from those of developed countries and that the different components and implementation levels of suppliers in emerging countries can affect MNEs' decisions regarding CSR extension, the first research question guiding this study is as follows:

RQ1: *What is the nature of CSR heterogeneity based on the different components of CSR in emerging countries?*

To increase market acceptance and secure business legitimacy, MNEs tend to extend CSR to suppliers in emerging countries to better monitor and control suppliers' CSR levels. A stream of

research has been conducted on how buyer and supplier firms manage CSR in a coordinated fashion, showing that buyers can use different strategies to extend CSR to supplier partners, including increasing buyer-initiated auditing, providing loans to suppliers, and establishing a buyer–consortium audit with other stakeholders (Rezaei et al. 2016, Letizia and Hendrikse 2016, Plambeck and Taylor 2015). More recently, Huq et al. (2016) argued that “collaboration capabilities” between MNE buyer firms and their suppliers are helpful for more effectively extending CSR to suppliers in emerging countries. Moreover, regulators (e.g., the government) in emerging countries are increasingly proactive in promoting and monitoring CSR practices (Jamali and Karam 2016) by penalizing *Laggard* firms and offering subsidies to leading firms¹ (Arya and Mittendorf 2015). Nevertheless, managing CSR can be costly for MNEs and suppliers in emerging countries, particularly when suppliers are located in distant emerging countries and information asymmetry (e.g., an MNE buyer’s knowledge of CSR implementation levels adopted by potential suppliers is limited) between buyers and suppliers is high, meaning that extraordinary effort is required for MNE buyers to extend CSR to suppliers.

From an adaptation view of firms, a fit between strategic choices (e.g., adaptive behavior toward extending CSR to suppliers with varying levels of CSR implementation) and environmental change (e.g., government policies and adaption costs) would increase the likelihood of an organization surviving (Barr 1998, Haveman 1992). Khanna and Palepu (1997) argued that “companies must adapt their strategies to fit their institutional context.” MNE buyers would likely make appropriate choices for CSR extension to suppliers by updating (upgrading, maintaining, or downgrading) their CSR implementation levels in accordance with the fast-evolving business environment. Consequently, stimulated by government policies and the costs of updating CSR implementation levels in suppliers, an MNE buyer can assess the conditions under which extending CSR to a supplier at a certain level is most suitable for enhancing performance. For example, an MNE may estimate the benefits of *Do-Good* (upgrading or maintaining the CSR level of a supplier to or at the *Leader* standard of CSR) and the risks

¹ The reason that emerging country government imposes punitive / supportive tactics can be found in Porteous et al. (2015)’s study which suggests that “an air and water pollution database of factory environmental violations in China reordered over 100,000 violations between 2006 and 2012. Notably, it has made public evidence that suppliers of world-renowned brands, including Apple and Marks & Spencer, are polluting rivers and the air in China”. Consequently, government adopts carrots and sticks (i.e., supportive and punitive schemes) in improving suppliers’ social and environmental performance.

of *Do-Harm* (downgrading or maintaining the CSR level of a supplier to or at the *Laggard* standard) to determine the most suitable choice for CSR extension to a supplier. However, little is known about how and why MNE buyers make choices of extending CSR to suppliers that vary in their CSR implementation levels in dynamic environments. In particular, because conventional empirical methods such as surveys, case studies, and econometric analyses focus only on cross-sectional and simple linear relationships where findings are limited by the data that exist (Linderman et al. 2017), the present study is a system-level analysis, purposely designed to examine the dynamic and nonlinear interrelationships between various factors that influence MNE buyers' choices in extending CSR to suppliers. As shown in Figure 1, the multi-method approach of this study insights into the roles of costs for adaption and government policies in influencing how MNE buyers should decide on CSR extensions to suppliers in emerging countries when implementing CSR practices. Considering this gap in the published research, we identify the second research question to guide this study as follows:

RQ2: *What are the roles of costs for adaption and government policies in influencing MNE buyers to extend CSR to suppliers in dynamic environments?*

---Insert Figure 1 about here---

2. Literature Review

We review the following four broad categories of CSR literature: 1) heterogeneous levels of CSR implementation, 2) costs and benefits of CSR implementation, 3) buyer–supplier relationship in extending CSR, and 4) roles of stakeholders in CSR implementation. Previous related studies inform our arguments related to the contextual factors that MNE buyers may encounter when extending CSR to suppliers.

2.1. Heterogeneous Levels of CSR Implementation

As CSR implementation levels in emerging markets can be heterogeneous, selecting OEM suppliers is a management challenge for many MNEs; for example, a longitudinal study of corporate sustainable

development conducted by Bansal (2005) showed that firms' levels of commitment to sustainability change over time, and thus their levels of CSR implementation can be heterogeneous, which supports the view of CSR evolution. Huq et al. (2016, p.19) found that firms have differing levels of "social management capability," which influence how buyers and suppliers "respond to stakeholder pressures, address regulatory gaps, and improve social performance." Some studies have discussed that firms either *Do-Good* or *Do-Harm* in CSR management (Crilly et al. 2015), and the proportions of *Do-Good* (*Leader*) and *Do-Harm* (*Laggard*) firms are largely comparable (Castelló and Lozano 2011). Heterogeneity in CSR implementation exists and the literature generally considers two levels of CSR implementation (*Do-Good* and *Do-Harm*).

2.2. Costs and Benefits of CSR Implementation

The aforementioned body of literature examines the costs and benefits of adopting CSR practices, which refer to the CSR implementation costs and the reputational or financial benefits of CSR implementation. Studies have shown that implementing CSR requires financial investment and the reconfiguration of organizational structures (Goss and Roberts 2011, McWilliams and Siegel 2001). In addition, maintenance fees are required to renew and maintain CSR performance (Harjoto and Jo 2015, Kiessling et al. 2015). Institutional pressure from stakeholders (e.g., customers and media) is considered a major factor influencing whether organizations engage in CSR (Sharma and Henriques 2005, Christmann and Taylor 2006). One branch of the literature uses an institutional theoretical lens to argue that firms may only symbolically adopt CSR practices, and that little substantive benefit can be expected from such practices (Aguinis and Glavas 2012, Tenbrunsel et al. 2000).

Another branch of the literature highlights the corporate reputation and financial performance associated with firms' CSR implementation (Brammer and Pavelin, 2006, Tang et al. 2012, Turban and Greening 1997). A previous study on corporate environmental management suggests that environmental performance awards received by firms are associated with significant increases in their stock market returns, whereas environmental management crises have significant impacts in the opposite direction (Klassen and McLaughlin 1996). Other previous studies have investigated the moderating effects on

the link between CSR adoption and positive corporate outcomes (Chatterji and Toffel 2010, Tang et al. 2012); for example, Tang et al. (2012) found that the extent to which firms can improve their financial performance depends on how they have previously engaged in CSR investments. In other words, more consistent, relevant, and internal-to-firm engagement can provide greater benefits to a firm. In addition, a longitudinal study on corporate sustainable development (Bansal 2005) showed that over time, certain drivers of CSR (e.g., organizational slack and media attention) have less of an influence on the benefits derived from corporate sustainable development.

2.3. Extending CSR to Suppliers: Buyer–Supplier Relationship

Despite extensive studies on CSR development being conducted in recent decades, the insights derived from such studies are mainly focused at the organizational level (Aguinis and Glavas 2012). Scholars have noted that “CSR is conceptualized as a complex phenomenon that is contextual and multimodal and often initiated in collaboration with others inside and outside the corporation” (Jamali and Karam 2016, p.13). Emerging research has urged the extension of CSR from buying firms to their suppliers through coordination between the two (Bendixen and Abratt 2007, Boström 2015, Letizia and Hendrikse 2016, Plambeck and Taylor 2015). This is particularly crucial for MNE buyers that source from emerging countries where CSR implementation by upstream suppliers is relatively primitive. The three examples cited in Section 1 highlight the operational risks that MNE buyers may encounter when their suppliers are publically deemed socially irresponsible. We review the literature on the buyer–supplier relationship and how it facilitates (or hinders) buyers in extending CSR to suppliers. Plambeck and Taylor (2015) used a mathematical modeling approach to investigate the conditions under which a buyer can hinder the extension of CSR to suppliers, and suggested approaches such as auditing, publicizing negative audit reports, and providing loans to suppliers to increase the likelihood that suppliers will hide information to pass the buyer’s audit. For contractual designs specifying payments with reference to CSR performance, Letizia and Hendrikse (2016) examined the impact of supply chain structure (supplier–buyer relationship) on suppliers’ CSR investments. The researchers’ findings offer managerial insights into how buyers can effectively extend CSR to suppliers. Pedersen and Andersen

(2006) discussed the importance of developing new methods for managing cross-organizational (buyer–supplier) relationships for CSR compliance to manage global supply chains. Their results showed that although buyers may not be successful in extending CSR to suppliers, some protective mechanisms to safeguard buyers from suppliers' noncompliance with CSR requirements would mitigate such risk.

2.4. Roles of Stakeholders in CSR Implementation

Firms respond to various pressures from their stakeholders, including governments, customers, regulators, communities, and nongovernmental organizations (NGOs) in managing CSR. Wu et al. (2014) examined the role of the government in suppliers' energy efficiency initiatives. The researchers showed that the Chinese government enforces energy efficiency and environmental initiatives in industrial sectors but that the implementation of such initiatives is contingent upon suppliers' ownership characteristics. Arya and Mittendorf (2015) investigated how the design of subsidies offered by a government affects suppliers' behaviors toward CSR adoption. Yin and Jamali (2016) proposed an integrative model for analyzing CSR implemented by MNEs in China and highlighted the importance of stakeholder support to penetrate the market, ease uncertainty, and lower the costs of CSR management in developing economies.

Studies have shown that governments play a critical role in mandating the goals of social responsibility (Wu et al. 2014). Vallentin (2015) investigated the role of government in CSR development and found that in Denmark, the government plays a leading role in promoting CSR. Buhmann (2016) argued that public regulatory governance schemes such as the “Social License to Operate” regime are effective methods for promoting CSR in transnational economies. Stakeholders intending to achieve CSR goals (e.g., a government's goal to reduce energy consumption per unit of gross domestic product) can influence a firm's implementation of CSR.

The review of the four selected categories of CSR literature provides a rationale regarding how and in what ways MNEs should extend CSR practices to emerging country suppliers. In other words, because suppliers' CSR implementation levels in emerging countries are heterogeneous (Section 2.1) and costs and benefits exist in association with CSR practices (Section 2.2), buyer firms must have

operations strategies to extend CSR practices to their suppliers (Section 2.3) while considering the role of government policies to promote CSR (Section 2.4). Table 1 organizes some representative studies under four categories, as well as the “level of analysis,” which refers to organizational-, dyadic-, and system-level CSR implementation. We illustrate two aspects of the selected literature on CSR. First, research on CSR is largely concerned with the costs or benefits of CSR implementation at the organizational level such as financial return from the implementation of CSR practices (e.g., Carroll and Shabana 2010, Scherer and Palazzo 2011). However, this stream of research ignores supply chain dynamics such as the buyer–supplier relationship in affecting CSR adoption and effectiveness. Second, another branch of research examining a cooperative framework for managing CSR between the government, suppliers, or buyers focuses only on static processes and short-term goals, thereby failing to account for the dynamic behavioral adaption process of decision makers at the holistic system level. Incorporating a dynamic perspective is crucial for analyzing how CSR should be effectively implemented for contemporary global supply chain management.

---Insert Table 1 about here---

This study aims to fill the gap (bottom of Table 1) in the CSR literature by adopting a multi-agent system perspective. Specifically, this paper contributes to the literature by showing that, based on heterogeneous CSR implementation levels among suppliers in emerging countries, how and to what extent MNE buyers extend CSR to their suppliers in the presence of dynamic government policies and costs for adapting CSR levels. It is critical to fill the research gap identified above to understand the CSR diffusion process under different policy incentives where the government plays an important role in shaping the operating environment conditions.

3. Cluster Analysis and Data

3.1. Research Design

A standard assessment methodology of CSR is a useful baseline in this study. Hahn (2013) discussed the usefulness of ISO 26000, a standard CSR assessment program, to highlight that the program's guidelines are useful references for adopter firms seeking to advance CSR in operations. Recent studies

have shown that the ISO framework is a useful guidepost for implementing CSR practices in China (Zhu and Zhang 2015, Zhu et al. 2016). From a practical perspective, many MNEs such as Fujitsu have incorporated the essential elements of ISO 26000 to regulate their CSR practices and have continually cooperated with overseas suppliers to mitigate potential risks caused by violating ISO 26000 Standards (*CSR Activities Utilizing ISO 26000*, Fujitsu Group, 2017). The director of the China ISO 26000 Evaluation and Research Institute noted that “ISO 26000 can be regarded as an opportunity for China to adopt an internationalized and positive attitude, welcoming CSR through legislation and voluntary standards for the scientific, sustainable, and healthy development of the Chinese economy” (Zhao 2014, p. 77). To measure CSR implementation levels among the surveyed OEMs, we adopt the guidelines for evaluating CSR based on the *ISO 26000 Standards*. The seven core subjects in the *ISO 26000 Standards* are *organizational governance*, *human rights*, *labor practices*, *environment*, *fair operating practices*, *consumer issues*, and *community involvement and development*. *Organizational governance* refers to a formal system that a company implements to pursue its CSR objectives. In emerging countries, OEM suppliers servicing MNE buyers are mostly small and medium-sized enterprises (SMEs). Unlike large and resourceful firms, SMEs commonly implement CSR practices but cannot establish a formal system for organizing and publicizing CSR efforts (Baumann-Pauly et al. 2013). Our interviews conducted during pre-survey site visits and consultations with government officials responsible for monitoring OEMs show evidence that the vast majority of Chinese OEM suppliers do not have *organizational governance* in place. Hence, we developed a survey questionnaire based on the remaining six CSR dimensions and excluding *organizational governance* for data collection.

This study is conducted in the context of an emerging country based on survey data collected from Chinese OEMs. Although China has achieved significant economic growth in recent decades, it is still considered as an emerging country in terms of CSR awareness and implementation level (Yin and Zhang 2012); for example, the U.S. Chamber of Commerce considers China as an emerging country with respect to CSR implementation (*Corporate Responsibility and Sustainable Economic Development in China: Implications for Business*, March 2012). Chinese OEMs are suitable sample firms for studying CSR extension by MNEs to suppliers in emerging countries because China has been the largest supplier

of goods for imports to the U.S. with the largest scale of OEMs operating to service worldwide production demand (*Office of the United State Trade Representative*, 2017). Compared with a developed economy, China is the largest emerging economy that presents different operational characteristics that may influence the adaptive behaviors of buyer firms when extending CSR. According to an *IHS Markit* report, “of those sourcing from China, more than 80% source from the East region” (*An Update on Trends in Global Sourcing*, 2017, p. 4). We purposely selected three major cities in eastern China, namely Dalian in the northeast, Suzhou in the east, and Wenzhou in the southeast, as target cities for distributing the survey questionnaires. These three cities are highly export oriented and industrialized. Consequently, manufacturers in these cities are highly regulated by government monitoring programs. With the help of local governments, we obtained the full lists of all OEMs servicing overseas MNEs and their contact information. We issued 200 questionnaires to randomly selected OEMs in each of the three cities (600 survey questionnaires in total) by email or mail to request that they be anonymously completed by the senior managers or department directors responsible for managing social issues. In each questionnaire's cover letter, we explicitly requested that the target respondents accurately answer the survey questions to the best of their knowledge about their firms. We also notified them that the survey was not for the purpose of government monitoring of CSR compliance. To increase the response rate, we enclosed a supporting letter endorsed by the government for all questionnaires administered in Suzhou. In Wenzhou, all questionnaires were issued with a supporting letter endorsed by Wenzhou University. In Dalian, the government assisted with survey distribution but could not provide a supporting document. After two rounds of phone call follow-ups to those who did not respond, we obtained 199² useable responses (a 33.2% effective response rate), comprising 108 from Suzhou (54% response rate), 67 from Wenzhou (33.5% response rate), and 24 from Dalian (12% response rate). We acknowledge the different response rate in each city. The differences were *likely*

² The initial sample size was 211. However, three samples with missing values and three clusters whose sample sizes were less than two per cent of the total sample size (i.e., clusters containing only 4, 4, and 1 samples) were excluded. This practice is consistent with previous studies adopting the clustering strategy (Fan et al. 2014; Yeung et al. 2003). To check the robustness of the clustering results, we also conducted a series of tests. For example, the agglomeration coefficients, which are obtained from the hierarchical procedure, significantly increase for both one- and two-cluster solutions, while increasing less for a three-cluster solution and showing no significant increase for a four-cluster solution. Consequently, the three-cluster solution is considered optimal for clustering the OEMs.

attributable to the levels of support received from local governments or universities. Higher levels of support from legislative or educational institutions commonly could increase response rates among target respondents.

We conducted exploratory factor analysis by employing the most commonly used extraction method of principal component analysis, followed by varimax rotation with Kaiser normalization to identify the CSR factors. Items (questions) on *labor practices* for employees, *fair operating practices*, and *customer issues* were grouped as one factor and defined as *CSR practices related to employees, competitors, and customers* (ECC, CSR1)³. The other three CSR subjects were suitably grouped into the expected factors. In these OEM suppliers, employee rights are considered as equal to human rights under the *ISO 26000 Standards*. Consequently, we define the other three CSR factors as *employee rights* (Empl, CSR2), *community involvement and development* (Com, CSR3), and *environment* (Envi, CSR4). The Rotated Component Matrix on CSR Practices is summarized in Appendix A.

3.2. Cluster Analysis

We conduct cluster analysis to answer the first research question: *What is the nature of CSR heterogeneity based on the different components of CSR in emerging countries?* To answer the question, we identify the distribution of CSR implementation levels among all surveyed OEMs.

To ensure robustness in the clustering results, we employ a hierarchical method by using Ward's approach and a nonhierarchical method by using *K*-means clustering analysis (Hair et al. 2010). These two methods yield consistent results. Following Humphreys et al. (2001), we conduct an analysis of variance to examine whether the clustered OEMs vary in their CSR practice levels. We further employ a multivariate analysis of variance (MANOVA) to examine the collective comparisons among the four CSR factors. Table 2 reports the MANOVA results of the cluster analysis. As shown in the table, Cluster

³ Surprisingly, employees, competitors, and customers (three very different stakeholders) are grouped into ECC and CSR1, possibly because Chinese SMEs place more emphasis on CSR related to labor practices, competitors, and customers. In other words, the financial concerns of SMEs may promote CSR related to competitors and customers because the *Labor Contract Law* enacted in China on January 1, 2008 may have significantly triggered SMEs to implement CSR related to employees. Moreover, "labor practices" and "employee rights" were not parts of the same factor, and thus it is possible that China's *Labor Contract Law* mainly focuses on "labor practices," whereas the element of human rights in the *ISO 26000 Standards* (operationalized as "employee rights" in this study) is not clearly introduced in the law.

1 outperforms the other two clusters across all four measures of CSR practices. Thus, we label Cluster 1 as the *Leader* cluster. We label Cluster 2 as the *Follower* cluster because the mean values of all four factors are smaller than those of Cluster 1 but larger than those of Cluster 3, which is labeled as the *Laggard* cluster accordingly. The numbers of *Leader*, *Follower*, and *Laggard* OEMs are 62, 100, and 37, respectively, which suggests that the distribution of OEMs in terms of CSR implementation levels is skewed to the *Follower* cluster. This result contradicts the prevalent assumptions in the CSR literature that firms either *Do-Good* or *Do-Harm* in CSR management (Crilly et al. 2015) and that the proportions of *Do-Good* (*Leader*) and *Do-Harm* (*Laggard*) firms are largely comparable (Castelló and Lozano 2011).

---Insert Table 2 about here---

4. Multi-agent Simulation Study

Although the cluster analysis sheds light on the distribution and implementation levels of CSR in the three supplier clusters, the findings are limited to simple linear relationships drawn from statistically significant results (e.g., the cluster results can only be explained based on the data that exists) that restrict our understanding of “complex theoretical relationships among constructs, especially when challenging empirical data limitations exist” (Adner et al. 2001, p. 204). In other words, a simulation study can provide insights into the second research question posed in Section 1 regarding the roles of government policies and the costs of adapting CSR levels in influencing how MNEs extend CSR practices to suppliers. Specifically, cluster analysis alone cannot explain how external factors influence cluster evolution (Bansal 2005), which is the result of MNEs' choices in relation to CSR extension to their suppliers. In other words, as the importance of CSR is recognized for global supply chain management, MNEs must consider the current status of CSR implementation among suppliers in emerging countries. The empirical results obtained using the previously described conventional empirical method (i.e., survey-based cluster analysis) are inadequate for answering the second research question. Accordingly, we develop a simulation model to study dynamics in a multi-agent system

regarding CSR extension by MNE buyers to suppliers in emerging countries that vary in their implementation of CSR.

Specifically, we use an agent-based simulation model to investigate three strategies (upgrading, downgrading, and maintaining the CSR level) to extend CSR by MNEs in dynamic environments. Agent-based models have been applied extensively to formulate a system characterized by rich and nonlinear dynamics with multiple agents involved (Chandrasekaran et al. 2015, Rahmandad and Sterman 2008). The system evolves as individual agents adapt their behaviors in accordance with internal and external stimuli (e.g., costs and policies). Specifically, the choices of an MNE for extending CSR to suppliers are formulated using cost–benefit functions (see Appendix B) considering a set of influencing factors (the amounts of penalty, subsidy, upgrading cost, downgrading cost saving, and inspection rate) from multiple agents in emerging markets. MNE buyers extend CSR to suppliers (i.e., OEMs) in emerging countries, whereas the government plays a critical role as an exogenous agent to regulate and enforce CSR-related policies by monitoring and penalizing *Laggard* firms and providing subsidies to *Leader* firms. The associated cost of upgrading and the cost saving from downgrading the CSR level affect the choices of MNEs in extending CSR. To develop the multi-agent simulation model, we make several assumptions based on realistic conditions in China and define the behavioral rules that an agent (an MNE and its OEM supplier) would follow in a predetermined situation.

We study a multi-agent system comprising 50 MNEs and 199 OEMs. The selection of 50 MNEs is to ensure that on average, each MNE has approximately four candidate OEM partners to choose from. The 199 OEMs are candidate suppliers for servicing any of the 50 MNEs. In this setting, MNEs and OEMs are treated as autonomous and spontaneous “agents” (Tesfatsion 2003). The government is a regulator that intervenes in the market by enforcing CSR policies (i.e., penalties and subsidies) and serves as an exogenous agent. We do not consider NGOs in our simulation model because NGOs can cooperate with or even exert pressure on local government in enforcing a stringent CSR policy. In the simulation, the primary objective of an MNE is to extend CSR to an OEM supplier by selecting that OEM supplier as a long-term partner (i.e., an MNE and an OEM reach an agreement to manage CSR in a coordinated fashion). More specifically, an OEM agent is randomly selected by an MNE agent. An

MNE buyer and its selected OEM supplier make the decision on whether to upgrade, downgrade, or maintain CSR in a coordinated fashion. However, if the selected OEM belongs to the *Laggard* cluster, it may cheat and report misleading information (i.e., a fake CSR level) to its MNE partners (see Appendix C for details). Given the current penalty, inspection rate, subsidy, and costs for adapting CSR levels (the upgrading cost is incurred to elevate CSR to a higher level or saving is made by downgrading CSR to a lower level), MNE buyers have choices of CSR extension (i.e., upgrade, downgrade, or maintain at the current level) to update the CSR implementation levels in their OEM suppliers. The simulation of sequential events over time helps to reveal a dynamic process of MNE buyers extending CSR to OEM suppliers with various CSR implementation levels. The simulation assumptions are described as follows.

Simulation Assumptions

(1) *Extending CSR to suppliers.* An MNE extends CSR to an OEM supplier under the premise that both agree on the decision to upgrade, downgrade, or maintain CSR at the current level (the MNE buyer and the partnered OEM supplier make such choices in a coordinated fashion).

(2) *Information asymmetry and the impact of CSR performance.* We assume that information asymmetry exists for MNEs and that only a portion of MNEs (20%, called *smart* MNEs) know the distribution of the CSR implementation levels (i.e., proportion of each cluster) among OEMs and the mean level in each cluster. The remaining 80% of MNEs are not knowledgeable about the distribution of CSR implementation levels (but they know the mean level in each cluster). The CSR performance of an OEM affects its MNE partner. In other words, a high (low) CSR level provides more (less) benefits for the MNE partner. Such benefits include financial returns and a positive corporate reputation (Figure 2). MNEs can extend their CSR to OEMs by upgrading, downgrading, or maintaining their CSR levels to maximize the cost–benefit function.

(3) *Role of the government.* The government selectively screens the CSR performance of all the OEMs by using the *Do-No-Harm* and *Do-Good* thresholds. Specifically, the *Do-No-Harm* threshold splits the *Follower* and *Laggard* OEMs, whereas the *Do-Good* threshold splits the *Leader* and *Follower* OEMs. The central government makes and enforces regulations and laws while each local government plays a

role in coordinating the implementation of CSR practices. The domestic regulations and guidelines on CSR in China have been explicitly stated in various laws; for example, legal obligations for conformance to CSR practices in the *Employment Law*, *Consumer Protection Law*, *Environmental Law*, and *Insolvency Law* have been enforced (Zhao 2014). We introduce specific examples illustrating that governments inspect firms in relation to CSR compliance, provide incentives to *Do-Good* firms, and penalize *Do-Harm* firms. For example, directly governed by the State Council, the State Administration of Work Safety performs random (selective) work safety inspections in firms without prior notice (*China CSR Map*, 2017). The Chinese central government decided to impose severer punishments than ever before on firms operating under the stipulated minimal green goals (*CSR-China*, September 14, 2010). In addition, local governments offer subsidies (e.g., tax incentives) to firms with high CSR performance (Yin and Zhang 2012). In line with the aforementioned existing regulatory regimes in China, we assume that the government performs inspections with a probability of p and punishes MNEs and their OEM suppliers caught for being below the *Do-No-Harm* threshold (*Laggard*). The government also provides subsidies to MNEs and their partnered OEM suppliers with levels of performance above the *Do-Good* threshold (*Leader*).

---Insert Figure 2 about here---

4.1. Simulation Design

The objective of this simulation study is twofold. First, we verify the effectiveness of the identified variables (e.g., cost of upgrading, penalty scheme) in influencing CSR extension. Second, we demonstrate how the simulation model can resolve open-ended queries when the level of system dynamics increases. Specifically, Section 4.3 seeks to verify the effectiveness of the variables (factors) in influencing CSR extension at a systematic level while considering the dynamics of the relationships and interactions among them. Sections 4.4 and 4.5 extend the simulation model to explore two open-ended queries regarding how the government should make decisions when a higher level of dynamics (e.g., comparing two policies or switching between policies) is presented.

As shown in Figure 2, the two thresholds split OEMs in an emerging country into three clusters. The OEMs in the three clusters have distinct CSR performance levels. We simulate how MNEs extend CSR to OEM suppliers with heterogeneous CSR implementation levels in a dynamic environment by employing a multi-agent model. Specifically, an MNE seeks to maximize its cost–benefit function (see Appendix C) among the three clusters by extending CSR to OEM suppliers in a dynamic environment. In other words, an MNE has three options for extending CSR to an OEM supplier, described as follows. *Option 1*: Upgrade its CSR level (at a cost) to the *Leader* (obtain the government subsidy) or *Follower* standard. *Option 2*: Downgrade its CSR level (to save cost) to the *Follower* or *Laggard* standard (with a possible penalty). *Option 3*: Maintain the current CSR level. The overall consequences of the choices of CSR extension made by MNE buyers manifest systematically as a result of cluster evolution. Appendix C details the choices that an MNE can follow to extend CSR to suppliers with different CSR implementation levels (*Leader*, *Follower*, or *Laggard* standard). Specifically, the cost–benefit function is used to determine which option (upgrade, downgrade, or maintain) should be adopted in any given situation. Figure 3 shows the simulation flow diagram. We coded the simulation process in the Python-based Mesa framework (see Appendix D) and performed 100 replications (iterations) for each scenario (in a trial where an MNE chooses to upgrade, downgrade, or maintain its current CSR level, 50 MNEs make choices of one iteration). To this end, we coded the mathematical models (Appendix C) that formulate the choices (behavioral rules) of the agents into the Mesa framework. To ensure that the simulation system was compatible with our conceptual model, we performed several pilot analyses to debug and confirm the validity of the system.

---Insert Figure 3 about here---

We set the following initial values for the simulation.

OEMs. There were three clusters of OEMs (62 *Leaders*, 100 *Followers*, and 37 *Laggards*, all of which were identified from the cluster analysis results).

MNEs. 20% of MNEs were *smart* (see the simulation assumptions).

Government. A government enforced its policies (i.e., subsidy and penalty with an inspection rate of p). The subsidy was granted through voluntary application by firms (a common practice in China) and all *Leader* firms were expected to apply for subsidies. The penalty was enforced by inspection.

Previous studies have demonstrated that employee- and environment-related CSR practices are emphasized over community-related CSR practices in emerging countries (Zhu et al. 2016, Zhu and Zhang 2015). Accordingly, we assigned weights to the four dimensions of CSR. We set 0.4 for ECC and Envi, and 0.1 for Com and Empl. Therefore, the initial values of the mean CSR level were 2.8590 (*Laggard*), 3.8888 (*Follower*), and 4.6657 (*Leader*), and the proportions were 18.6% (37/199, *Laggard*), 50.3% (100/199, *Follower*), and 31.2% (62/199, *Leader*), respectively, for the simulation. We simulated how the cluster proportions evolved with the three possible choices of MNE buyers for extending CSR to OEM suppliers. The changes in the cluster proportions reflected how MNE buyers decided to extend CSR in the presence of government policies and updating costs at the system level. The ranges of the variables for simulation were as follows. Four types of penalties were implemented (i.e., penalties for ECC, Empl, Com, and Envi). Each penalty type varied within the range of (0.0, 0.1, 0.2... 2.0). The government inspection rates were: (0.0, 0.1, 0.2...1.0); government subsidies were: (0.0, 0.1, 0.2... 2.0); CSR upgrade costs were (0.0, 0.2, 0.4... 3.0); CSR downgrade cost savings were: (0.0, 0.2, 0.4... 3.0).

Because our simulation model contained multiple tunable variables, we used batch runs to investigate how MNEs adapted their behaviors when extending CSR to suppliers under the influence of government policies and costs for adapting CSR levels in a systematic manner. Specifically, a batch in our simulation contained a Cartesian product of all the tunable variables' discretized domains (e.g., for the tunable variable, "government subsidy," the discretized domain was "0.0, 0.1, 0.2... 2.0." Consequently, there were $21 \times 21 \times 21 \times 21 \times 11 \times 21 \times 31 \times 31 = 43,173,031,671$ unique tunable variable combinations in a batch (e.g., government penalty for ECC = 1, government penalty for Empl = 1, government penalty for Com = 1, government penalty for Envi = 1, government inspection rate = 0.0, government subsidy = 0.5, CSR upgrade cost = 0.5, and CSR downgrade cost saving = 0.5 constituted a batch element). We ran simulations five times for a batch and for each tunable variable combination in a batch, a simulation was executed 100 iterations, thereby enabling us to simulate a

highly dynamic time-varying environment that MNE buyers might encounter when extending CSR to OEM suppliers.

Cluster evolution emerges as a result of the choices made by MNE buyers in a dynamic environment. The simulated system consists of multiple agents (i.e., MNEs, OEMs, and the government), the interactions of which are nonlinear and dynamic. The government exerts influence on firms through supportive tactics for *Do-Good (Leader)* firms and punitive tactics for *Do-Harm (Laggard)* firms. Individual MNEs extend CSR to suppliers depending on the cost–benefit function (i.e., to determine whether and how to upgrade, downgrade, or maintain the current CSR level in OEM suppliers). In the following sections, we first investigate how the single influencing variables (e.g., upgrade cost, inspection rate) affect cluster evolution. However, because the two government tactics (penalty and subsidy) can be analyzed with respect to the costs involved and frequency of inspection, understanding when it would be better for the government to only implement penalties (or subsidies) is critical. Therefore, we investigate when subsidies are more effective than penalties for extending CSR to suppliers by comparing the schemes of the two government tactics mainly adopted to promote CSR.

4.2. The Nonlinear and Dynamic Feature of the Simulation System

Our multi-agent simulation model is nonlinear in nature and is an aggregated model that is useful for understanding how the system (multiple agents as a whole) evolves as individual agents adapt their behaviors (upgrading/downgrading/maintaining the CSR level) in accordance with internal and external stimuli (e.g., costs and penalties). In this research, we simulated a highly dynamic operating environment. Hereafter, “dynamic” has the following three meanings: 1) The direction of the system change is a collective result of various changing variables and their interactions. 2) Different agents have different functions (the government implements policies, MNEs extend CSR to OEMs). 3) The system evolves until the stop criteria are met. Consequently, the results of the multi-agent simulation are not driven by the simple economic argument that the costs and government subsidies affect CSR extension (i.e., the simple cost–benefit logic) in opposing manners. In these experiments, the results were insensitive to the specific parameter settings. Figure 4 provides one example showing the

dynamics and complexity of the simulation system. As seen in the figure, the proportions of the three clusters changed dramatically until the stop criterion was met (the fluctuation trend tends to be flat toward the end of the simulation), which suggests that we have simulated a highly dynamic environment that may be encountered by MNEs when extending CSR to suppliers.

---Insert Figure 4 about here---

4.3. Influence of a Single Factor

The simulation experiments help to reveal how and to what extent individual variables (e.g., the penalty, subsidy, upgrade cost, amount saved from downgrading, and inspection rate) can affect the overall trend of the cluster evolution. For this purpose, we conducted a set of simulation experiments to reveal the dynamics of cluster evolutions to enable us to investigate the effect of a single variable on the outcome in a highly dynamic system. We used the simulation model illustrated in Figure 3 and used the market share (proportions of the three clusters) to measure the cluster evolution due to the changes in costs and policies.

4.3.1. Impact of Costs on CSR Extension

Figure 5 depicts the effects of the two types of costs on the choices made by MNE buyers with respect to CSR extension. The simulation results show that with the increase in upgrade cost (Figure 5, left), the trend of the market share in terms of the three cluster proportions suggests that the number of *Leaders* decreases, whereas the numbers of *Followers* and *Laggards* increase. In other words, more MNEs tend to extend CSR to OEM suppliers by downgrading the CSR levels of OEM suppliers to a lower standard (e.g., *Follower* or *Laggard*).

Figure 5 (right) shows that the increase in cost saved from downgrading the CSR level leads to a decrease in the number of *Leader* firms and an increase in the number of *Follower* and *Laggard* firms. In other words, the increase in cost saving can motivate MNE buyers to downgrade the CSR implementation levels in OEM suppliers. Collectively, the preceding discussions lead to the following proposition.

---Insert Figure 5 about here---

PROPOSITION 1: *Cost of CSR adaption influences MNE buyers' choice (behavior) of extending CSR to OEM suppliers. Specifically, high expenses for CSR upgrading and large cost saving from CSR downgrading hinders CSR being diffused from MNE's buyers to their OEM suppliers.*

4.3.2. Impact of Government Policies on CSR Extension

Figure 6 shows the effects of government policies (punitive and supportive tactics) on the choices made by MNE buyers for extending CSR practices to suppliers. To investigate the effects of single influencing variables (i.e., the inspection rate and amounts of penalty and subsidy), we categorize the scenarios into “penalty without subsidy,” which considered a varying inspection rate and amount of penalty, and “subsidy without penalty,” which examined only the effect of a varying amount of subsidies.

Punitive Tactics (Penalty Amount and Inspection Rate)

In this section, we examine the effect of a “penalty without subsidy” scenario. Figure 6 (left) evidently shows that the evolution of the clusters is associated with the decrease in the proportion of the *Laggard* cluster, which is a result of the increase in the proportions of the *Follower* and *Leader* clusters.

Figure 6 (right) shows the effect of the inspection rate on cluster evolution, which suggests that the proportions of the *Leader* and *Follower* clusters increase while that of the *Laggard* cluster decreases when the inspection rate increases.

---Insert Figure 6 about here---

Governments may not impose penalties for all components; for example, they may do so for environment and labor, but not necessarily for issues such as “community development.” Consequently, we simulate how a cluster evolves when only a single dimension of CSR is inspected and issued a penalty (if any violation occurs). Figure 7 shows the impacts of the penalties of ECC, Empl, Com, and Envi on cluster evolution. The figure shows that the severer the penalty imposed on *Laggard* CSR practices related to ECC or Envi, the more the MNEs extend CSR in OEMs to the *Leader* standard. By contrast, the penalty does not have a significant impact on cluster evolution for CSR practices related to Com and Empl. These results show that the discriminating emphases (see the simulation assumption

that the government places more emphasis on ECC and Envi) on different components of CSR may result in distinctive effects of punitive tactics.

---Insert Figure 7 about here---

Supportive Tactics (Subsidy Amount)

Figure 8 illustrates the effects of subsidies (without penalties) on cluster evolution. In the absence of the penalty and inspection rate, the increase in subsidies causes more MNEs to extend CSR practices to the *Leader* cluster while the proportion of the *Laggard* cluster decreases.

---Insert Figure 8 about here---

Collectively, the single variable analysis of government policies suggests that the intensity of punitive tactics (penalty and inspection rate) and the amount of supportive tactics (subsidy) enforced by the government influence the choices of MNE buyers for extending CSR practices to suppliers, which leads to the following proposition.

PROPOSITION 2: *Government's punitive and supportive tactics influence MNE buyers' choice (behavior) of extending CSR to OEM suppliers. That is, increasing inspection rate, penalty, or subsidy facilitates CSR being diffused from MNE buyers to their OEM suppliers.*

4.4. Which Policy is More Effective: Punitive Versus Supportive Tactics

Because “the use of government incentives tied to market prices as means of boosting corporate social responsibility has expanded notably in recent years” (Arya and Mittendorf 2015, p. 1346), we empirically demonstrate that in a highly dynamic environment, both punitive (penalty with inspection) and supportive (subsidy) government tactics are effective for promoting a *Leader*-oriented CSR market. Although the literature is informative about the effectiveness of various tactics that regulatory agencies could leverage to promote CSR practices among supply chain partners (Arya and Mittendorf 2014, Krass et al. 2013), it is less clear which of the two tactics (subsidy vs. penalty) enforced on different target firms (*Leaders* and *Laggards*) is more effective under certain conditions. We investigate when subsidies are more effective than penalties and vice versa when CSR is extended to suppliers. Specifically, we endeavor to determine the thresholds (i.e., penalty or subsidy amount) that the

government can rely on to make policies (i.e., designing penalty or subsidy schemes) for promoting CSR.

Essentially, the mechanisms of subsidies and penalties differ in how they influence cluster evolution. In other words, subsidies stimulate *Followers* and *Laggards* to pursue the standard of *Leaders* because only *Leader* firms can obtain subsidies when penalties are enforced on *Laggard* firms only. Because penalties and subsidies have distinctive effects on different clusters, we compare the effectiveness of these two tactics (penalty vs. subsidy) according to the proportion of *Laggard* OEMs. To determine which policy (subsidy vs. penalty) is more effective, we use the proportion of the *Laggard* cluster to measure the effectiveness of a certain policy when solely implemented. In the simulation, we fix the cost of upgrading and cost saved from downgrading and set the inspection rate from low to high levels (0.0, 0.1, 0.2... 1.0). A penalty scheme is compared to its corresponding subsidy scheme, which carries an identical value (e.g., penalty = subsidy = 0.9). When the proportion of *Laggards* associated with the penalty scheme is smaller than the proportion of *Laggards* associated with the subsidy scheme, a penalty is more effective than a subsidy for extending CSR to suppliers, and vice versa. Table 3 presents some of the results of the comparison of subsidy versus penalty schemes with different inspection rates.

Assume that the government needs to initiate a penalty policy (with inspection rate = 0.6) that would be expected to be effective as or even better than a subsidy policy (subsidy = 0.7). The feasible penalty schemes that can be selected from are those with a penalty lower than 0.7, thereby meeting the condition that a subsidy is not more effective (in other words, a penalty is more effective) for decreasing the proportion of *Laggard* firms. By contrast, with the same inspection level (0.6), if the subsidy policy is 1.0, which falls into the regime of “subsidy is more effective (than penalty),” if and only if the government adopts a penalty scheme equal to or larger than 1.6, of which the corresponding *Laggards* percentage is 0.271, the effect of such a penalty policy is superior to the previously considered subsidy policy (1.0), of which the corresponding proportion of *Laggards* is 0.296 (>0.271). This is an example of applying a choice between the two policies in policy-making.

Figure 9 shows a diagram illustrating the simulation results of various penalty and subsidy counterparts with differing inspection rates. The diagram serves as a heuristic rule for choosing from “either subsidy or penalty” when a specific inspection rate is provided (shown in the horizontal axis). One polyline splits the area into two regions representing two strategies recommended for adoption. In Regions I and II, penalty and subsidy are preferable to their counterparts, respectively. With a predetermined inspection rate, when the intensity of either the subsidy or penalty increases, there is a threshold, which renders the subsidy policy favorable for greater schemes (following the direction of the arrow), whereas the penalty policy is favorable for the remaining schemes. Let's assume that the government intends to implement a subsidy or a penalty (inspection rate = 30%) policy. A subsidy is more effective than a penalty when an equivalent penalty versus subsidy scheme is greater than the threshold value in the vertical axis ($\text{Penalty/Subsidy}_{\text{threshold}}$, a scheme close to 0.6). This diagram provides a heuristic method for searching for the preferred policy in relation to a pair of equivalent subsidy and penalty schemes and the inspection rate, which should help regulators to make decisions regarding which policy to implement to promote CSR extension.

---Insert Table 3 about here---

---Insert Figure 9 about here---

PROPOSITION 3: *There exists a heuristic rule for the government to determine whether only imposing penalty could be more effective than only imposing subsidy and vice versa when the inspection rate is fixed at a certain level, i.e., a threshold splitting the subsidy-more-effective vs. penalty-more-effective schemes helps the government to promote CSR diffusion in a dynamic system.*

4.5. Model Extension: Switching of the Government Policy in a Sequential Time Series

The preceding discussions are all based on the premise of a consistent (time invariant) government policy. In other words, the government consistently adopts both (e.g., Section 4.3.1) or only one (e.g., Section 4.3.2) tactic throughout the simulation process without switching between policies. In this section, we provide an extension of the model to further explore a more complex system where the government may switch its policy from one tactic (supportive or punitive) to another at a specific time point during the simulation. The extended model is simulated from the practical perspective that the

government may be unable to simultaneously implement two tactics because of limited resources (e.g., budget or labor) and that the tactic adopted in the first period proves to be somehow less satisfactory than expected. We consider the following two scenarios. The government first adopts only a subsidy (penalty) and subsequently switches to a penalty (subsidy) only at the middle point (iteration = 50) in a sequential simulation (total number of iterations = 100). While the other variables are being controlled equally, we adjust only tactic-related variables in the two scenarios.

The simulation results of the two sequential iterations are presented in Figure 10. Scenarios A and B both show that in all 100 iterations, the inconsistency of the government policies implemented can lead to the divergent distribution of clusters; for example, in the first 50 iterations in Scenario A, the government fails to promote a *Leader*-oriented market by implementing only a supportive tactic. Similarly, the results of the second 50 iterations associated with the replaced policy (subsidy replaced with penalty) suggest that policy switching does not improve CSR extension because of the currently fixed schemes of cost and inspection rate. By contrast, the results from Scenario B suggest that after switching from penalty to subsidy (from iteration 50 onwards), the CSR extension improves (the proportion of *Leaders* increases significantly). Evidently, the two settings (Scenarios A and B) are characterized by a higher level of dynamics (i.e., switching between subsidies and penalties in a time-sequential manner) than those of any of the other scenarios discussed before this section. Accordingly, multi-agent-based modeling is superior to the simple cost–benefit analysis (we do not indicate that the previous simulation studies are based on a simple cost–benefit argument, but rather that they are also nonlinear and dynamic) because it can consider a high level of dynamics. Therefore, the simulation model can help policymakers to better understand a highly complex and dynamic system for promoting CSR extension. In other words, when the level of dynamics increases, the simulation model can be applied to suggest an optimal combination of the influencing variables that can help promote CSR extension.

---Insert Figure 10 about here---

5. Conclusions

5.1. Implications for Theory and Practice

Prior studies on the diffusion of CSR assume a uniformly distributed implementation level among firms. That is, firms either *Do-Good* or *Do-Harm* in CSR management (Cottrill 1990, Muller and Kolk 2009). This bifurcation is attributable to the situation that “many of these summative efforts have focused on CSR in developed countries, with applicability to developing contexts still underexplored” (Jamali and Karam 2016, p. 2). However, our cluster analysis results suggest a three-tier CSR implementation structure among Chinese OEM suppliers and that the proportion is skewed to the *Follower* cluster, indicating greater heterogeneity than that previously identified in the literature. We find that suppliers in China vary in their CSR implementation levels. The heterogeneous CSR implementation levels among suppliers are noticeable among MNE buyers that extend CSR to suppliers.

Second, this study contributes knowledge to the growing amount research on the importance of coordination between MNEs and suppliers in CSR management (Huq et al. 2016, Letizia and Hendrikse 2016, Pedersen and Andersen 2006) and the critical role of regulators in promoting and monitoring CSR (Arya and Mittendorf 2015, Atasu et al. 2008, Dhanorkar et al. 2017). Previous studies have considered whether and how MNEs should extend CSR to their supplier partners and the boundary conditions under which the extended CSR would benefit MNEs (Boström 2015, Huq et al. 2016, Letizia and Hendrikse 2016). This study proposes a framework for how MNE buyers extend CSR to upstream suppliers through a coordinated relationship with suppliers in emerging countries in dynamic environments. To date, scholars have mostly focused on the motivations of MNE buyers to influence suppliers' CSR and how buyer–supplier monitoring and trust occurs to increase or decrease the CSR implementation levels of suppliers. However, relevant studies have been unable to demonstrate the significance of motivations or monitoring and trust mechanisms for suppliers' CSR management outcomes at the system level. By contrast, the present study shows that stimulated by punitive and supportive government policies and costs for adapting CSR levels, MNE buyers extend CSR to OEM suppliers by upgrading the CSR implementation levels of OEM suppliers to *Leader* standard. Previous studies have suggested that developed countries are “characterized by less regulation and more incentive for voluntary social roles

for business firms” (Jamali and Karam 2016, p. 2). This may not reflect situations in emerging countries, as Jamali and Karam (2016) highlighted the necessity to “determine what has been found to be distinctive about CSR in developing countries.” Some recent studies have called for attention to the use of government policies as a means of boosting CSR (Arya and Mittendorf 2015, Atasu and Van Vassenhove 2012). We consider the following three tactics that a government may use to leverage CSR implementation in emerging countries: penalty, inspection rate, and subsidy. Although some studies have investigated how government policies affect CSR implementation (Arya and Mittendorf 2015), such studies have investigated only either supportive (e.g., incentives) or punitive (e.g., sanctions) strategies, thereby failing to highlight the interaction between such tactics. The present study contributes knowledge to this branch of research by showing how governments can choose either punitive or supportive tactics under certain conditions (e.g., varying inspection rates) to promote CSR. More crucially, our simulation results shed light on the specific schemes (e.g., subsidy or penalty amount) that a government can refer to when adopting a certain tactic.

Third, extant research has advanced our knowledge of how and under what conditions individual firms can benefit from CSR implementation (Arya and Zhang 2009, Barnett and Salomon 2006, Hull and Rothenberg 2008). However, such studies have viewed CSR implementation from a static perspective, thereby failing to consider multi-agent environments. The motivation for and outcomes of extending CSR to suppliers are affected by various factors residing in dynamic environments. As such, our study contributes to operations management literature on CSR by adopting a multi-agent system approach. Specifically, we examine how and the conditions under which MNE buyers would extend CSR to OEM suppliers in a dynamic environment. As part of their agenda for future CSR research, Aguinis and Glavas (2012, p.957) proposed that “the type of research needed to advance our knowledge of CSR is multilevel in nature.” Accordingly, combining the macro level (e.g., how to manage relationships between a focal firm and its external stakeholders) and micro level (e.g., the underlying mechanism through which MNE buyers can benefit from extending CSR) would be a promising approach to studying CSR in multilevel settings. The operational realities required by MNE buyers to effectively extend CSR to suppliers in emerging countries in the presence of differing

government policies and costs for adapting CSR levels motivate us to investigate how a multiagent system evolves as a result of MNE buyers' choices of extending CSR to their suppliers.

This study proposes a system of multiple agents characterized by nonlinear and dynamic relationships (i.e., a dynamic multiagent environment encountered by MNE buyers where several stimuli influence decision-making) to investigate how variables that have been previously tested independently of one another interact and affect MNE buyers' decisions at the system level. In this study, we demonstrate the importance of MNE buyers' awareness of the varying CSR implementation levels of suppliers in emerging countries and that their choices of CSR extension should consider CSR heterogeneity. MNE buyers tend to extend CSR to their suppliers by upgrading suppliers' CSR levels to *Leader* standard in response to punitive and supportive government policies, as well as the costs of adapting CSR levels.

This study offers crucial and novel implications for operations managers and policymakers. The cluster analysis results based on a survey study of Chinese OEM suppliers provide a more sophisticated categorization of the CSR implementation levels of suppliers in emerging countries, thereby informing policymakers that the CSR implementation levels of such suppliers can be highly heterogeneous. The varying level of CSR practice implementation informs MNE buyers that they must differentiate their choices to upgrade, maintain, or downgrade their current levels of CSR extended to suppliers. The levels of influencing factors (e.g., policies and costs) in the environment can also affect MNE buyers' choices of CSR extension to suppliers. However, for an MNE buyer, the strategy of extending CSR to a supplier by upgrading its CSR level to *Leader* standard appears to be more advantageous than the choice of downgrading or maintaining the current CSR level. In addition, governments can refer to the cluster analysis results to set thresholds for splitting *Leader* and *Laggard* firms, thereby providing a standard for promoting more effective management of CSR in emerging countries. In addition, the comparison between punitive and supportive government tactics adopted by the government provides feasible schemes for both tactics (Table 3). From a dynamic system perspective, the agents of the system adapt their behaviors in response to various environmental stimuli (e.g., punitive and supportive government policies and costs for adapting CSR levels), thereby affecting the overall trend of the evolution of

adaptive behaviors of MNEs in extending CSR to suppliers. The findings enable managers to consider the impacts of changes in regulatory policies and costs on MNE buyers' choices of CSR extension to suppliers in dynamic environments. By contrast, investment in CSR extension can be affordable for MNE buyers to promote a higher level of CSR implementation for their supplier partners. Continuous CSR improvement in emerging countries can be compromised in the long term if policymakers fail to update market information (e.g., cluster distribution). Hence, regulators must update the standards (thresholds) set for penalties (*Laggard*) and subsidies (*Leader*) and initiate more educational programs to promote higher levels of CSR implementation.

Government regulators can be instructed to monitor OEMs' CSR implementation levels based on the distribution characteristics. Specifically, government regulators can offer incentives (e.g., subsidies) to *Leader* firms and penalize *Laggard* firms (e.g., issue fines). For this, the government should be knowledgeable about the distribution of CSR levels among firms and set criteria to assess firms' CSR implementation levels. For example, the government can set two thresholds to categorize firms into *Leaders* and average-performing firms (*Do-Good* threshold), and *Laggards* and average-performing firms (*Do-No-Harm* threshold), and subsidies and fines can be enforced based on these criteria. In addition, based on the distribution information, the government can inspect firms at a certain level of probability because a high rate of inspection is costly, whereas a low rate of inspection may result in ineffective monitoring of firms, which could lead to an increase in the proportion of *Laggard* firms. In conclusion, this multi-method study enables us to understand the current status of implementation of CSR practices in an emerging country by survey research and predict the future development using simulation.

5.2. A Problem that MNE Buyers Face When Outsourcing to Suppliers (broadly)

In interpreting the results of this study, it might not be appropriate to generalize them to all the emerging countries because the data were collected from a single country, i.e., China, and the simulation assumptions were largely based on the policy schemes in that country. In other words, whether the

statements suggesting the findings are unique or applicable to most of the emerging countries have not been tested.

The distribution of CSR implementation levels will likely vary between emerging, developed, and undeveloped nations. Hence, the segmentation of developed and emerging countries in the present study is applicable when buyers outsource to suppliers broadly. However, buyers face a problem when outsourcing to foreign suppliers. That is, the differing policy schemes and other contextual factors that cannot possibly be captured in our empirical and simulation studies may influence the decision-making of buyer firms when outsourcing to suppliers, so they should be factored into the simulation model when studying another country. For example, in some under-developed economies, the governments set economic development as the priority over implementation of CSR practices, in which case the government plays a weaker role in regulating CSR. The range of government subsidy schemes may not vary as widely as assumed in the present simulation model and the penalty may be much lower. To further investigate the effectiveness of the factors in these countries, the overall structure of the simulation model can be retained, yet the preliminary settings of the variables should be carefully adjusted. In sum, buyers should note the major CSR issues faced by their suppliers and understand the institutional environment that influences government support in the suppliers' countries if they are to effectively extend CSR practices to suppliers in such countries.

5.3. Benefits of the Multi-method of Agent-based Simulation with Their Cluster Analyses

Adopting an empirical research combined with an agent-based simulation approach enables us to unearth multifaceted insights. Successfully managing CSR extended to suppliers in emerging countries may require MNE buyers to consider several issues, namely the distribution of CSR levels among suppliers, government policies, and the costs of updating CSR. Specifically, this study draws attention to the importance and effectiveness of MNE buyers extending CSR to suppliers in emerging markets. Cluster analysis can reveal the start-up conditions of the distribution and implementation of CSR practices among suppliers. Because the environment encountered by MNE buyers for extending CSR to suppliers in emerging countries is highly dynamic and continuously evolving, which may affect the

operating conditions, we consider various time-varying situations that are likely to affect the choices made by MNEs for extending CSR. The simulation results help capture and predict the system-level consequences attributable to how and to what degree MNE buyers extend CSR to their suppliers. Therefore, the insights that were developed by the empirical research combined with an agent-based simulation in this study would have been ignored by just looking at the empirical analyses.

5.4. Limitations and Future Research

Although we have taken several precautions, this study still has several limitations in the interpretation of its results. The first is the generalizability of the cluster analysis results based on a survey study of Chinese OEMs. The distribution and implementation levels of clusters in other countries such as Vietnam and Indonesia might differ from the results in our surveyed areas. Considering that some Southeast Asian countries are less costly for implementing CSR practices, MNE buyers increasingly prefer suppliers for development located in low-cost areas. Further survey studies could be conducted to understand the unique distribution and implementation levels of CSR among suppliers in such emerging countries. Nonetheless, the choices (behavioral rules) that we propose for understanding MNE buyers' decision-making for CSR extension to suppliers are still valid, irrespective of the CSR distribution of specific suppliers. Therefore, this study makes a broad contribution to understanding the behaviors of MNE buyers in relation to CSR extension to suppliers in emerging countries.

In the simulation study, we assume a completely mutual agreement that MNEs coordinate with suppliers to determine whether and the degree to which suppliers update their current CSR levels. However, some MNEs might have limited powers to mandate CSR practice improvements for OEM suppliers. Further research is encouraged to investigate the bargaining power between buyers and suppliers (Chen et al. 2015) that may influence a buyer's CSR extension behavior toward suppliers. Our findings suggest that punitive and supportive tactics adopted by governments are effective in influencing MNE buyers' choices of CSR extension to suppliers. However, an investigation into how governments can administer two tactics in a complementary manner to better promote a *Leader*-oriented market for CSR management would be worthwhile for exploring how the sequential timings of

enforcing punitive and supportive policies (first punitive and then supportive or vice versa) affect the outcomes of cluster evolution. Such an investigation may require system dynamics simulation to study causal loops among the influencing factors. Furthermore, because we offer three testable propositions, future research could collect primary or secondary data or conduct case studies to validate these propositions. We hope that this research helps to advance a more profound understanding of the dynamics of MNE buyers' choices of CSR extension to suppliers in emerging countries.

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References

- Adner, R., Polos, L., Ryall, M., & Sorenson, O. (2001). The Case for Formal Theory. *Academy of Management Review*, 34(2), 201-208.
- Aguilera, R. V., & Jackson, G. (2003). The cross-national diversity of corporate governance: Dimensions and determinants. *Academy of management Review*, 28(3), 447-465.
- Aguinis, H., & Glavas, A. (2012). What we know and don't know about corporate social responsibility: A review and research agenda. *Journal of Management*, 38(4), 932-968.
- An update on Trends in Global Sourcing. January 2017. IHS Markit. <https://cdn.ihs.com/www/pdf/IHSMarkit-PNP-GlobalSourcingSurveyResults-2017.pdf>. Last accessed on Feb 14, 2017.
- Arya, A., & Mittendorf, B. (2015). Supply chain consequences of subsidies for corporate social responsibility. *Production and Operations Management*, 24(8), 1346-1357.
- Arya, B., & Zhang, G. (2009). Institutional reforms and investor reactions to CSR announcements: Evidence from an emerging economy. *Journal of Management Studies*, 46(7), 1089-1112.
- Asgary, N., & Li, G. (2016). Corporate Social Responsibility: Its economic impact and link to the bullwhip effect. *Journal of Business Ethics*, 135(4), 665-681.
- Atasu, A., & Wassenhove, L. N. (2012). An operations perspective on product take-back legislation for E-waste: Theory, practice, and research needs. *Production and Operations Management*, 21(3),

407-422.

- Atasu, A., Sarvary, M., & Van Wassenhove, L. N. (2008). Remanufacturing as a marketing strategy. *Management Science*, 54(10), 1731-1746.
- Aulakh, P. S., Rotate, M., & Teegen, H. (2000). Export strategies and performance of firms from emerging economies: Evidence from Brazil, Chile, and Mexico. *Academy of Management Journal*, 43(3), 342-361.
- Bansal, P. (2005). Evolving sustainably: A longitudinal study of corporate sustainable development. *Strategic Management Journal*, 26(3), 197-218.
- Barnett, M. L., & Salomon, R. M. (2006). Beyond dichotomy: The curvilinear relationship between social responsibility and financial performance. *Strategic Management Journal*, 27(11), 1101-1122.
- Barr, P. S. (1998). Adapting to unfamiliar environmental events: A look at the evolution of interpretation and its role in strategic change. *Organization Science*, 9(6), 644-669.
- Baumann-Pauly, D., C. Wickert, L.J. Spence & Scherer, A.G.(2013). Organizing corporate social responsibility in small and large firms: Size matters. *Journal of Business Ethics*, 115 (4), 693-705.
- Bendixen, M., & Abratt, R. (2007). Corporate identity, ethics and reputation in supplier-buyer relationships. *Journal of Business Ethics*, 76(1), 69-82.
- Boström, M. (2015). Between monitoring and trust: Commitment to extended upstream responsibility. *Journal of Business Ethics*, 131(1), 239-255.
- Brammer, S. J., & Pavelin, S. (2006). Corporate reputation and social performance: The importance of fit. *Journal of Management Studies*, 43(3), 435-455.
- Brammer, S., Brooks, C., & Pavelin, S. (2006). Corporate social performance and stock returns: UK evidence from disaggregate measures. *Financial management*, 35(3), 97-116.
- Buhmann, K. (2016). Public regulators and CSR: The 'Social License to Operate' in recent United Nations instruments on business and human rights and the juridification of CSR. *Journal of Business Ethics*, 1-16.
- Carroll, A. B., & Shabana, K. M. (2010). The business case for corporate social responsibility: A review of concepts, research and practice. *International Journal of Management Reviews*, 12(1), 85-105.
- Castelló, I., & Lozano, J. M. (2011). Searching for new forms of legitimacy through corporate responsibility rhetoric. *Journal of Business Ethics*, 100(1), 11-29.
- Chandrasekaran, A., Linderman, K., Sting, F. J., & Benner, M. J. (2015). Managing R&D project shifts in high-tech organizations: A multi-method study. *Production and Operations Management*, 25(3), 390-416.
- Chatterji, A. K., & Toffel, M. W. (2010). How firms respond to being rated. *Strategic Management Journal*. 31(9), 917-945.
- Chen, J., Zhao, X., Lewis, M., & Squire, B. (2015). A Multi-method investigation of buyer power and supplier motivation to share knowledge. *Production and Operations Management*, 25(3), 417-431.

China CSR Map 2017. http://www.chinacsmap.org/Org_Show_EN.asp?ID=694. Last accessed on May 29, 2017.

Christmann, P., & Taylor, G. (2006). Firm self-regulation through international certifiable standards: Determinants of symbolic versus substantive implementation. *Journal of International Business Studies*, 37(6), 863-878.

Corporate Responsibility and Sustainable Economic Development in China: Implications for Business (March 2012). https://www.uschamber.com/sites/default/files/legacy/international/files/17296_China%20Corp%20Social%20Responsibility_Opt.pdf

Cottrill, M. T. (1990). Corporate social responsibility and the marketplace. *Journal of Business Ethics*, 9(9), 723-729.

Crilly, D., Ni, N., & Jiang, Y. (2015). Do-no-harm versus do-good social responsibility: Attributional thinking and the liability of foreignness. *Strategic management journal*, 37(7), 1316-1329.

CSR Activities Utilizing ISO 26000, Fujitsu Group. <http://www.fujitsu.com/cn/en/about/csr/vision/iso26000>. Last accessed on May 29, 2017.
 CSR-China, September 14, 2010. <http://old.csr-china.net/templates/node/index.aspx?nodeid=6f379abb-abe3-46d7-9964-f7f25da70a1f&page=contentpage&contentid=ec4ea990-59b5-4ca1-89b5-2c25da5ead91&l=en>. Last accessed on May 29, 2017.

Dhanorkar, S., Siemsen, E., & Linderman, K. W. (2017). Promoting change from the outside: Directing managerial attention in the implementation of environmental improvements. *Management Science* (in press). DOI: <https://ssrn.com/abstract=289698>.

Fan, D., Lo, C. K., Ching, V., & Kan, C. W. (2014). Occupational health and safety issues in operations management: A systematic and citation network analysis review. *International Journal of Production Economics*, 158, 334-344.

Forbes. August 22, 2016. <http://www.forbes.com/sites/bensin/2016/08/22/the-real-cost-of-the-iphone-7-more-foxconn-worker-deaths/#12907c5661b7>. Last accessed on Jan 31, 2017.

Goss, A., & Roberts, G. S. (2011). The impact of corporate social responsibility on the cost of bank loans. *Journal of Banking & Finance*, 35(7), 1794-1810.

Hahn, R. (2013). ISO 26000 and the standardization of strategic management processes for sustainability and corporate social responsibility. *Business Strategy and the Environment*, 22(7), 442-455.

Hair, J.F., R.E. Anderson, R.L. Tatham & Black, W.C. (2010). *Multivariate Data Analysis*. Seventh ed. New Jersey: Prentice-Hall.

Harjoto, M. A., & Jo, H. (2015). Legal vs. normative CSR: Differential impact on analyst dispersion, stock return volatility, cost of capital, and firm value. *Journal of Business Ethics*, 128(1), 1-20.

Haveman, H. A. (1992). Between a rock and a hard place: Organizational change and performance under conditions of fundamental environmental transformation. *Administrative Science Quarterly*, 37, 48-75.

Hull, C. E., & Rothenberg, S. (2008). Firm performance: The interactions of corporate social performance with innovation and industry differentiation. *Strategic Management Journal*, 29(7),

781-789.

- Humphreys, P.K., M.K. Lai & Sculli, D.(2001), An inter-organizational information system for supply chain management. *International Journal of Production Economics*, 70 (3), 245-255.
- Huq, F. A., Chowdhury, I. N., & Klassen, R. D. (2016). Social management capabilities of multinational buying firms and their emerging market suppliers: An exploratory study of the clothing industry. *Journal of Operations Management*, 46 (September), 19-37.
- Jamali, D., & Karam, C. (2016). Corporate social responsibility in developing countries as an emerging field of study. *International Journal of Management Reviews*. DOI: 10.1111/ijmr.12112.
- Jamali, D., & Neville, B. (2011). Convergence versus divergence of CSR in developing countries: An embedded multi-layered institutional lens. *Journal of Business Ethics*, 102(4), 599-621.
- Khanna, T., & Palepu, K. (1997). Why focused strategies may be wrong for emerging markets. *Harvard Business Review*, 75(4), 41-48.
- Kiessling, T., Isaksson, L., & Yasar, B. (2015). Market orientation and CSR: Performance implications. *Journal of Business Ethics*, 1-16.
- Klassen, R. D., & McLaughlin, C. P. (1996). The impact of environmental management on firm performance. *Management Science*, 42(8), 1199-1214.
- Krass, D., Nedorezov, T., & Ovchinnikov, A. (2013). Environmental taxes and the choice of green technology. *Production and Operations Management*, 22(5), 1035-1055.
- Letizia, P., & Hendrikse, G. (2016). Supply chain structure incentives for corporate social responsibility: An incomplete contracting analysis. *Production and Operations Management*, 25(11), 1919-1941.
- Linderman, K., Chandrasekaran, A., & Sting, F. (2017). Call for papers: Combining Simulation and Empirical Research Methods in Operations Management. <https://www.journals.elsevier.com/journal-of-operations-management/call-for-papers/call-for-papers-combining-simulation-and-empirical-research>. Last accessed on Feb 13, 2017.
- McWilliams, A., & Siegel, D. (2001). Corporate social responsibility: A theory of the firm perspective. *Academy of Management Review*, 26(1), 117-127.
- Muller, A., & Kolk, A. (2009). CSR performance in emerging markets evidence from Mexico. *Journal of Business Ethics*, 85, 325-337.
- Office of the United State Trade Representative: <https://ustr.gov/countries-regions/china-mongolia-taiwan/peoples-republic-china>. Last accessed on Jan 19, 2017.
- Pedersen, E. R., & Andersen, M. (2006). Safeguarding corporate social responsibility (CSR) in global supply chains: how codes of conduct are managed in buyer-supplier relationships. *Journal of Public Affairs*, 6(3-4), 228-240.
- Peloza, J. (2009). The challenge of measuring financial impacts from investments in corporate social performance. *Journal of Management*, 35(6), 1518-1541.
- Porteous, A. H., Rammohan, S. V., & Lee, H. L. (2015). Carrots or sticks? Improving social and environmental compliance at suppliers through incentives and penalties. *Production and*

Operations Management, 24(9), 1402-1413.

Plambeck, E. L., & Taylor, T. A. (2015). Supplier evasion of a buyer's audit: Implications for motivating supplier social and environmental responsibility. *Manufacturing & Service Operations Management*, 18(2), 184-197.

Public Policy and the Promotion of Corporate Social Responsibility, 2009. https://www.bsr.org/reports/Public_Policy_Promotion_of_CSR.pdf. Last accessed on Jan 31, 2017.

Rahmandad, H., & Sterman, J. (2008). Heterogeneity and network structure in the dynamics of diffusion: Comparing agent-based and differential equation models. *Management Science*, 54(5), 998-1014.

Reimann, F., Rauer, J., & Kaufmann, L. (2015). MNE subsidiaries' strategic commitment to CSR in emerging economies: The role of administrative distance, subsidiary size, and experience in the host country. *Journal of Business Ethics*, 132(4), 845-857.

Rezaei, J., Nispeling, T., Sarkis, J., & Tavasszy, L. (2016). A supplier selection life cycle approach integrating traditional and environmental criteria using the best worst method. *Journal of Cleaner Production*, 135, 577-588.

Ruamsook, K., Russell, D., & Thomchick, E. (2007). US sourcing from low-cost countries: A comparative analysis of supplier performance. *Journal of Supply Chain Management*, 43(4), 16-30.

Scherer, A. G., & Palazzo, G. (2011). The new political role of business in a globalized world: A review of a new perspective on CSR and its implications for the firm, governance, and democracy. *Journal of Management Studies*, 48(4), 899-931.

Sharma, S., & Henriques, I. (2005). Stakeholder influences on sustainability practices in the Canadian forest products industry. *Strategic Management Journal*, 26(2), 159-180.

Tang, Z., Hull, C. E., & Rothenberg, S. (2012). How corporate social responsibility engagement strategy moderates the CSR–financial performance relationship. *Journal of Management Studies*, 49(7), 1274-1303.

Tenbrunsel, A. E., Wade-Benzoni, K. A., Messick, D. M., & Bazerman, M. H. (2000). Understanding the influence of environmental standards on judgments and choices. *Academy of Management Journal*, 43(5), 854-866.

Tesfatsion, L. (2003). Agent-based computational economics: modeling economies as complex adaptive systems. *Information Sciences*, 149(4), 262-268.

Turban, D. B., & Greening, D. W. (1997). Corporate social performance and organizational attractiveness to prospective employees. *Academy of Management Journal*, 40(3), 658-672.

Vallentin, S. (2015). Governmentalities of CSR: Danish government policy as a reflection of political difference. *Journal of Business Ethics*, 127(1), 33-47.

Williams, C. A., & Aguilera, R. V. (2008). Corporate social responsibility in a comparative perspective. In A. Crane, A. McWilliams, D. Matten, J. Moon, & D. S. Siegel (Eds.), *The Oxford Handbook of Corporate Social Responsibility*: 452-472. New York: Oxford University Press.

Wu, Z., Ellram, L. M., & Schuchard, R. (2014). Understanding the role of government and buyers in supplier energy efficiency initiatives. *Journal of Supply Chain Management*, 50(2), 84-105.

Yeung, A. C. L., Chan, L. Y., & Lee, T. S. (2003). An empirical taxonomy for quality management systems: a study of the Hong Kong electronics industry. *Journal of Operations Management*, 21(1), 45-62.

Yin, J. L., & Jamali, D. (2016). Strategic Corporate Social Responsibility of Multinational Companies Subsidiaries in Emerging Markets: Evidence from China. *Long Range Planning*, 49(5), 541-558.

Yin, J., & Zhang, Y. (2012). Institutional dynamics and corporate social responsibility (CSR) in an emerging country context: Evidence from China. *Journal of Business Ethics*, 111(2), 301-316.

Zhao, J. (2014). *Corporate social responsibility in contemporary China*. Edward Elgar Publishing.

Zhu, Q. H., Liu, J. J., & Lai, K. H. (2016). Corporate social responsibility practices and performance improvement among Chinese national state-owned enterprises. *International Journal of Production Economics*, 171(3), 417-426.

Zhu, Q., & Zhang, Q. (2015). Evaluating practices and drivers of corporate social responsibility: The Chinese context. *Journal of Cleaner Production*, 100 (August), 315-324.

Table 1. Literature Review of Selected CSR Topics and Research Gaps

	Focus			
Level of analysis	Heterogeneous levels of CSR implementation	CSR implementation costs and benefits	Extending CSR to suppliers: Buyer-supplier relationship	The role of stakeholder on CSR management
Organization (Firm/regulator)	Bansal (2005); Castelló and Lozano (2011); Crilly et al. (2015); Huq et al. (2016)	Brammer et al. (2006); Goss and Roberts (2011); McWilliams and Siegel (2001); Peloza (2009)		Aguilera and Jackson (2003); Buhmann (2016); Williams and Aguilera (2008); Vallentin (2015)
Dyad (relationship)			Bendixen and Abratt (2007); Boström (2015); Letizia and Hendrikse (2016); Pedersen and Andersen (2006); Plambeck and Taylor (2015); Rezaei et al. (2016)	Arya and Mittendorf (2015); Wu et al. (2014); Yin and Jamali (2016)
System (multi-agent/dynamics)	Research gap addressed by this study			

Table 2. Cluster Analysis: MANOVA Results of CSR Practices

CSR practice	Cluster 1: <i>Leaders</i> (n=62)	Cluster 2: <i>Followers</i> (n=100)	Cluster 3: <i>Laggards</i> (n=37)	Total (n=199)	<i>F</i>
ECC(CSR1)	4.82 (0.23)	4.33 (0.51)	3.75 (0.74)	4.37 (0.62)	55.02***
Empl(CSR2)	4.62 (0.46)	3.82 (0.72)	2.70 (0.89)	3.86 (0.95)	96.92***
Com(CSR3)	4.57 (0.47)	3.50 (0.77)	2.29 (0.81)	3.61 (1.05)	37.92***
Envi(CSR4)	4.65 (0.44)	3.91 (0.55)	2.69 (0.75)	3.91 (0.87)	83.37***
Tests	Value	Between groups <i>d.f.</i>	<i>F</i>	Within groups <i>d.f.</i>	<i>p</i>
Pillai's Trace	0.87	8	37.23	388	0.000***
Wilks' Lambda	0.15	8	78.17	386	0.000***
CSR practices	Sum of square	Mean square	<i>d.f.</i>	<i>F</i>	<i>p</i>
ECC (CSR1)	75.42	13.33	2	53.59	0.000***
Empl (CSR2)	177.83	42.80	2	90.95	0.000***
Com (CSR3)	218.77	61.68	2	126.72	0.000***
Envi (CSR4)	151.46	44.51	2	139.72	0.000***

** $p < 0.01$;

*** $p < 0.001$;

Standard errors appear in parentheses.

Table 3. Which Policy Is More Effective: Punitive Versus Supportive Tactics

Penalty	Subsidy	Inspection rate = 0.2			Inspection rate = 0.6			Inspection rate = 1.0		
		Laggards % (Penalty)	Laggards % (Subsidy)	Subsidy is more effective?	Laggards % (Penalty)	Laggards % (Subsidy)	Subsidy is more effective?	Laggards % (Penalty)	Laggards % (Subsidy)	Subsidy is more effective?
0.1	0.1	0.977	0.992	No	0.882	0.992	No	0.688	0.992	No
0.2	0.2	0.950	0.957	No	0.912	0.957	No	0.568	0.957	No
0.3	0.3	0.967	0.982	No	0.864	0.982	No	0.495	0.982	No
0.4	0.4	0.910	0.967	No	0.852	0.967	No	0.324	0.967	No
0.5	0.5	0.977	0.905	Yes	0.867	0.905	No	0.269	0.905	No
0.6	0.6	0.967	0.955	Yes	0.872	0.955	No	0.188	0.955	No
0.7	0.7	0.980	0.905	Yes	0.784	0.905	No	0.158	0.905	No
0.8	0.8	0.962	0.942	Yes	0.784	0.942	No	0.126	0.942	No
0.9	0.9	0.952	0.628	Yes	0.714	0.628	Yes	0.113	0.628	No
1	1	0.957	0.296	Yes	0.704	0.296	Yes	0.128	0.296	No
1.1	1.1	0.947	0.204	Yes	0.661	0.204	Yes	0.121	0.204	No
1.2	1.2	0.975	0.209	Yes	0.565	0.209	Yes	0.128	0.209	No
1.3	1.3	0.960	0.294	Yes	0.543	0.294	Yes	0.126	0.294	No
1.4	1.4	0.965	0.294	Yes	0.472	0.294	Yes	0.126	0.294	No
1.5	1.5	0.945	0.168	Yes	0.372	0.168	Yes	0.121	0.168	No
1.6	1.6	0.935	0.088	Yes	0.271	0.088	Yes	0.118	0.088	Yes
1.7	1.7	0.965	0.055	Yes	0.204	0.055	Yes	0.133	0.055	Yes
1.8	1.8	0.960	0.033	Yes	0.173	0.033	Yes	0.126	0.033	Yes
1.9	1.9	0.950	0.013	Yes	0.196	0.013	Yes	0.123	0.013	Yes
2	2	0.960	0.000	Yes	0.161	0.000	Yes	0.131	0.000	Yes

Note. This table only shows part of the simulation results (inspection rates = 0.2, 0.6, and 1.0). The simulated scenarios with other inspection rates are consistent with the increasing threshold trends (highlighted in shadows). Subsidy is more effective than penalty when the proportion of *Laggards* under the penalty scheme is greater than the proportion of *Laggards* under the subsidy scheme.

Figure 1. Multi-method Research Framework

Figure 2. Corporate Financial and Social Performance and CSR Implementation Level

Figure 3. Simulation Flow Chart

Figure 4. Simulation System Dynmaics

Figure 5. Impact of Upgrading and Saving Cost on Cluster Evolution

Figure 6. Impact of Penalty (penalty without subsidy)⁴ and Inspection Rate on Cluster Evolution

Figure 7. Penalty Imposed only on One Dimension of CSR Practice

⁴ In Figure 6 (left), we include all four dimensions of CSR (i.e., ECC, Empl, Com, and Envi) and they are treated equally important (equivalent value of the penalty for each dimension) in the simulation. To better show the changing trend of three clusters in an aggregated manner, we enlarge the range of the penalty to 0-30. We thank one reviewer for suggesting separating the four dimensions to examine the impact of penalty imposed only on a single dimension of CSR practice (see Figure 7).

Figure 8. Impact of Government Subsidy on Cluster Evolution

Figure 9. Which Policy is More Effective: Punitive Versus Supportive Tactics

Figure 10. Switching of Government Policy in a Sequential Time Series (Scenario A: left; Scenario B: right)

Appendix A: Rotated Component Matrix on CSR Practices

Items	Factors			
	1	2	3	4
1. Make continuous efforts to investigate situation guaranteeing employee rights	.252	<u>.827</u>	.227	.188
2. Develop processes to control potential events related to employee rights infringement	.197	<u>.815</u>	.294	.184
3. Establish rules to avoid employee rights infringement	.322	<u>.809</u>	.136	.133
4. Strengthen communication among all employees to resolve grievance	.526	<u>.659</u>	.041	.166
5. Respect employment and employment relationships	<u>.736</u>	.168	.037	.065
6. Guarantee employees' health and safety at work	<u>.654</u>	.082	.032	.375
7. Establish a professional health and safety management system	<u>.538</u>	.214	.108	.442
8. Make efforts on pollution prevention	.391	.218	.202	<u>.654</u>
9. Make efforts on energy saving	.072	.074	.088	<u>.553</u>
10. Make effort on protection of the environment, biodiversity, and restoration of natural habitats	.374	.239	.161	<u>.702</u>
11. Increase environmental investment to improve work processes	.085	.068	.347	<u>.658</u>
12. Maintain fair competition	<u>.613</u>	.257	.124	.299
13. Respect for protection of intellectual property	<u>.722</u>	.137	.126	.164
14. Respect rights for indigenous people	<u>.743</u>	.087	.193	.099
15. Implement fair marketing practices with factual and unbiased information	<u>.825</u>	.183	.106	.197
16. Implement fair contractual practices	<u>.828</u>	.200	.141	.103
17. Make products that protect consumers' health and safety	<u>.804</u>	.174	.137	.093
18. Make products that emphasize sustainable consumption meeting the requirements of energy saving and pollution reduction	<u>.716</u>	.192	.199	.247
19. Provide service and support for consumers, especially for complaints and dispute resolution	<u>.806</u>	.169	.108	.032
20. Guarantee consumer data protection and privacy	<u>.828</u>	.104	.110	.070
21. Participate in and support development of a local community	.119	.069	<u>.842</u>	.147
22. Support local community's culture and education development	.179	.045	<u>.851</u>	.127
23. Consider local employment needs in company's human resources strategy	.205	.210	<u>.781</u>	.076
24. Make effort for technology development and access by cooperation with governments, companies, universities, and research institutions in a local community	-.020	.089	<u>.814</u>	.127
25. Avoid health damage to a local community	.424	.073	<u>.602</u>	.145
26. Support promotion of health situation in a local community	.198	.145	<u>.783</u>	.123
27. Invest resources in initiatives and programs aimed at improving social aspects of community life	-.004	.151	<u>.823</u>	.149

Note: Extraction method: principal component analysis; rotation method: varimax with Kaiser Normalization. Rotation converged in six iterations.

Appendix B: MNE Buyers' CSR Extension to Suppliers.

Signs

Ω : An OEM cluster.

i : Cluster $i, i \in \{1, 2, 3\}$. The CSR performance of OEMs, cluster 1 > cluster 2 > cluster 3.

$\Phi_{Leaders}, \Phi_{Followers}, \Phi_{Laggards}$, the sets for OEM *Leaders*, *Followers*, and *Laggards* clusters.

ω_j : The weight for each dimension to assess the CSR performance of an OEM, $j \in \{1, 2, \dots, m\}$.

μ_i : The mean CSR level of OEMs in Cluster i , and.

$$\mu_i = \sum_{i \in \{1, 2, 3\}} \frac{\omega_1 ECC_i + \omega_2 Empl_i + \omega_3 Com_i + \omega_4 Envi_i}{\text{Number of OEMs in Cluster } i}$$

w_i : The proportion of OEMs with CSR Level i .

There are four dimensions for evaluating CSR performance in this study.

50 MNEs (20% smart MNEs and 80% ordinary MNEs). The major difference between the two types of MNEs refers to the *expected benefits* that they perceive. An MNE follows the steps below to make choices in CSR extension to their OEM suppliers.

Step 1: Select an OEM randomly (OEM i selected);

Step 2: Compare the benefit of coordinating with OEM i (benefit i) with the *expected benefit* (see note on how it is estimated);

Step 3: If current benefit i is greater than the *expected benefit*, then select OEM i in this iteration, otherwise, select another OEM j randomly and repeat step 2 until benefit j is greater than the *expected benefit*.

Note: the maximal OEM selection trial number is five, if all the five trials' benefit j s are smaller than the *expected benefit*, select the OEM with the largest value of benefit j among the five benefit j s.

For the *smart* MNEs (20%), the *expected benefit (smart)* = $w_{Laggards} \times \mu_{Laggards} + w_{Followers} \times \mu_{Followers} + w_{Leaders} \times \mu_{Leaders}$;

where $w_{Laggards} = |\Phi_{Laggards}|/n$; $w_{Followers} = |\Phi_{Followers}|/n$; $w_{Leaders} = |\Phi_{Leaders}|/n$; $\mu_{Laggards}$ = average CSR in $\Phi_{Laggards}$; $\mu_{Followers}$ = average CSR in $\Phi_{Followers}$; $\mu_{Leaders}$ = average CSR in $\Phi_{Leaders}$.

For the *ordinary* MNEs (80%), *expected benefit (ordinary)* $= \frac{1}{3} \times \bar{\mu}_{Laggards} + \frac{1}{3} \times \bar{\mu}_{Followers} + \frac{1}{3} \times \bar{\mu}_{Leaders}$;

where $\bar{\mu}_{Laggards}, \bar{\mu}_{Followers}, \bar{\mu}_{Leaders}$ are the initial average CSR levels for the three clusters.

Appendix C: Cost-benefit Functions for Upgrading/ Downgrading/Remaining CSR (The Behavioral Rules for MNE Buyers' choices in CSR Extension to Suppliers)

CSR Benefit-Cost Functions

$\prod(CSR_{t=T})$: The benefit for an MNE at moment $t = T$, which is a function of three variables.

That is, CSR level of the OME, government penalty/subsidy and CSR upgrading cost/downgrading saving.

$f(CSR_{t=T}) = f(ECC, Empl, Com, Envi) = \underbrace{\omega_1 ECC + \omega_2 Empl + \omega_3 Com + \omega_4 Envi}_{CSR\ Level\ t=T}$. It is a

function of CSR at moment $t = T$.

$P_{ECC}, P_{Empl}, P_{Com}, P_{Envi}$: Government inspection rate on each dimension (probability of monitoring towards four dimensions for evaluating CSR performance), and $P_{ECC}, P_{Empl}, P_{Com}, P_{Envi} \in [0,1]$.

The four inspection rates are *independent identically distributed*.

$P = P_{ECC} + P_{Empl} + P_{Com} + P_{Envi}$: the overall government inspection rate.

s_g : Government subsidy granted for the *Leader* OEMs and their MNE partners.

$c_{ECC_penalty}, c_{Empl_penalty}, c_{Com_penalty}, c_{Envi_penalty}$: Penalties to OEMs in the *Laggard* cluster and their MNE partners. It is considered as a risk (with inspection rates $P_{ECC}, P_{Empl}, P_{Com}, P_{Envi}$).

$c_{CSR_improving}$: The cost of CSR improving/upgrading.

$c_{CSR_cost_saving}$: Cost saving due to CSR downgrading.

Simulation Model Development

Cost-benefit Models

For each MNE, there are at most three options in extending CSR to suppliers: upgrading the CSR level of a supplier to a higher level, remain its current CSR level unchanged, downgrading its CSR level to a lower level. In the simulation, an MNE would compare among the three options and choose the one that maximizes the cost-benefit function.

For OEM in *Leaders* Cluster:

- 1) Remain its CSR level unchanged

$$\prod(CSR_{t=T}) = f(CSR_{t=T+1}) + S_G + \varepsilon \text{ and } CSR_{t=T} = CSR_{t=T+1}$$

- 2) Downgrading its CSR level into Laggards cluster, its CSR level has been changed from $CSR_{t=T}$ to $CSR_{t=T+1}$

$$\prod(CSR_{t=T+1}) = f(\mu_2) \times \left(1 - \sum_{k \in \{ECC, Empl, Com, Envi\}} P_k\right) + f(CSR_{t=T}) - \sum_{k \in \{ECC, Empl, Com, Envi\}} P_k c_{k_penalty} + (CSR_{t=T} - CSR_{t=T+1}) \times c_{CSR_cost_saving} + \varepsilon$$

Note that OEM *pretends* that it belongs to cluster 2 (it pretends that its CSR level meets the *Do-no-*

harm level criterion), and it can be successful with probability $1 - \sum_{k \in \{ECC, Empl, Com, Envi\}} P_k$, failed with

probability $\sum_{k \in \{ECC, Empl, Com, Envi\}} P_k$ (end up with being inspected and caught).

$$\mu_2 = \sum_{j \in \text{Cluster 2}} \frac{CSR_j}{\text{Amount of Cluster 2}}$$

Its CSR level $CSR_{t=T}$ remain unchanged where ε is a random error.

- 3) Downgrading its CSR level into Followers cluster, its CSR level has been changed from $CSR_{t=T}$ to $CSR_{t=T+1}$

$$\prod(CSR_{t=T+1}) = f(CSR_{t=T+1}) + (CSR_{t=T} - CSR_{t=T+1}) \times c_{CSR_cost_saving} + \varepsilon$$

For OEM in *Followers* Cluster:

- 1) Remain its CSR level unchanged

$$\prod(CSR_{t=T}) = f(CSR_{t=T}) + \varepsilon \text{ and } CSR_{t=T} = CSR_{t=T+1}$$

- 2) Upgrading its CSR level into *Leaders* cluster, its CSR level has been changed from $CSR_{t=T}$ to

$$CSR_{t=T+1}$$

$$\prod(CSR_{t=T+1}) = f(CSR_{t=T+1}) - (CSR_{t=T+1} - CSR_{t=T}) \times c_{CSR_improving} + S_G + \varepsilon$$

- 3) Downgrading its CSR level into *Laggards* cluster, its CSR level has been changed from $CSR_{t=T}$

$$\text{to } CSR_{t=T+1}$$

$$\prod(CSR_{t=T+1}) = f(\mu_2) \times \left(1 - \sum_{k \in \{ECC, Empl, Com, Envi\}} P_k \right) + f(CSR_{t=T}) - \sum_{k \in \{ECC, Empl, Com, Envi\}} P_k c_{k_penalty} + (CSR_{t=T} - CSR_{t=T+1}) \times c_{CSR_cost_saving} + \varepsilon$$

For OEM in *Laggard* Cluster:

- 1) Remain its CSR level unchanged

$$\prod(CSR_{t=T}) = f(\mu_2) \times \left(1 - \sum_{k \in \{ECC, Empl, Com, Envi\}} P_k \right) + f(CSR_{t=T}) - \sum_{k \in \{ECC, Empl, Com, Envi\}} P_k c_{k_penalty} + \varepsilon \text{ and}$$

$$CSR_{t=T} = CSR_{t=T+1}$$

- 2) Upgrading its CSR level to *Followers* cluster. As a result, its CSR level has been changed from

$$CSR_{t=T} \text{ to } CSR_{t=T+1}$$

$$\prod(CSR_{t=T+1}) = f(CSR_{t=T+1}) - (CSR_{t=T+1} - CSR_{t=T}) \times c_{CSR_improving} + \varepsilon$$

Note that $CSR_{t=T+1}$ is a random CSR implementation level variable in *Followers* cluster.

- 3) Upgrading its CSR level into *leaders* cluster, its CSR level has been changed from $CSR_{t=T}$ to

$$CSR_{t=T+1}$$

$$\prod(CSR_{t=T+1}) = f(CSR_{t=T+1}) - (CSR_{t=T+1} - CSR_{t=T}) \times c_{CSR_improving} + S_G + \varepsilon$$

Note that $CSR_{t=T+1}$ is a random CSR implementation level variable in *Leaders* cluster and S_G is the government subsidy.

Appendix D: Pseudo-code for Multi-agent Simulation

Require p_{ecc} (punishment for Ecc), p_{empl} (punishment for Empl), p_{com} (punishment for Com), p_{envi} (punishment for Envi), r (inspection rate), r_{csr} (inspection intensity for Ecc, Empl, Com, and, Envi), s (subsidy amount), $c_{improve}$ (CSR improving cost), $c_{degrade}$ (CSR degrading saving), m (number of MNEs), n (number of OEMs), w_s (smart MNE percentage), it (number of iterations), τ (MNE maximal OEM selection trial number).

Create $\Phi_{Laggards}$, $\Phi_{Followers}$, $\Phi_{Leaders}$, the sets for OEM laggards, Followers, and leaders clusters, respectively. Let $\bar{\mu}_{Laggards}$, $\bar{\mu}_{Followers}$, $\bar{\mu}_{Leaders}$, be initial average CSR levels for the above 3 clusters. Create Θ , the set of MNEs and initialize it by $\lfloor m \times w_s \rfloor$ smart MNEs and $(m - \lfloor m \times w_s \rfloor)$ other MNEs.

```

for i = 1 to it do
    Create  $\Lambda$ , the set of available OEMs in the current iteration;
    Create  $Y$ , the set of paused OEMs (i.e., the OEMs who have been inspected and penalized in
    previous iteration) in the current iteration;
    for mne in  $\Theta$  do
        for t = 1 to  $\tau$  do
            oem = random selection from  $\Lambda$ ;
            new_cluster, best_benefit, csr_target = oem.STEP();
            if best_benefit >= mne.EXPECTED_BENEFIT() then
                Select oem as the cooperating OEM for mne;
                Record the oem in the memory M;
                break;
            else
                Record the current oem and its best_benefit in the memory M;
            end if
        end for
        Select the OEM in M with the maximal best_benefit;
        Remove the selected OEM from  $\Lambda$ ;
    end for
    for oem in  $Y$  do
        if oem is paused by Ecc inspection then
            Upgrade oem's Ecc;
        End if
        if oem is paused by Empl inspection then
            Upgrade oem's Empl;
        End if
        if oem is paused by Com inspection then

```

```

        Upgrade oem's Com;
    End if
    if oem is paused by Envi inspection then
        Upgrade oem's Envi;
    End if
    Remove oem from Y;
end for
Create  $\Gamma$ , the set of selected OEMs by MNEs;
for oem in  $\Gamma$  do
    if oem is in  $\Phi_{Laggards}$  then
        Select which CSR dimension to inspect based on  $r_{CSR}$ ;
         $t$  = selected CSR dimension;
         $\kappa$  = random sample from [0, 1];
        if  $\kappa \leq r$  then
            Mark oem as paused OEM;
            Mark oem is paused by CSR dimension  $t$ ;
        end if
    end if
end for
for mne in  $\theta$  do
    Mark mne's coupled OEM as NULL;
    if mne is a smart MNE then:
        Update its global OEM information, i.e., each cluster's distribution and average
        CSR level;
    end if
end for
Update  $\Phi_{Laggards}$ ,  $\Phi_{Followers}$ ,  $\Phi_{Leaders}$ ;
end for

MNE.EXPECTED_BENEFIT()
If MNE is smart then
     $w_{Laggards} = |\Phi_{Laggards}|/n$ ;
     $w_{Followers} = |\Phi_{Followers}|/n$ ;
     $w_{Leader} = |\Phi_{Leader}|/n$ ;
     $\mu_{Laggards}$  = average CSR in  $\Phi_{Laggards}$ ;
     $\mu_{Followers}$  = average CSR in  $\Phi_{Followers}$ ;
     $\mu_{Leader}$  = average CSR in  $\Phi_{Leader}$ ;
    return  $w_{Laggards} \times \mu_{Laggards} + w_{Followers} \times \mu_{Followers} + w_{Leaders} \times \mu_{Leader}$ ;
else
    return  $\frac{1}{3} \times \bar{\mu}_{Laggards} + \frac{1}{3} \times \bar{\mu}_{Followers} + \frac{1}{3} \times \bar{\mu}_{Leaders}$ ;
end if

```

OEM.STEP()

Let $\alpha = []$;

Let $\beta = []$;

Let punishment $p = r_{csr}[0] \times p_{ecc} + r_{csr}[1] \times p_{empl} + r_{csr}[2] \times p_{com} + r_{csr}[3] \times p_{envi}$;

if OEM is in $\Phi_{Laggards}$ **then**

// remain in Laggards cluster

α appends $f(\mu_{Followers}) \times (1 - r) + (f(OEM.CSR) - p) \times r + \xi$;

β appends OEM.CSR;

// upgrade to Followers cluster

target = **OEM.PEEK**(Followers);

α appends $f(target) - (target - OEM.CSR) \times c_{improve} + \xi$;

β appends target;

// upgrade to Leader cluster

target = **OEM.PEEK**(Leader);

α appends $f(target) - (target - OEM.CSR) \times c_{improve} + s + \xi$;

β appends target;

end if

if OEM is in $\Phi_{Followers}$ **then**

// degrade to Laggards cluster

target = **OEM.PEEK**(Laggards);

α appends $f(\mu_{Followers}) \times (1 - r) + (f(target) - p) \times r + (OEM.CSR - target) \times c_{degrade} + \xi$;

β appends target;

// remain in Followers cluster

α appends $f(OEM.CSR) + \xi$;

β appends OEM.CSR;

// upgrade to Leader cluster

target = **OEM.PEEK**(Leader);

α appends $f(target) - (target - OEM.CSR) \times c_{improve} + s + \xi$;

β appends target;

end if

if OEM is in Φ_{Leader} **then**

// degrade to Laggards cluster

target = **OEM.PEEK**(Laggards);

α appends $f(\mu_{Followers}) \times (1 - r) + (f(target) - p) \times r + (OEM.CSR - target) \times c_{degrade} + \xi$;

β appends target;

// degrade to Followers cluster

target = **OEM.PEEK**(Followers);

α appends $f(target) + (OEM.CSR - target) \times c_{degrade} + \xi$;

β appends target;

// remain in Leader cluster

```

         $\alpha$  appends  $f(OEM.CSR) + s + \xi$ ;
         $\beta$  appends OEM.CSR;
    end if
    Get the index  $\eta$  whose corresponding element in  $\alpha$  is the maximum;
    return  $\eta, \alpha[\eta], \beta[\eta]$ ;

OEM.PEEK(v)
    if  $\Phi_v$  is empty then
        return OEM.CSR;
    else
        low = the minimal CSR in  $\Phi_v$ ;
        high = the maximal CSR in  $\Phi_v$ ;
        return random draw from U(low, high);
    end if

```