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Abstract. *Problem definition*: In this paper, we explore how a firm's concern about profit distribution and the size of downstream firms in supply chains affect corporate social responsibility (CSR) investment strategy. *Methodology/results*: In a supply chain consisting of one supplier and one manufacturer, both players decide whether to invest to reduce CSR violations, and they negotiate over a wholesale price. Distributive comparison behavior makes the manufacturer compare the profit with his equitable payoff, which is determined by the supplier's profit. Advantageous (resp. disadvantageous) inequality occurs when the manufacturer's profit is higher (resp. lower) than the manufacturer's equitable payoff. We compare this supply chain to the one without distributive comparison behavior. We find that when advantageous inequality occurs, or when neither inequality occurs and the manufacturer's sensitivity to the supplier's profit is low, the manufacturer's distributive comparison behavior makes the manufacturer less (resp. supplier more) likely to invest in CSR, which we call negative (resp. positive) impacts of distributive comparison behavior; otherwise, it makes the manufacturer more (resp. supplier less) likely to invest. In most cases, the weak bargaining power of the small manufacturer leads to larger positive or smaller negative impacts of distributive comparison behavior. Also, the low efficiency of the small manufacturer to reduce CSR violations leads to smaller negative impacts of distributive comparison behavior. *Managerial implications*: Our results show that governments and nongovernmental organizations (NGOs) should investigate firms' distributive comparison behavior in supply chains. When downstream firms show the aversion to lower (resp. higher) profits than ones from upstream firms, the measures to monitor and support upstream (resp. downstream) firms' CSR investments should be taken to avoid CSR violations. In the supply chains with small downstream firms, extra efforts should be made to induce firms' distributive comparison behavior.

1. Introduction

Corporate social responsibility (CSR) has become a clear priority for many firms. Supply chain managers and executives seek to align CSR with their business goals, missions, or values. Firms are more energized to improve their CSR when they realize that their brand images and market shares may be affected if their products are not environmentally friendly or associated with socially harmful activities (Besiou and Van Wassenhove 2015). Consumers are increasingly willing to

pay more for socially responsible products and they have an intrinsic desire to expect socially responsible behavior from firms (Iyer and Soberman 2016). A survey from PwC reveals that 47% of consumers are willing to choose sustainable products in 2021, up from 35% in 2019 (PwC 2021).

To improve CSR in a supply chain, it requires efforts from all supply chain members. Even though some firms are devoted to improving CSR, there have been frequent CSR violations in recent years. For example, in

order to reduce CSR violations in its supply chain, Tesla invests in innovative approaches to limit packaging and reduce waste (Tesla 2020). However, Capchem, which supplies lithium batteries for Tesla, discharged wastewater containing chemical oxygen demand exceeding the legal standard (IPE 2021). P&G commits to provide sustainable products, and the company proclaims to fight PM2.5 that causes serious environmental issues in China. However, Xingfa, one of P&G's suppliers, discharged sulfur dioxide exceeding emission standards over the past few years (IPE 2017). Such CSR violations not only harm the public but also raise suspicion toward the CSR commitments of the firms, such as Tesla and P&G, causing reputation loss, widespread protests, and even financial loss (Guo et al. 2016, Chen and Lee 2017, Cho et al. 2019, Hua and Spier 2020).

The joint effort required by CSR may lead to firms' concerns about the fairness in the distribution of the benefit generated from their efforts. Such concern is considered as one common type of comparison behavior in the literature, which has been shown to play an important role in business-to-business transactions (Kahneman et al. 1986, Anderson and Weitz 1992, Corsten and Kumar 2005). Sanfey et al. (2003) stated that a basic sense of fairness and unfairness is essential to societal and personal decision-making. Besides, the decision-makers, who have distributive fairness, are not only averse to receiving fewer outcomes than others, that is, *disadvantageous inequality aversion*, but also averse to receiving more outcomes than others, that is, *advantageous inequality aversion*. For example, according to the survey of car dealerships in the United States and The Netherlands, Kumar et al. (1995) showed that distributive fairness impacts the profit distribution between the upstream and downstream firms, and it is a significant determinant of the quality of channel relationships. Another survey, including 417 American auto dealers and 289 Dutch auto dealers in Scheer et al. (2003), indicated that auto dealers have concerns for distributive fairness with their business partners. Companies such as Starbucks have introduced various initiatives to ensure fairness in their supply chains (Chen et al. 2022). Because distributive fairness affects the profit distribution among supply chain members, it will determine firms' CSR strategies.

Previous research about CSR has focused mainly on large downstream firms (e.g., Tesla and P&G), whereas there is a strong need to understand the role of small downstream firms in CSR as they become more and more important (Baumann-Pauly et al. 2013, SMEC 2013, European Commission 2019, CSRhub 2021). On the one hand, an increasing number of small firms have endeavored to improve CSR. For example, small firms in Singapore such as Givo, Active Global Caregivers, and Happy Marketer undertake multiple CSR initiatives (Shiao 2017). Similarly, small firms in Ireland such as

Achill Island Sea Salt, the Q Café Company, and the Little Milk Company are reported to maintain a high level of CSR (CSRhub 2021). On the other hand, some factors make small firms unwilling to invest in CSR. For example, small firms have weak power in supply chains (SMEC 2013). Small firms may lack the knowledge to manage social responsibility efficiently (Tilley 1999, SMEC 2013). Some managers of small firms believe that the social and environmental impacts of their firms are negligible (Petts et al. 1999). Despite small firms' different attitudes toward CSR investments, there has been little research evaluating small firms' CSR investment strategies in supply chains. Furthermore, it has been shown that small firms are particularly concerned about fairness and desire to be treated fairly by their supply chain partners (Anderson and Weitz 1992, Kumar et al. 1995).

Our specific research questions are as follows: (Q1) What are the impacts of distributive comparison behavior on CSR investment strategy in a supply chain? (Q2) How does the difference between large and small downstream firms affect the answer to the first question?

To address these questions, we develop a game-theoretical model of a supply chain in which one manufacturer sources a critical component from one supplier to make the product. The game has two stages. In stage 1, both players decide whether to invest in CSR or not, and CSR investments can reduce the probability of CSR violations. In stage 2, the manufacturer decides the order quantity of the critical component first. Then the two players negotiate over the wholesale price. If they reach an agreement, the transaction between them happens, and otherwise, there is no transaction. Consumers are heterogeneous, and each derives a utility from product use, which is determined by the consumer type, but suffers disutility when there are CSR violations. In our base model, we consider that the manufacturer has distributive comparison behavior. Distributive comparison behavior makes the manufacturer concern the difference between the profit from sales and *equitable payoff*. The equitable payoff is defined as the *fairness ideal* times the supplier's profit from sales, where the fairness ideal describes the manufacturer's sensitivity to the supplier's profit. When the manufacturer's profit from sales is more (resp. less) than the equitable payoff, advantageous (resp. disadvantageous) inequality occurs. We compare this base model with the supply chain without distributive comparison behavior. To analyze the role of small firms in CSR, we compare the results under a large manufacturer with those under a small manufacturer. The large and small manufacturers differ in their bargaining powers or efficiencies to reduce the probability of CSR violations.

Our analysis shows that when advantageous (resp. disadvantageous) inequality occurs, or when neither inequality occurs and the manufacturer's fairness ideal

is relatively small (resp. large), distributive comparison behavior makes the manufacturer less (resp. more) likely to invest in CSR than in the supply chain without distributive comparison behavior, that is, negative (resp. positive) impacts of distributive comparison behavior, but it makes the supplier more (resp. less) likely to invest in CSR. Our results imply that governments and nongovernmental organizations (NGOs) should investigate firms' distributive comparison behavior, especially in the industry sectors such as apparel and footwear, where supply chain fairness incidents appear to be prominent (Chen et al. 2022). When downstream firms show the aversion to lower (resp. higher) profits than ones from upstream firms, the measures to monitor and support upstream (resp. downstream) firms' CSR investments should be taken to avoid CSR violations.

We find that distributive comparison behavior affects the CSR investment strategy through the wholesale price from the negotiation between the manufacturer and the supplier. When the manufacturer's fairness ideal is small (resp. large), a wholesale price that leads to advantageous (resp. disadvantageous) inequality is reached, and it is higher (resp. lower) than the wholesale price without distributive comparison behavior. The higher (resp. lower) wholesale price makes the manufacturer less (resp. more) likely to invest in CSR, but it makes the supplier more (resp. less) likely to invest in CSR. When the manufacturer's fairness ideal is intermediate, a wholesale price that leads to neither inequality is reached. In this case, the relatively small (resp. large) fairness ideal leads to the higher (resp. lower) wholesale price than that without distributive comparison behavior.

By comparing the results under a large manufacturer with strong bargaining power to those under a small manufacturer with weak bargaining power, in most cases, the small manufacturer leads to larger positive or smaller negative impacts of distributive comparison behavior on the CSR investment. This is because the small manufacturer accepts a higher wholesale price than the large manufacturer. As a result, the small manufacturer suffers less, and the supplier gains more from the increase in the wholesale price caused by distributive comparison behavior than the large manufacturer. Furthermore, the comparison on the efficiency to reduce CSR violations shows that the small manufacturer with low efficiency generally leads to smaller negative impacts of distributive comparison behavior than the large manufacturer with high efficiency. Thus, our results imply that, in the industry sectors such as food services and construction, where there are large numbers of small downstream firms (USAFacts 2020), governments and NGOs should make extra efforts to induce firms' distributive comparison behavior due to its larger positive impacts and smaller negative impacts.

The remainder of this paper is organized as follows. In Section 2, we review the literature related to our paper. Section 3 and Section 4 describe our model formulations and analysis. In Section 5, we consider and analyze several extensions of our base model. In Online Appendix A, additional analysis is presented. In Online Appendix B, we present the proofs of the lemmas and propositions.

2. Related Literature

Our research is related to two streams of literature. One stream is about CSR in supply chains, and another stream is about comparison behavior.

2.1. CSR in Supply Chains

CSR in supply chains has received increasing attention in operations management (OM) literature. Topics such as poor working conditions (Guo et al. 2016), employment of child labor (Cho et al. 2019), and product liability (Hua and Spier 2020) have been widely investigated. The literature generally considers that CSR violations hurt both consumers and firms in supply chains, especially downstream firms, and firms' efforts can reduce CSR violations. Specifically, Bhaskaran and Krishnan (2009) find that investment sharing is more attractive for new-to-the-world product projects. Guo et al. (2016) identify four possible sourcing strategies and find that efforts that focus on enforcement and penalizing the buyer lead to more responsible sourcing and less risky sourcing. Chen and Lee (2017) designed contracts to screen and identify unethical suppliers. Chen et al. (2017a) investigated how commitments between the firms improve CSR. Chen et al. (2019) studied the impacts of NGOs' auditing efforts and suppliers' compliance efforts on a firm's disclosure decision about its suppliers. Chen et al. (2020a) considered a supply network with multiple buyers and suppliers and showed that joint auditing can correct inefficiencies. Hua and Spier (2020) found that whether a firm's investment to reduce CSR violations is efficient is determined by consumer types, and legal interventions are necessary to raise the level of product safety. Chen et al. (2020b) showed that a shutout contract of different forms should be adopted in the setting of responsible sourcing under supplier-auditor collusion. Chen and Lee (2021) summarized compliance risks and motivations in responsible supply chains as well as how the violations and noncompliance can be addressed. Huang et al. (2022) considered a three-level supply chain and compared the impacts of direct control and delegation on improving upper-tier suppliers' CSR. Ha et al. (2022) analyzed the supplier choice decisions of competing suppliers when audit information was shared to improve supply chain CSR. Readers can refer to Sodhi (2015) and Chen et al. (2017b) for a detailed review.

The Nash bargaining model (Nash 1950, 1953) has been used to investigate the negotiation in supply

chains. Nagarajan and Sošić (2008) provided a detailed review about the implication of the Nash bargaining model in supply chain cooperation. A few papers have considered its application in CSR in supply chains. Sheu and Gao (2014) utilized the Nash bargaining game to analyze a reverse logistics provider alliance and no reverse logistics provider alliance. They find that the former can increase the power of reverse logistics providers but may reduce all firms' profits. Ghosh and Shah (2015) adopted the Nash bargaining model to determine the cost-sharing contract parameter in two cost-sharing contracts in a green supply chain. Feng et al. (2022) applied a multiunit bilateral bargaining framework to coordinate environmental and social responsibility (ESR) investments in a general supply network and explained how an ESR initiator expands its responsibility along its supply chain. In our paper, we utilize the Nash bargaining model to explore how firms' comparison behavior affects CSR investment strategy for different levels of bargaining power. To the best of our knowledge, this is not considered in the literature on bargaining. Our result contributes to this stream of literature by revealing the interaction between distributive comparison behavior and bargaining power on profit distribution among firms. Especially, we find that when neither inequality of distributive comparison behavior occurs, profit distribution among firms is determined by the fairness ideal rather than the bargaining power.

Some literature considers the roles of small firms in CSR, but most of them are conceptual and descriptive. Jenkins (2006) proposed an integrated approach to help small firms understand what CSR means for them and how to integrate it into their core business practices. Murillo and Lozano (2006) analyzed four case studies on Catalan firms' social and environmental practices and show the difficulty faced by small firms in fulfilling CSR. Lepoutre and Heene (2006) investigated the theoretical and empirical contributions on the size-social responsibility relationship among small businesses. They found that a small firm should seek cooperation or network contacts with stakeholders to overcome the difficulties in improving CSR. Russo and Perrini (2010) found that the notion of social capital is a useful way to understand the CSR approach of small firms. Baumann-Pauly et al. (2013) found that small firms are not necessarily less advanced in CSR than large firms. Jamali et al. (2015) reviewed the literature on small firms and CSR in developing countries. They concluded that the research focusing on the role of small firms in CSR has received relatively less attention. The European Commission mentioned that, up to now, there has been little analysis on the uptake of CSR by small firms and the ways in which the adoption of strong CSR can help them to grow (European Commission 2019). We analyze the role of small firms in CSR analytically. In particular, we consider small downstream firms' distributive comparison behavior,

which, to the best of our knowledge, has not been studied in the literature.

2.2. Comparison Behavior

Comparison behavior has been studied in several settings. Kahneman et al. (1986), as well as Anderson and Weitz (1992), pointed out that comparison behavior affects people's business activities significantly. Avcı et al. (2014) showed that organizations may emphasize social comparison deliberately to provide incentives for better performance. A comprehensive review can be found in Suls and Wheeler (2000) and Thaler and Sunstein (2008). Our research focuses on its application in CSR in supply chains.

There are a handful of papers on fairness, which is a typical type of comparison behavior. The literature has provided ample evidence that decision-makers are concerned about fairness. For example, Sanfey et al. (2003) and Stephen and Pham (2008) found that decision-makers' feeling of fairness plays an important role in ultimatum games and negotiations. The literature generally models fairness as inequality aversion. Fehr and Schmidt (1999) as well as Bolton and Ockenfels (2000) revealed that individuals resist inequitable payoffs. They considered that firms care about not only the absolute sizes of their payoffs but also how their payoffs compare with others'. The inequality aversion makes one firm experience disutility and will motivate the firm to give up some material payoff to move in the direction of more equitable outcomes. It happens not only when one firm receives less than others (i.e., when disadvantageous inequality occurs) but also when one firm receives more (i.e., when advantageous inequality occurs). Fehr and Schmidt (1999) revealed that subjects exhibit a stronger aversion against disadvantageous inequality than advantageous inequality. The inequality aversion captures the critical feature of fairness in decision making (Fehr and Schmidt 2006).

Fairness-concerned behavior affects business activities and channel relationships in supply chain management (Kumar et al. 1995, Corsten and Kumar 2005). Most of the existing research considers the equitable payoff for one firm as a certain factor, fairness ideal, times the other firm's payoff. The fairness ideal captures one firm's sensitivity to the other firm's payoff. Cui et al. (2007) analyzed the impacts of distributive fairness on a dyadic channel, and they found that a supplier can use a wholesale price contract to coordinate a channel if a manufacturer has a strong concern about fairness. Loch and Wu (2008) showed that comparison in profit distribution between the firms in a two-echelon supply chain makes them deviate from profit-maximizing decisions. More recently, there is an increasing number of OM literature about fairness, including Katok and Pavlov (2013), Ho et al. (2014), and Wu and Niederhoff (2014). Readers can refer to Donohue et al. (2018) for a detailed review. In

particular, Chen et al. (2022) showed that supply chain fairness is directly linked to social responsibility issues and discuss the opportunities to improve fairness in supply chains.

In this stream of literature, the research that is most related to our study is Cui and Mallucci (2016). They considered the impacts of distributive comparison behavior on firms' investment and pricing decisions. Their focus was to compare different types of fairness ideals. Our paper differs from the above literature on distributive comparison behavior in several ways. First, we consider the impacts of distributive comparison behavior on CSR investments. Cui and Mallucci (2016) considered marketing investments that increase the demand for the entire supply chain. However, we consider that CSR investments have external and internal effects through reducing CSR violations. The external effect is improving the utility of socially conscious consumers, and the internal effect is reducing the manufacturer's loss caused by CSR violations. Whereas the benefit from the external effect is shared between the manufacturer and the supplier, the internal effect benefits mainly the manufacturer. Second, we consider a supply chain in which a downstream firm and an upstream firm negotiate over a wholesale price. This enables us to provide insights into understanding CSR investment decisions in supply chains with different power structures, which is not analyzed in the literature. Last, we focus on small downstream firms. We consider that the large and small firms can differ not only in bargaining power but also in efficiency to reduce CSR violations. This enables us to investigate the impacts of distributive comparison behavior on firms' CSR investments for small firms.

3. Model Formulations

We consider a dyadic supply chain in which one manufacturer sources a critical component from one supplier to make the product. We use subscripts T, M, and S to denote the supply chain, the manufacturer, and the supplier, respectively.

The manufacturer (resp. supplier) first decides independently whether to make CSR investment, denoted by $I_M \in \{0, 1\}$ (resp. $I_S \in \{0, 1\}$), to reduce its own probability of CSR violations $r_M(I_M)$ (resp. $r_S(I_S)$). For example, Tesla may decide whether to invest in more sustainable packaging, and Capchem may decide whether to invest in cleaner production processes. The supply chain is free of violations only when neither the manufacturer nor the supplier is involved in CSR violations. We denote the supply chain CSR violation probability by $r(I_M, I_S)$, where (I_M, I_S) is the supply chain CSR investment strategy. Specifically, when the violations of the manufacturer and the supplier are independent, the supply chain CSR violation probability is $r(I_M, I_S) = 1 - [1 - r_M(I_M)][1 - r_S(I_S)]$. In order to be general, we

do not assume such a functional form for $r(I_M, I_S)$, and instead, we make the following Assumption 1. One can verify that the above-mentioned functional form of $r(I_M, I_S)$ satisfies Assumption 1. The manufacturer's (resp. supplier's) CSR investment cost is given by $c_M I_M$ (resp. $c_S I_S$).

Assumption 1. $r(1, 1) < r(1, 0) < r(0, 0)$, $r(1, 1) < r(0, 1) < r(0, 0)$, *and* $r(0, 0) - r(1, 0) \le r(0, 1) - r(1, 1)$.

After the CSR investments, following the literature (see, e.g., Mahtani et al. 2015, Hsu et al. 2016, Feng et al. 2020), we consider that the manufacturer decides order quantity Q to source from the supplier, and then the players engage in a negotiation over wholesale price W. This corresponds to the setting in which the wholesale price of a component depends on its order size and thus should be negotiated after the manufacturer specifies the quantity that the manufacturer intends to purchase. For example, buyers, who intend to negotiate with potential suppliers on the Oracle sourcing platform, need to provide their order quantities first (Mahtani et al. 2015). We consider that each product requires one component so that the order quantity of the component is equal to the selling quantity of the product. A transaction happens if and only if the two players reach an agreement on the wholesale price. The manufacturer then sources from the supplier and sells the product to consumers. The CSR violations are disclosed to consumers after the sales. The decision sequence is given in Figure 1.

Following the literature (see, e.g., Hua and Spier 2020), consumers are heterogeneous, and each has a type x, which is uniformly distributed on a support $[x_{min}, x_{max}]$ with $0 \le x_{min} < x_{max}$. A type-x consumer derives a utility $gx \ge 0$ from product use but suffers disutility $h > 0$ when there are CSR violations with probability $r(I_M, I_S)$. We assume $g > h$ and make Assumption 2 in Online Appendix A to ensure an interior solution of x in the interval $[x_{min}, x_{max}]$ in the equilibrium. Hence, a type-x consumer's net utility is given by $u(x) = gx - hr(I_M, I_S) - p$, where p is the market price of the product. A type-x consumer will purchase the product if and only if $u(x) \ge 0$. Thus, we obtain the demand as $Q = \{x_{max} - [p + hr(I_M, I_S)]/g\}$ and the inverse demand function as $p = gx_{max} - hr(I_M, I_S) - gQ$. Consumer surplus is defined as the total net utility of the consumers who purchase the product, which is given by $CS = \int_{[hr(I_M, I_S) + p]/g}^{x_{max}} u(x) dx = \{gx_{max} - [hr(I_M, I_S) + p]\}^2/(2g)$.

We consider that the manufacturer suffers a loss l from CSR violations with probability $r(I_M, I_S)$. Following the literature (Wazir 2001, Guo et al. 2016, Orsdemir et al. 2019, Chen et al. 2020b, Ha et al. 2022), this loss captures reputation loss, widespread protests, and financial loss. For example, when the suppliers of Tesla and P&G are disclosed for environmental violations,

Figure 1. The Sequence of Decisions
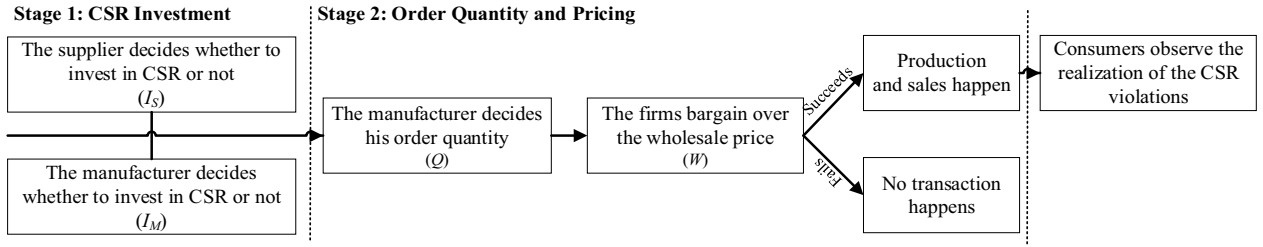
it raises public suspicion of Tesla's and P&G's CSR commitments (IPE 2017, 2021). Thus, the manufacturer's profit from sales π_M is given by $\pi_M = (p - W)Q - lr(I_M, I_S)$, and the supplier's profit from sales π_S is given by $\pi_S = WQ$. Note that we assume zero production cost, and our results continue to hold with a positive production cost. Furthermore, we define the net profit as the difference between the profit from sales and the CSR investment cost. Then, the manufacturer's net profit Π_M is given by $\Pi_M = \pi_M - c_M I_M$, and the supplier's net profit Π_S is given by $\Pi_S = \pi_S - c_S I_S$. Note that CSR investment costs (i.e., $c_M I_M$ and $c_S I_S$) are incurred in stage 1, before the negotiation over the wholesale price. In contrast, CSR violations are exposed after production and sales, so consumers and the manufacturer suffer losses (i.e., $hr(I_M, I_S)$ and $lr(I_M, I_S)$) in stage 2 when both players also generate their revenues (i.e., $(p - W)Q$ and WQ).

We consider that with distributive comparison behavior, the manufacturer suffers disutility f_M from inequality in the distribution of profit from sales (Fehr and Schmidt 1999). Following the literature (Cui and Mallucci 2016), we consider that the manufacturer compares the profit from sales π_M with that of the supplier π_S. The disutility of the manufacturer from distributive comparison behavior f_M is given by

$$f_M = -\alpha \max\{\gamma\pi_S - \pi_M, 0\} - \beta\max\{\pi_M - \gamma\pi_S, 0\}, \quad (1)$$

where $\gamma\pi_S$ is the manufacturer's *equitable payoff* and γ is the manufacturer's *fairness ideal* representing the manufacturer's sensitivity to the supplier's profit from sales π_S. Three cases will occur. If the manufacturer's profit from sales π_M is lower than the equitable payoff $\gamma\pi_S$, *disadvantageous inequality* occurs, which results in disutility $\alpha \max\{\gamma\pi_S - \pi_M, 0\}$ for the manufacturer. The parameter α describes the degree of the manufacturer's aversion to disadvantageous inequality. If π_M is higher than $\gamma\pi_S$, *advantageous inequality* occurs, which results in disutility $\beta \max\{\pi_M - \gamma\pi_S, 0\}$. The parameter β describes the degree of the manufacturer's aversion to advantageous inequality. If π_M is equal to $\gamma\pi_S$, *neither inequality* occurs.

Overall, with distributive comparison behavior, the manufacturer's net utility U_M consists of the net profit

Π_M as well as the disutility f_M from inequality in the distribution of profit from sales. We assume that the supplier does not have distributive comparison behavior in the base model so that the supplier's net utility U_S is the net profit Π_S. Therefore, the net utility functions of the manufacturer and supplier are given below

$$U_M(I_M, Q, W) = \Pi_M(I_M, Q, W) + f_M(I_M, Q, W), \quad (2)$$
$$U_S(I_S, W) = \Pi_S(I_S, W). \quad (3)$$

We use $\Pi_T = (\pi_M + \pi_S) - (c_M I_M + c_S I_S)$ to denote the supply chain's net profit and $\pi_T = (\pi_M + \pi_S)$ to denote the supply chain's profit from sales.

We use the Nash bargaining model (Nash 1950, 1953) for the negotiation between the supplier and manufacturer over the wholesale price. We assume that the players decide their CSR investments before they negotiate over the wholesale price because CSR investments are usually considered as firms' long-term strategies. Under such a decision sequence, the CSR investment costs are sunk if the negotiation breaks down. For example, as an initiative to provide Internet services to farmers in rural areas, Huawei invested in wireless Internet services in the United States in 2014. After the negotiation with AT&T failed, Huawei's wireless Internet investment was sunk (Kang 2019). Thus, the players' disagreement utilities are given by $d_M = -c_M I_M$ and $d_S = -c_S I_S$. Then, we can obtain the Nash Bargaining Solution (NBS) of the wholesale price by solving the following problem

$$\max_{U_M > d_M, U_S > d_S} (U_M - d_M)^\varphi (U_S - d_S)^{(1-\varphi)}, \quad (4)$$

where φ and $(1 - \varphi)$ $(0 < \varphi < 1)$ represent the manufacturer's and supplier's bargaining powers, respectively. We use $\Phi = \varphi/(1 - \varphi)$ to denote the manufacturer's bargaining power relative to that of the supplier. To rule out uninteresting cases, we make assumptions about α, β, and φ in Online Appendix A.

We define social welfare SW as the summation of supplier's net utility U_S, manufacturer's net utility U_M, and consumer surplus CS, that is, $SW = U_M + U_S + CS$. We list the parameters and decision variables in Table 1.

Table 1. The Parameters and Decisions in the Model

Parameters	
g	Consumer's utility from product use
h	Consumer's disutility from CSR violations
p	Market price of the product
c_i	CSR investment cost, $i = S$ or M
l	Manufacturer's loss caused by CSR violations
φ	Manufacturer's bargaining power
$1 - \varphi$	Supplier's bargaining power
Φ	Manufacturer's bargaining power relative to that of the supplier, $\Phi = \varphi/(1-\varphi)$
α	Degree of manufacturer's aversion to disadvantageous inequality
β	Degree of manufacturer's aversion to advantageous inequality
γ	Manufacturer's fairness ideal
π_i	Profit from sales, $i = M$, S, or T
$\gamma\pi_S$	Manufacturer's equitable payoff
f_M	Manufacturer's disutility from inequality in the distribution of profit from sales
Π_i	Net profit, $i = M$, S, or T
U_i	Net utility, $i = M$ or S
CS	Consumer surplus
SW	Social welfare and $SW = U_M + U_S + CS$
d_i	Disagreement utility if the negotiation breaks down, $i = M$ or S
$r(I_M, I_S)$	Probability of CSR violations in the supply chain

Decision variables	
I_i	CSR investment decision, $I_i \in \{0,1\}$ and $i = M$ or S
(I_M, I_S)	CSR investment strategy of the supply chain
W	Wholesale price of per unit product
Q	Manufacturer's order quantity

4. Model Analysis

In this section, we first consider the supply chain without distributive comparison behavior as the benchmark in Section 4.1. Then, we explore how distributive comparison behavior affects the supply chain's CSR investment strategy in Section 4.2. Finally, we analyze how the aforementioned impacts differ between large and small manufacturers in Section 4.3.

4.1. Benchmark: Supply Chain Without Distributive Comparison Behavior

We consider the supply chain without distributive comparison behavior as our benchmark. In the benchmark, the players' net utilities are the same as their net profits. In the following, we compare a centralized supply chain with a decentralized supply chain. In the centralized supply chain, the supplier and manufacturer jointly decide the supply chain's CSR investment strategy and order quantity to maximize the supply chain's net profit. In the decentralized supply chain, the supplier (resp. manufacturer) maximizes the supplier's (resp. manufacturer's) net profit, and the wholesale price is determined through negotiation. We use backward induction to solve for the equilibrium. When there exist multiple

Nash equilibria, we apply the refinement of Pareto dominance, which selects the equilibrium that gives the manufacturer and the supplier the highest net profits/utilities. We use superscripts $\mathbb{C}$ and $\mathbb{D}$ to denote the centralized and decentralized supply chains, respectively.

In the centralized supply chain, the players decide the CSR investment strategy (I_M, I_S) before deciding the order quantity Q to maximize the supply chain's net profit, given as

$$\max_{I_M, I_S \in \{0,1\}, Q > 0} \Pi_T^{\mathbb{C}}(I_M, I_S, Q) = pQ - lr(I_M, I_S) - (c_M I_M + c_S I_S). \quad (5)$$

In the decentralized supply chain, the net profits of the supplier and manufacturer, Π_S and Π_M, are given in Section 3. Given the supply chain's CSR investment strategy (I_M, I_S) and order quantity Q, the wholesale price can be derived from the Nash Bargaining Solution:

$$W^{\mathbb{D}}(I_M, I_S, Q) = \{[gx_{max} - hr(I_M, I_S) - gQ]Q - lr(I_M, I_S)\}/[(1+\Phi)Q]. \quad (6)$$

Although we assume that players' CSR investments have no direct impact on their bargaining power (Binmore et al. 1986, Osborne and Rubinstein 1990, Feng and Lu 2013, Feng et al. 2022), Equation (6) shows that the supplier's CSR investment can still improve the supplier's bargaining outcome. Specifically, the supplier who makes the CSR investment obtains a higher wholesale price than the one who does not, that is, $W^{\mathbb{D}}(I_M, 1, Q) > W^{\mathbb{D}}(I_M, 0, Q)$.

Given the supply chain's CSR investment strategy (I_M, I_S), the following lemma compares the centralized supply chain with the decentralized supply chain.

Lemma 1. *Given the supply chain's CSR investment strategy (I_M, I_S), the optimal order quantity, supply chain's net profit, consumer surplus, and social welfare in the decentralized supply chain are the same as those in the centralized supply chain, that is, $Q^{\mathbb{D}}(I_M, I_S) = Q^{\mathbb{C}}(I_M, I_S)$, $\Pi_T^{\mathbb{D}}(I_M, I_S) = \Pi_T^{\mathbb{C}}(I_M, I_S)$, $CS^{\mathbb{D}}(I_M, I_S) = CS^{\mathbb{C}}(I_M, I_S)$, and $SW^{\mathbb{D}}(I_M, I_S) = SW^{\mathbb{C}}(I_M, I_S)$.*

Lemma 1 reveals that without distributive comparison behavior, given the supply chain's CSR investment strategy, the negotiation over the wholesale price in the decentralized supply chain leads to the same quantity, net profit, consumer surplus, and social welfare as those in the centralized supply chain. This happens because, with the negotiation, each of the two players obtains a share of the supply chain's net profit. Their net profits are maximized if and only if the supply chain's net profit is maximized. Therefore, the manufacturer will choose the order quantity to maximize the

supply chain's net profit, which is the same as the optimal quantity in the centralized supply chain. The same quantity will lead to the same net profit, consumer surplus, and social welfare.

Figure 2 shows the equilibrium CSR investment strategies of the centralized and decentralized supply chains. The conditions of the equilibrium strategies are provided in Lemma A.1 in Online Appendix A.1. Following the literature (Guo et al. 2016, Letizia and Hendrikse 2016, Cho et al. 2019, Orsdemir et al. 2019), we focus on pure strategy equilibrium. When a player is indifferent between making CSR investment and not, we assume that the player makes the investment. Figure 2 shows the thresholds $c_{My}^{\mathbb{C}}$ and $c_{My}^{\mathbb{D}}$ (resp. $c_{Sy}^{\mathbb{C}}$ and $c_{Sy}^{\mathbb{D}}$), $y = 1, 2$, which determine whether the manufacturer (resp. supplier) makes the CSR investment in the centralized and decentralized supply chains, respectively. For example, in the decentralized supply chain, when the CSR investment cost of the manufacturer is less than the threshold $c_{My}^{\mathbb{D}}$, the manufacturer makes the CSR investment, and otherwise, the manufacturer does not invest. We consider that as the thresholds increase (resp. decrease), the manufacturer or supplier is more (resp. less) likely to invest in CSR. For example, by comparing thresholds $c_{S1}^{\mathbb{D}}$ and $c_{S2}^{\mathbb{D}}$, we find that the supplier becomes more likely to invest in CSR when the manufacturer invests in CSR.

The comparison of the equilibrium CSR investment strategies between the centralized and decentralized supply chains leads to the following proposition.

Proposition 1. *The manufacturer and supplier in the decentralized supply chain are less likely to invest in CSR*

Figure 2. The Equilibrium CSR Investment Strategy Without Distributive Comparison Behavior: The Centralized Supply Chain (Dashed Lines, $j = \mathbb{C}$) vs. the Decentralized Supply Chain (Solid Lines, $j = \mathbb{D}$)
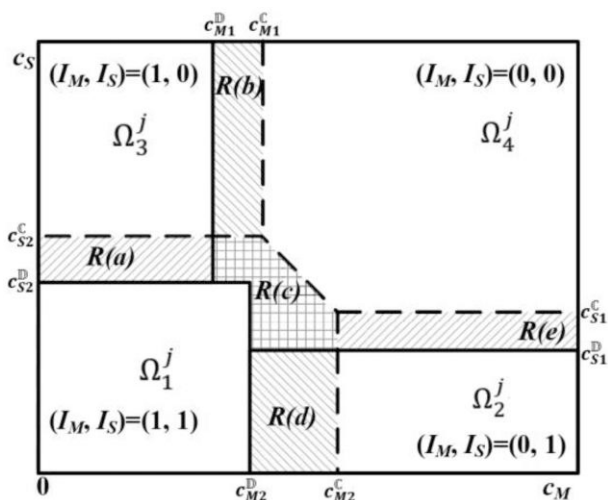
Table 2. The Equilibrium CSR Investment Strategy Without Distributive Comparison Behavior: The Centralized Supply Chain ($I_M^{\mathbb{C}}, I_S^{\mathbb{C}}$) vs. the Decentralized Supply Chain ($I_M^{\mathbb{D}}, I_S^{\mathbb{D}}$)

Region	($I_M^{\mathbb{C}}, I_S^{\mathbb{C}}$) vs. ($I_M^{\mathbb{D}}, I_S^{\mathbb{D}}$)
R(a)	$I_M^{\mathbb{C}} = I_M^{\mathbb{D}}$ and $I_S^{\mathbb{C}} > I_S^{\mathbb{D}}$
R(b)	$I_M^{\mathbb{C}} > I_M^{\mathbb{D}}$ and $I_S^{\mathbb{C}} = I_S^{\mathbb{D}}$
R(c)	$I_M^{\mathbb{C}} > I_M^{\mathbb{D}}$ and $I_S^{\mathbb{C}} > I_S^{\mathbb{D}}$
R(d)	$I_M^{\mathbb{C}} > I_M^{\mathbb{D}}$ and $I_S^{\mathbb{C}} = I_S^{\mathbb{D}}$
R(e)	$I_M^{\mathbb{C}} = I_M^{\mathbb{D}}$ and $I_S^{\mathbb{C}} > I_S^{\mathbb{D}}$

than those in the centralized supply chain, that is, $c_{iy}^{\mathbb{D}} < c_{iy}^{\mathbb{C}}$ ($i = M, S; y = 1, 2$).

In Figure 2, there are five regions R(a) – R(e) in which at least one player in the decentralized supply chain becomes less likely to invest in CSR than in the centralized supply chain. Table 2 below provides the comparison in these five regions. This happens because, in the decentralized supply chain, the CSR investment leads to a weaker position in the negotiation over the wholesale price through a lower disagreement utility. Furthermore, in the centralized supply chain, both players' CSR investment costs may be covered by the supply chain's profit from sales. However, in the decentralized supply chain, the supplier's CSR investment cost cannot be covered by the manufacturer's share of profit and vice versa. Therefore, given a CSR investment strategy, even though the profit from sales of the decentralized supply chain is the same as that of the centralized supply chain, the profit distribution between the two players in the decentralized supply chain may make one of them less likely to invest in CSR than in the centralized supply chain.

4.2. Impacts of Distributive Comparison Behavior

In this section, we explore how distributive comparison behavior affects the supply chain's CSR investment strategy. To isolate the impacts of distributive comparison behavior, we use the decentralized supply chain without distributive comparison behavior as the benchmark, referred as the "decentralized benchmark." We use superscripts β, α, and o to denote the cases in which advantageous inequality occurs (i.e., $\pi_M > \gamma \pi_S$), disadvantageous inequality occurs (i.e., $\pi_M < \gamma \pi_S$), and neither of them occurs (i.e., $\pi_M = \gamma \pi_S$), respectively.

Given the CSR investment strategy (I_M, I_S) and the manufacturer's order quantity Q, the wholesale price in the cases in which advantageous inequality occurs, disadvantageous inequality occurs, or neither inequality occurs can be derived by solving (4). The optimal wholesale price is shown in Lemma 2.

Lemma 2. *Given the CSR investment strategy (I_M, I_S) and the manufacturer's order quantity Q, the optimal wholesale*

price in the supply chain with distributive comparison behavior is

$$W^*(I_M, I_S, Q) =$$

$$\begin{cases} W^\beta(I_M, I_S, Q) = \dfrac{(1-\beta)\{[gx_{max} - hr(I_M, I_S) - gQ]Q - lr(I_M, I_S)\}}{(1+\Phi)[1-\beta(1+\gamma)]Q}, \\[6pt] \qquad\qquad\qquad\qquad if \ \gamma < \dfrac{\Phi(1-\beta)}{(1+\Phi\beta)}; \\[10pt] W^\alpha(I_M, I_S, Q) = \dfrac{(1+\alpha)\{[gx_{max} - hr(I_M, I_S) - gQ]Q - lr(I_M, I_S)\}}{(1+\Phi)[1+\alpha(1+\gamma)]Q}, \\[6pt] \qquad\qquad\qquad\qquad if \ \gamma > \dfrac{\Phi(1+\alpha)}{(1-\alpha\Phi)}; \\[10pt] W^o(I_M, I_S, Q) = \dfrac{\{[gx_{max} - hr(I_M, I_S) - gQ]Q - lr(I_M, I_S)\}}{(1+\gamma)Q}, \\[6pt] \qquad\qquad if \ \dfrac{\Phi(1-\beta)}{(1+\Phi\beta)} \le \gamma \le \dfrac{\Phi(1+\alpha)}{(1-\alpha\Phi)}; \end{cases}$$

$$(7)$$

when $\gamma < \Phi(1-\beta)/(1+\Phi\beta)$, *advantageous inequality occurs; when* $\gamma > \Phi(1+\alpha)/(1-\alpha\Phi)$, *disadvantageous inequality occurs; when* $\Phi(1-\beta)/(1+\Phi\beta) \le \gamma \le \Phi(1+\alpha)/(1-\alpha\Phi)$, *neither inequality occurs.*

Lemma 2 shows that distributive comparison behavior affects the wholesale price from the negotiation between the players. We find that there exists a unique wholesale price for each of the three cases. In the negotiation over the wholesale price in our model, across the three cases, the wholesale price with the highest objective function in the Nash bargaining game is selected. Besides, similar to (6), Equation (7) also reveals that the supplier who makes the CSR investment obtains a higher wholesale price than the one who does not.

When the manufacturer's fairness ideal is small, that is, $\gamma < \Phi(1-\beta)/(1+\Phi\beta)$, the manufacturer is likely to experience disutility from advantageous inequality, that is, $\pi_M > \gamma\pi_S$. To maximize $(U_M - d_M)^\varphi (U_S - d_S)^{(1-\varphi)}$ in (4), the tradeoff is among the manufacturer's profit from sales, the manufacturer's disutility caused by advantageous inequality, and the supplier's profit from sales. A lower wholesale price increases the manufacturer's profit from sales, decreases the supplier's profit from sales, and thus increases the manufacturer's disutility caused by advantageous inequality. When the manufacturer's fairness ideal is small, the increase in the manufacturer's profit from sales dominates. Hence, the wholesale price that makes advantageous inequality occur is chosen, which is lower than that making neither inequality occur, that is, $W^\beta(I_M, I_S, Q) < W^o(I_M, I_S, Q)$.

When the manufacturer's fairness ideal is large, that is, $\gamma > \Phi(1+\alpha)/(1-\alpha\Phi)$, the manufacturer is likely to experience disutility from disadvantageous inequality, that is, $\gamma\pi_S > \pi_M$. To maximize $(U_M - d_M)^\varphi (U_S -$

$d_S)^{(1-\varphi)}$ in (4), the tradeoff is similar, and in this case, a higher wholesale price decreases the manufacturer's profit from sales, increases the supplier's profit from sales, and thus increases the manufacturer's disutility caused by disadvantageous inequality. When the manufacturer's fairness ideal is large, the increase in the supplier's profit from sales dominates. Because the wholesale price that makes disadvantageous inequality occur is higher than that making neither inequality occur, that is, $W^\alpha(I_R, I_M, Q) > W^o(I_R, I_M, Q)$, $W^\alpha(I_R, I_M, Q)$ is chosen in this case.

When the manufacturer's fairness ideal is intermediate, that is, $\Phi(1-\beta)/(1+\Phi\beta) \le \gamma \le \Phi(1+\alpha)/(1-\alpha\Phi)$, the players choose the wholesale price that makes neither inequality occur, that is, $\gamma\pi_S = \pi_M$. In this case, because the manufacturer's equitable payoff $\gamma\pi_S$ increases with γ, as γ becomes larger, the wholesale price that makes the manufacturer's profit from sales equal to the equitable payoff becomes lower. In another word, when neither inequality occurs, the wholesale price decreases with the manufacturer's fairness ideal. This implies that the profit distribution between the players is determined by the manufacturer's fairness ideal.

The comparison between the wholesale prices in (6) and (7) reveals how distributive comparison behavior affects the wholesale price. Given (I_M, I_S) and Q, when advantageous (resp. disadvantageous) inequality occurs, distributive comparison behavior leads to a higher (resp. lower) wholesale price, which reduces the manufacturer's disutility caused by distributive comparison behavior. When neither inequality occurs, the wholesale price is determined by the manufacturer's fairness ideal. In this case, if the manufacturer's fairness ideal is small (resp. large), that is, $\Phi(1-\beta)/(1+\Phi\beta) \le \gamma < \Phi$ (resp. $\Phi \le \gamma \le \Phi(1+\alpha)/(1-\alpha\Phi)$), the wholesale price with distributive comparison behavior is higher (resp. lower) than that in the benchmark.

Given the CSR investment strategy (I_M, I_S), the comparison between the decentralized benchmark and the supply chain with distributive comparison behavior reveals the following impacts of distributive comparison behavior:

Lemma 3. *Given the CSR investment strategy* (I_M, I_S),

1. *Optimal order quantity, supply chain's net profit, and consumer surplus in the supply chain with distributive comparison behavior are the same as those in the decentralized benchmark, that is,* $Q^\beta(I_M, I_S) = Q^\alpha(I_M, I_S) = Q^o(I_M, I_S) = Q^\mathbb{D}(I_M, I_S)$, $\Pi_T^\beta(I_M, I_S) = \Pi_T^\alpha(I_M, I_S) = \Pi_T^o(I_M, I_S) = \Pi_T^\mathbb{D}(I_M, I_S)$, *and* $CS^\beta(I_M, I_S) = CS^\alpha(I_M, I_S) = CS^o(I_M, I_S) = CS^\mathbb{D}(I_M, I_S)$;

2. *Social welfare with distributive comparison behavior is lower than that in the decentralized benchmark when advantageous inequality and disadvantageous inequality occur, that is,* $SW^\beta(I_M, I_S) < SW^\mathbb{D}(I_M, I_S)$ *and* $SW^\alpha(I_M, I_S) < SW^\mathbb{D}(I_M, I_S)$, *and it is the same as that in the decentralized*

benchmark when neither inequality occurs, that is, SW^o $(I_M, I_S) = SW^{\mathbb{D}}(I_M, I_S)$.

Lemma 3 shows that, given the CSR investment strategy, the manufacturer's distributive comparison behavior does not affect the order quantity, supply chain's net profit, or consumer surplus. This is because of the same reason mentioned in the discussion of Lemma 1. However, when advantageous inequality and disadvantageous inequality occur, distributive comparison behavior reduces the manufacturer's utility and thus reduces social welfare. When neither inequality occurs, social welfare stays the same as that in the decentralized benchmark.

The structure of the equilibrium CSR investment strategy of the supply chain with distributive comparison behavior in case z ($z = \beta$, α, o) is similar to that of the decentralized benchmark. The regions of investment costs, that is, Ω_y^z ($y = 1, 2, 3, 4$), are provided in Online Appendix A.2.

Despite being of the same order quantity and profit, the CSR investment strategy in the supply chain with distributive comparison behavior is different from that in the decentralized benchmark. Because according to (6) and (7), distributive comparison behavior changes the wholesale prices, and then it changes the profit distribution between the players. Such different profit distributions lead to different CSR investment strategies between the supply chain with distributive comparison behavior and the decentralized benchmark. As mentioned previously, when the threshold of CSR investment cost, below which the manufacturer (resp. supplier) makes the CSR investment, increases, the manufacturer (resp. supplier) is more likely to invest in CSR. The comparison in the regions of investment costs between the case with distributive comparison behavior and the decentralized benchmark shows how

distributive comparison behavior affects the CSR investment strategy, which is summarized in Proposition 2 below. The definitions of Φ_1 and Φ_2 are provided in Online Appendix A.

Proposition 2. *The distributive comparison behavior of the manufacturer has the following impacts on the CSR investment strategy:*

1. When advantageous inequality occurs, or when neither inequality occurs and $\Phi(1 - \beta)/(1 + \beta\Phi) \le \gamma \le \Phi_1$, distributive comparison behavior makes the manufacturer less likely to invest in CSR, but it makes the supplier more likely to invest in CSR;

2. When disadvantageous inequality occurs, or when neither inequality occurs and $\Phi_2 \le \gamma \le \Phi(1 + \alpha)/(1 - \alpha\Phi)$, distributive comparison behavior makes the manufacturer more likely to invest in CSR, but it makes the supplier less likely to invest in CSR.

Proposition 2.1 (resp. 2.2) demonstrates that when advantageous (resp. disadvantageous) inequality occurs, or when neither inequality occurs and the manufacturer's fairness ideal is small (resp. large), distributive comparison behavior makes the supplier (resp. manufacturer) more likely to invest in CSR, but it makes the manufacturer (resp. supplier) less likely to invest. Figure 3 illustrates the results in Proposition 2. Figure 3(a) corresponds to the results in Proposition 2.1, and Figure 3(b) corresponds to the results in Proposition 2.2.

When advantageous inequality occurs, or when neither inequality occurs and the manufacturer's fairness ideal is small, Figure 3(a) illustrates that there are five regions where the CSR investment strategies are different between the decentralized benchmark and the supply chain with distributive comparison behavior. Table 3 below provides a comparison in these regions. According to (6) and (7), when advantageous inequality occurs,

Figure 3. The Equilibrium CSR Investment Strategy: The Decentralized Benchmark (Solid Lines) vs. the Supply Chain With Distributive Comparison Behavior (Dotted Lines) (Superscripts β, α, and o Denote the Cases in Which Advantageous Inequality Occurs, Disadvantageous Inequality Occurs, and Neither of Them Occurs, Respectively)
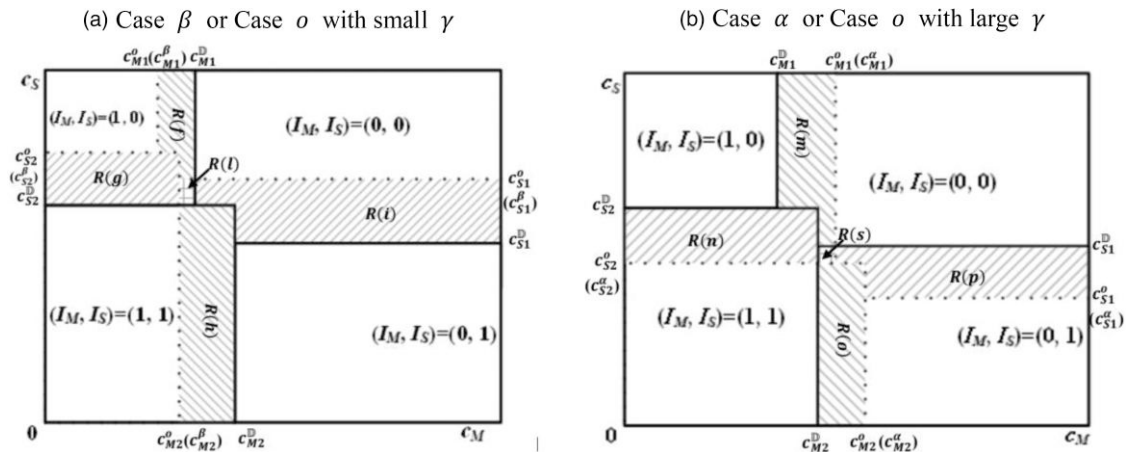
Table 3. The Equilibrium CSR Investment Strategy: The Decentralized Benchmark $(I_M^{\mathbb{D}}, I_S^{\mathbb{D}})$ vs. the Supply Chain With Distributive Comparison Behavior (I_M^z, I_S^z)

Region	$(I_M^{\mathbb{D}}, I_S^{\mathbb{D}})$ vs. (I_M^z, I_S^z) $z = \beta$, o	Region	$(I_M^{\mathbb{D}}, I_S^{\mathbb{D}})$ vs. (I_M^z, I_S^z) $z = \alpha$, o
$R(f)$	$I_M^{\mathbb{D}} > I_M^z$ and $I_S^{\mathbb{D}} = I_S^z$	$R(m)$	$I_M^{\mathbb{D}} < I_M^z$ and $I_S^{\mathbb{D}} = I_S^z$
$R(g)$	$I_M^{\mathbb{D}} = I_M^z$ and $I_S^{\mathbb{D}} < I_S^z$	$R(n)$	$I_M^{\mathbb{D}} = I_M^z$ and $I_S^{\mathbb{D}} > I_S^z$
$R(h)$	$I_M^{\mathbb{D}} > I_M^z$ and $I_S^{\mathbb{D}} = I_S^z$	$R(o)$	$I_M^{\mathbb{D}} < I_M^z$ and $I_S^{\mathbb{D}} = I_S^z$
$R(i)$	$I_M^{\mathbb{D}} = I_M^z$ and $I_S^{\mathbb{D}} < I_S^z$	$R(p)$	$I_M^{\mathbb{D}} = I_M^z$ and $I_S^{\mathbb{D}} > I_S^z$
$R(l)$	$I_M^{\mathbb{D}} > I_M^z$ and $I_S^{\mathbb{D}} < I_S^z$	$R(s)$	$I_M^{\mathbb{D}} < I_M^z$ and $I_S^{\mathbb{D}} > I_S^z$

or when neither inequality occurs and the manufacturer's fairness ideal is small, distributive comparison behavior leads to a higher wholesale price than that in the decentralized benchmark. As a result, the supplier, who obtains a larger share of the profit from sales, becomes more likely to invest in CSR (in regions $R(g)$, $R(i)$, and $R(l)$ in Table 3). Furthermore, a higher wholesale price reduces the manufacturer's profit so that the manufacturer is less likely to invest in CSR (in regions $R(f)$, $R(h)$, and $R(l)$ in Table 3). In region $R(l)$ in Table 3, only the supplier invests in CSR replacing the role of the manufacturer in the decentralized benchmark.

When disadvantageous inequality occurs, or when neither inequality occurs and the manufacturer's fairness ideal is large, Figure 3(b) illustrates that there are five regions where the CSR investment strategies are different. In these cases, distributive comparison behavior leads to a lower wholesale price than that in the decentralized benchmark. It makes the manufacturer more (resp. supplier less) likely to invest in CSR than that in the decentralized benchmark. In region $R(s)$ in Table 3, only the manufacturer invests in CSR replacing the role of the supplier in the decentralized benchmark.

When neither inequality occurs, as the manufacturer's fairness ideal becomes larger, distributive comparison behavior makes the manufacturer more (resp. supplier less) likely to invest in CSR. When the manufacturer's fairness ideal is small in region $R(l)$ in Table 3, only the supplier invests in CSR replacing the role of the manufacturer in the decentralized benchmark. In contrast, when the manufacturer's fairness ideal is large in region $R(s)$ in Table 3, only the manufacturer invests in CSR.

Overall, because the CSR investment strategies are determined by distributive comparison behavior, our results indicate that governments and NGOs should take measures such as surveys, interviews, and organizing forums to investigate firms' distributive comparison behavior, especially in the industry sectors such as apparel and footwear, where supply chain fairness incidents appear to be prominent (Chen et al.

2022). When downstream firms show the aversion to lower (resp. higher) profits than upstream firms, the measures to monitor and support upstream (resp. downstream) firms' CSR investment should be taken to avoid CSR violations, such as through audits and certifications (Chen and Lee 2017, Heyes and Martin 2017), violation reporting (Orsdemir et al. 2019), shut-out contracts (Chen et al. 2020b), and disclosure mandates (Kraft et al. 2020).

4.3. Comparison Between Large and Small Manufacturers

We consider that the large and small manufacturers can differ in the following two characteristics: bargaining power or efficiency to reduce CSR violations. In practice, a small manufacturer may not bear both characteristics, and thus we study each of them separately isolating its impacts. We use subscripts "Large" and "Small" to denote the large and small manufacturers, respectively.

When distributive comparison behavior makes the manufacturer (resp. supplier) less likely to invest in CSR, we refer to the decrease in the thresholds of CSR investment cost as the negative impact of distributive comparison behavior on the manufacturer's (resp. supplier's) CSR investment, denoted by N_M (resp. N_S). When it makes the manufacturer (resp. supplier) more likely to invest in CSR, we refer to the increase in the thresholds of CSR investment cost as the positive impact of distributive comparison behavior on the manufacturer's (resp. supplier's) CSR investment, denoted by P_M (resp. P_S).

4.3.1. Manufacturer's Bargaining Power. In this subsection, we consider the difference in bargaining power between the small and large manufacturers. We consider that the small (resp. large) manufacturer has weak (resp. strong) relative bargaining power in the negotiation with the supplier over the wholesale price, that is, $\Phi_{Large} > \Phi_{Small}$.

The following proposition compares N_M, N_S, P_M, and P_S caused by the small manufacturer with weak bargaining power to those caused by the large manufacturer with strong bargaining power.

Proposition 3. *The weak bargaining power of the small manufacturer leads to the larger positive impacts or smaller negative impacts of distributive comparison behavior in the following cases:*

1. P_M caused by the small manufacturer is larger than that caused by the large manufacturer when neither inequality occurs and $\Phi_2 \leq \gamma \leq \Phi(1 + \alpha)/(1 - \alpha\Phi)$;

2. P_S caused by the small manufacturer is larger than that caused by the large manufacturer when advantageous inequality occurs;

3. N_M caused by the small manufacturer is smaller than that caused by the large manufacturer when: 1) neither

inequality occurs and $\Phi(1 - \beta)/(1 + \beta\Phi) \leq \gamma \leq \Phi_1$ *or 2) advantageous inequality occurs.*

Proposition 3 demonstrates that, in most cases, the weak bargaining power of the small manufacturer leads to larger positive impacts or smaller negative impacts of distributive comparison behavior on the CSR investment.

When neither inequality occurs, the manufacturer's fairness ideal γ affects the supply chain's CSR investment strategy, because as mentioned previously, the wholesale price is determined by γ in this case. Furthermore, when $\Phi_2 \leq \gamma \leq \Phi(1 + \alpha)/(1 - \alpha\Phi)$, distributive comparison behavior leads to a lower wholesale price than that in the decentralized benchmark, and the reduction in the wholesale price is larger for the small manufacturer with weak bargaining power than the large manufacturer with strong bargaining power. Thus, because a lower wholesale price makes the manufacturer obtain more profit from sales, the small manufacturer benefits more than the large manufacturer. Therefore, we obtain that P_M is larger for the small manufacturer in Proposition 3.1. When $\Phi(1 - \beta)/(1 + \beta\Phi) \leq \gamma \leq \Phi_1$, distributive comparison behavior leads to a higher wholesale price than that in the decentralized benchmark, which makes the manufacturer obtain less profit from sales. In this case, the decrease in the manufacturer's profit from sales is smaller for the small manufacturer with weak bargaining power than the large manufacturer with strong bargaining power. Therefore, we obtain that N_M is smaller for the small manufacturer in Proposition 3.3.

When advantageous inequality occurs, distributive comparison behavior has a negative impact on the manufacturer's CSR investment. The negative impact is smaller for the small manufacturer with weak bargaining power than the large manufacturer with strong bargaining power because the small manufacturer accepts a higher wholesale price, which makes the difference between π_M and $\gamma\pi_S$ smaller. Therefore, we obtain that N_M is smaller for the small manufacturer in Proposition 3.3. Furthermore, distributive comparison behavior has a positive impact on the supplier's CSR investment. Because the small manufacturer accepts a higher wholesale price, the positive impact caused by the small manufacturer is larger than that caused by the large manufacturer. Therefore, we obtain that P_S caused by the small manufacturer is larger in Proposition 3.2.

Therefore, our results highlight the importance to understand power structures in supply chains with distributive comparison behavior. In the supply chains with small downstream firms, such as food services and construction (USAFacts 2020), extra efforts should be made to induce firms' distributive comparison behavior due to its larger positive impacts and smaller negative impacts.

4.3.2. Efficiency to Reduce the Probability of CSR Violations.
As mentioned in the introduction, some small firms lack the knowledge to manage social responsibility efficiently, and they believe that the social and environmental impacts of their firms are negligible. This motivates us to consider the difference in efficiency to reduce the probability of CSR violations between large and small manufacturers.

Referring to the definition of $r(I_M, I_S)$ in Section 3, given the supplier's CSR investment I_S, let the reduction in the probability of CSR violations $r(0, I_S) - r(1, I_S)$ represent the manufacturer's efficiency to reduce CSR violations. Similarly, given the manufacturer's CSR investment I_M, let $r(I_M, 0) - r(I_M, 1)$ represent the supplier's efficiency to reduce CSR violations. We consider that (1) the small manufacturer's efficiency to reduce CSR violations is lower than that of the large manufacturer, that is, $r_{Small}(0, I_S) - r_{Small}(1, I_S) < r_{Large}(0, I_S) - r_{Large}(1, I_S)$; (2) the efficiency of the small manufacturer's supplier is lower than that of the large manufacturer's supplier, that is, $r_{Small}(I_M, 0) - r_{Small}(I_M, 1) < r_{Large}(I_M, 0) - r_{Large}(I_M, 1)$; and (3) the CSR violation probability of the supply chain with the small manufacturer is higher than that with the large manufacturer, that is, $r_{Small}(0, I_S) > r_{Large}(0, I_S)$ and $r_{Small}(1, I_S) > r_{Large}(1, I_S)$.

The following proposition compares N_M, N_S, P_M, and P_S caused by the small manufacturer with low efficiency to reduce CSR violations to those caused by the large manufacturer with high efficiency to reduce CSR violations.

Proposition 4. *The low efficiency of the small manufacturer to reduce CSR violations leads to smaller negative impacts of distributive comparison behavior in the following cases:*

1. N_M *caused by the small manufacturer is smaller than that caused by the large manufacturer when: 1) advantageous inequality occurs or 2) neither inequality occurs and* $\Phi(1 - \beta)/(1 + \beta\Phi) \leq \gamma \leq \Phi_1$;

2. N_S *caused by the small manufacturer is smaller than that caused by the large manufacturer when 1) disadvantageous inequality occurs, or 2) neither inequality occurs and* $\Phi_2 \leq \gamma \leq \Phi(1 + \alpha)/(1 - \alpha\Phi)$.

Proposition 4 demonstrates that the low efficiency of the small manufacturer to reduce CSR violations leads to smaller negative impacts of distributive comparison behavior on both the manufacturer and supplier, that is, smaller N_M and N_S.

As mentioned in the discussion of Proposition 2, when disadvantageous inequality occurs or when neither inequality occurs and $\Phi_2 \leq \gamma \leq \Phi(1 + \alpha)/(1 - \alpha\Phi)$, distributive comparison behavior decreases the supplier's profit and makes the supplier less likely to invest in CSR. Because of the low efficiency to reduce CSR violations, the decrease in the supplier's profit caused by the small manufacturer is smaller than that

caused by the large manufacturer. Hence, in this case, N_S caused by the small manufacturer is smaller. Similarly, when advantageous inequality occurs or when neither inequality occurs and $\Phi(1 - \beta)/(1 + \beta\Phi) \leq \gamma \leq \Phi_1$, N_M caused by the small manufacturer is smaller.

Even though it is less efficient for the small manufacturer to reduce CSR violations, the negative impacts of distributive comparison behavior caused by the small manufacturer on both the manufacturer and supplier are smaller than those caused by the large manufacturer. Therefore, despite the low efficiency, governments and NGOs should still provide support for small firms' CSR investments and perhaps make them better informed about the benefits of such investments.

We also investigate the impacts of the manufacturer's loss caused by CSR violations (i.e., l). We find that both the manufacturer and the supplier are more likely to invest in CSR with a positive loss than without it. In addition, the existence of a positive loss enhances the negative and positive impacts of distributive comparison behavior. As a result, the above differences between the large and small manufacturers become more prominent with a positive loss of the manufacturer.

5. Extensions
In this section, we consider several extensions of our base model. In Section 5.1, we consider multiple small manufacturers with weak bargaining power. In Section 5.2, we consider multiple small suppliers with weak bargaining power. In Section 5.3, we consider peer-induced comparison behavior. In Section 5.4, we consider an alternative event sequence in which the manufacturer and supplier negotiate over a wholesale price before the manufacturer decides the order quantity. In Section 5.5, we consider distributive comparison behavior regarding CSR investments. We denote these extensions with superscripts 1−5, respectively.

5.1. Multiple Small Manufacturers with Weak Bargaining Power
In this subsection, we consider a supply chain consisting of n small manufacturers with weak bargaining power and one supplier. The manufacturers have distributive comparison behavior, and they are homogeneous. We consider that the manufacturers form an alliance to make the CSR investment decision jointly. In addition, the alliance decides a total order quantity and negotiates with the supplier over a wholesale price. If the alliance and the supplier reach an agreement on the wholesale price, the alliance sources the component from the supplier; otherwise, no transaction happens. The manufacturers share the profit from sales equally in the alliance. The details are provided in Online Appendix A.3.

We use our base model with the large manufacturer with strong bargaining power as a benchmark and use φ to denote the bargaining power of the large manufacturer. We use $\mu\varphi$ to denote the bargaining power of each small manufacturer, where $0 < \mu < 1$. We define $\Phi = \varphi/(1 - \varphi)$ as the large manufacturer's relative bargaining power and $\Phi^{(1)} = n\mu\varphi/(1 - n\mu\varphi)$ as the alliance's relative bargaining power so that $\Phi^{(1)} = n\mu\Phi/[1 + (1 - n\mu)\Phi]$. We make Assumptions A.1 to A.5 in Online Appendix A.3 about the alliance of the manufacturers.

We can verify that most of our main results from the base model still hold in this extended study. For example, when advantageous (resp. disadvantageous) inequality occurs, distributive comparison behavior makes the alliance less (resp. more) likely to invest in CSR, but it makes the supplier more (resp. less) likely to invest in CSR than in the supply chain without distributive comparison behavior. When neither inequality occurs, distributive comparison behavior makes the supplier more likely to invest in CSR if the fairness ideal of the manufacturers is small; otherwise, it makes the alliance more likely to invest in CSR.

In the following, we explore the impacts of the number of manufacturers n. Intuitively, the more manufacturers in the alliance, the stronger bargaining power the alliance has. The results are summarized in the following proposition.

Proposition 5. *The equilibrium CSR investment strategy of the supply chain with the alliance of small manufacturers has the following differences from that with the large manufacturer:*

1. When advantageous or disadvantageous inequality occurs,

 a. If $n\mu < 1$, the alliance is less likely to invest in CSR than the large manufacturer, but the supplier is more likely to invest in CSR with the alliance than with the large manufacturer;

 b. If $n\mu = 1$, the CSR investment strategy of the supply chain with the alliance is the same as that with the large manufacturer;

 c. If $1 < n\mu$, the alliance is more likely to invest in CSR than the large manufacturer, but the supplier is less likely to invest in CSR with the alliance than with the large manufacturer.

2. When neither inequality occurs, the CSR investment strategy of the supply chain with the alliance is the same as that with the large manufacturer.

Proposition 5 suggests that when advantageous or disadvantageous inequality occurs, as the number of manufacturers increases, the alliance is more likely to invest in CSR, whereas the supplier is less likely to invest in CSR. When the number of manufacturers is sufficiently high, the alliance is even more likely to invest in CSR than the large manufacturer with strong

bargaining power. However, a large number of manufacturers in the alliance may make the supplier not invest in CSR. When neither inequality occurs, the CSR investment strategy of the supply chain with the alliance is the same as that with the large manufacturer. This is because in this case the CSR investment is determined by the manufacturer's fairness ideal rather than bargaining power.

5.2. Multiple Small Suppliers with Weak Bargaining Power

In this subsection, we consider a supply chain consisting of n small suppliers with weak bargaining power and one manufacturer. The suppliers are homogeneous, and they form an alliance to make a CSR investment decision jointly. The manufacturer has distributive comparison behavior and decides an order quantity. The alliance of small suppliers and the manufacturer negotiate over a wholesale price. If the alliance and the manufacturer reach an agreement on the wholesale price, the manufacturer sources the component from the alliance; otherwise, no transaction happens. The suppliers share the profit from sales equally in the alliance. Additional details are provided in Online Appendix A.4.

We can verify that most of our main results from the base model still hold in this extended study. Regarding the impacts of the number of suppliers n, we find that, when advantageous or disadvantageous inequality occurs, as the number of suppliers increases, the alliance of small suppliers is more likely to invest in CSR, whereas the manufacturer is less likely to invest in CSR. When neither inequality occurs, the CSR investment strategy of the supply chain with the alliance is the same as that with one supplier.

5.3. Peer-Induced Comparison Behavior

In this subsection, we consider a supply chain consisting of two manufacturers (Manufacturers 1 and 2) and one supplier and analyze how peer-induced comparison behavior affects the supply chain. We consider that only Manufacturer 1 has peer-induced comparison behavior, which makes Manufacturer 1 compare the profit from sales with that of Manufacturer 2. As a result, Manufacturer 1's utility consists of the profit from sales and the disutility caused by the peer-induced comparison

behavior. Manufacturer 2 does not have peer-induced comparison behavior and maximizes the profit from sales. In addition, we also consider that Manufacturer 1 and Manufacturer 2 may have different bargaining powers.

We consider that the manufacturers form an alliance to make a CSR investment decision jointly. Besides, the alliance decides a total order quantity and negotiates with the supplier over a wholesale price. We denote the alliance, Manufacturer 1, and Manufacturer 2 by subscripts M, M_1, and M_2, respectively. Similar to the base model, the inverse demand function is given by $p = gx_{max} - hr(I_M, I_S) - gQ$, where I_M represents the CSR investment decision of the alliance and Q represents the total order quantity.

The sequence of players' decisions is shown in Figure 4. In stage 1, the supplier and the alliance decide whether to invest in CSR simultaneously. In stage 2, two manufacturers first negotiate with each other over Manufacturer 1's share of the profit from sales ρ, with Manufacturer 2's share being $(1 - \rho)$. If the two manufacturers reach an agreement on the share, they decide the alliance's total order quantity jointly. Then, the alliance negotiates with the supplier over the wholesale price. If they reach an agreement on the wholesale price, the alliance sources the component from the supplier; otherwise, no transaction happens.

We use the decentralized supply chain without peer-induced comparison behavior as the benchmark. The comparison between the supply chains with and without peer-induced comparison behavior shows that our results obtained in Lemma 3 still hold in this extended study. Additional details are provided in Online Appendix A.5.

Proposition 6 shows how peer-induced comparison behavior affects the supply chain's CSR investment strategy.

Proposition 6. *The peer-induced comparison behavior of the manufacturer has the following impacts on the CSR investment strategy:*

1. When advantageous or disadvantageous inequality occurs, peer-induced comparison behavior makes the two manufacturers less likely to invest in CSR, but it does not affect the supplier's CSR investment decision;

Figure 4. The Sequence of Decisions With Peer-Induced Comparison Behavior
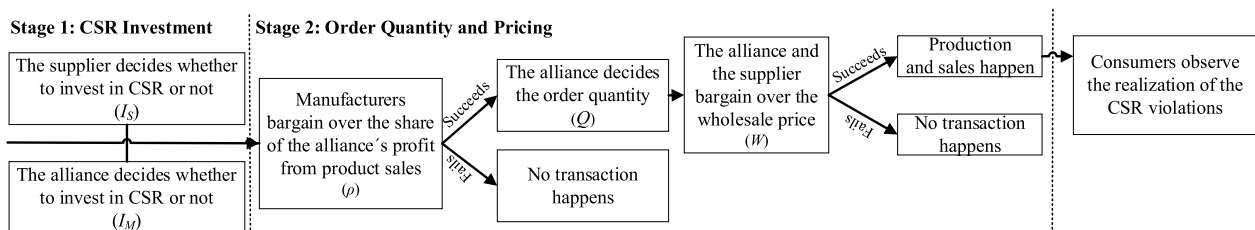
2. *When neither inequality occurs, peer-induced comparison behavior does not affect the CSR investment strategy.*

Proposition 6 demonstrates that when advantageous or disadvantageous inequality occurs, peer-induced comparison behavior makes the manufacturers less likely to invest in CSR, but it does not affect the supplier's CSR investment decision. We refer to the decrease in the thresholds of CSR investment cost as the negative impact of peer-induced comparison behavior on the manufacturer's CSR investment and denote it as N_M. When neither inequality occurs, peer-induced comparison behavior does not affect the CSR investment strategy.

When advantageous or disadvantageous inequality occurs, peer-induced comparison behavior causes disutility to Manufacturer 1, which reduces the alliance's net utility. But it does not transfer this loss to the supplier and makes the wholesale price stay the same as that in the benchmark without peer-induced comparison behavior. Therefore, the alliance is less likely to invest in CSR, and the supplier's CSR investment decision remains the same. When neither inequality occurs, the alliance's utility and the supplier's profit from sales are the same as those in the benchmark without peer-induced comparison behavior. Therefore, peer-induced comparison behavior does not affect the CSR investment strategy.

In the following, we compare N_M when Manufacturer 1 has weak bargaining power to that when Manufacturer 1 has strong bargaining power.

Proposition 7. *N_M is smaller (resp. larger) when Manufacturer 1 has weak bargaining power than when Manufacturer 1 has strong bargaining power if advantageous (resp. disadvantageous) inequality occurs.*

Proposition 7 can be explained as follows. When advantageous or disadvantageous inequality occurs, peer-induced comparison behavior reduces the alliance's utility. The decrease in the utility is smaller (resp. larger) when Manufacturer 1 has weak bargaining power if advantageous (resp. disadvantageous) inequality occurs. When neither inequality occurs, as mentioned in the discussion of Proposition 6, peer-induced comparison behavior does not affect the CSR investment strategy.

5.4. Alternative Event Sequence

In this subsection, we consider an alternative event sequence shown in Figure 5. The manufacturer and the supplier negotiate over a wholesale price W at the beginning of stage 2. If they reach an agreement on the wholesale price, the manufacturer decides the order quantity; otherwise, no transaction happens. This alternative model setup is intractable under the set of assumptions that we make for the base model. Therefore, to simplify the analysis, we further assume that the loss incurred by the manufacturer from CSR violations is given by $l = eQ$, where Q is the order quantity and e is the unit loss. We consider the decentralized supply chain without distributive comparison behavior as our benchmark. Additional details are provided in Online Appendix A.6.

The comparison between the benchmark and the supply chain with distributive comparison behavior reveals that most of the results shown in Lemma 3 hold in this extended study. Given the supply chain's CSR investment strategy, when advantageous or disadvantageous inequality occurs, the manufacturer's distributive comparison behavior does not affect the order quantity, the supply chain's net profit, or consumer surplus, but it reduces social welfare. Additional details are given in Lemma A.5 in Online Appendix A.6.

Under this alternative event sequence, the comparison of the equilibrium CSR investment strategy between the supply chain with distributive comparison behavior and benchmark reveals that most of our main results from the base model still hold. For example, when advantageous (resp. disadvantageous) inequality occurs, distributive comparison behavior makes the manufacturer less (resp. more) likely to invest in CSR, but it makes the supplier more (resp. less) likely to invest in CSR than in the supply chain without distributive comparison behavior.

5.5. Distributive Comparison Behavior Regarding CSR Investments

In addition to firms' concerns about profit distribution, firms may compare their CSR investments with those of

Figure 5. The Alternative Sequence of Decisions
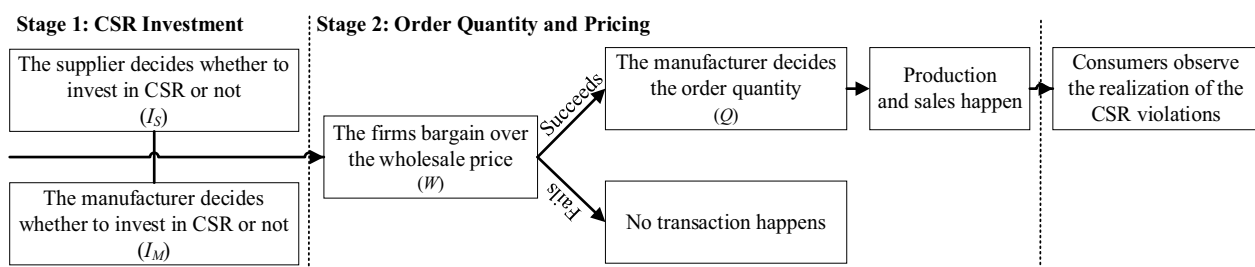
their supply chain partners. Governments and NGOs may publish various CSR rankings and create CSR awards to motivate such comparisons. In this subsection, we consider that the manufacturer compares the CSR investment with that of the supplier and benefits by investing more than the supplier. This makes the manufacturer willing to overperform relative to the supplier in the CSR investment. This behavior is considered as one type of *ahead-seeking behavior* (Roels and Su 2014). Additional details are provided in Online Appendix A.7.

We use the decentralized supply chain without ahead-seeking behavior as the benchmark. The comparison between supply chains with and without ahead-seeking behavior shows that our results obtained in Lemma 3.1 still hold in this extended study. However, in this extended study, ahead-seeking behavior improves the manufacturer's utility, and thus social welfare with ahead-seeking behavior is higher than that in the benchmark.

Proposition 8. *The ahead-seeking behavior of the manufacturer makes the manufacturer more likely to invest in CSR, and it makes the supplier more (resp. less) likely to invest in CSR when the supplier's CSR investment cost is low (resp. high).*

Ahead-seeking behavior improves the manufacturer's utility, and it makes the manufacturer more likely to invest in CSR. Whether it makes the supplier more likely to invest in CSR depends on the supplier's CSR investment cost.

Similar to our base model, in the following, we compare P_M and N_S caused by the manufacturer's ahead-seeking behavior for the small manufacturer with weak bargaining power and those for the large manufacturer with strong bargaining power.

Proposition 9. P_M *(resp. N_S) caused by the small manufacturer with weak bargaining power is smaller (resp. larger) than those caused by the large manufacturer with strong bargaining power.*

Proposition 9 shows that if the manufacturer has ahead-seeking behavior, the positive (resp. negative) impact of ahead-seeking behavior is smaller (resp. larger) when the manufacturer has weak bargaining power. Therefore, when governments and NGOs observe that firms are willing to overperform relative to their supply chain partners in CSR investments, extra efforts need to be made to monitor and support CSR in the supply chains with small downstream firms.

6. Conclusion

CSR has become a clear priority for many firms. To improve CSR in a supply chain, it requires efforts from all supply chain members. The joint efforts may lead to firms' concerns about fairness in the distribution of the benefit generated from CSR investments. Such a concern is considered as distributive comparison behavior in the literature. The existing literature on people-centric operations focuses mainly on how comparison behavior affects channel pricing (Ho et al. 2014, Cui and Mallucci 2016). In this paper, we consider how distributive comparison behavior affects CSR investment strategies by comparing a supply chain with distributive comparison behavior and one without such behavior. We highlight the interactions between comparison behavior and CSR in supply chains.

Although previous research about CSR has focused mainly on large downstream firms, there is a strong need to understand the role of small firms in CSR. We explore how the impacts of distributive comparison behavior on firms' CSR investments differ between large and small manufacturers. We consider that a small manufacturer may have weaker bargaining power or lower efficiency to reduce CSR violations than a large manufacturer.

We find that, when advantageous inequality occurs or when neither inequality occurs and the manufacturer's fairness ideal is small, distributive comparison behavior results in a higher wholesale price than the supply chain without distributive comparison behavior. It reduces the manufacturer's utility but increases the supplier's profit. Thus, the manufacturer is less likely to invest in CSR than in the supply chain without distributive comparison behavior, that is, negative impacts of distributive comparison behavior, but the supplier is more likely to invest, that is, positive impacts of distributive comparison behavior. When disadvantageous inequality occurs or when neither inequality occurs and the manufacturer's fairness ideal is large, distributive comparison behavior results in a lower wholesale price. Thus, the manufacturer is more likely to invest in CSR, but the supplier is less likely to invest.

About the difference between the large and small manufacturers, in most of the cases, the weak bargaining power of the small manufacturer leads to larger positive or smaller negative impacts of distributive comparison behavior on the CSR investment. Furthermore, the low efficiency of the small manufacturer to reduce CSR violations generally leads to smaller negative impacts of distributive comparison behavior.

Our results provide the following implications for governments and NGOs. First, governments and NGOs should take measures such as surveys, interviews, and organizing forums to investigate firms' distributive comparison behavior in supply chains. When downstream firms show the aversion to lower (resp. higher) profits than upstream firms, the measures to monitor and support upstream (resp. downstream) firms' CSR investment should be taken to avoid CSR violations, such as through audits and certifications, disclosure mandates, and violation reporting suggested in the literature. Second, our results highlight the importance to understand power structures in supply chains with distributive

comparison behavior. In the supply chains with small downstream firms, extra efforts should be made to induce firms' distributive comparison behavior due to its larger positive impacts and smaller negative impacts. Last, despite the low efficiency to reduce CSR violations, governments and NGOs should still provide support for small firms' CSR investments and perhaps make them better informed about the benefits of such investments.

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