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Combating Child Labor: Incentives and Information Disclosure in Global Supply Chains

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Problem Definition: We investigate multinational firms' inspection and pricing strategies to address the challenges of combating child labor in global supply chains. We also examine how several factors (such as information disclosure, goodwill loss, inspection cost, external monitoring by NGOs, and penalty scheme) affect firms' incentives to use different strategies to combat child labor.

Academic/Practical Relevance: Nearly 200 million children are engaged in child labor, many in developing countries that are part of the supply base of global manufacturing networks. However, there has been little research on evaluating the impact of firms' strategies and NGOs' initiatives on child labor.

Methodology: We develop a game-theoretic model based on a two-tier supply chain, in which a multinational firm in a developed country sells the product made by a supplier in a developing country.

Results: If internal inspections are economical, a global firm can reduce the incidence of child labor by inspecting the supplier's use of child labor. Otherwise, the firm can deter the supplier's child labor employment by offering a sufficiently high wholesale price, or by simultaneously using internal inspections and a medium wholesale price. The latter strategy should be adopted only when information about the firm's inspection policy can be informed credibly. This strategy combats child labor more effectively when a higher penalty is levied onto the supplier's use of child labor.

Managerial Implications: A multinational firm which adopts a zero-tolerance policy should consider disclosing its effort to combat child labor (e.g., through social responsibility report), whereas it should take extra caution when using other penalty schemes. NGOs should help raise the firm's goodwill cost (e.g., through campaigns and consumer education), but they should be careful about helping to reduce the firm's inspection cost (e.g., by improving a monitoring system). To prevent children from going back to work after initial removal, a sufficient amount of compensation should be provided to those children, especially when firms rely on inspections without paying a high wholesale price to suppliers.

1 Introduction

International Labor Organization (ILO) defines child labor as "work that is mentally, physically, socially or morally dangerous and harmful to children; and interferes with their schooling." In 2012 there were 168 million child laborers worldwide, accounting for around 11% of the entire child population (ILO 2013). According to ILO, child labor is deemed as a severe human rights violation: *"All child labour, and especially the worst forms, should be eliminated. It not only undermines the roots of human nature and rights but also threatens future social and economic progress worldwide.*

Trade, competitiveness and economic efficiency should not be a pretext for this abuse."

Alarmingly, the decline of child labor has slowed down (ILO 2010). The progress to end child labor is challenged by the prevalence of global outsourcing. Economic research suggests that firms' global search for cheap labor has boosted the demand for child labor (Acaroglu and Dagdemir 2010). There are numerous examples of items produced by child labor, including cotton from Uzbekistan, cocoa from Ivory Coast, carpets and garments from India and Pakistan, and electronic products and toys from China (U.S. Department of Labor 2014). In these countries, child labor is often treated as a moral issue, and it lacks effective regulations (O'Rourke 2003). Moreover, child labor enables local suppliers to keep production costs down, and the surplus from such low costs is then passed on to multinational firms along the global value chain (Locke 2003). Therefore, many multinational firms lack motivation to control their local suppliers' use of child labor.

Even when some firms intend to address child labor in their supply chains, they are hindered by the lack of direct control over their suppliers' use of child labor. As such, firms often adopt two indirect approaches to tackle the issue: internal inspections and penalty schemes (Kolk and van Tulder 2002a). These approaches, however, have some drawbacks. First, internal inspections on child labor are costly and imperfect. Monitoring of labor conditions requires investigation of production sites, which is often challenging or "virtually impossible" (International Finance Corporation 2002). For example, in carpet production in India, 175,000 looms were estimated to be in the Uttar Paradesh carpet belt alone, and most were located in small workshops and even local households. IKEA, one of major retailers of the Indian carpets, concluded that "no one could monitor such a fragmented production process" (Bartlett et al. 2006). Kolk and van Tulder (2002b) also mention the complexity of inspecting suppliers in the garment industry because sourcing networks may involve thousands of factories spread across multiple countries. Second, it is likewise costly for a firm to influence its supplier's practice through penalty schemes. A firm may deter its supplier from hiring child labor by requiring the supplier to take costly corrective actions when child labor is found or by threatening to terminate the contract. However, for this threat to be effective, the firm may have to leave considerable profits to the supplier, which in turn will increase the firm's outsourcing cost. For example, Obeetee, an Indian carpet manufacturer, increased wages significantly as an incentive to loom owners, while informing them (in writing) that if found employing child labor, they would lose their business and be blacklisted from doing any future business with the company (International Finance Corporation 2002). Similarly, Bayer CropScience put 5% of its procurement price as a bonus for crop farmers who did not use child labor (Subramanian 2013).[1]

In light of these challenges, several initiatives have been undertaken. First, to impose pressure

[1] In order to urge Bayer Group to eliminate child labor, a group of European NGOs cosigned an open letter in 2003, which states: "In order to prevent your suppliers from using child labor, the prices paid to their products need be high enough so that employment of adults is profitable to the suppliers" (Subramanian 2013).

on global firms, third-party organizations have developed programs to monitor child labor practices at local production sites, and launched consumer education campaigns to increase consumer awareness of child labor. Due to extensive media reach coupled with advances in information technology, firms that sell the products involved in child labor would likely incur a reputation loss in both consumer and financial markets (Smith 2003). Second, firms have undertaken a variety of strategies to improve their abilities to monitor suppliers' practices in a more cost-effective manner (U.S. Department of Labor 2000). For example, firms collaborate through Child Labor Elimination Group in the agriculture industry of India or through the Atlanta Agreement in the global footwear industry. A data base system is set up to record information gathered from various auditing programs (e.g., the ILO's International Program on the Elimination of Child Labor). Third, firms have been encouraged to disclose their policies and efforts in combating child labor to their stakeholders including their employees, supply chain partners and third-party organizations (International Finance Corporation 2002). Companies such as Apple, Sony and Nike publish social responsibility reports every year, which disclose the measures taken to combat child labor. Recently, a bill on supply chain information disclosure – the California Transparency in Supply Chains Act (Senate Bill 657) (hereinafter the "Act") is passed, which requires manufacturers and retailers in California with annual revenue of $100 million or more to publicly disclose to which degree the firms are engaged in combating forced labor (including child labor) in their supply chains. In particular, those firms are required to disclose their inspection policies on whether they have internal auditing on their suppliers, and such information is recorded by websites such as `https://www.knowthechain.org/`.

Despite the significance of child labor problems in the world, to date, there has been little research on evaluating the impact of these initiatives on child labor in global supply chains. Although there is an increasing number of empirical work on information disclosure in the context of environmental violations (e.g., Toffel and Short 2011, Doshi et al. 2013), which suggests the benefits of information disclosure, it is unclear whether such benefits can also be achieved through firms' disclosure of their inspection policies on child labor. If not, are there any potential measures that can enhance the benefit of information disclosure regarding child labor? This paper aims to provide insights by examining how the initiatives to improve inspections and information disclosure affect firms' strategies and incentives to control their suppliers' use of child labor. To this end, we develop a game-theoretic model based on a two-tier supply chain, in which a multinational manufacturer ('she') outsources her production to a local supplier ('he') through a wholesale-price contract[2]. The supplier has an option to use child labor in place of legitimate labor at a lower cost. However, child labor, if exposed to the public, would incur a goodwill loss to the manufacturer. The manufacturer may carry out costly (but imperfect) internal inspections to monitor her

[2] We consider a wholesale-price contract because it is most common in practice (e.g., Kalkancı et al. 2011, Hwang et al. 2016) and in related literature (e.g., Hwang et al. 2006, Hsieh and Liu 2010, Chen and Deng 2013, Guo et al. 2016, Plambeck and Taylor 2016), while extending the analysis to a deferred payment contract.

supplier's child labor practice. When the manufacturer finds the supplier's use of child labor or when a third party does so through external monitoring, the manufacturer may require the supplier to take corrective actions by removing child laborers and compensating them, or alternatively the manufacturer may terminate the contract with her supplier. We examine the impact of information disclosure by comparing the following two scenarios: In a non-disclosure scenario, the supplier and third party organizations are unable to observe the manufacturer's inspection effort, whereas in a disclosure scenario they are informed of the manufacturer's inspection effort.

We summarize our main findings in the following three aspects[3]:

1. Strategies to combat child labor: A global manufacturer may use three different strategies to control the use of child labor in her supply chain. First, when internal inspections are economical, the manufacturer can reduce the incidence of child labor by undertaking inspections to detect and remove child labor hired by the supplier. Second, when internal inspections are costly, the manufacturer can deter the supplier's child labor employment by offering a sufficiently high wholesale price, which will guarantee the supplier a high profit margin and thus cause him a high potential loss when he loses a contract with the manufacturer. Third, the manufacturer could simultaneously use internal inspections and a medium wholesale price to deter the employment of child labor. This strategy should be adopted only in the disclosure scenario because the supplier is willing to accept the medium wholesale price and employs no child labor only when he is informed that the manufacturer's inspections are comprehensive. This strategy combats child labor more effectively when the manufacturer can enforce a higher penalty onto the supplier from internal inspections.

2. Factors that affect manufacturers' strategies: As expected, increasing a goodwill cost (e.g., by enhancing consumer awareness) or adding more value to business relation helps reduce child labor. However, the manufacturer may replace price premium with inspection in combating child labor, so that reducing inspection costs does not necessarily reduce child labor. When inspections are costly, global manufacturers faced with high potential goodwill loss would choose to combat child labor by offering high wholesale prices, which could incentivize suppliers not to employ child labor in the first place. However, when inspections become less costly, these manufacturers may rely entirely on internal inspections (instead of offering high wholesale prices) to reduce the incidence of child labor. This could introduce more child labor because inspections are imperfect and may not always find child labor employed by suppliers. In contrast, third parties' monitoring may or may not raise manufacturers' inspection effort. The impact of these factors is unaffected by the disclosure of the manufacturer's inspection effort, except that the unintended consequence of low

[3]The results from our base model can be potentially applied to other issues in social responsibility and environmental sustainability of supply chains, including the cases in which the supplier can find cheaper, but socially undesirable, sources of inputs (e.g., hiring illegal immigrants, skipping pollution-treatment process, or using cheap material with potential safety or environmental problems). In §7, we enrich our model and analysis by considering a household's decision to send its child to work.

inspection costs is less likely to occur with the disclosure.

3. Information disclosure: Although policy makers seem to advocate information disclosure in supply chains, information disclosure may not always reduce child labor. On the one hand, manufacturers' disclosure of their efforts to combat child labor can help reduce child labor by enabling manufacturers to use the combined strategy of internal inspections and medium wholesale prices. On the other hand, it is possible that information disclosure gives manufacturers incentives to offer low wholesale prices and disclose low inspection efforts. This could inadvertently lead suppliers to employ child labor. Such adverse effect could be mitigated by several measures including a zero-tolerance policy (although our result indicates that this is not always a preferred policy).

2 Literature Review

In this section, we review three most related research streams.

(1) Economics of Child Labor and Inspection. Economic research on child labor mainly examines the issue from two aspects: supply and demand of child labor. Research on the supply side analyzes factors that affect parents' incentives to send their children to work. These factors include agriculture output (Beegle et al. 2006), crop price under trade liberalization (Edmonds and Pavcnik 2005), and household holding of lands (Basu et al. 2010). Other papers, including ours, focus on the demand side and study how to induce employers to hire less child labor (Basu 1999, Basu and Zarghamee 2009, Davies 2005). Most economic papers implicitly assume that pressure imposed on local employers directly come from concerned consumers and organizations. We instead study the case in which such pressure is transferred from consumers to local employers through global supply chains. This perspective captures the current trend that child labor is increasingly involved in the items procured by multinational firms through global outsourcing, and that end-consumers have influence on multinational firms but less so on local employers of child labor.

Broadly, our paper is also related to economic research on inspection and compliance in law enforcement (including labor and environmental laws). Becker (1968) considers an enforcement authority who combines random audits with penalties to maximize the probability of seizing violators. Tsebelis (1990) considers a one-shot simultaneous game (called 'inspection game') to model the interactions between the enforcement authority and violators. See Polinsky and Shavell (2007) for a survey of related economic theories. The focus of this stream of literature is the effectiveness of penalties including imprisonment, and the enforcement authority is usually a government. Different from this literature, our paper aims to evaluate the effectiveness of various initiatives to improve inspections and information disclosure, and enforcement effort is mainly exerted by a multinational firm. In addition to inspections, the firm can use a contract price to induce compliance from a supplier. Interaction between these two means in a supply chain leads to novel results.

(2) Socially Responsible Supply Chain Management. This stream of work aims to achieve an overall social goal by coordinating various supply chain members. Babich and Tang (2012) study

mechanisms for dealing with product adulteration such as deferred payment. Kim (2014) investigates the relationship between a regulator's inspection activities and a production firm's voluntary disclosure of self-noncompliance. Chen and Lee (2016) focus on screening responsible suppliers through delayed payment contracts. Guo et al. (2016) analyze a manufacturer's outsourcing choice between responsible and risky suppliers when consumers are socially conscious. Kraft et al. (2016) use an experiment to study how supply chain visibility impacts consumers' valuations of a company's social responsibility practices in its supply chain. Kalkanci et al. (2016) show that if a government mandates firms to disclose what they learn about their social and environmental impacts in their supply chains, it could deter firms from measuring and improving those impacts. Chen et al. (2016) find that it may be beneficial for a buyer to reveal her supplier list even if revealed suppliers face a different level of scrutiny from non-governmental organizations (NGOs) than unrevealed suppliers.

Similar to our paper, Plambeck and Taylor (2016) study how a buyer can motivate its supplier to exert more effort to comply with labor and environmental standards. Our paper differs in several aspects. First, while Plambeck and Taylor (2016) assume a fixed wholesale price, our model considers a global firm that determines a wholesale price as well as a level of internal inspection. As discussed in §1, the wholesale price has a significant influence on the incentive of a supplier hiring child labor, and our analysis hinges crucially on the interplay between these two levers. Second, consistent with industry practice, a global firm in our model can use various penalty schemes for a supplier who employs child labor (corrective action, contract termination, or combination of both), and it has some influence over the magnitude of the supplier's potential loss through endogenous choice of the wholesale price and the compensation paid to a child worker. Third, we examine the impact of information disclosure on a global firm's joint decision on inspection level and wholesale price, and its consequence on child labor. Similar in spirit, Plambeck and Taylor (2016) study the impact of a buyer's pre-commitment to auditing effort but under a fixed wholesale price. Although they state that if the supplier were unable to hide, the ability to pre-commit would cause the buyer to do more auditing, we find that this is not always true when wholesale price is determined endogenously. Lastly, we consider a unique feature of the child labor problem by analyzing a household's decision to send its child to work.

(3) Quality Management. Our paper is related to a stream of papers that study the joint effects of contract, inspections, and information. Hwang et al. (2006) study how to control suppliers' product quality through a combination of inspections and contracts, but they do not consider the role of information in inspections. There are some papers that examine the role of information in quality investment under a fixed wholesale price (e.g., observability of information in Hsieh and Liu 2010, information noise in third-party certification in Chen and Deng 2013). Some papers study the joint impact of contract, inspections and information on product quality, but their focus is different from ours. Balachandran and Radhakrishnan (2005) consider the setting in which a product comprises

components made by a buyer and a supplier, and examine how the information of the buyer's quality effort shapes the design of penalties imposed onto the supplier during internal and external failures. Baiman et al. (2000) study the impact of the supplier's knowledge of the buyer's inspection effort on product quality. They find that once information about the buyer's inspection effort is known to the supplier, the supplier would make more effort to improve quality, and therefore product quality would always be improved. In contrast, in our paper, even if information about the buyer's effort is known to the supplier in the disclosure scenario, it may induce more child labor, causing inferior product quality in the socially responsible sense (although real product quality remains the same).

In general, defective products could be detected by manufacturers through sampling approaches and inspection technology, and if not, they could be found later by consumers after they are sold in the market. In contrast, a product made by child labor is not necessarily defective in product functionality, and detection of child labor is more complicated because neither manufacturers nor consumers can learn it from inspecting products. It may also involve a third stakeholder such as NGOs. Manufacturers may need these organizations' support, training, and information for their internal inspections, and consumers may well get some information from these organizations. Public policy such as the Act also plays a role in determining information disclosure.

3 The Model

We consider a decentralized supply chain in which a manufacturer ('she') outsources her production to a supplier ('he') via a wholesale-price contract. The outsourced production quantity is fixed, and is normalized to one. We assume that the supplier needs one unit of labor to produce this product. Let d denote the supplier's decision: $d = 1$ means that the supplier employs a child laborer, and $d = 0$ means that the supplier employs an adult laborer. For ease of exposition, we consider the case where the supplier chooses a pure strategy of either employing a child laborer or an adult laborer. In addition, we analyze the case where the supplier may choose a mixed strategy as well as the case where the supplier may hire only a portion of workforce with child labor. These cases lead to similar equilibrium outcomes, and the key insights we obtain for a binary d continue to hold for these cases. (More details are provided in the supplemental file which is available upon request.) We denote by s_H and s_L the labor cost for the supplier to hire an adult and a child, respectively, where $s_H > s_L$. Without loss of generality, all other production costs are normalized to 0. The product is sold to the market at a fixed retail price v (> 0).

The manufacturer decides the wholesale price w and the amount of effort θ to inspect the supplier's employment of child labor. The effort θ determines the probability that the manufacturer will detect the supplier's employment of child labor, if it exists, during her internal inspections. We thus refer to θ as the level of "internal" inspections. For tractable analysis, following Hwang et al. (2006) and Babich and Tang (2012), we adopt a binary inspection level: $\theta \in \{\theta_L, \theta_H\}$,

where θ_H (θ_L) denotes high (low) inspection level, and θ_L is set to 0 (i.e., no inspections).[4] The corresponding inspection costs are $I(\theta_H) = I > 0$ and $I(\theta_L = 0) = 0$, respectively. We consider the following two scenarios: *non-disclosure* scenario and *disclosure* scenario.

In the *non-disclosure* scenario, the manufacturer does not disclose her inspection level θ. In addition to internal inspections, child labor is also subject to monitoring by third parties (e.g., NGOs such as UNICEF and ILO, or the media). Let e ($\in (0,1)$) denote the probability in this scenario that the supplier's use of child labor, if it exists, will be detected through such "external" inspections. If the manufacturer is found to use child labor in the outsourced production of her product, she will suffer from goodwill cost g (> 0), which includes short-term sales loss and long-term damage in reputation. We can describe the sequence of decisions and events in this scenario as follows (see Figure 1 for illustration):

(S1) The manufacturer offers a wholesale price w to the supplier. The supplier accepts the contract if he can earn a higher expected profit than his reservation profit (normalized to zero).

(S2) If the supplier accepts the contract, he makes a hiring decision on d and carries out production, while the manufacturer chooses her inspection level θ. Since the supplier and manufacturer are unaware of each other's decision, following the literature (e.g., Babich and Tang 2012, Plambeck and Taylor 2016), we assume that their decisions are simultaneous; i.e., they engage in a game of imperfect information.

(S3) The manufacturer conducts internal inspections with the level θ.

(S4) Once the production is over, the manufacturer pays w to the supplier, and sells the product to the market at the retail price v.

(S5) External inspections are conducted with the level e.

In the *disclosure* scenario, the manufacturer discloses θ in its website (as required by the Act), social responsibility report, contract with the supplier, or agreement with a third-party organization who works with the manufacturer. In this scenario, third parties may react to the manufacturer's inspection effort by choosing an external inspection level that depends on θ.[5] We assume that if

[4] We set θ_L to 0 for ease of exposition. All of our main results still hold even if $0 < \theta_L < \theta_H$ (i.e., low inspection level instead of no inspections). Although the exact measurement of inspection effort may not be easy in practice, there is a clear difference between the companies that regularly conduct internal inspections for child labor and those that do not. For example, companies such as Apple, Sony and Nike audit their suppliers' labor practices frequently. However, companies such as IDEX, Caterpillar, and Danaher state that they do not verify their supply chains or audit suppliers to evaluate risks of human trafficking and slavery (see the online appendix for details). One may interpret that these companies disclose no or low-level inspection efforts. Companies may rely on other organizations (e.g., GoodWeave) for their internal inspections - in this case, the inspection cost in our model captures the fee paid to those organizations.

[5] In reality, the manufacturer who discloses low inspection effort may draw attention from the media and third parties. For example, KnowTheChain publicizes the names of the companies who disclosed that they did not audit suppliers to evaluate risks of child labor after California Transparency in Supply Chains Act (KnowTheChain 2014). Given the limited resources, third parties may then increase (decrease) their effort of external inspection on those

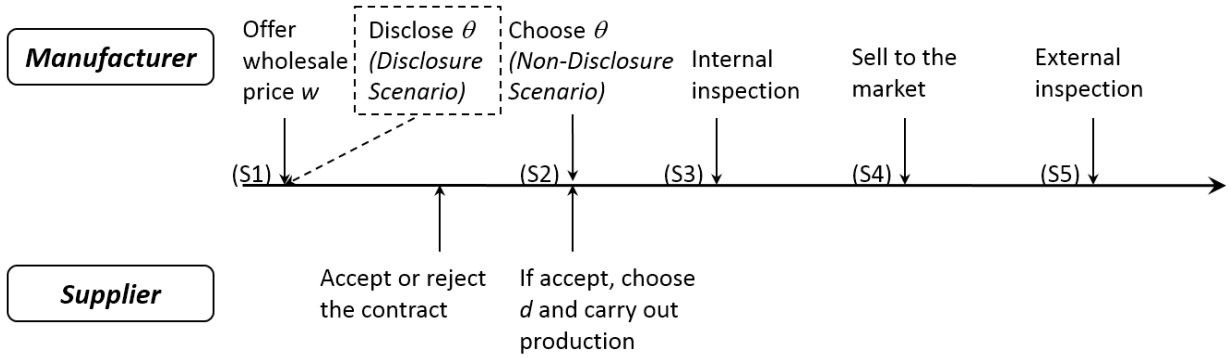

Figure 1: The Sequence of Decisions and Events

the disclosed level θ is low (resp., high), third parties choose a high (resp., low) level of external inspection; i.e., $e(\theta_L) = e_H$ (resp., $e(\theta_H) = e_L$, where $0 < e_L \leq e_H < 1$). Since the supplier has information about the manufacturer's internal inspection level before he accepts the contract, we can revise the sequence above as follows (see Figure 1 where the manufacturer's inspection decision is shown in the dashed text box):

(S1') The manufacturer offers a wholesale price w and discloses her inspection level θ. The supplier decides whether to accept the contract or not.

(S2') If the supplier accepts the contract, he decides on d, and carries out production.

(S3') and (S4') are the same as (S3) and (S4), respectively.

(S5') External inspections are conducted with the level e_H (resp., e_L) if the level of internal inspections is θ_L (resp., θ_L).

For both non-disclosure and disclosure scenarios, we can express the manufacturer's expected profit U and the supplier's expected profit Π as a function of (w, θ, d). The manufacturer's expected profit U is given as

$$U(w, \theta, d) = v - w - I(\theta) - e(\theta) g d (1 - \theta), \tag{1}$$

where $e(\theta) g d (1 - \theta)$ represents the expected goodwill cost. Recall that the manufacturer incurs the goodwill cost g when: (i) child labor is employed by the supplier (i.e., $d = 1$); (ii) it passes the manufacturer's internal inspections with probability $(1 - \theta)$;[6] and (iii) it is detected and reported to the public by third parties with probability $e(\theta)$. A similar assumption is made by Plambeck and Taylor (2016) and Chen and Lee (2016). For ease of exposition, we define $d_E \equiv d(1 - \theta)$ as the expected amount of child labor that is *used* in outsourced production (and thus can be potentially

manufacturers who have disclosed low (high) inspection effort. A similar assumption is made in Chen et al. (2016).

[6] Here we assume that if the supplier's use of child labor is detected (and thus corrected) by the manufacturer internally, the manufacturer would not incur any goodwill cost. In reality, NGOs might still be able to identify the supplier's past use of child labor, causing some goodwill loss to the manufacturer. Our supplemental analysis shows that the key insights continue to hold for this case.

exposed to the public). In our subsequent analysis, we use d_E as one measure of the severity of the child labor issue: $d_E = 0$ in the best case where the supplier does not employ child labor, $d_E = 1$ in the worse case where the supplier employs child labor and the manufacturer makes no effort to resolve the issue, and $d_E \in (0, 1)$ in the moderate case where the supplier employs child labor and the manufacturer makes some effort to resolve the issue.

To express the supplier's expected profit Π, we need to assume a certain penalty scheme imposed on the supplier when his use of child labor is discovered during internal or external inspections. In what follows, we describe the base penalty scheme that is commonly observed in practice[7], while considering two alternative schemes in §6. Under the base penalty scheme, when the supplier's employment of child labor is discovered by the manufacturer in internal inspections, the supplier is mandated to perform a corrective action by paying the child worker a monetary compensation of m (> 0) and rehiring an adult to complete production. The compensation m reflects living and education costs in a certain country. The provision of such stipends is important to avoid children from moving from one workplace to another, and it is often required by industry agreements (e.g., the Atlanta Agreement in the footwear industry and the agreement among Bangladesh Garment Manufacturers and Exporters Association, ILO and UNICEF). For simplicity, we assume that the detection occurs at the beginning of production[8], and that wages are paid at the end of production; thus when a child worker is found, s/he is removed with no wage but the monetary compensation m, and the adult worker is rehired at the adult wage s_H. When the supplier's employment of child labor is discovered by third parties in external inspections, the supplier will lose a fraction or all of future business from the manufacturer. We assume that the supplier's opportunity cost of losing future business is γ (> 0) times his profit from the current order; thus, the manufacturer can increase the supplier's opportunity cost by leaving more profit to the supplier through a high wholesale price. Let $\Delta(\theta)$ denote the supplier's expected labor cost saving from hiring child labor when the manufacturer has chosen her internal inspection level θ. Then we can express $\Delta(\theta)$ as

$$\Delta(\theta) \equiv s_H - \{(1-\theta) s_L + \theta (s_H + m)\} = (s_H - s_L) - (s_H - s_L + m)\theta. \tag{2}$$

Using $\Delta(\theta)$, we can express the supplier's expected profit Π as

$$\Pi(w, \theta, d) = (1 - \gamma e(\theta) d(1-\theta))(w - s_H + d\Delta(\theta)). \tag{3}$$

[7] For example, IKEA normally required the supplier to implement a corrective action when finding child labor (IKEA's Position on Child Labour 2003), but when a television program broadcast an investigation report for a supplier employing child labor in India, IKEA immediately terminated the contract with the supplier (Bartlett et al. 2006). Similarly, Apple requires its suppliers to return child laborers to their homes and pay for their basic needs if they are found during inspections, whereas Apple terminated its contract with the supplier involved in its most public child-labor incident (Fernholz 2014).

[8] We also consider the case in which the internal inspection is conducted randomly at the beginning or end of production, and find that such random inspections may not reduce child labor.

In (3), $w - s_H + d\Delta(\theta)$ represents the supplier's profit when there is no risk of child labor being detected by third parties. The term $\gamma e(\theta) d(1-\theta)(w - s_H + d\Delta(\theta))$ represents the supplier's expected opportunity cost due to child labor, in which $e(\theta)(1-\theta)$ represents the probability that the manufacturer will discontinue her contract with the supplier due to child labor discovered during external inspections after passing internal inspections.

The manufacturer chooses her wholesale price w and inspection level θ to maximize her profit, and the supplier chooses his child labor employment level d to maximize her profit. In the non-disclosure scenario, the supplier observes only w, whereas he observes both w and θ in the disclosure scenario. In §4 and §5, we derive firms' equilibrium decisions in the non-disclosure and disclosure scenarios, respectively. In the online appendix, we present proofs and assumptions on parameters that rule out unrealistic or uninteresting cases.

4 Non-Disclosure Scenario

In the non-disclosure scenario, the manufacturer does not disclose her internal inspection level θ when offering the contract to the supplier. Thus, in a subgame for a given wholesale price w, the manufacturer and the supplier simultaneously determine the inspection level θ and the child labor decision d, respectively, anticipating the best response of the other party to his/her own decision. Throughout the paper we let the superscript "*non*" indicate results in the non-disclosure scenario.

Let $(\theta^{non}(w), d^{non}(w))$ denote the equilibrium in the subgame for a given w. Anticipating $(\theta^{non}(w),\ d^{non}(w))$, the manufacturer solves the following program at the contract stage (S1) to choose the wholesale price w that maximizes her expected profit U:

$$\max_{w} \quad U\left(w, \theta^{non}(w), d^{non}(w)\right) \tag{4}$$

$$s.t. \quad w - s_H + \Delta\left(\theta^{non}(w)\right) d^{non}(w) \geq 0 \tag{5}$$

$$\theta^{non}(w) \quad = \underset{\theta \in \{0, \theta_H\}}{\arg\max}\ U\left(w, \theta, d^{non}(w)\right) = \underset{\theta \in \{0, \theta_H\}}{\arg\max}\ v - w - I(\theta) - e(1-\theta) g d^{non}(w) \tag{6}$$

$$d^{non}(w) = \underset{d \in \{0,1\}}{\arg\max}\ \Pi\left(w, \theta^{non}(w), d\right) = \underset{d \in \{0,1\}}{\arg\max}\ \ \{1 - \gamma e(1 - \theta^{non}(w)) d\}\{w - s_H + \Delta(\theta^{non}(w)) d\}. \tag{7}$$

Constraint (5) ensures that the supplier earns non-negative expected profit to accept the contract. Constraints (6) and (7) ensure that the manufacturer's inspection decision $\theta^{non}(w)$ and the supplier's employment decision $d^{non}(w)$ are the best response to each other's equilibrium strategy for any given w. We first find equilibrium $(\theta^{non}(w), d^{non}(w))$ in a subgame for a given w from (6) and (7), and then substitute them into (4) and (5) to find a subgame-perfect equilibrium w^{non}.

4.1 Equilibrium in a Subgame of a Fixed w

For any fixed w, the supplier determines his best response $d^{non}(\theta, w)$ to the manufacturer's decision on θ by evaluating the difference in his expected profit between hiring child labor and not. We can

easily show that $d^{non}(\theta, w)$ is determined as[9]

$$
\begin{aligned}
&d^{non}(\theta, w) = 1 \ \forall \theta \in \{\theta_L, \theta_H\} \text{ for } w \in \left[0, s_H + \tfrac{\Delta(\theta_H)}{\gamma e(1-\theta_H)} - \Delta(\theta_H)\right);\\
&d^{non}(\theta_L, w) = 1 \text{ and } d^{non}(\theta_H, w) = 0 \text{ for } w \in \left[s_H + \tfrac{\Delta(\theta_H)}{\gamma e(1-\theta_H)} - \Delta(\theta_H), s_H + \tfrac{\Delta(\theta_L)}{\gamma e} - \Delta(\theta_L)\right);\\
&d^{non}(\theta, w) = 0 \ \forall \theta \in \{\theta_L, \theta_H\} \text{ for } w \in \left[s_H + \tfrac{\Delta(\theta_L)}{\gamma e} - \Delta(\theta_L), +\infty\right).
\end{aligned} \tag{8}
$$

From (8), we observe that the manufacturer's internal inspections reduce the supplier's child labor employment when the wholesale price is neither too high nor too low. When the wholesale price is very low, the supplier always employs child labor to lower his labor cost regardless of the manufacturer's inspections. Conversely, when the wholesale price is very high, high expected opportunity costs from contract termination always deter the supplier from hiring child labor.

By evaluating the difference in the manufacturer's expected profit between choosing θ_H and choosing θ_L, we can also obtain the best response function of the manufacturer $\theta^{non}(d, w)$ to the supplier's decision on d as follows:

$$
\theta^{non}(d=0, w) = \theta_L; \ \theta^{non}(d=1, w) = \begin{cases} \theta_H & \text{if } I < e\theta_H g; \\ \theta_L & \text{if } I \geq e\theta_H g. \end{cases} \tag{9}
$$

Clearly, if the manufacturer expects that the supplier has no incentive to hire any child labor, then she will not conduct internal inspections (i.e., $\theta^{non}(d=0, w) = \theta_L = 0$). However, if the manufacturer expects that the supplier has an incentive to hire child labor, she will conduct internal inspections (i.e., $\theta^{non}(d=1, w) = \theta_H$) only when the inspection cost I is lower than the amount of expected goodwill loss reduced by inspections, $e\theta_H g$.

Finally, using $d^{non}(\theta, w)$ and $\theta^{non}(d, w)$, we obtain the following fixed point $(\theta^{non}(w), d^{non}(w))$ that satisfies $\theta^{non}(w) = \theta^{non}(d^{non}(w), w)$ and $d^{non}(w) = d^{non}(\theta^{non}(w), w)$[10]:

$$
(\theta^{non}(w), d^{non}(w)) = \begin{cases} (\theta_L, 1) & \text{if } I \geq e\theta_H g \text{ and } w < s_H + \tfrac{\Delta(\theta_L)}{\gamma e} - \Delta(\theta_L); \\ (\theta_L, 0) & \text{if } w \geq s_H + \tfrac{\Delta(\theta_L)}{\gamma e} - \Delta(\theta_L); \\ (\theta_H, 1) & \text{if } I < e\theta_H g \text{ and } w < s_H + \tfrac{\Delta(\theta_H)}{\gamma e(1-\theta_H)} - \Delta(\theta_H). \end{cases} \tag{10}
$$

4.2 Subgame-Perfect Equilibrium

In this section we study the manufacturer's decision on the wholesale price. The manufacturer determines a wholesale price w that maximizes her expected profit by solving the following program:

$$
\max_{w} U(w, \theta^{non}(w), d^{non}(w)); \ s.t. \ (5). \tag{11}
$$

[9] We assume that the supplier, if indifferent between hiring child labor and not, chooses not to hire child labor. Similarly, the manufacturer, if indifferent between conducting inspections and not, conducts no inspections.

[10] There is no fixed point when $w \in \left[s_H + \tfrac{\Delta(\theta_H)}{\gamma e(1-\theta_H)} - \Delta(\theta_H), s_H + \tfrac{\Delta(\theta_L)}{\gamma e} - \Delta(\theta_L)\right)$ and $I < e\theta_H g$.

Proposition 1 *The subgame-perfect equilibrium in the non-disclosure scenario is:*

$$(w^{non}, \theta^{non}, d^{non}) = \begin{cases} (s_H + (1/(\gamma e) - 1)\Delta(\theta_L), \theta_L, 0) & \text{if } \xi_3^{non} \leq I < \xi_1^{non} \text{ or } \{I \geq \xi_1^{non} \text{ and } g \geq \xi_2^{non}\}; \\ (s_H - \Delta(\theta_H), \theta_H, 1) & \text{if } I < \min\{\xi_1^{non}, \xi_3^{non}\}; \\ (s_H - \Delta(\theta_L), \theta_L, 1) & \text{otherwise,} \end{cases} \tag{12}$$

where $\xi_1^{non} \equiv e\theta_H g$, $\xi_2^{non} \equiv \Delta(\theta_L)/\gamma e^2$, *and* $\xi_3^{non} \equiv (1/(\gamma e) - 1)\Delta(\theta_L) + \Delta(\theta_H) - ge(1 - \theta_H)$.

Proposition 1 presents three possible subgame-perfect equilibrium outcomes. The first outcome in (12) indicates that, to incentivize the supplier not to employ child labor (i.e., $d^{non} = 0$), the manufacturer should adopt no inspections in equilibrium (i.e., $\theta^{non} = \theta_L$), and offer the supplier the wholesale price $s_H + (1/(\gamma e) - 1)\Delta(\theta_L)$. This price is higher than his labor cost s_H, and the supplier earns positive surplus. As indicated by our analysis in §4.1, such a price premium deters the supplier from hiring child labor by imposing high opportunity costs onto the supplier. In the other two equilibrium outcomes given in (12), however, no price premium is paid. In both outcomes, the manufacturer pays the wholesale price that covers only the supplier's labor cost of child labor (i.e., $w^{non} = s_H - \Delta(\theta^{non})$), and thus the supplier cannot but employ child labor (i.e., $d^{non} = 1$) and obtain zero surplus. Whether or not the manufacturer undertakes internal inspections separates these two outcomes. When the manufacturer conducts inspections, the second outcome in (12), $(w^{non}, \theta^{non}, d^{non}) = (s_H - \Delta(\theta_H), \theta_H, 1)$, emerges in equilibrium. In this case, child labor will be replaced with adult labor with probability θ_H. When the manufacturer chooses no inspections, the third outcome in (12), $(w^{non}, \theta^{non}, d^{non}) = (s_H - \Delta(\theta_L), \theta_L, 1)$, occurs in equilibrium.

This result implies that in equilibrium the manufacturer chooses one of the following three strategies in the non-disclosure scenario: pay a premium, conduct internal inspections, or do neither of the first two. In the rest of this paper, we refer to these strategies as "premium alone," "inspection alone," and "do-nothing" strategies, respectively. The supplier does not employ child labor (i.e., $d_E = 0$) under the premium-alone strategy, he employs child labor but the manufacturer makes effort to replace it (i.e., $d_E = 1 - \theta_H$) under the inspection-alone strategy, and the manufacturer makes no effort (i.e., $d_E = 1$) under the do-nothing strategy. This suggests that the premium-alone (resp., do-nothing) strategy brings about the best (resp., worst) outcome for child labor.[11]

We next examine the factors that affect the equilibrium strategy. Figure 2 illustrates the three strategies divided by threshold lines ξ_1^{non}, ξ_2^{non} and ξ_3^{non} defined in Proposition 1. First, we observe from Figure 2 that as the goodwill cost g increases, the manufacturer may change her strategy from do-nothing to premium-alone when the inspection cost I is high, or from do-nothing to inspection-alone and then to premium-alone when I is low. In the former case, the supplier stops employing child labor, and in the latter case, the child labor problem is at least alleviated by the internal inspection (see discussion above). This is intuitive: A high goodwill cost incentivizes the

[11] If $\theta_L > 0$, the do-nothing strategy may be called a low-effort strategy. As mentioned earlier, this strategy can be interpreted similarly to the do-nothing strategy.

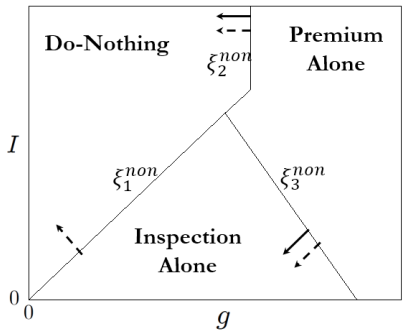

Figure 2: Equilibrium Outcomes in the Non-Disclosure Scenario. (*Note.* Solid arrows indicate how threshold lines change with γ, and dashed arrows indicate how threshold lines change with e.)

manufacturer to combat child labor. This result is consistent with industrial examples, in which firms take actions to combat child labor after they incur a high goodwill cost from intensive media coverage of their violations. For example, after a television program broadcast IKEA's supplier employing child labor in India, the company assigned the staff dedicated to monitoring child labor and set IKEA Way of Purchasing as one of ten strategic priorities (IKEA 2003).

Second, as illustrated in Figure 2, as the manufacturer's inspection cost I decreases, the manufacturer may change her strategy from do-nothing to inspection-alone when the goodwill cost g is low, or from premium-alone to inspection-alone when g is high. Although the former impact of I is intuitive, the latter impact of I is less so and merits some explanation. The latter impact implies that with a lower inspection cost I, the manufacturer may conduct internal inspections, while paying no premium to the supplier. This happens because by conducting inspections the manufacturer can lower the risk of exposing child labor, if any, to the public, and hence has less incentive to pay a premium to deter the supplier from hiring child labor. Therefore, as the inspection cost I decreases, the supplier may be induced to hire child labor when the manufacturer moves from the premium-alone strategy to the inspection-alone strategy in spite of the high goodwill cost g. This finding implies that various efforts of an industry and NGOs to reduce the manufacturer's cost of internal inspection (see §1 for examples) may not always be effective or even weaken the effect of a high goodwill cost. Additionally, Figure 2 indicates that the manufacturer may also change her strategy from do-nothing to premium-alone when the inspection cost I decreases from a high value (i.e., $I \geq \max(\xi_1^{non}, \xi_3^{non})$) to a medium value (i.e., $\xi_3^{non} \leq I \leq \xi_1^{non}$). When I is not very high (i.e., $I \leq \xi_1^{non}$), the supplier expects that the manufacturer can afford to conduct the internal inspection and thus would reject the low wholesale price offered under the do-nothing strategy. However, for the manufacturer, the inspection cost I is still not low enough (i.e., $I \geq \xi_3^{non}$) to make inspection-only a preferred strategy. Thus, the manufacturer adopts the premium-alone strategy in this case.

Third, solid arrows in Figure 2 illustrate that as the ratio of future orders to the current order, γ, increases, the threshold lines ξ_2^{non} and ξ_3^{non} move left. This means that when the value of future business is high, the manufacturer prefers the premium-alone strategy. The reason is as follows. With a higher γ, the supplier incurs a larger loss from hiring child labor, leading to a lower price premium $(1/(\gamma e)-1)\Delta(\theta_L)$ that the manufacturer pays to incentivize the supplier not to employ child labor. Therefore, the manufacturer is more likely to use the premium-alone strategy in this case. This suggests that adding more value into business relations could help a manufacturer address her child labor issue. For example, after suffering from a 69% fall in its earnings due to its scandal of severe labor rights violation in 1997, Nike instituted a new global value chain named "Future Vision" that emphasizes exclusive production relationships with its lead suppliers (Lim and Phillips 2008).

Finally, dashed arrows in Figure 2 illustrate that as the external inspection level e increases, the threshold lines ξ_2^{non} and ξ_3^{non} move left as in the solid arrows. In addition, the threshold line ξ_1^{non} moves left as well - this effect is unique to e, indicating that a higher e can lead the manufacturer to choose the inspection-alone strategy to combat child labor. Thus, the internal inspection effort may be increasing in the external inspection level. This is because under a higher external inspection level, the manufacturer faces a greater risk of losing consumer goodwill when child labor is employed, but internal inspections reduce the chance of child labor being exposed to the public. This result suggests that the increased external inspection level e can help deter the supplier's employment of child labor when the goodwill cost g is high (i.e., expanding the area where premium-alone is in equilibrium) or at least alleviate the child labor issue through the internal inspection when g is low (i.e., reducing the area where do-nothing is in equilibrium).

5 Disclosure Scenario

In the disclosure scenario, the manufacturer's inspection level θ is disclosed publicly. After observing the manufacturer's decision on θ, the supplier determines his child labor decision on d. Let the superscript "dis" indicate results in the disclosure scenario. At the contract stage (S1), the manufacturer solves the following program to choose (w,θ) that maximizes her expected profit U:

$$\max_{w,\theta\in\{0,\theta_H\}} \quad U\left(w,\theta,d^{dis}(\theta,w)\right) \tag{13}$$

$$s.t. \quad w - s_H + \Delta(\theta)\, d^{dis}(\theta,w) \geq 0 \tag{14}$$

$$d^{dis}(\theta,w) \quad = \arg\max_{d\in\{0,1\}} \Pi(w,\theta,d) = \arg\max_{d\in\{0,1\}} \{1-\gamma e(\theta)(1-\theta)\, d\}\{w - s_H + \Delta(\theta)\, d\}. \tag{15}$$

Constraint (14) ensures that the supplier earns non-negative expected profits. Constraint (15) requires that given the manufacturer's decisions on w and θ, the supplier chooses $d^{dis}(\theta,w)$ to maximize his expected profit. In §5.1 we derive the subgame-perfect equilibrium of this program, which is then compared with that in the non-disclosure scenario in §5.2.

5.1 Subgame-Perfect Equilibrium

Similar to the non-disclosure scenario, the supplier determines his best response function $d^{dis}(\theta, w)$ to the manufacturer's decision on (θ, w) by comparing his expected profit between hiring child labor and not. We obtain the supplier's best response as follows:

$$\begin{aligned}
&d^{dis}(\theta, w) = 1 \ \forall \theta \in \{\theta_L, \theta_H\} \text{ for } w \in \left[0, s_H + \tfrac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H)\right);\\
&d^{dis}(\theta_L, w) = 1 \text{ and } d^{dis}(\theta_H, w) = 0 \text{ for } w \in \left[s_H + \tfrac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H), s_H + \tfrac{\Delta(\theta_L)}{\gamma e_H} - \Delta(\theta_L)\right);\\
&d^{dis}(\theta, w) = 0 \ \forall \theta \in \{\theta_L, \theta_H\} \text{ for } w \in \left[s_H + \tfrac{\Delta(\theta_L)}{\gamma e_H} - \Delta(\theta_L), +\infty\right). \qquad (16)
\end{aligned}$$

Next we substitute $d^{dis}(\theta, w)$ into (13) and (14), and then determine the manufacturer's wholesale price w^{dis} and inspection level θ^{dis} by solving the following program:

$$\max_{w, \theta \in \{0, \theta_H\}} U\left(w, \theta, d^{dis}(\theta, w)\right); s.t. \ (14). \qquad (17)$$

Proposition 2 *The subgame-perfect equilibrium in the disclosure scenario is:*

$$(w^{dis}, \theta^{dis}, d^{dis}) = \begin{cases} \left(s_H + \left(\frac{1}{\gamma e_H} - 1\right)\Delta(\theta_L), \theta_L, 0\right) & \text{if } g \geq \xi_2^{dis}, I \geq \xi_3^{dis}, I \geq \xi_5^{dis} \\ (s_H - \Delta(\theta_H), \theta_H, 1) & \text{if } I \leq \xi_1^{dis}, I \leq \xi_3^{dis}, g \leq \xi_4^{dis} \\ (s_H - \Delta(\theta_L), \theta_L, 1) & \text{if } I \geq \xi_1^{dis}, g \leq \xi_2^{dis}, I \geq \xi_6^{dis} \\ \left(s_H + \left\{\frac{1}{\gamma e_L(1-\theta_H)} - 1\right\}\Delta(\theta_H), \theta_H, 0\right) & \text{if } I \leq \xi_6^{dis}, g \geq \xi_4^{dis}, I \leq \xi_5^{dis}, \end{cases}$$

where $\xi_1^{dis} \equiv \Delta(\theta_H) - \Delta(\theta_L) + g\{e_H - e_L(1-\theta_H)\}$, $\xi_2^{dis} \equiv \Delta(\theta_L) / (\gamma e_H^2)$, $\xi_3^{dis} \equiv \Delta(\theta_H) + \Delta(\theta_L) / (\gamma e_H) - \Delta(\theta_L) - e_L g(1-\theta_H)$, $\xi_4^{dis} \equiv \Delta(\theta_H) / \{\gamma e_L^2 (1-\theta_H)^2\}$, $\xi_5^{dis} \equiv \Delta(\theta_H) - \Delta(\theta_L) - \Delta(\theta_H) / \{\gamma e_L(1-\theta_H)\} + \Delta(\theta_L) / (\gamma e_H)$, *and* $\xi_6^{dis} \equiv \Delta(\theta_H) + e_H g - \Delta(\theta_H) / \{\gamma e_L(1-\theta_H)\} - \Delta(\theta_L)$.

The first three equilibrium outcomes given in Proposition 2 correspond to the premium-alone, inspection-alone, and do-nothing strategies, respectively. In addition, the fourth equilibrium outcome shows a new "premium & inspection" strategy, under which the manufacturer conducts internal inspections (i.e., $\theta^{dis} = \theta_H$) and at the same time pays a price premium (i.e., $w^{dis} = s_H + \{1/(\gamma e_L(1-\theta_H)) - 1\}\Delta(\theta_H)$). Under this strategy, no child labor is used as in the premium-alone strategy. Thus, unlike the inspection-alone strategy which induces child labor employment, the manufacturer does not face the risk of goodwill loss from child labor by paying a price premium to the supplier under the premium & inspection strategy. Moreover, by conducting internal inspections, this strategy pays a lower price premium to the supplier than the premium-alone strategy as discussed earlier in §4.2: The manufacturer replaces some of the price premium with inspection effort, thus leaving less surplus to the supplier.

To examine the factors that affect the equilibrium strategy, in Figure 3 we illustrate the four equilibrium strategies, which are divided by the threshold lines $\xi_1^{dis}, \xi_2^{dis}, ..., \xi_6^{dis}$ defined in Proposition 2. Similar to the non-disclosure scenario, as the goodwill cost g increases, the manufacturer

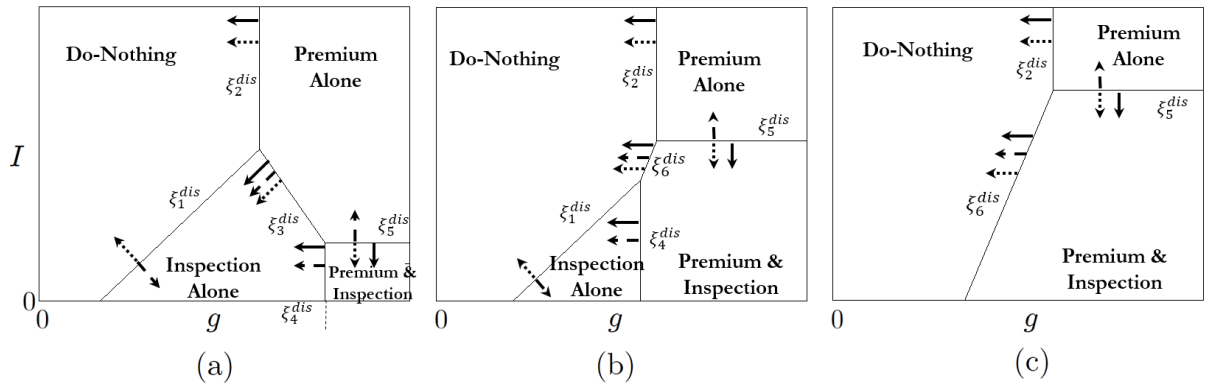

Figure 3: Equilibrium Outcome in the Disclosure Scenario: (a) Low m, (b) Medium m, and (c) High m. (*Note.* Solid arrows indicate changes with γ, long-dash arrows indicate changes with e_L, and round-dot arrows indicate changes with e_H.)

may change her strategy from do-nothing to premium-alone or inspection-alone. In the disclosure scenario, as the goodwill cost g increases further, the manufacturer may change her strategy from do-nothing or inspection-alone to premium & inspection strategy. This may explain Nestlé's recent practice: Facing the lawsuit over child slavery in Ivory Coast, Nestlé started to provide premiums to farmers for maintaining social standards in addition to an internal monitoring and remediation system for child labor (Nestlé 2012). Nestlé also publishes on its own website the internal monitoring efforts that the company has taken (Nestlé 2017).

The impact of inspection cost I on the equilibrium strategy in the disclosure scenario differs from that in the non-disclosure scenario. Recall in the non-disclosure scenario that a lower inspection cost I may change the equilibrium strategy from premium-alone to inspection-alone, resulting in more child labor. However, in the disclosure scenario, this is found only in Figure 3(a) for a smaller range of goodwill cost g (than that in Figure 2), but not in Figure 3(b)-(c) due to the existence of premium & inspection strategy in the disclosure scenario. This suggests that in the disclosure scenario a lower inspection cost is less likely or even unlikely to result in more child labor. Nike, for example, posts its audit data and standards in its corporate social responsibility report since 2005, and has established its scalable monitoring system, while providing premiums to its suppliers. The company has been a leader in the industry in social responsibility (Nisen 2013).

In the disclosure scenario, the supplier's penalty of using child labor m (i.e., the amount of compensation the supplier pays to the child worker discovered during internal inspections) plays an important role. We can observe from Figure 3(a)-(c) that as m increases, the premium & inspection strategy is more likely to be in equilibrium, whereas the inspection-alone strategy is less likely to be in equilibrium, and it is no longer in equilibrium when m is sufficiently large. The reason is as follows. When the manufacturer conducts internal inspections, an increase of the supplier's penalty m reduces the supplier's expected labor cost saving from using child labor (i.e., $\Delta(\theta_H)$

in (2) decreases with m). With the reduced benefit of using child labor, the manufacturer can deter the supplier from hiring child labor by paying a lower price premium (i.e., the price premium $(1/(\gamma e_L(1-\theta_H))-1)\Delta(\theta_H)$ decreases with m). Therefore, under the premium & inspection strategy, the manufacturer's expected profit increases with the penalty m. In contrast, under the inspection-alone strategy, an increase of m reduces $\Delta(\theta_H)$, which in turn increases the wholesale price $s_H - \Delta(\theta_H)$. This happens because the supplier uses child labor under this strategy, and the manufacturer has to pay a higher wholesale price to compensate a loss in the supplier's expected labor cost saving from using child labor. Therefore, the manufacturer's expected profit decreases with the penalty m under the inspection-alone strategy. As a result, with a higher m, this strategy is less likely to be in equilibrium, whereas the premium & inspection strategy is more likely to be in equilibrium. This finding suggests that when the manufacturer can enforce a high penalty onto the supplier from internal inspections, the manufacturer can adopt the premium & inspection strategy and combat child labor more effectively.

Lastly, it is not difficult to verify from Figures 2 and 3 that the impact of γ is the same in both non-disclosure and disclosure scenarios, and the impact of e_L on ξ_3^{dis} as well as the impact of e_H on ξ_2^{dis} and ξ_3^{dis} are similar to the corresponding impacts of e in the non-disclosure scenario. Notice that e_L has no impact on ξ_2^{dis} because ξ_2^{dis} is the threshold between do-nothing and premium-alone strategies and the external inspection level is e_H under both strategies. The impacts of e_L and e_H on ξ_4^{dis} and ξ_6^{dis} can be explained similarly. We also find that e_L and e_H have opposite impacts on ξ_1^{dis} and ξ_5^{dis}. Interestingly, when the manufacturer pays no premium to the supplier under the two strategies divided by ξ_1^{dis}, she has more incentive to conduct internal inspections (i.e., adopt inspection-alone strategy instead of do-nothing) as e_H increases or e_L decreases; on the contrary, when the manufacturer pays the premium under the two strategies divided by ξ_5^{dis}, she has less incentive to conduct internal inspections (i.e., adopt premium & inspection strategy instead of premium-alone) as e_H increases or e_L decreases. The reason is that when the manufacturer pays no premium, a high external inspection level means a high chance for her to incur the goodwill cost, whereas when she pays the premium, a high external inspection level means a lower premium required by the supplier to employ an adult laborer. Our results imply that if NGOs' reactions to the manufacturer's low effort are strong, the manufacturer would prefer the inspection-alone (resp., premium-alone) strategy to the do-nothing (resp., premium & inspection) strategy.

5.2 Effects of Information Disclosure

In this section we examine the effects of information disclosure by comparing the equilibrium outcomes in the non-disclosure scenario with those in the disclosure scenario. For ease of comparison, we first present the result when $e_H = e_L = e$, and then the result when $e_H > e > e_L$.

First, we consider the case when $e_H = e_L = e$. Figure 4 which overlaps Figure 2 with Figure 3 illustrates that there are four areas $R(a) - R(d)$ in which the equilibrium outcomes are different

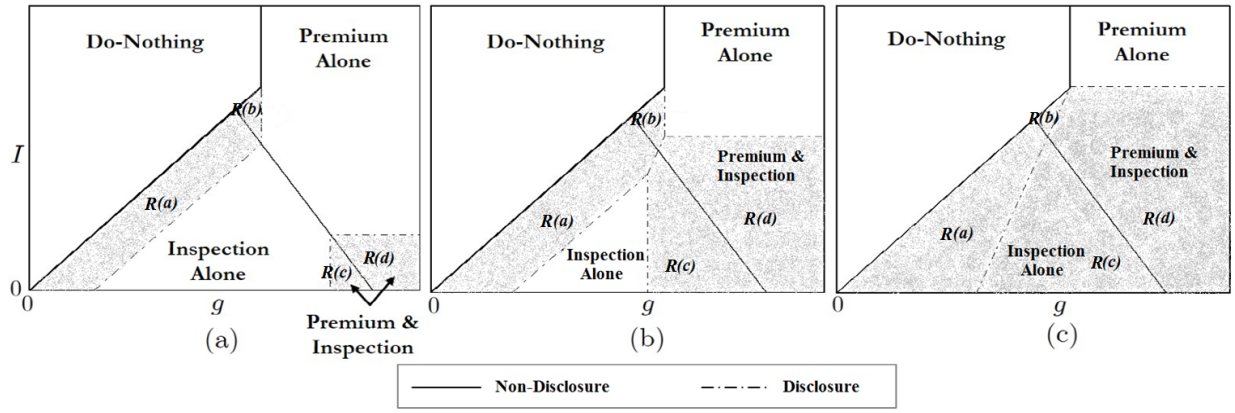

Figure 4: Comparison of Equilibrium Outcomes between the Non-Disclosure Scenario in Figure 2 and the Disclosure Scenario in Figure 3 when $e_H = e_L = e$: (a) Low m, (b) Medium m, and (c) High m.

between the two scenarios; see Table 1 for precise conditions for these four areas. The comparison of the two scenarios reveals the effects of information disclosure on the manufacturer's profit, the supplier's profit, and child labor as summarized in the next proposition.

Proposition 3 *Information disclosure will lead to the following results, ceteris paribus:*
(a) The supplier's profit remains the same in $R(a)$, decreases in $R(b)$ or $R(d)$, and increases in $R(c)$.
(b) The manufacturer's profit increases in all areas.
(c) The expected amount of child labor d_E increases in $R(a)$ or $R(b)$, decreases in $R(c)$, and remains the same in $R(d)$.

Table 1: Manufacturer's Equilibrium Strategy: Non-Disclosure Scenario vs. Disclosure Scenario

Area	Equilibrium Outcomes: Non-Disclosure → Disclosure	Conditions
$R(a)$	Inspection Alone →Do-Nothing	$\max\left(\xi_1^{dis}, \xi_6^{dis}\right) \leq I \leq \min\left(\xi_1^{non}, \xi_3^{dis}\right)$
$R(b)$	Premium Alone →Do-Nothing	$\max\left(\xi_3^{dis}, \xi_6^{dis}\right) \leq I \leq \xi_1^{non}$ and $g \leq \xi_2^{dis}$
$R(c)$	Inspection Alone →Premium & Inspection	$I \leq \min\left(\xi_3^{dis}, \xi_6^{dis}\right)$ and $g \geq \xi_4^{dis}$
$R(d)$	Premium Alone →Premium & Inspection	$\xi_3^{dis} \leq I \leq \min\left(\xi_5^{dis}, \xi_6^{dis}\right)$

Proposition 3(a) indicates that the effect of information disclosure on the supplier's profit depends on how the disclosure of internal inspection effort changes the manufacturer's equilibrium strategy in each area. When the manufacturer pays no premium in $R(a)$ under both scenarios, the supplier's profit remains the same. Yet, when the manufacturer eliminates the premium in the disclosure scenario in $R(b)$ or reduces the premium in $R(d)$, the disclosure of internal inspection effort hurts the supplier's profit. Finally, when the manufacturer changes her strategy from paying no premium into paying a premium in $R(c)$, the supplier benefits from information disclosure.

Contrary to the effect of information disclosure on the supplier, Proposition 3(b) states that the disclosure of internal inspection effort always benefits the manufacturer. The reason is as follows. On the one hand, if the manufacturer discloses a high inspection level, then the new strategy of premium & inspection can potentially lead to a higher profit. On the other hand, if she discloses a low inspection effort, then the supplier would accept a low wholesale price, thereby benefitting the manufacturer. This can be easily seen by inspecting program (4)-(7) which includes an additional (incentive) constraint (6) with respect to the manufacturer's inspection level as compared with program (13)-(15). This result may explain the observation in the empirical literature (e.g., Toffel and Short 2011) that firms have incentives to voluntarily disclose their social responsibility efforts. We can also show that if the manufacturer discloses θ after the supplier accepts the contract (rather than before the supplier does so as in Figure 1), her expected profit is the same as that in the non-disclosure scenario. Proposition 3(b) indicates that when $e_H = e_L = e$, the manufacturer prefers to disclose θ before the supplier accepts the contract rather than after.

Proposition 3(c) shows that information disclosure indeed reduces the use of child labor in $R(c)$. In this case, driven by a high goodwill cost and a low inspection cost, the manufacturer has a strong incentive to combat child labor by using the combined strategy of both inspection and premium in the disclosure scenario. However, in the non-disclosure scenario, the manufacturer cannot use that strategy because the premium in the combined strategy is not as high as the one in the premium-alone strategy. Thus, without the knowledge of comprehensive internal inspections, the premium in the combined strategy is not high enough to prevent the supplier from using child labor. However, Proposition 3(c) also suggests that information disclosure may not necessarily reduce child labor. Specifically, Table 1 shows that the disclosure of internal inspection effort may induce the manufacturer to change her equilibrium strategy from the inspection-alone strategy in $R(a)$ or the premium-alone strategy in $R(b)$ (both of which combat child labor) to the do-nothing strategy (which takes advantage of low-cost child labor). This change to the do-nothing strategy occurs when the manufacturer faces a low goodwill cost (i.e., $g \leq \xi_2^{dis}$) and has a low inspection cost (i.e., $I \leq \xi_1^{non}$). In the non-disclosure scenario, however, the manufacturer could not adopt the do-nothing strategy in $R(a)$ or $R(b)$ because, without the knowledge of the low inspection level, the supplier would reject the low wholesale price offered under the do-nothing strategy. With such a low inspection cost, the supplier would expect that the manufacturer could afford to conduct internal inspections in order to reduce the chance of child labor being exposed to the public and thereby reduce the risk of a goodwill loss.

To minimize such adverse effects, industries and third parties should reduce the manufacturer's incentive to use the do-nothing strategy in the two areas $R(a)$ and $R(b)$. There are several intuitive measures that can help achieve this goal. First, the manufacturer may disclose only a minimum level of inspection effort, and possibly raise her effort later. When the supplier expects the manufacturer to do so, even if the manufacturer discloses low inspection effort, the supplier may not accept the

low wholesale price associated with low inspection effort. Thus, the adverse effect of information disclosure could be mitigated. Furthermore, this does not affect the premium & inspection strategy because the manufacturer can still disclose high inspection effort under this strategy. Second, increasing the goodwill cost g by arousing more consumer awareness of child labor will be helpful because this will increase the manufacturer's potential loss from the incidence of child labor. Third, if third-party organizations can help the manufacturer to reduce the inspection cost I by facilitating industry collaboration or improving a monitoring system (see §1), then the manufacturer would be more willing to conduct inspections to combat child labor.

Next, we discuss the effects of information disclosure in the following two cases (while providing a detailed analysis in the online appendix): (*i*) third party organizations increase their external inspection levels for those manufacturers who disclose low internal inspection levels (i.e., $e_H > e = e_L$), and (*ii*) third party organizations reduce their external inspection levels for those manufacturers who disclose high internal inspection levels (i.e., $e_H = e > e_L$).

Corollary 1 *(i) Suppose $e_H > e = e_L$. Information disclosure will lead to three additional changes in equilibrium outcome: from do-nothing to premium-alone, from inspection-alone to premium-alone, and from do-nothing to premium & inspection. In these cases, (a) the supplier's profit increases; (b) the manufacturer's profit may decrease if do-nothing is changed to premium-alone or premium & inspection; (c) the expected amount of child labor d_E decreases.*
(ii) Suppose $e_H = e > e_L$. Information disclosure will lead to three additional changes in equilibrium outcome: from do-nothing to premium & inspection, from do-nothing to inspection-alone, and from premium-alone to inspection-alone. In these cases, (a) the supplier's profit increases, stays the same or decreases, respectively; (b) the manufacturer's profit increases; (c) the expected amount of child labor d_E decreases, decreases or increases, respectively.

Corollary 1(i) shows that the manufacturer's strategy may change from do-nothing or inspection-alone in the non-disclosure scenario to premium-alone or premium & inspection in the disclosure scenario, indicating that paying premium is more preferred if third party organizations increases their external inspection levels for those manufacturers who disclose low internal inspection levels. As a result of the change in the manufacturer's strategy, the supplier's profit increases and the amount of child labor decreases as shown in Corollary 1(i)-(a) and (c). This result suggests that raising the external inspection level for the manufacturer who discloses the low internal level can enhance the effectiveness of information disclosure to combat child labor. On the other hand, Corollary 1(i)-(b) shows that the manufacturer's profit may decrease as her strategy changes from do-nothing in the non-disclosure scenario to premium-alone or premium & inspection in the disclosure scenario. In this case, the manufacturer does not choose the do-nothing strategy in the disclosure scenario because this strategy would bring in significant loss under a higher level of external scrutiny. If the manufacturer can choose the timing of the disclosure, in this case, she would

choose to disclose θ after the supplier accepts the contract because then her expected profit would be the same as that in the non-disclosure scenario.

Corollary 1(ii) shows that if third party organizations reduce their external inspection levels for those manufacturers who disclose high internal inspection levels (i.e., $e_H = e > e_L$), the manufacturer's strategy may change from do-nothing or premium-alone in the non-disclosure scenario to inspection-alone or premium & inspection in the disclosure scenario, indicating that inspection is more preferred. If the manufacturer replaces the premium with the inspection, the supplier's profit decreases and the amount of child labor increases as shown in Corollary 1(ii)-(a) and (c). The manufacturer's profit always increases as shown in Corollary 1(ii)-(b) because a lower level of external scrutiny results in lower goodwill loss on expectation.

Note that we assume the manufacturer discloses her inspection effort truthfully, since the information provided in its website (as required by the Act), social responsibility report, contract with the supplier, or agreement with a third-party organization is in general verifiable. In the case when such information is not verifiable, the manufacturer may not always have an incentive to disclose her inspection effort truthfully. The manufacturer may voluntarily disclose a low inspection effort truthfully when a higher level of external scrutiny reduces the price premium that the manufacturer needs to pay in order to incentivize the supplier not to employ child labor under the premium-alone strategy (i.e., $g \geq \xi_2^{dis}$ and $I \geq \max(\xi_3^{dis}, \xi_5^{dis})$). In this case, the Act may well be irrelevant, since even without it the manufacturer would still choose to disclose her inspection effort for her own benefit. However, the manufacturer may not have such an incentive when a higher level of external scrutiny brings in a significant goodwill loss under the do-nothing strategy (i.e., $g \leq \xi_2^{dis}$ and $I \geq \max(\xi_1^{dis}, \xi_6^{dis})$). In this case, if the manufacturer selectively reveals the information, she would choose not to disclose her inspection effort. The implementation of the Act, which requires the manufacturer to truthfully disclose her inspection effort, can increase the manufacturer's inspection effort or the price premium, resulting in less child labor in this case.

6 Other Penalty Schemes

In this section, we analyze two alternative penalty schemes: zero tolerance in §6.1 and corrective actions only in §6.2. We compare results under these schemes with those under the base penalty scheme.

6.1 Zero Tolerance

Under this penalty scheme (for which we use "zero" in a subscript of our notation), if the supplier does not pass internal inspections, the manufacturer terminates the contract with the supplier. The manufacturer switches to a backup supplier with additional cost a (≥ 0). Following the literature (e.g., Guo et al. 2015, Plambeck and Taylor 2016), we assume for simplicity that the back-up supplier is a reliable one (i.e., using no child labor), although it can be more expensive. The

manufacturer's expected profit under this scheme is given as

$$U_{zero}(w,\theta,d) = v - w - I(\theta) - e(\theta)gd(1-\theta) - d\theta a.$$

Under this penalty scheme, if the supplier employs a child laborer (i.e., $d = 1$), his labor cost is s_L (which is different from $(1-\theta)s_L + \theta(s_H + m)$ under the base penalty scheme). If the supplier employs an adult laborer (i.e., $d = 0$), his labor cost is s_H, so his cost saving from using child labor is revised from (2) to $\Delta_{zero} = s_H - s_L$ for any $\theta \in \{\theta_L, \theta_H\}$. The supplier's profit function becomes

$$\Pi_{zero}(w,\theta,d) = (1 - \gamma d(\theta + (1-\theta)e(\theta)))(w - s_H + d\Delta_{zero}).$$

Note that we assume the supplier loses the future orders from the manufacturer if he does not pass internal inspections. Our insights continue to hold in the case when the supplier also loses the current order. Following the same procedure as presented in §4, we can derive the following subgame-perfect equilibrium in the non-disclosure scenario:

Corollary 2 *Under the zero-tolerance scheme, the subgame-perfect equilibrium in the non-disclosure scenario is*

$$\{w^{non}_{zero}, \theta^{non}_{zero}, d^{non}_{zero}\} = \begin{cases} (s_H + \Delta_{zero}/\gamma e - \Delta_{zero},\ \theta_L, 0) & \text{if } \xi^{non}_{3,zero} \le I < \xi^{non}_{1,zero} \text{ or} \\ & \{I \ge \xi^{non}_{1,zero} \text{ and } g \ge \xi^{non}_{2,zero}\}; \\ (s_H - \Delta_{zero}, \theta_H, 1) & \text{if } I < \min\{\xi^{non}_{1,zero}, \xi^{non}_{3,zero}\}; \\ (s_H - \Delta_{zero}, \theta_L, 1) & \text{otherwise,} \end{cases}$$

where $\xi^{non}_{1,zero} = e\theta_H g - a\theta_H$, $\xi^{non}_{2,zero} = \Delta_{zero}/\gamma e^2$ *and* $\xi^{non}_{3,zero} = \Delta_{zero}/\gamma e - ge(1-\theta_H) - a\theta_H$.

As expected, this scheme has no impact on do-nothing and premium-alone strategies, since the manufacturer does not conduct internal inspections under these strategies. Under the inspection-alone strategy, the equilibrium wholesale price becomes $s_H - \Delta_{zero} = s_H - (s_H - s_L) = s_L$, which is lower than the wholesale price under the base penalty scheme, while being equal to the wholesale price under the do-nothing strategy. This is because under the new scheme the supplier will not have a chance to replace a child laborer with an adult laborer after internal inspections, so the supplier's labor cost is the same under both inspection-alone and do-nothing strategies. The lower wholesale price under the zero-tolerance scheme indicates that the manufacturer prefers this penalty scheme to the base penalty scheme if she implements the inspection-alone strategy (i.e., $I < \min\{\xi^{non}_1, \xi^{non}_3, \xi^{non}_{1,zero}, \xi^{non}_{3,zero}\}$).

We can show that under the zero-tolerance scheme, the effects of the goodwill cost g and the inspection cost I on the equilibrium strategy of the manufacturer are the same as those under the base penalty scheme. Therefore, increasing the goodwill cost g can incentivize the manufacturer to combat child labor under the zero-tolerance scheme, whereas decreasing the inspection cost I may

induce the manufacturer to move from the premium-alone strategy to the inspection-alone strategy and lead to more child labor.

We next examine the effects of the zero-tolerance scheme in the disclosure scenario. We can derive the subgame-perfect equilibrium similarly as follows.

Corollary 3 *Under the zero-tolerance scheme, the subgame-perfect equilibrium in the disclosure scenario is*

$$\left\{w_{zero}^{dis},\theta_{zero}^{dis},d_{zero}^{dis}\right\}=$$
$$\begin{cases} \left(s_H+\left(\frac{1}{\gamma e_H}-1\right)\Delta_{zero},\theta_L,0\right) & \text{if } g\geq\xi_{2,zero}^{dis},I\geq\xi_{3,zero}^{dis},I\geq\xi_{5,zero}^{dis}; \\ \left(s_H-\Delta_{zero},\theta_H,1\right) & \text{if } I\leq\xi_{1,zero}^{dis},I\leq\xi_{3,zero}^{dis},g\leq\xi_{4,zero}^{dis}; \\ \left(s_H-\Delta_{zero},\theta_L,1\right) & \text{if } I\geq\xi_{1,zero}^{dis},g\leq\xi_{2,zero}^{dis},I\geq\xi_{6,zero}^{dis}; \\ \left(s_H+\left\{\frac{1}{\gamma(\theta_H+(1-\theta_H)e_L)}-1\right\}\Delta_{zero},\theta_H,0\right) & \text{if } g\geq\xi_{4,zero}^{dis},I\leq\xi_{5,zero}^{dis},I\leq\xi_{6,zero}^{dis}, \end{cases}$$

where $\xi_{1,zero}^{dis}=g\left\{e_H-e_L\left(1-\theta_H\right)\right\}-a\theta_H$, $\xi_{2,zero}^{dis}=\Delta_{zero}/\gamma e_H^2$, $\xi_{3,zero}^{dis}=\Delta_{zero}/\gamma e_H-ge_L\left(1-\theta_H\right)-a\theta_H$, $\xi_{4,zero}^{dis}=\frac{\Delta_{zero}}{e_L^2\gamma(1-\theta_H)(\theta_H+(1-\theta_H)e_L)}-\frac{a\theta_H}{e_L(1-\theta_H)}$, $\xi_{5,zero}^{dis}=\frac{\Delta_{zero}}{\gamma e_H}-\frac{\Delta(\theta_L)}{\gamma(\theta_H+(1-\theta_H)e_L)}$, *and* $\xi_{6,zero}^{dis}=ge_H-\frac{\Delta_{zero}}{\gamma(\theta_H+(1-\theta_H)e_L)}$.

Similar to the non-disclosure scenario, the zero-tolerance scheme has no impact on do-nothing and premium-alone strategies, and results in a lower wholesale price (than the base penalty scheme) under the inspection-alone strategy. Interestingly, as a result of the lower wholesale price, the inspection-alone strategy has become so prevailing that the adverse effect of information disclosure (that introduces more child labor by inducing the manufacturer to switch from the inspection-alone strategy or the premium-alone strategy to the do-nothing strategy) no longer exists under this scheme; i.e., $R\left(a\right)$ and $R\left(b\right)$ do not exist in Figure 4 as manufacturers in these two areas would choose the inspection-alone strategy instead of the do-nothing strategy in the disclosure scenario. This implies that information disclosure combined with the zero-tolerance scheme helps reduce child labor in supply chains. For example, after Samsung disclosed its effort to combat child labor and announced its zero-tolerance scheme on child labor in 2014, the company is reported to be on a "meteoric rise" in terms of improved corporate social responsibility (Samsung 2014, Wang 2016).

Under the premium & inspection strategy in the disclosure scenario, we find that the wholesale price can be higher or lower than that under the base penalty scheme. When a child laborer is found during internal inspections, the supplier loses future business under the zero-tolerance scheme, while he has to undertake costly corrective actions under the base penalty scheme. Depending on which penalty is more costly, the wholesale price that the supplier would accept for employing no child labor is different under these two schemes. As a result, when the manufacturer implements the premium & inspection strategy (i.e., $g\geq\min\{\xi_4^{dis},\xi_{4,zero}^{dis}\}$ and $I\leq\min\{\xi_5^{dis},\xi_6^{dis},\xi_{5,zero}^{dis},\xi_{6,zero}^{dis}\}$), she does not always prefer the zero-tolerance scheme to the base penalty scheme. This may explain why this scheme is not a preferred choice by many firms including Apple, IKEA and Nike.

6.2 Corrective Actions Only

Under the penalty scheme that requires only corrective actions (for which we use "only" in a subscript of our notation), the manufacturer's profit function is the same as that under the base penalty scheme; i.e., $U_{only}(w,\theta,d) = U(w,\theta,d)$. If the supplier employs a child laborer (i.e., $d=1$), then the supplier's cost differs depending on whether she passes internal or external inspections: it is s_L when he passes both internal and external inspections, $s_H + m$ when he does not pass internal inspections, or $s_L + m$ when he passes internal inspections but does not pass external inspections (since the supplier need not rehire an adult laborer after completing production). Thus, the supplier's expected cost saving from hiring a child laborer is revised from (2) to $\Delta_{only}(\theta) = (s_H - s_L)(1-\theta)(1-e(\theta)) - m\theta + (s_H - s_L - m)(1-\theta)e(\theta)$. Under this penalty scheme, the supplier does not lose future business from the manufacturer, so his profit function becomes

$$\Pi_{only}(w,\theta,d) = w - s_H + d\Delta_{only}(\theta).$$

As the manufacturer's wholesale price has no impact on the supplier's child labor decision, the supplier employs child labor as long as he can save his labor cost in expectation from hiring child labor (i.e., $\Delta_{only}(\theta) > 0$). The following corollary presents equilibrium for any fixed w (ref. (8) under the base penalty scheme) in the non-disclosure scenario.

Corollary 4 *Under the penalty scheme that requires only corrective actions, the following results hold for any w:*
(a) $d^{non}_{only}(\theta,w) = 1\ \forall\theta \in \{\theta_L,\theta_H\}$ *if* $\Delta_{only}(\theta_L) > \Delta_{only}(\theta_H) \geq 0$*;*
(b) $d^{non}_{only}(\theta_L,w) = 1$ *and* $d^{non}(\theta_H,w) = 0$ *if* $\Delta_{only}(\theta_L) > 0 \geq \Delta_{only}(\theta_H)$*;*
(c) $d^{non}_{only}(\theta,w) = 0\ \forall\theta \in \{\theta_L,\theta_H\}$ *if* $0 \geq \Delta_{only}(\theta_L) > \Delta_{only}(\theta_H)$*.*

Corollary 4 suggests that under this scheme the manufacturer adopts either inspection-alone or do-nothing strategy. Under both strategies, the manufacturer chooses low wholesale prices that leave the supplier zero surplus. We can further show that as the goodwill cost g increases or the inspection cost I decreases, the manufacturer moves from the do-nothing strategy to the inspection-alone strategy, resulting in less child labor. The impact of decreasing I is different from the base penalty scheme, under which it may result in more child labor. This result suggests that NGOs' initiatives in reducing manufacturers' inspection costs are effective when the manufacturers adopt the penalty scheme that requires only corrective actions.

Note that the supplier's expected cost saving from hiring a child laborer under this penalty scheme is lower than that under the base penalty scheme (i.e., $\Delta_{only}(\theta) \leq \Delta(\theta)$). When the goodwill cost g is small, the manufacturer implements the inspection-alone or do-nothing strategy. In this case, since the manufacturer pays $s_H - \Delta_{only}(\theta)$ (resp., $s_H - \Delta(\theta)$) under this scheme (resp., the base scheme), she prefers the base scheme to this scheme. When the goodwill cost g is large, the manufacturer can use the premium-alone strategy to avoid the large goodwill loss under the base

scheme, whereas she cannot avoid that loss under the penalty scheme that requires only corrective actions. As a result, we can conclude that the manufacturer always prefers the base scheme to this scheme.

In the disclosure scenario, the manufacturer cannot adopt the premium & inspection strategy to combat child labor, and information disclosure has no impact under this penalty scheme. This is again because the manufacturer can influence the supplier's decision only through internal inspections but not through wholesale price.

7 Household's Decision for Sending Children to Work

In our base model, when the manufacturer finds a child laborer during internal inspections, she requires the supplier to provide the child the compensation. In practice, the amount of the compensation is crucial to determine whether such a practice is effective in combating child labor. Specifically, if the compensation is so low that the household still cannot afford the child's living expenses or schooling, then the household may send the child back to work, perhaps, in a different factory. Therefore, in this section, we enrich our model by considering a household's decision, and identify the situation where the compensation fails to keep the child away from working even after the child is removed from the supplier's site. Our analysis proceeds in three steps. First, we derive conditions under which a household would send its child back to work. Second, we study the manufacturer's choice on the compensation provided to children found during internal inspections. Finally, we discuss the conditions under which the compensation is not sufficient for the household to keep its child away from working.

First, we introduce a household's utility function u, which is modified from the one in Basu and Zarghamee (2009) by taking into account the education of a child. For simplicity, we assume that the household has one working adult and one child. The household chooses its consumption level c (≥ 0), a proportion r_s ($\in [0,1]$) of the child's time for school, and a proportion r_w ($\in [0,1]$ and $r_s + r_w \leq 1$) of the child's time for work. The household has a minimal level of consumption v (≥ 0). If its consumption is higher than this level, then the household cares about the child's education r_s (Ranjan 2001). The household's utility function can be expressed as[12]

$$u(c, r_s) = \begin{cases} r_s & if\ c \geq v \\ c - v & if\ c < v. \end{cases} \tag{18}$$

Let t_s (≥ 0) denote the child's full-time education cost. When a child is found during the manufacturer's internal inspection, the supplier provides the child the compensation which consists of two parts: the education support m_e ($0 \leq m_e \leq t_s$) and the living support m_v (≥ 0) to satisfy the

[12] Following Basu and Zarghamee (2009), this function assumes that the household cares little about consumption beyond the minimum level. Our results hold as long as the household places sufficiently lower weight on excess consumption beyond the minimum level than on the child's education.

child's basic needs. In practice, some companies require their suppliers to provide only the education support (IKEA 2003), while others require both (Apple 2016). For any given compensations m_e and m_v, the household's problem is to determine (c, r_s, r_w) by solving the following program:

$$\begin{aligned} \max_{c,r_s,r_w \geq 0,\ r_s+r_w \leq 1} \quad & u(c, r_s) \\ s.t. \quad & c \leq s_H + r_w s_L + m_v \\ & r_s t_s \leq s_H + r_w s_L + m_v - c + m_e. \end{aligned} \tag{19}$$

The first constraint in (19) ensures that the household's consumption level does not exceed its income plus the living compensation. The second constraint ensures that the child's education cost does not exceed the household's surplus from consumption plus the education compensation.

Lemma 1 *The household's optimal decision on the child's proportion of working time r_w^* is*

$$r_w^* = \begin{cases} 0 & if\ m_v + m_e \geq v + t_s - s_H \\ \max\left\{\frac{v - s_H - m_v}{s_L}, \frac{v + t_s - s_H - m_v - m_e}{s_L + t_s}\right\} & if\ m_v + m_e < v + t_s - s_H\ \&\ m_v \geq v - s_L - s_H \\ 1 & if\ m_v + m_e < v + t_s - s_H\ \&\ m_v < v - s_L - s_H. \end{cases} \tag{20}$$

Lemma 1 shows that the household would never send its child to work when the adult's wage s_H cover the minimal consumption level v and the child's full time education cost t_s (i.e., $v + t_s - s_H \leq 0$). In this case, the compensation from the supplier is irrelevant. Thus, we focus on the case where $v + t_s - s_H > 0$ in the rest of this section. Lemma 1 also suggests that the household would keep its child from working when the total compensation $m_v + m_e$ plus the adult wage s_H covers the minimum consumption v and the child's full time education cost t_s (i.e., $m_v + m_e + s_H \geq v + t_s$); otherwise, the household would send its child back to work either part time (if receiving low total compensation with $m_v + m_e < v + t_s - s_H$ but high living compensation with $m_v \geq v - s_L - s_H$) or full time (if receiving low total compensation as well as low living compensation).

Next, we analyze the manufacturer's decision on the compensation. We generalize two assumptions in the base model: (1) When determining inspection level θ, the manufacturer is also allowed to choose $m \in \{m_e, m_e + m_v\}$ (i.e., offer only education support or both education and living support). We assume that these decisions are made simultaneously because the compensation is relevant only when child labor is caught by the internal inspection. (2) The supplier can choose a proportion of child labor in its production (i.e., $d \in [0, 1]$ instead of $d \in \{0, 1\}$). For the *non-disclosure* scenario, our analysis shows that the manufacturer would adopt a new strategy in equilibrium, called "partial-premium & inspection" in addition to the three strategies identified in the base model. Under this new strategy, the manufacturer conducts internal inspections and pays the supplier a partial premium, which induces the supplier to hire only a portion of workforce, $d_I = I/(e\theta_H g)$, with child labor. The following corollary presents the manufacturer's choice on the compensation in the non-disclosure scenario:

Corollary 5 *In the non-disclosure scenario, suppose that the manufacturer chooses* $m \in \{m_e, m_e + m_v\}$ *endogenously, and that the supplier chooses a portion of child labor* $d \in [0, 1]$.
(a) If internal inspections are not conducted (i.e., $\theta = \theta_L$*), the manufacturer is indifferent between* m_e *and* $m_e + m_v$.
(b) If internal inspections are conducted (i.e., $\theta = \theta_H$*), the manufacturer chooses* m_e *under the inspection-alone strategy and* $m_e + m_v$ *under the partial-premium & inspection strategy.*

When the manufacturer conducts no inspections under the strategy of do-nothing or premium-alone, the manufacturer is obviously indifferent between m_e and $m_e + m_v$ because no compensation would be provided. When the manufacturer conducts inspections under the inspection-alone strategy, the manufacturer prefers m_e to $m_e + m_v$ because it reduces the supplier's expected cost of employing child labor, hence allowing the manufacturer to pay a lower wholesale price. However, under the partial-premium & inspection strategy, the manufacturer prefers $m_e + m_v$ because higher compensation reduces the premium the manufacturer pays to the supplier. For the *disclosure* scenario, we find that the manufacturer still chooses one of the four strategies in equilibrium: do-nothing, inspection-alone, premium-alone, and premium & inspection. We can also show that the manufacturer's choice on the compensation is the same as Corollary 5, except that she would choose $m_e + m_v$ under the premium & inspection strategy.

Finally, we discuss the effect of the manufacturer's compensation choice on the household's decision to send its child back to work. Note that such effect exists only when the manufacturer conducts inspections and the supplier employs child labor. From our earlier discussions and Corollary 5, this is the case when the manufacturer chooses the inspection-alone strategy or the partial premium & inspection strategy in the non-disclosure scenario, or the inspection-alone strategy in the disclosure scenario. (Recall that the supplier does not employ child labor under the premium & inspection strategy in the disclosure scenario.) Combining this observation with Lemma 1, we derive the conditions under which the household may send its child back to work even after the child is removed from the supplier's site.

Proposition 4 *Suppose that the manufacturer chooses* $m \in \{m_e, m_e + m_v\}$ *endogenously, and that the supplier chooses a portion of child labor* $d \in [0, 1]$. *Then the compensation provided to the child workers found during the manufacturer's internal inspections cannot keep them from working under the following conditions:*
(i) $v - s_H > 0$ *or* $m_e < v - s_H + t_s$ *when the manufacturer adopts the inspection-alone strategy in both non-disclosure and disclosure scenarios;*
(ii) $m_e + m_v < v - s_H + t_s$ *when the manufacturer adopts the partial-premium & inspection strategy in the non-disclosure scenario.*

Case (i) indicates that when the manufacturer chooses the inspection-alone strategy, the compensation cannot keep children from working under one of two conditions. First, if the household's

minimum consumption level exceeds the adult wage (i.e., $v - s_H > 0$), its child always needs to work. Second, even if the adult wage is higher than the household's minimum consumption level (i.e., $v - s_H \leq 0$), the child still needs to work for the tuition to receive more education when the full-time education cost cannot be covered by the sum of the surplus (after consumption) and the education compensation (i.e., $s_H - v + m_e < t_s$). Therefore, in order to keep children from working, it is important to ensure that a sufficient amount of the education compensation is provided to them. Case (ii) applies when the manufacturer adopts the partial-premium & inspection strategy. In this case, the compensation would fail only if a total amount of the education and living compensations is too low (i.e., $m_e + m_v < v - s_H + t_s$). In other words, different from case (i), no matter the household's minimum consumption level exceeds the adult wage or not, the child does not need to work with a sufficient amount of the total compensation. Further, the condition that $m_e + m_v < v - s_H + t_s$ is stronger than the condition $m_e < v - s_H + t_s$ in case (i). Taken together, these results suggest that the compensation chosen by the manufacturer is less likely to keep children away from working when the manufacturer adopts the inspection-alone strategy. Therefore, governmental and non-governmental organizations should ensure that sufficient compensation is provided to child workers, especially when manufacturers use the inspection-alone strategy without paying a sufficiently high wholesale price to their suppliers.

Lastly, we note that there are some features regarding the household's decision that may warrant future study. For example, while we consider a representative household in this section, households are heterogeneous in reality, e.g., in terms of their consumption levels. In addition to wages, households may have other sources of income.

8 Conclusion

Nearly 200 million children are engaged in child labor, many in developing countries that are part of the supply base of global manufacturing networks. Even when firms have incentives to address child labor in their supply chains, they are hindered by the lack of direct control over their suppliers. This paper studies several initiatives that aim to address the challenge of combating child labor in global supply chains. We develop a game-theoretic model based on a two-tier supply chain, in which a multinational manufacturer in a developed nation selling the product made by a supplier in a developing country. The supplier has an option to use child labor in place of legitimate labor at a lower cost, and if child labor is exposed to the public, the manufacturer would incur a goodwill loss. The supplier's labor practice is subject to costly but imperfect inspections from both the manufacturer and third-party organizations. In addition to inspections, the manufacturer also deals with child labor through her supply contract. We analyze how several factors (such as goodwill cost, inspection cost, future business, external monitoring, and penalty scheme) affect the manufacturer's incentives to use different strategies to combat child labor. Furthermore, motivated by the California Transparency in Supply Chains Act, we examine the impact of information disclosure

	Base penalty scheme	Zero tolerance	Corrective actions only
Strategies to combat child labor	Price premium, inspection	Price premium, inspection	Inspection
Improving information disclosure	Ineffective when goodwill costs are low	Effective	No impact
Raising goodwill costs	Effective	Effective	Effective
Reducing inspection costs	Ineffective when goodwill costs are high	Ineffective when goodwill costs are high	Effective

Figure 5: Strategies and initiatives to combat child labor

by comparing the non-disclosure scenario (in which the supplier and third-party organizations are unable to observe the manufacturer's inspection effort) with the disclosure scenario (in which they are informed of such effort).

Our findings have the following implications to multinational manufacturers (or retailers) and NGOs (see Figure 5 for the summary). First, if a manufacturer adopts the base or zero-tolerance penalty scheme, she can reduce the incidence of child labor by directly undertaking inspections to detect and remove child labor, or alternatively she can deter child labor by offering a sufficiently high wholesale price to the supplier. However, if a manufacturer adopts the penalty scheme that requires only corrective actions, she can only use inspections to combat child labor. Second, if a manufacturer adopts the zero-tolerance scheme, she should consider disclosing her effort to combat child labor through her website, social responsibility report, or contract. Such disclosure enables the manufacturer to increase the profit through a strategy that combines internal inspection and medium wholesale price. However, if a manufacturer adopts the base penalty scheme, extra caution should be taken in considering information disclosure as it may inadvertently introduce more child labor when the manufacturer relies only on internal inspections to combat child labor. Third, NGOs should help to raise manufacturers' goodwill costs, for example, through campaigns and consumer education, because this will help reduce the use of child labor in supply chains no matter which penalty scheme the manufacturer uses. Fourth, if a manufacturer adopts the penalty scheme that requires only corrective actions, NGOs should help to reduce the manufacturer's inspection costs (e.g., by facilitating industry collaboration or improving a monitoring system). However, if the manufacturer adopts the base or zero-tolerance penalty scheme, NGOs need to be careful about doing so as it may not be effective in combating child labor and even weaken the effect of high goodwill costs. Lastly, to prevent children from going back to work after being removed from one supplier's site, governmental and non-governmental organizations should ensure that a sufficient amount of compensation is provided to those children, especially when manufacturers rely on inspections without paying a sufficiently high wholesale price to their suppliers.

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Online Appendix for "Combating Child Labor: Incentives and Information Disclosure in Global Supply Chains"

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A. Different External Inspection Levels

In this section, we discuss the case of $e_H > e > e_L$ in details. For ease of presentation, we first present the comparison between the two scenarios for each of the two cases: (i) $e_H > e = e_L$ and (ii) $e_H = e > e_L$, respectively, and then based on these comparisons we discuss the results for $e_H > e > e_L$.

Table 2: Manufacturer's Equilibrium Strategy under Different External Inspection Levels: Non-Disclosure Scenario vs. Disclosure Scenario in Case (i) $e_H > e = e_L$ and Case (ii) $e_H = e > e_L$

Case	Area	Equilibrium Outcomes: Non-Disclosure → Disclosure	Conditions
(i)	$R(e)$	Do-Nothing → Premium Alone	$I \geq \max\left(\xi_1^{non}, \xi_5^{dis}\right)$ and $\xi_2^{dis} \leq g \leq \xi_2^{non}$
(i)	$R(f)$	Inspection Alone → Premium Alone	$\max\left(\xi_3^{dis}, \xi_5^{dis}\right) \leq I \leq \xi_3^{non}$ and $g \geq \xi_2^{dis}$
(i)&(ii)	$R(g)$	Do-Nothing → Premium & Inspection	$\xi_1^{non} \leq I \leq \min\left(\xi_5^{dis}, \xi_6^{dis}\right)$ and $g \leq \xi_2^{non}$
(ii)	$R(h)$	Do-Nothing → Inspection Alone	$\xi_1^{non} \leq I \leq \min\left(\xi_1^{dis}, \xi_3^{dis}\right)$ and $g \leq \xi_2^{non}$
(ii)	$R(l)$	Premium Alone → Inspection Alone	$\xi_3^{non} \leq I \leq \min\left(\xi_1^{dis}, \xi_3^{dis}\right)$ and $g \leq \xi_4^{dis}$

First, for case (i) $e_H > e = e_L$, Figure 6 illustrates that there are seven areas $R(a) - R(g)$ in which the equilibrium outcomes are different between the two scenarios. Out of the seven areas, the first four areas $R(a) - R(d)$ have the same outcome changes and conditions as their respective areas in Table 1, and the details for the three new areas $R(e) - R(g)$ are provided in Table 2. In $R(e)$, the manufacturer's strategy changes from do-nothing to premium-alone. This change is driven by the premise that the manufacturer who discloses the low internal inspection level is under a higher level of external scrutiny (i.e., $e_H > e$). As a result, the supplier faces a higher chance of being penalized for hiring child labor. This lowers the price premium $(1/(\gamma e_H) - 1)\Delta(\theta_L)$ that the manufacturer needs to pay in order to incentivize the supplier not to employ child labor. Therefore, the manufacturer is more likely to use the premium-alone strategy in the disclosure scenario. The same explanation applies to $R(f)$ in which the manufacturer's strategy changes from inspection-alone to premium-alone. Similarly, in $R(g)$, the manufacturer's strategy changes from do-nothing to premium & inspection because the manufacturer is less likely to choose the do-nothing strategy

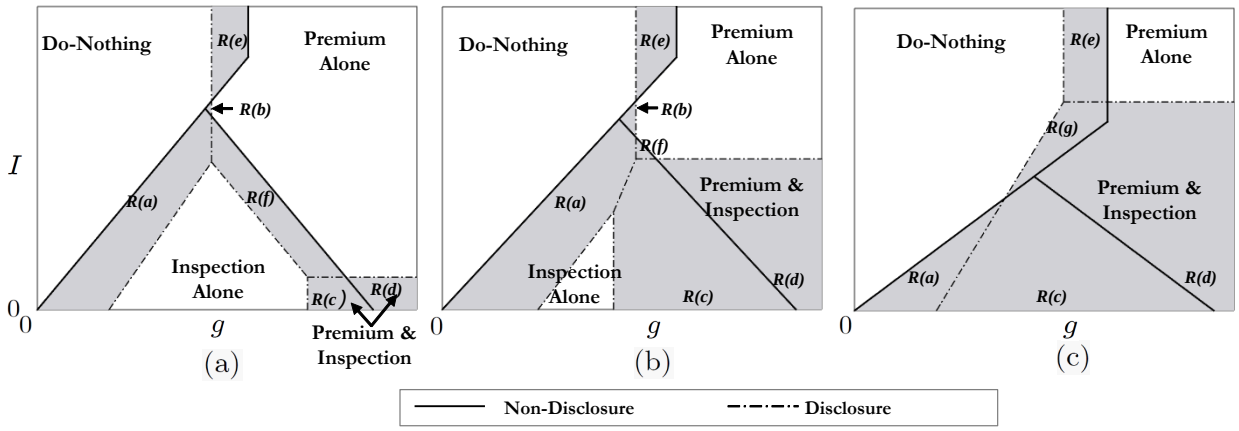

Figure 6: Comparison of Equilibrium Outcomes between the Non-Disclosure Scenario and the Disclosure Scenario for Case (i) ($e_H > e = e_L$) with: (a) Low m, (b) Medium m, and (c) High m.

in the disclosure scenario.

Second, we examine case (ii) $e_H = e > e_L$, in which third party organizations reduce their external inspection level for the manufacturer who chooses the high internal inspection level in the disclosure scenario. Figure 7 illustrates that there are seven areas $R(a) - R(d), R(g), R(h)$, and $R(l)$ in which the equilibrium outcomes are different between the two scenarios. Similar to the first case, the first four areas $R(a) - R(d)$ are the same as their respective areas in Table 1. In addition, the area $R(g)$ is the same as that in case (i). The precise conditions for the two areas $R(h)$ and $R(l)$ are provided in Table 2. In $R(h)$, the manufacturer's strategy changes from do-nothing to inspection-alone. In $R(l)$, the manufacturer's strategy changes from premium-alone to inspection-alone. Thus, in both $R(h)$ and $R(l)$, the manufacturer changes to the inspection-alone strategy in the disclosure scenario. This is because the manufacturer who discloses the high-level internal inspection faces a lower level of scrutiny from NGOs (i.e., $e_L < e$). This gives additional incentives for manufacturers to undertake high-level internal inspections.

Lastly, we discuss the case when $e_H > e > e_L$. Since this case is a combination of cases (i) and (ii) above, there are possibly nine areas $R(a) - R(l)$ in which the equilibrium outcomes are different between the two scenarios for $e_H > e > e_L$. In particular, out of the nine areas, $R(a) - R(d)$ and $R(g)$ are caused by the information disclosure, $R(e) - R(f)$ are caused by the premise that $e_H > e$, and $R(h) - R(l)$ are caused by the premise that $e > e_L$.

B. Proofs of Analytical Results

We make the following assumptions to rule out unrealistic or uninteresting cases: (A1) $\gamma e(\theta) \leq 1$, (A2) $\theta_H \leq \dfrac{s_H - s_L}{s_H - s_L + m}$, (A3) $\theta_H \geq 1 - \dfrac{m}{(s_H - s_L + m)\gamma e}$, and (A4) $\frac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H) < \frac{\Delta(\theta_L)}{\gamma e_H} - \Delta(\theta_L)$. (A1) rules out the case where the supplier would never hire child labor even when no internal inspection is undertaken. With (A2), we do not consider an uninteresting case where the manufacturer's internal inspections stop the supplier from hiring child labor for every wholesale

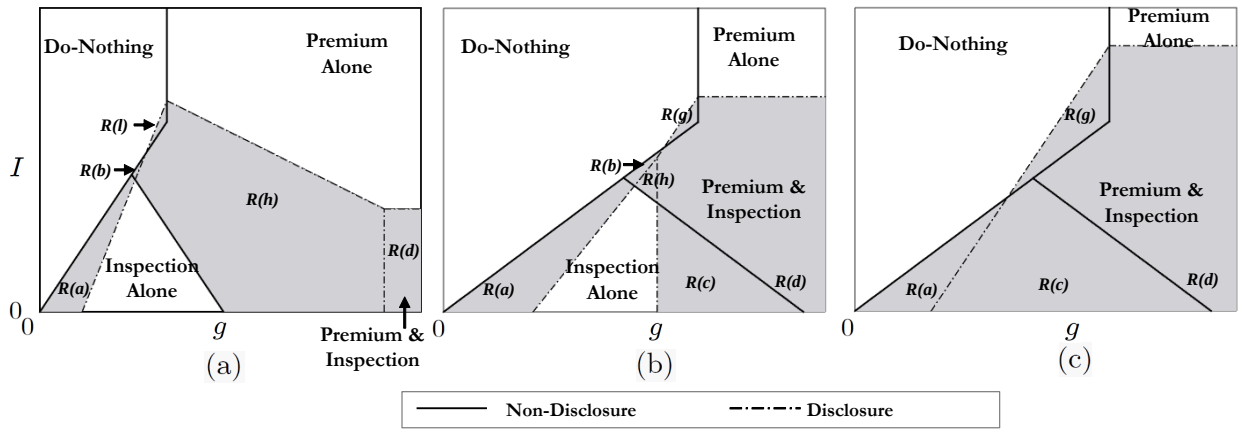

Figure 7: Comparison of Equilibrium Outcomes between the Non-Disclosure Scenario and the Disclosure Scenario for Case (ii) ($e_H = e > e_L$) with: (a) Low m, (b) Medium m, and (c) High m.

price w. (A3) and (A4) ensure that the supplier's expected profit from hiring child labor is lower when the manufacturer conducts inspections than when no inspections are undertaken in the non-disclosure and disclosure scenarios, respectively; otherwise the supplier would be more likely to hire child labor when the manufacturer chooses a higher inspection level, which is unrealistic.

Proof of Proposition 1. First, we simplify the program (11) by substituting $(\theta^{non}(w), d^{non}(w))$ given in (10) into (11), and obtain

$$\max_{w} \begin{cases} U(w, \theta_L, 1) = v - w - eg \text{ where } w = s_H - \Delta(\theta_L) & \text{if } I \geq \xi_1^{non} \\ U(w, \theta_L, 0) = v - w \text{ where } w = s_H + \frac{\Delta(\theta_L)}{\gamma e} - \Delta(\theta_L) & \\ U(w, \theta_H, 1) = v - w - eg(1 - \theta_H), \text{ where } w = s_H - \Delta(\theta_H) & \text{if } I < \xi_1^{non}. \end{cases}$$

Next we solve for the equilibrium wholesale price w^{non}. If $I \geq \xi_1^{non}$, the manufacturer chooses $w = s_H + (1/(\gamma e) - 1)\Delta(\theta_L)$ when

$$U(s_H + (1/(\gamma e) - 1)\Delta(\theta_L), \theta_L, 0) \geq U(s_H - \Delta(\theta_L), \theta_L, 1) \Leftrightarrow g \geq \xi_2^{non}.$$

If $I < \xi_1^{non}$, the manufacturer chooses $w = s_H + (1/(\gamma e) - 1)\Delta(\theta_L)$ when

$$U(s_H + (1/(\gamma e) - 1)\Delta(\theta_L), \theta_L, 0) \geq U(s_H - \Delta(\theta_H), \theta_H, 1) \Leftrightarrow I \geq \xi_3^{non}.$$

As a result, the outcome $(s_H + (1/(\gamma e) - 1)\Delta(\theta_L), \theta_L, 0)$ is in equilibrium if and only if $\{I \geq \xi_1^{non}, g \geq \xi_2^{non}\}$ or $\{I < \xi_1^{non}, I \geq \xi_3^{non}\}$, the outcome $(s_H - \Delta(\theta_H), \theta_H, 1)$ is in equilibrium if and only if $I < \xi_1^{non}$ and $I < \xi_3^{non}$, and the outcome $(s_H - \Delta(\theta_L), \theta_L, 1)$ is in equilibrium otherwise. ■

Proof of Proposition 2. Substituting $d^{dis}(\theta, w)$ given in (16) into (17) and simplifying it, we obtain

$$\max_{w,\theta} \begin{cases} U(w, \theta, 1) = v - w - I(\theta) - e(\theta)(1 - \theta)g \quad \text{where } w = s_H - \Delta(\theta); \\ U(w, \theta_L, 1) = v - w - e_H(1 - \theta_L)g \quad \text{where } w = s_H + \frac{\Delta(\theta_H)}{\gamma e_H(1-\theta_H)} - \Delta(\theta_H); \\ U(w, \theta_H, 0) = v - w - I \quad \text{where } w = s_H + \frac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H); \\ U(w, \theta, 0) = v - w - I(\theta) \quad \text{where } w = s_H + \frac{\Delta(\theta)}{\gamma e(\theta)(1-\theta)} - \Delta(\theta). \end{cases}$$

In the above, the second $U(w, \theta_L, 1)$ is dominated by the first $U(w, \theta, 1)$ when $\theta = \theta_L$ because $w = s_H + \frac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H)$ is larger than $w = s_H - \Delta(\theta_L)$ by $s_H + \frac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H) > s_H >$

$s_H - \Delta(\theta_L)$. Also, the third $U(w, \theta_H, 0)$ is a special case of the fourth $U(w, \theta, 0)$ when $\theta = \theta_H$. Therefore, we can simplify the above maximization program into the following:

$$\max_{\theta} \begin{cases} U(s_H - \Delta(\theta), \theta, 1) = v - (s_H - \Delta(\theta)) - I(\theta) - e(\theta)(1-\theta) g; \\ U\left(s_H + \frac{\Delta(\theta)}{\gamma e(\theta)(1-\theta)} - \Delta(\theta), \theta, 0\right) = v - \left(s_H + \frac{\Delta(\theta)}{\gamma e(\theta)(1-\theta)} - \Delta(\theta)\right) - I(\theta). \end{cases} \tag{21}$$

From (21), we obtain $d^{dis} = 1$ if and only if:

$$U(s_H - \Delta(\theta_L), \theta_L, 1) \geq U\left(s_H + \frac{\Delta(\theta_L)}{\gamma e_H(1-\theta_L)} - \Delta(\theta_L), \theta_L, 0\right) \Leftrightarrow g \leq \xi_2^{dis} \text{ when } \theta = \theta_L; \tag{22}$$

$$U(s_H - \Delta(\theta_H), \theta_H, 1) \geq U\left(s_H + \frac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H), \theta_H, 0\right) \Leftrightarrow g \leq \xi_4^{dis} \text{ when } \theta = \theta_H. \tag{23}$$

In the rest of the proof, we provide the remaining conditions under three possible structures of the equilibrium outcome that depend on the value of m. Lemmas 2-4 together prove Proposition 2. Figures 3(a), 3(b) and 3(c) illustrate the equilibrium presented in Lemmas 2-4, respectively. We present the proof of Lemma 2 here, while omitting the proofs of Lemmas 3 and 4. For convenience, we rewrite assumptions (A2) and (A3), respectively, as $m \leq \overline{m} \equiv \frac{(1-\theta_H)(s_H - s_L)}{\theta_H}$ and $m \geq \underline{m} \equiv \frac{(e_H - e_L + \gamma e_L e_H \theta_H)(1-\theta_H)(s_H - s_L)}{\theta_H e_H [1 - \gamma e_L (1-\theta_H)]}$. ■

Lemma 2 *When* $\underline{m} \leq m < m_1 \equiv \frac{1}{e_H^2 \theta_H}\left(e_H^2 - e_L^2(1-\theta_H)\right)(1-\theta_H)(s_H - s_L)$ *and* $\gamma < \frac{1}{e_H + e_L(1-\theta_H)}$, *the equilibrium outcome of program (21) is*

$$\left(w^{dis}, \theta^{dis}, d^{dis}\right) = \begin{cases} \left(s_H + \left(\frac{1}{\gamma e_H} - 1\right)\Delta(\theta_L), \theta_L, 0\right) & \text{if } g \geq \xi_2^{dis}, I \geq \xi_3^{dis}, I \geq \xi_5^{dis}; \\ (s_H - \Delta(\theta_L), \theta_L, 1) & \text{if } I \geq \xi_1^{dis}, g \leq \xi_2^{dis}; \\ (s_H - \Delta(\theta_H), \theta_H, 1) & \text{if } I \leq \xi_1^{dis}, I \leq \xi_3^{dis}, g \leq \xi_4^{dis}; \\ \left(s_H + \left\{\frac{1}{\gamma e_L(1-\theta_H)} - 1\right\}\Delta(\theta_H), \theta_H, 0\right) & \text{if } g \geq \xi_4^{dis}, I \leq \xi_5^{dis}. \end{cases} \tag{24}$$

Proof of Lemma 2. The condition $\gamma < \frac{1}{e_H + e_L(1-\theta_H)}$ ensures that there exists $m \in [\underline{m}, m_1)$, and the condition $m < m_1$ suggests that $\xi_4^{dis} > \xi_2^{dis}$. Given that $\xi_4^{dis} > \xi_2^{dis}$, program (21) can be simplified as follows:

$$\begin{array}{ll} \max\{U(s_H - \Delta(\theta_L), \theta_L, 1), U(s_H - \Delta(\theta_H), \theta_H, 1)\} & \text{if } g \leq \xi_2^{dis}; \\ \max\left\{U(s_H - \Delta(\theta_H), \theta_H, 1), U\left(s_H + \frac{\Delta(\theta_L)}{\gamma e_H} - \Delta(\theta_L), \theta_L, 0\right)\right\} & \text{if } \xi_2^{dis} < g \leq \xi_4^{dis}; \\ \max\left\{U\left(s_H + \frac{\Delta(\theta_L)}{\gamma e_H} - \Delta(\theta_L), \theta_L, 0\right), U\left(s_H + \frac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H), \theta_H, 0\right)\right\} & \text{if } g > \xi_4^{dis}. \end{array}$$

Therefore, we obtain the following results:

(i) $(s_H - \Delta(\theta_L), \theta_L, 1)$ is the equilibrium outcome if and only if $g \leq \xi_2^{dis}$ and

$$U(s_H - \Delta(\theta_L), \theta_L, 1) \geq U(s_H - \Delta(\theta_H), \theta_H, 1) \Leftrightarrow I \geq \xi_1^{dis}. \tag{25}$$

(ii) $(s_H - \Delta(\theta_H), \theta_H, 1)$ is the equilibrium outcome if and only if $\left\{g \leq \xi_2^{dis}, I \leq \xi_1^{dis}\right\}$, or $\left\{\xi_2^{dis} < g \leq \xi_4^{dis}, I \leq \xi_3^{dis}\right\}$, where

$$U(s_H - \Delta(\theta_H), \theta_H, 1) \geq U\left(s_H + \frac{\Delta(\theta_L)}{\gamma e_H} - \Delta(\theta_L), \theta_L, 0\right) \Leftrightarrow I \leq \xi_3^{dis}. \tag{26}$$

We can show that these conditions can be further simplified to $g \leq \xi_4^{dis}, I \leq \xi_3^{dis}$, and $I \leq \xi_1^{dis}$.

(iii) $\left(s_H + \frac{\Delta(\theta_L)}{\gamma e_H} - \Delta(\theta_L), \theta_L, 0\right)$ is the equilibrium outcome if and only if $\left\{\xi_2^{dis} < g \leq \xi_4^{dis}, I \geq \xi_3^{dis}\right\}$

or $\left\{g > \xi_2^{dis},\, I \geq \xi_5^{dis}\right\}$, where

$$U\left(s_H + \frac{\Delta(\theta_L)}{\gamma e_H} - \Delta(\theta_L), \theta_L, 0\right) \geq U\left(s_H + \frac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H), \theta_H, 0\right) \Leftrightarrow I \geq \xi_5^{dis}. \quad (27)$$

Similar to (ii), these conditions can be simplified to $g > \xi_2^{dis}$, $I \geq \xi_3^{dis}$ and $I \geq \xi_5^{dis}$.

(iv) $\left(s_H + \frac{\Delta(\theta_H)}{\gamma e_L(1-\theta_H)} - \Delta(\theta_H), \theta_H, 0\right)$ is the equilibrium outcome if and only if $g > \xi_4^{dis}$ and $I \leq \xi_5^{dis}$. ■

Lemma 3 *When* $m_1 \leq m \leq m_2 \equiv \frac{1}{\theta_H}(s_H - s_L)(1-\theta_H)\left(1 - \frac{(1-\theta_H)\gamma e_L^2}{e_H - e_L(1-\theta_H) + \gamma e_L^2(1-\theta_H)^2}\right)$ *and* $\gamma < \frac{1}{e_H + e_L(1-\theta_H)}$, *the equilibrium outcome of program (21) is*

$$\left(w^{dis}, \theta^{dis}, d^{dis}\right) = \begin{cases} \left(s_H + \left(\frac{1}{\gamma e_H} - 1\right)\Delta(\theta_L), \theta_L, 0\right) & \text{if } g \geq \xi_2^{dis}, I \geq \xi_5^{dis}; \\ \left(s_H - \Delta(\theta_L), \theta_L, 1\right) & \text{if } I \geq \xi_1^{dis}, g \leq \xi_2^{dis}, I \geq \xi_6^{dis}; \\ \left(s_H - \Delta(\theta_H), \theta_H, 1\right) & \text{if } I \leq \xi_1^{dis}, g \leq \xi_4^{dis}; \\ \left(s_H + \left\{\frac{1}{\gamma e_L(1-\theta_H)} - 1\right\}\Delta(\theta_H), \theta_H, 0\right) & \text{if } I \leq \xi_6^{dis}, g \geq \xi_4^{dis}, I \leq \xi_5^{dis}. \end{cases}$$

Lemma 4 *When* $\left\{m_2 < m < \overline{m}, \gamma < \frac{1}{e_H + e_L(1-\theta_H)}\right\}$ *or* $\gamma > \frac{1}{e_H + e_L(1-\theta_H)}$, *the equilibrium outcome of program (21) is*

$$\left(w^{dis}, \theta^{dis}, d^{dis}\right) = \begin{cases} \left(s_H + \left(\frac{1}{\gamma e_H} - 1\right)\Delta(\theta_L), \theta_L, 0\right) & \text{if } g \geq \xi_2^{dis}, I \geq \xi_5^{dis}; \\ \left(s_H - \Delta(\theta_L), \theta_L, 1\right) & \text{if } g \leq \xi_2^{dis}, I \geq \xi_6^{dis}; \\ \left(s_H + \left\{\frac{1}{\gamma e_L(1-\theta_H)} - 1\right\}\Delta(\theta_H), \theta_H, 0\right) & \text{if } I \leq \xi_6^{dis}, I \leq \xi_5^{dis}. \end{cases}$$

Proof of Proposition 3. (a) The supplier's profit is 0 under the inspection-alone strategy or the do-nothing strategy, $(1/(\gamma e_H) - 1)\Delta(\theta_L)$ under the premium-alone strategy, and $\{1/(\gamma e_L(1-\theta_H)) - 1\}$ $\Delta(\theta_H)$ under the premium & inspection strategy, where $(1/(\gamma e_H) - 1)\Delta(\theta_L) > \{1/(\gamma e_L(1-\theta_H)) - 1\}$ $\Delta(\theta_H)$. From Table 1, we can verify the change of the supplier's profit in each area.

(b) The proof is provided in the main body.

(c) This can be verified from the change of the manufacturer's strategy shown in Table 1. ■

Proof of Corollary 1. Case (i): Refer to Table 2 for the conditions under which an equilibrium strategy is changed from one strategy to another.

(a) This can be easily proved similarly to the proof of Proposition 3(a).

(b) First, we prove that in the case of $e_H > e = e_L$ the manufacturer's profit increases as the manufacturer changes her strategy from inspection-alone in the non-disclosure to do-nothing or premium-alone or premium & inspection in the disclosure scenario. The manufacturer's profit under the inspection-alone strategy in the non-disclosure scenario is $U((s_H - \Delta(\theta_H), \theta_H, 1)) = v - (s_H - \Delta(\theta_H)) - I - eg(1-\theta_H)$, and that under the do-nothing strategy in the disclosure scenario is $v - (s_H - \Delta(\theta_L)) - e_H g$. The latter is higher than the former when $e = e_L$, as suggested by the condition $I \geq \xi_1^{dis} = \Delta(\theta_H) - \Delta(\theta_L) + g\{e_H - e_L(1-\theta_H)\}$ (see the condition for $R(a)$ in Table 1). Similarly, we could show that when $e = e_L$ the manufacturer's profit under the premium-alone strategy in the disclosure scenario $v - \left(s_H + \left(\frac{1}{\gamma e_H} - 1\right)\Delta(\theta_L)\right) \geq U((s_H - \Delta(\theta_H), \theta_H, 1))$, as suggested by the condition $I \geq \xi_3^{dis} = \Delta(\theta_H) + \Delta(\theta_L)/(\gamma e_H) - \Delta(\theta_L) - e_L g(1-\theta_H)$ (see the condition for $R(f)$ in Table 2), and her profit under the premium & inspection strategy in the

disclosure scenario $v-\left(s_H+\left\{\frac{1}{\gamma e_L(1-\theta_H)}-1\right\}\Delta(\theta_H)\right)-I \geq U((s_H-\Delta(\theta_H),\theta_H,1))$, as suggested by the condition $g \geq \xi_4^{dis}=\Delta(\theta_H)/\{\gamma e_L^2(1-\theta_H)^2\}$ (see the condition for $R(c)$ in Table 1).

Second, when $e_H > e$, as the manufacturer changes her strategy from premium-alone in the non-disclosure to do-nothing in the disclosure scenario, her profit increases from $v-\left(s_H+\left(\frac{1}{\gamma e}-1\right)\Delta(\theta_L)\right)$ to $v-(s_H-\Delta(\theta_L))-e_H g$, as suggested by the conditions $g \leq \xi_2^{dis}=\Delta(\theta_L)/\left(\gamma e_H^2\right)$ (see the condition for $R(b)$ in Table 1). Similarly, when $e_H \geq e$, as the manufacturer changes her strategy from premium-alone in the non-disclosure to premium & inspection in the disclosure scenario, her profit increases from $v-\left(s_H+\left(\frac{1}{\gamma e}-1\right)\Delta(\theta_L)\right)$ to $v-\left(s_H+\left\{\frac{1}{\gamma e_L(1-\theta_H)}-1\right\}\Delta(\theta_H)\right)-I$, as suggested by the condition $I \leq \xi_5^{dis}=\Delta(\theta_H)-\Delta(\theta_L)-\Delta(\theta_H)/\{\gamma e_L(1-\theta_H)\}+\Delta(\theta_L)/(\gamma e_H)$ (see the condition for $R(d)$ in Table 1).

However, the manufacturer's profit may decrease as the manufacturer changes her strategy from do-nothing to premium-alone or premium & inspection. Table 3 provides the conditions under which the manufacturer's profit decreases (or increases).

Table 3: Manufacturer's Profit Change under Different External Inspection Levels: Non-Disclosure Scenario vs. Disclosure Scenario in Case (i) ($e_H > e = e_L$)

Equilibrium Outcomes: Non-Disclosure → Disclosure	Do-Nothing → Premium Alone	Do-Nothing → Premium & Inspection
Profit in Non-Disclosure	$v-(s_H-\Delta(\theta_L))-eg$	$v-(s_H-\Delta(\theta_L))-eg$
Profit in Disclosure	$v-s_H-(\frac{1}{\gamma e_H}-1)\Delta(\theta_L)$	$v-s_H-(\frac{1}{\gamma e_L(1-\theta_H)}-1)\Delta(\theta_H)-I$
Profit Difference ΔU: Disclosure - Non-Disclosure	$eg-\frac{\Delta(\theta_L)}{\gamma e_H}$	$eg-\Delta(\theta_L)-(\frac{1}{\gamma e_L(1-\theta_H)}-1)\Delta(\theta_H)-I$
Conditions for $\Delta U<0$	$I \geq \max(\xi_1^{non},\xi_5^{dis})$ and $\xi_2^{dis} \leq g \leq \frac{e_H}{e}\xi_2^{dis}(=\frac{e}{e_H}\xi_2^{non})$	$I \geq \max(\xi_1^{non},\xi_6^{dis}-(e_H-e)g)$, $I \leq \min\left(\xi_5^{dis},\xi_6^{dis}\right)$ and $g \leq \frac{e}{e_H}\xi_2^{non}$
Conditions for $\Delta U \geq 0$	$I \geq \max(\xi_1^{non},\xi_5^{dis})$ and $\frac{e_H}{e}\xi_2^{dis} \leq g \leq \xi_2^{non}$	$\xi_1^{non} \leq I \leq \min\left(\xi_5^{dis},\xi_6^{dis}-(e_H-e)g\right)$ and $g \leq \xi_2^{non}$

(c) This can be verified from the change of the manufacturer's strategy.

Case (ii): Refer to Table 2 for the conditions under which an equilibrium strategy is changed from one strategy to another.

(a) This can be easily proved similarly to the proof of Proposition 3(a).

(b) Following the proof of case (i)-(b), it is not difficult to verify that in the case of $e_H = e > e_L$, the manufacturer's profit increases as the manufacturer changes her strategy from inspection-alone in the non-disclosure to do-nothing or premium & inspection in the disclosure scenario (under the same condition provided by the proof of case (i)-(b) for $R(a)$ and $R(c)$ in Table 1, respectively). Similarly, we can show that the manufacturer's profit increases as the manufacturer changes her strategy from premium-alone in the non-disclosure to do-nothing or premium & inspection in the disclosure scenario in the case of $e_H = e > e_L$ (under the same condition provided by the proof of case (i)-(b) for $R(b)$ and $R(d)$ in Table 1, respectively).

Next we prove how the manufacturer's profit changes when $e_H = e$. First, as the manufacturer

changes her strategy from do-nothing to premium & inspection, her profit changes from $v-(s_H-\Delta(\theta_L))-eg$ to $v-s_H-(\frac{1}{\gamma e_L(1-\theta_H)}-1)\Delta(\theta_H)-I$, and her profit increases under the condition $I\leq\xi_6^{dis}=\Delta(\theta_H)+e_Hg-\Delta(\theta_H)/\{\gamma e_L(1-\theta_H)\}-\Delta(\theta_L)$ (see the condition for $R(g)$ in Table 2). Second, as the manufacturer changes her strategy from do-nothing to inspection-alone, her profit changes from $v-(s_H-\Delta(\theta_L))-eg$ to $v-(s_H-\Delta(\theta_H))-I-e_Lg(1-\theta_H)$, and her profit increases under the condition $I\leq\xi_1^{dis}\equiv\Delta(\theta_H)-\Delta(\theta_L)+g\{e_H-e_L(1-\theta_H)\}$ (see the condition for $R(h)$ in Table 2). Finally, as the manufacturer changes her strategy from premium-alone to inspection-alone, her profit changes from $v-s_H-(\frac{1}{\gamma e}-1)\Delta(\theta_L)$ to $v-(s_H-\Delta(\theta_H))-I-e_Lg(1-\theta_H)$, and her profit increases under the condition $I\leq\xi_3^{dis}\equiv\Delta(\theta_H)+\Delta(\theta_L)/(\gamma e_H)-\Delta(\theta_L)-e_Lg(1-\theta_H)$ (see the condition for $R(l)$ in Table 2).

(c) This can be verified from the change of the manufacturer's strategy. ■

Proof of Lemma 1. First, we claim that for the optimal r_s^* and r_w^* the constraint $r_s+r_w\leq 1$ is always tight (i.e. $r_s^*+r_w^*=1$); otherwise if $r_s^*+r_w^*<1$, through increasing r_w^* one could always increase the optimal c^* or r_s^* and thus the household's utility $u(c,r_s)$. Then the household's utility maximization program in (19) is equivalent to the following program:

$$\max_{c,r_s\geq 0}\ u(c,r_s)=\begin{cases}r_s & c\geq v;\\ c-v & c<v.\end{cases}$$
$$s.t.\ \ s_Lr_s+c\leq s_H+s_L+m_v$$
$$(t_s+s_L)r_s+c\leq s_H+s_L+m_v+m_e$$

The above program could be solved graphically, giving the following solution

$$r_s^*=\begin{cases}1 & if\ m_v+m_e\geq v+t_s-s_H\\ \min\left\{\frac{s_H+s_L+m_v-v}{s_L},\frac{s_H+s_L+m_v+m_e-v}{s_L+t_s}\right\} & if\ m_v+m_e<v+t_s-s_H\ \&\ m_v\geq v-s_L-s_H\\ 0 & otherwise.\end{cases}$$

which suggests that

$$r_w^*=\begin{cases}0 & if\ m_v+m_e\geq v+t_s-s_H\\ \max\left\{\frac{v-s_H-m_v}{s_L},\frac{v+t_s-s_H-m_v-m_e}{s_L+t_s}\right\} & if\ m_v+m_e<v+t_s-s_H\ \&\ m_v\geq v-s_L-s_H\\ 1 & otherwise.\end{cases}$$ ■

Proof of Corollary 5. (a) For ease of exposition, let $m_L=m_e$ and $m_H=m_e+m_v$. Similar to $\Delta(\theta)$ in the base model, we define

$$\Delta(\theta,m)\equiv s_H-\{(1-\theta)s_L+\theta(s_H+m)\}=(s_H-s_L)-(s_H-s_L+m)\theta.$$

It is easy to see that for $\theta=\theta_L=0$, $\Delta(\theta_L,m)=s_H-s_L\ \forall m\in\{m_L,m_H\}$. Since m affects the supplier's and the manufacturer's profits only through $\Delta(\theta,m)$, we conclude that when $\theta=\theta_L$, the manufacturer is indifferent between m_L and m_H.

(b) The derivation of the subgame-perfect equilibrium under a portion of child labor d ($\in[0,1]$) is similar to that of the base model. In the equilibrium, we find that when internal inspections are conducted (i.e., $\theta=\theta_H$), the manufacturer's wholesale price is $w=s_H-\Delta(\theta_H,m)$ under the inspection-alone strategy. Since the manufacturer's profit is decreasing in w and $\Delta(\theta_H,m_L)>\Delta(\theta_H,m_H)$, the manufacturer prefers m_L to m_H in this case. On the other hand, under the

partial-premium & inspection strategy, we obtain $w = \left(\frac{1}{\gamma e\left(1-\theta_H\right)} - 2d_I\right)\Delta\left(\theta_H, m\right) + s_H$, where $d_I = \frac{I}{e\theta_H g}$. In the parameter regions where the equilibrium exists, we have $\frac{1}{\gamma e\left(1-\theta_H\right)} - 2d_I > 0$, so the manufacturer prefers m_H to m_L in this case. ■

Proof of Proposition 4. Case (i): According to Corollary 5 (and its discussion below), when the manufacturer adopts the inspection alone strategy in either scenario, the manufacturer chooses the education compensation m_e, which suggests that $m_v = 0$ in this case. Substituting $m_v = 0$ into (20) suggests that $r_w^* > 0$ if and only if $m_e < v + t_s - s_H$. Since $m_e \leq t_s$, the inequality $m_e < v + t_s - s_H$ always holds if $0 < v - s_H$, irrespective of the amount of m_e.

Case (ii): According to Corollary 5, when the manufacturer adopts the partial-premium & inspection strategy in the non-disclosure scenario, the manufacturer chooses to pay the sum of education and living compensation $m_e + m_v$. Then from (20) we know that $r_w^* > 0$ if and only if $m_e + m_v < v + t_s - s_H$. ■

C. Examples of Companies Disclosing No or Low-Level Inspection Efforts

- Caterpillar Inc.: "We do not currently verify our product supply chain or audit suppliers specifically to evaluate risks of human trafficking and slavery or require our direct suppliers to certify that materials incorporated into products comply with laws regarding slavery and human trafficking in the countries in which they are doing business." (Source: www.caterpillar.com/en/company/suppliers/supplier-conduct.html, Accessed on January 31, 2015 and July 7, 2016)

- Danaher Corp.: "Accordingly, Danaher Corporation does not verify its supply chains to evaluate the risks of human trafficking or slavery, audit its suppliers for compliance with or require suppliers to certify compliance with the laws regarding human trafficking and slavery" (Source: www.danaher.com/sites /default/files/California_Transparency_in_Supply_Chains_Act_of _2010.pdf, Accessed on January 31, 2015 and July 7, 2016)

- IDEX Corporation: "Although IDEX Units expect their suppliers to comply with applicable laws and frequently obtain agreements and certifications from their key suppliers relating to compliance with applicable laws in supplying products to them, IDEX Units do not verify their supply chain or audit suppliers specifically to evaluate risks of human trafficking and slavery or require their suppliers to certify specifically that products supplied to them were not produced with child labor or slave labor." (Source: http://idexcorp.com/terms/SupplyChainTransparency. asp, Accessed on January 31, 2015 and July 7, 2016)

- Hyundai Motor America: "Hyundai has no policy regarding, and does not monitor, human trafficking and slavery in its direct product supply chain." (Source: https://www.hyundaiusa. com/terms-conditions.aspx, Accessed on January 31, 2015 and July 7, 2016)

- Krispy Kreme Doughnuts, Inc.: "We do not engage in verification of product supply chains to evaluate and address risks of human trafficking and slavery, nor conduct audits of suppliers to evaluate supplier compliance with company standards against trafficking and slavery in supply chains." (Source:

http://www.krispykreme.com/SharedContent/Media/FormsLib/supply_chains_act.pdf, Accessed on January 31, 2015 and July 7, 2016)

- Orora North America: "Orora has not (a) reviewed its product supply chains to evaluate and address risks of human trafficking and slavery or employed a third party to audit or evaluate such risks, (b) established entity standards on human trafficking and slavery and then conducted supplier audits to evaluate whether suppliers comply with standards." (Source: http://www.mppmfg.com/docs/CA-Transparency-Supply-Chain-Act.pdf, Accessed on January 31, 2015 and July 7, 2016)

- Overhill Farms, Inc.: "Overhill Farms does not (1) engage in verification of product supply chains to determine and address risks of human trafficking and slavery; (2) conduct audits of suppliers to determine supplier compliance with company standards for human trafficking and slavery in supply chains;" (Source: http://www.overhillfarms.com/pdf/Supply%20Chains%20Act%20Disclosure%20_OFI_%20Final1.pdf, Accessed on January 31, 2015 and July 7, 2016)