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Supplier Evasion of a Buyer's Audit: Implications for Motivating Supplier Social and Environmental Responsibility

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Prominent buyers' brands have been damaged because their suppliers caused major harm to workers or the environment, e.g., through a deadly factory fire or release of toxic chemicals. How can buyers motivate suppliers to exert greater care to prevent such harm? This paper characterizes a "backfiring condition" under which actions taken by prominent buyers (increasing auditing, publicizing negative audit reports, providing loans to suppliers) motivate a supplier to exert greater effort to pass the buyer's audit by hiding information and *less* care to prevent harm. Intuitively appealing actions for a buyer (penalizing a supplier for harming workers or the environment, or for trying to deceive an auditor) may be similarly counterproductive. Contrary to conventional wisdom, squeezing a supplier's margin (by reducing the price paid to the supplier or increasing wages for workers) motivates the supplier to exert greater care to prevent harm—under the backfiring condition. Whereas the necessary and sufficient condition depends on the relative convexity of the supplier's hiding cost function, a simple sufficient condition is that the supplier is likely to successfully hide information from the auditor, in equilibrium. Anecdotal evidence suggests that the backfiring condition is prevalent or becoming increasingly so. Similar insights apply to mitigation of unauthorized subcontracting.

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1. Introduction

When the heat is turned up too fast and hard, it drives the factories to move in the other direction. They end up hiding information from us. —Kevin O'Donnell, Director of Environmental Engineering, Nike (November 2, 2009)

Apple, Disney, Marks & Spencer, Zara, and other prominent firms have recently been exposed as sourcing from suppliers that have caused major harm to workers or the environment (Chamberlain 2011, Duggan 2012, Duhigg and Barboza 2012, Institute of Public and Environmental Affairs 2012). When a firm's supplier is revealed as abusing workers (e.g., through hazardous working conditions leading to workplace injuries and deaths) or damaging the environment (e.g., through a major illegal release of toxic chemicals), the ensuing scandal damages the brand of the buying firm. A supplier's risk of causing a major harm to workers or the environment depends on the extent of the supplier's effort to employ responsible safety and environmental practices. Currently, buyers' auditing of suppliers' practices is the primary motivation for suppliers to exert that responsibility effort, because regulatory institutions and law enforcement are weak in developing and emerging economies in which suppliers are concentrated (Economy 2007, Locke et al. 2007).

The aforementioned buying firms have responded to the scandals by increased auditing (Disney 2011, Duhigg and Wingfield 2012, Genasci 2012, Inditex 2012). Other buying firms have recently increased auditing to avert such scandals (Carbone 2012, Biraj 2013). However, based on data from Nike's audits of its suppliers, Locke et al. (2007) find that auditing alone is ineffective in improving factory conditions. This paper provides an explanation for how increased auditing can reduce suppliers' efforts to prevent harm to workers and the environment.

Buying firms are under increasing pressure from nongovernmental organizations (NGOs) and other actors that expose and publicize suppliers' harms to workers and the environment. NGOs pressure buyers because the buyers are concerned about reputation and brand, whereas their suppliers are largely indifferent (Lee et al. 2009, 2012b). Newly founded Chinese NGOs generated the recent scandals for the aforementioned buying firms (Chamberlain 2011, Duggan

2012, Duhigg and Barboza 2012, Institute of Public and Environmental Affairs 2012). Only recently has China's government started to permit some "orderly" activism by NGOs and established the public's right to know about environmental pollution (Economy 2007, Lee et al. 2012b). Journalists and activists are identifying branded firms that sourced, directly or through unauthorized subcontracting, from facilities in which workers died in recent fires and collapsed buildings in Bangladesh (Strauss et al. 2013, Motlagh 2014). In addition, NGOs are pressuring buyers to pay higher prices to their suppliers, thinking that this will motivate suppliers to improve safety (Dudley 2012a). This paper provides an explanation for how all these heightened pressures on buyers could backfire by reducing suppliers' efforts to be responsible.

To do so, this paper models the widespread phenomenon that suppliers attempt to hide information about potentially unsafe practices or conditions from buyers. A prominent multinational buyer that observes a "red flag" that a factory is unsafe typically will withdraw its business from the supplier rather than risk brand damage (Dudley 2012b, Lee et al. 2012a). Facing that loss of business and the high cost of responsible practices, many suppliers instead attempt to hide information from their buyers' auditors (Foster and Harney 2005, Gould 2005).

An audit typically consists of touring the factory, reviewing documents, and interviewing factory employees; suppliers act to deceive auditors in each of these elements (Wong 2007). Some suppliers build walls or block entrances to hide portions of facilities with possible safety problems (Roberts and Engardio 2006). Falsifying documents is a widespread practice (Foster and Harney 2005, Harney 2008). Suppliers commonly maintain a false set of work and training logs to show to auditors in order to hide any evidence of abusive or unsafe working conditions (Roberts and Engardio 2006). Some create false records of inspection and maintenance of buildings and equipment for safety and pollution prevention, and some create false records of safety training that did not actually occur (Pruett 2005, Walsh and Greenhouse 2012, Patel 2014). Training workers and managers to mislead auditors also is a widespread practice (Foster and Harney 2005, Roberts and Engardio 2006). Employees are motivated to deceive auditors by the threat of financial or physical punishment for whistleblowing and because their jobs would be at risk if their employer failed the audit and lost the buyer as a customer (Esbenshade 2004, Egels-Zandén 2007).

Not only do many suppliers attempt to deceive an auditor, they commonly succeed in passing an audit through deception or bribery. Suppliers deceive auditors in regions around the world, "from China to Cambodia to Turkey to Guatemala [to] India . . . [and] Bangladesh" (Goodman 2013). Suppliers have become increasingly sophisticated in their abilities to deceive auditors, in part because of the emergence of software for producing false documents and consulting organizations that help suppliers deceive auditors (Gould 2005, Roberts and Engardio 2006). Suppliers also pass audits through bribery (China Labor Watch 2009, Motlagh 2014). Suppliers have strong financial incentives to pass audits (Clifford and Greenhouse 2013), whereas auditors have little incentive to reject bribes because their wages tend to be low and their turnover high (Harney 2008, Plambeck et al. 2012). The recent news is marked by violations by suppliers that passed audits through deception or bribery (Walsh and Greenhouse 2012, Clifford and Greenhouse 2013).

In summary, the anecdotal evidence above suggests that at least some suppliers are "hiding"—exerting effort to pass a buyer's audit through deception or bribery—and are likely to be successful in doing so. This paper shows that that is a sufficient condition for various actions aimed at improving supplier responsibility (e.g., increased auditing) to backfire and have the opposite effect. Section 3 identifies the necessary and sufficient "backfiring condition" under which increased auditing effort reduces a supplier's responsibility effort. Increased pressure on buyers, from NGOs that expose and publicize their suppliers' harm to workers or the environment, also does so.

Whereas buyers historically have relied on auditing, §4 examines alternative ways in which a buyer might motivate a supplier to exert more responsibility effort to avoid harm to workers and the environment, including penalizing the supplier for harm or hiding effort, providing a loan to the supplier, paying a higher price, publicizing negative audit reports, and making hiding more difficult. These actions may be harmful or helpful, depending on whether or not the backfiring condition holds.

Motivated by recent events in Bangladesh, §5 shows how our model and results extend to the setting where the buyer invests in making the supplier's facility safe, but the supplier subcontracts to unauthorized, unsafe factories.

1.1. Related Literature

In the law enforcement literature, Kambhu (1989), Malik (1990), and Innes (2001) model an offender's hiding effort and show how that changes the socially optimal penalty and monitoring effort to catch offenders. In the financial auditing literature, Baiman et al. (1991), Kornish and Levine (2004), and Khalil et al. (2010), and papers surveyed therein model a manager's bribery of an auditor to obtain a favorable report and show how that changes shareholders' optimal policy for compensating managers and auditors.

Similarly, in the supply chain management literature, this paper is the first to model a supplier's effort to hide safety or environmental problems from a buyer, and it shows how that changes a buyer's optimal policy. For example, the papers surveyed in the next paragraph associate supplier responsibility with a higher price, reduced production cost, or other strong financial incentive for the supplier; in the spirit of Kerr (1975), this paper identifies conditions under which such policies promote hiding instead of responsibility.

In the literature on responsible supply chain management, Guo et al. (2015) examine a buyer's choice to pay a high price to a "responsible" supplier or pay a low price and risk a scandal. In Chen and Lee (2014), a buyer screens for an ethical supplier by offering a menu of contracts in which a high price is coupled with withholding payment in the event of a responsibility violation. In Aral et al. (2014), a buyer audits prospective suppliers and then runs an auction in which suppliers with favorable audit reports receive higher prices. In Izhutov and Lee (2013), a supplier makes sequential investments that increase the probability that it qualifies as responsible; increasing the supplier's margin motivates greater investment. In Lewis et al. (2013), a buyer makes sequential investments that reduce a supplier's cost to produce in a more responsible manner. In Xu et al. (2015), a buyer may audit or pay a premium to motivate supplier responsibility; a government mandate to disclose auditing effort enables precommitment, which can reduce auditing and supplier responsibility. Corbett and DeCroix (2001), Caro et al. (2013), and this paper model noncontractible efforts by multiple firms in a supply chain that jointly determine the supply chain environmental impact.

In closely related quality literature, a supplier's effort determines the probability that a product is not defective, and a buyer's inspection effort determines the probability of detecting a defective product. Assuming that the firms' efforts are noncontractible, Baiman et al. (2000) show that the first-best efforts are induced by contracting for the supplier to pay a penalty if the product fails either the buyer's inspection or in use. Acknowledging the difficulties of implementing such a penalty contract, Baiman et al. propose a returns contract and characterize the resulting second-best efforts. Several papers extend the model in Baiman et al. and address the problem that a buyer cannot force its supplier to pay a penalty for defects (Babich and Tang 2012, Bondareva and Pinker 2013) or can extract at most limited, "fair" compensation (Balachandran and Radhakrishnan 2005). In Bondareva and Pinker (2013), a supplier willingly pays a limited penalty for defects to avoid losing future business. In Babich and Tang (2012), a buyer delays payment to the supplier to withhold payment in the event that the product fails in use. In each of these mechanisms, the magnitude of the penalty is limited. Similarly, §4.5 of this paper evaluates an option for a buyer to impose a limited penalty on a supplier for causing a major harm to workers or the environment. Hwang et al. (2006) identify conditions under which, rather than inspect the supplier's product, a buyer should conduct a quality audit of the supplier's facility and source from the supplier only if the facility passes the audit. Our model can be interpreted as addressing the latter situation while incorporating a supplier's effort to pass the quality audit through deception.

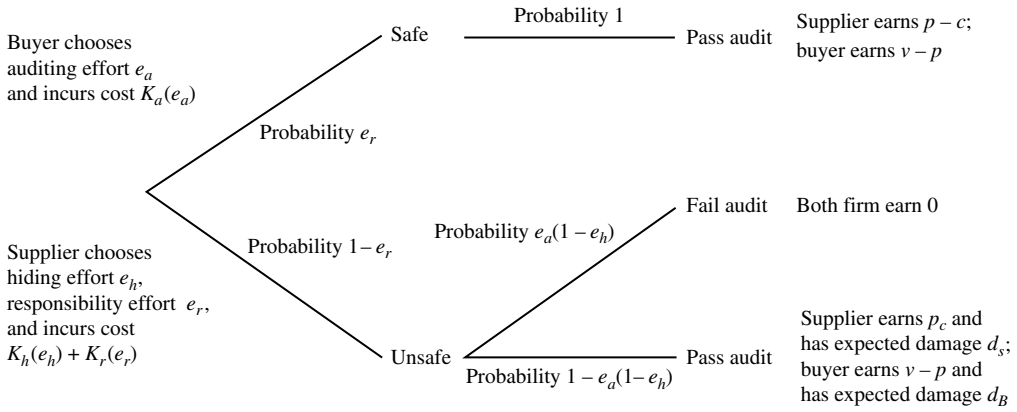
Kim (2015) surveys the literature on optimal monitoring in law enforcement. In contrast to that literature and our paper, Kim models dynamic variation over time in factory pollution and inspection by a regulator.

2. Model Formulation

As depicted in Figure 1, a supplier chooses a level of responsibility effort e_r to avoid causing a major harm to workers or the environment and chooses a level of hiding effort e_h to evade the buyer's audit. The efforts are chosen on the scale of e_r, $e_h \in [0, 1]$ because they correspond to probabilities. With probability $1 - e_r$, the supplier's facility is "unsafe," meaning that operating the facility may cause a major harm to workers or the environment (e.g., a deadly fire or major release of toxic chemicals). With probability e_h, the supplier is able to successfully hide any evidence that the factory is unsafe. The supplier incurs costs $K_r(e_r)$ and $K_h(e_h)$ that increase with its levels of responsibility and hiding effort.

The buyer chooses an auditing effort $e_a \in [0, 1]$ and incurs cost $K_a(e_a)$ that increases with e_a. If the supplier's facility is unsafe, then, by exerting more auditing effort, the buyer becomes more likely to observe the problematic practices or conditions that make the facility unsafe (unless these are successfully hidden by the supplier). Hence, with probability $e_a(1-e_h)$, an unsafe facility fails the audit. Otherwise, the facility passes the audit. The likelihood that the facility passes the audit is $1 - e_a(1 - e_h)(1 - e_r)$. If the buyer sources from the supplier, she sources a fixed quantity (which we scale to 1), pays the supplier p, and has a contribution margin of $v - p > 0$, whereas the supplier has a contribution margin $p - c > 0$; v denotes the buyer's value of sourcing from the supplier, and c denotes the supplier's production cost. If the supplier's facility is unsafe and the buyer sources from the supplier, then the buyer incurs an additional expected cost of d_B; this parameter combines the probability that a major harm to workers or the environment will actually

Figure 1 Model of Auditing, Hiding, and Responsibility Efforts



occur, the probability that it will be publicized, and the expected resulting costs for the buyer. We assume that the buyer does not want to source from an unsafe facility,

$$d_B > v - p,$$

which implies that if the supplier fails the audit, then the buyer does not source from the supplier.

We rule out uninteresting equilibria in which the buyer exerts zero auditing effort or the supplier exerts zero responsibility effort, because then there is no meaningful interaction between the firms. Instead, v and p are sufficiently large that, in equilibrium, both firms exert effort, the buyer sources from the supplier in the event that the supplier passes the audit, and both firms earn a strictly positive expected profit. The buyer chooses auditing effort e_a to maximize expected profit:

$$\pi_b = [1 - e_a(1-e_h)(1-e_r)](v-p) - (1-e_r)[1-e_a(1-e_h)]d_B - K_a(e_a); \quad (1)$$

the supplier chooses responsibility effort e_r and hiding effort e_h to maximize expected profit:

$$\pi_s = [1 - e_a(1-e_h)(1-e_r)](p-c) - (1-e_r)[1-e_a(1-e_h)]d_S - K_r(e_r) - K_h(e_h), \quad (2)$$

where d_B is the buyer's expected damage from sourcing from an unsafe supplier, and d_S is the supplier's expected damage from operating an unsafe facility. The latter represents all the supplier's expected costs associated with harm to workers or the environment.

We assume that the cost functions $K_i(e_i)$ for $i \in \{a, h, r\}$ are strictly increasing, twice differentiable, convex and satisfy $K_i(0) = 0$. Convexity is natural in that one would expect each firm to prioritize the most cost-effective activities. For example, to increase the likelihood of detecting an unsafe facility, the buyer could increase the amount of time that an auditor spends inspecting the facility, interviewing employees, or reviewing paperwork; hire a more expensive, more capable auditor; or expend resources on training the auditor. Assuming that the buyer prioritizes the most cost effective of those activities, achieving an increasingly high level of e_a will incur an increasing marginal cost $K_a'(e_a)$.

We assume that the supplier's best-response hiding and responsibility efforts $(\tilde{e}_h(e_a), \tilde{e}_r(e_a))$ are interior (i.e., $\tilde{e}_i(e_a) \in (0,1)$ for $i \in \{h, r\}$ for $e_a \in (0,1]$) and the unique solution to the first-order conditions:

$$\partial\pi_s/\partial e_r = d_S + e_a(1-e_h)(p-c-d_S) - K_r'(e_r) = 0, \quad (3)$$

$$\partial\pi_s/\partial e_h = e_a(1-e_r)(p-c-d_S) - K_h'(e_h) = 0; \quad (4)$$

further, $\tilde{e}_i(e_a)$ is continuous in e_a for $i \in \{h, r\}$. The buyer knows the supplier's objective function (2) but cannot observe the supplier's actual responsibility and hiding efforts, which leads us to focus on a simultaneous-move Nash equilibrium. Hence, we assume the existence of a unique equilibrium (e_a^*, e_r^*, e_h^*) that is the unique solution to (3), (4), and

$$\partial\pi_b/\partial e_a = (1-e_h)(1-e_r)(d_B - v + p) - K_a'(e_a) = 0. \quad (5)$$

Conditions that ensure the existence of a unique equilibrium, which is interior, are in the appendix. Our focus on the interior solution rules out a scenario in which a supplier intentionally causes a major harm to workers or the environment, e.g., by dumping chemicals. However, it does allow for the major harm to be occurring at the time of the buyer's audit, as with a leakage of chemicals or worker exposure to toxic chemicals arising from insufficient inspection and maintenance of equipment or insufficient safety precautions. At the time that the supplier chooses how much effort to exert in hiding information from the buyer, e.g., by falsifying its record of inspection, maintenance, and safety training, the supplier does not yet know whether its factory will turn out to be safe or cause major harm.

The price p is a constant (except in §4.3) rather than optimized jointly with auditing effort e_a. This reflects the reality of most buying firms in which a procurement organization seeks quality, rapid delivery, etc., at a low price (high v and low p) and a *separate* organization seeks to prevent sourcing from a supplier that harms workers or the environment. Those two organizations are often at odds, have poor communication, and fail to work closely together (Harney 2008).

The online supplement (available as supplemental material at http://dx.doi.org/10.1287/msom.2015.0550) establishes that our results hold in a more complex model, in which the supplier's facility may be in a variety of different unsafe states $j \in \{1, \ldots, N\}$, each corresponding to a different level of expected damage for the buyer d_B^j. In that model, the supplier's responsibility effort e_r decreases the buyer's expected damage in the event that the supplier is unsafe and the buyer sources from the supplier.

3. Results: Buyer's Auditing Effort

A buyer might reasonably expect that increased auditing will lead to increased responsibility effort. That is true if the supplier cannot hide. However, Proposition 1 shows that increased auditing can "backfire" by reducing the supplier's responsibility effort. All proofs are in the online supplement.

Proposition 1. (a) *The supplier's best-response responsibility effort $\tilde{e}_r$ decreases in the buyer's auditing effort e_a if and only if*

$$K_h'(\tilde{e}_h)/K_h''(\tilde{e}_h) > 1 - \tilde{e}_h. \tag{6}$$

(b) *A sufficient condition for (6) to hold is that*

$$\tilde{e}_h > \underline{e}_h, \tag{7}$$

where the threshold $\underline{e}_h < 1$ if $K_h''(e_h) \le K$ for some $K < \infty$.

The rationale is that increased auditing motivates the supplier to exert more hiding effort, which is a substitute for responsibility effort. When the backfiring condition (6) holds, pushing the supplier harder has the effect of encouraging the supplier to "give up" on exerting responsibility effort and instead focus on hiding any evidence of potentially unsafe conditions or practices.

Some evidence suggests that the backfiring condition is prevalent or becoming more so. Because

$$K_h'(\tilde{e}_h) = e_a(1 - \tilde{e}_r)(p - c - d_S), \tag{8}$$

(6) tends to hold when the buyer's auditing effort e_a is large, the supplier's expected damage from operating an unsafe facility d_S is small relative to the supplier's margin $p - c$, the supplier's responsibility effort $\tilde{e}_r$ is small, and the supplier's hiding effort $\tilde{e}_h$ is large. Commonly in practice, as documented in §1, buyers are increasing their auditing efforts e_a, and suppliers are likely to pass audits by hiding information; i.e., $\tilde{e}_h$ is large. Suppliers' safety and environmental responsibility efforts are inadequate because responsibility is costly and government enforcement is weak; i.e., $\tilde{e}_r$ and d_S are low (Foster and Harney 2005, Egels-Zandén 2007, Harney 2008). A supplier's financial incentive to pass an audit, represented by $p - c$ in our model, is large (Foster and Harney 2005). Jacobs and Singhal (2014) provide evidence that margins $p - c$ are large for publicly traded Bangladeshi garment suppliers. Yet buyers are under pressure to pay increasingly high prices p (Dudley 2012a, Jacobs and Singhal 2014). Finally, as documented in §1, a supplier's harm to workers or the environment is increasingly likely to be publicized and linked to a buyer, which increases a buyer's expected damage from sourcing from an unsafe supplier d_B and thus, as shown in Proposition 2 below, increases auditing effort e_a.

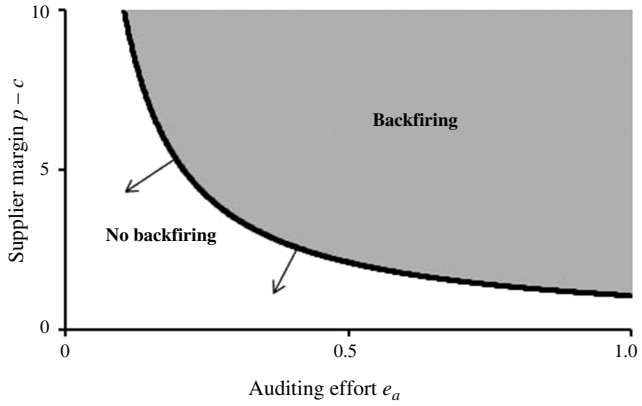
To understand why backfiring occurs under the specified conditions, focus first on the sufficient condition in Proposition 1(b). Backfiring occurs when the supplier is likely to pass the buyer's audit by hiding information; i.e., $\tilde{e}_h$ is sufficiently large. To the extent that $\tilde{e}_h$ is large, the supplier's marginal value of responsibility effort,

$$d_S + e_a(1 - \tilde{e}_h)(p - c - d_S), \tag{9}$$

is small and has a small partial derivative with respect to e_a, meaning that increased auditing has little direct effect on responsibility effort. The small marginal value of responsibility effort implies that $\tilde{e}_r$ is small. Consequently, the supplier's marginal value of hiding effort, the right-hand side of (8), has a large partial derivative with respect to e_a. Hence, increased auditing stimulates a large increase in hiding effort $\tilde{e}_h$, which decreases the marginal value of responsibility effort (9) and causes the supplier to reduce her responsibility effort.

Figure 2 illustrates that backfiring occurs when the supplier's damage from operating an unsafe facility d_S is small, responsibility is costly, and either the supplier's margin $p - c$ or the buyer's auditing effort e_a is sufficiently large. In the shaded region of Figure 2, increasing the buyer's auditing effort e_a backfires by reducing the supplier's best-response responsibility effort $\tilde{e}_r$; with power cost functions for hiding and responsibility $K_h(e_h) = \alpha_h(e_h)^{\beta_h}$ and $K_r(e_r) = \alpha_r(e_r)^{\beta_r}$, the parameters are $\alpha_h = 1$, $\beta_h = 3/2$, $\alpha_r = 2$, $\beta_r = 2$, and $d_S = 0$. Increasing the supplier's cost of responsibility α_r or decreasing the supplier's expected damage from operating an unsafe facility d_S shifts the backfiring region boundary in the direction of the arrows.

Figure 2 **Backfiring as a Function of the Buyer's Auditing Effort and Supplier's Margin**



Intuitively, the supplier's incentive to exert hiding effort—and consequently, $\tilde{e}_h$—is large when the supplier faces little penalty for operating an unsafe facility, has a high cost for responsibility effort, has a strong financial reward for passing the audit, and faces sufficient scrutiny from the buyer. Mathematically, those conditions correspond to a high marginal value of hiding effort in the right-hand side of (8) and high $\tilde{e}_h$, so (6) holds.

Finally, backfiring tends to occur when the supplier's hiding cost function exhibits little relative convexity. To the extent that $K_h''(\tilde{e}_h)$ is small, after an increase in the buyer's auditing effort e_a increases the marginal value of hiding (right-hand side of (8)), the supplier makes a relatively large increase in her hiding effort $\tilde{e}_h$ to equate the marginal cost with the marginal value of hiding, which prompts the supplier to reduce her responsibility effort. When the hiding cost function exhibits little relative convexity, i.e., $K_h''(\tilde{e}_h)$ is small relative to $K_h'(\tilde{e}_h)$ so that the left-hand side of (6) is large, then backfiring occurs even if the conditions that favor backfiring described above (large e_a or $p - c - d_S$ and costly responsibility, which induce small $\tilde{e}_r$, large $\tilde{e}_h$, and a large marginal value and cost of hiding in (8)) do *not* hold. In the sufficient condition for backfiring (7), the threshold $\underline{e}_h$ is less than $1 - \min_{e_h \in [0,1]}\{K_h'(e_h)/K_h''(e_h)\}$, which implies that $\underline{e}_h$ is small when the hiding cost function exhibits little relative convexity.

Why should a buyer increase its auditing effort when that would backfire by causing the supplier to exert more hiding effort and less responsibility effort? Proposition 2 shows that that can be an optimal response to the increasing pressure from NGOs and other actors that expose and shame buying firms for the social and environmental harms caused by their suppliers. In equilibrium, as d_B increases so that the buyer is more motivated to eliminate an unsafe supplier, the buyer's optimal auditing level increases—even when that increase in auditing backfires.

Let (6′) and (7′) denote (6) and (7) evaluated at the equilibrium levels of responsibility, hiding, and auditing efforts.

Proposition 2. *The buyer's equilibrium auditing effort e_a^* increases with the buyer's expected damage from sourcing from an unsafe supplier d_B. The supplier's equilibrium responsibility effort e_r^* decreases with d_B if and only if* (6′).

A rich literature shows how a buyer can reduce the expected cost associated with the risk of disruption of a supplier's production process, notably by developing a backup alternative source (Tomlin 2006, Gurnani et al. 2012). That would be captured in our model by adding $+e_a(1 - e_h)(1 - e_r)m$ to the buyer's expected profit (1), where m represents the contribution the buyer receives by sourcing from the backup supplier in the event that the primary supplier fails the audit. As is evident from the first-order conditions (3)–(5), increasing m has directionally the same effect as increasing d_B on the equilibrium auditing, hiding, and responsibility efforts. Hence, under the backfiring condition (6′), having a backup alternative source might make the buyer worse off by causing the buyer to spend more on auditing and the primary supplier to become less responsible.

4. Results: Other Ways a Buyer Might Improve Supplier Responsibility

Historically, buyers have sought to improve supplier responsibility through increased auditing, but, as shown in §3, that may be counterproductive. Therefore, this section evaluates other actions a buyer might take to improve supplier responsibility.

4.1. Providing a Loan to the Supplier

Walmart, Gap, and other buyers are offering loans to Bangladeshi garment suppliers with the aim of enabling those suppliers to make their facilities safe (Wohl 2013). This motivates an extension to our model formulation in which the supplier has a budget constraint,

$$K_r(e_r) + K_h(e_h) \le B. \tag{10}$$

By providing a loan to the supplier, the buyer increases the supplier's budget B. If the budget constraint (10) is not binding in equilibrium, then a loan to the supplier has no effect on the supplier's equilibrium levels of responsibility and hiding effort. In this subsection, therefore, we focus on the interesting case where (10) is binding in equilibrium.

If the supplier's expected damage from operating an unsafe facility d_S is large, then the supplier has substantial incentive to exert responsibility effort. Consequently, increasing the supplier's budget naturally leads the supplier to increase her responsibility

effort e_r^*. Proposition 3 shows that if the supplier's expected damage d_S is small, the opposite can occur.

In reality, many suppliers have negligible expected damage d_S from operating an unsafe facility. Regulatory institutions are weak in the developing and emerging economies in which suppliers are concentrated (Economy 2007, Locke et al. 2007). For example, in Bangladesh, garment factory owners have paid little or no compensation to families of workers who died in the collapsed buildings and factory fires of 2012–2013 (Motlagh 2014). China has stringent environmental laws, but expected fines for violations are negligible because regulators lack resources, prioritize economic growth, and are corruptible (Economy 2007, Lee et al. 2009). NGOs target multinational buyers rather than their suppliers because the buyers are concerned about brand damage, whereas "few [suppliers] pay any attention to this sort of public pressure," according to the director of a prominent NGO (Lee et al. 2009, p. 18).

Proposition 3. *Suppose the supplier's expected damage from operating an unsafe facility $d_S = 0$: Increasing the supplier's budget B decreases the supplier's equilibrium responsibility effort e_r^* if and only if* (6′).

The intuition is that when the backfiring condition (6′) holds, the supplier is highly motivated to increase hiding effort to pass the audit. She uses the expanded budget to do so, which decreases her incentive for responsibility effort.

4.2. Precommitting to Auditing Effort

Auditing effort is noncontractible in our base model because, in reality, auditing is complex. To increase the likelihood of detecting an unsafe facility, a buyer could, for example, increase the skill, sophistication, and motivation of the auditor, or increase the level of scrutiny that the auditor applies in review of documents, interviews of workers and managers, or facility inspection. To contractually specify all relevant aspects of auditing effort and enforce the contract could be prohibitively difficult if not impossible.

Nevertheless, suppose that the buyer finds a way to commit to her auditing effort level in advance. She chooses auditing effort e_a to maximize expected profit (1) with the supplier's best response $\tilde{e}_i$ replacing e_i for $i \in \{r, h\}$. Let $(\hat{e}_a, \hat{e}_r, \hat{e}_h)$ denote the resulting equilibrium in auditing, responsibility and hiding efforts, and let (6″) denote inequality (6), where $\hat{e}_h$ replaces $\tilde{e}_h$. If the supplier were unable to hide, the ability to precommit would cause the buyer to do more auditing. Proposition 4 shows the opposite result.

Proposition 4. *If the buyer can commit to her auditing effort in advance and* (6″) *holds, then the buyer chooses a lower auditing effort,*

$$\hat{e}_a < e_a^*. \tag{11}$$

The intuition is that when (6″) holds, the supplier's hiding effort is sensitive to auditing, so auditing intensely backfires by increasing hiding and reducing responsibility. Consequently, by committing to a lower level of auditing, the buyer reduces hiding, which increases her expected profit. Note that (6″) may hold, meaning that auditing backfires by reducing the supplier's responsibility effort even at the equilibrium optimal precommitment auditing effort, because auditing enables the buyer to detect and avoid sourcing from an unsafe facility.

4.3. Squeezing the Supplier's Margin

A common view is that "squeezing" a supplier's margin causes the supplier to neglect safety and environmental responsibilities (Dudley 2012a, Goodman 2013). Therefore, as discussed above, NGOs are pressuring buyers to pay higher prices to suppliers. Furthermore, some academic literature suggests that buyers can improve supplier responsibility by helping suppliers to improve their production efficiencies (Locke et al. 2007, Locke and Romis 2010), which translates to reducing the supplier's production cost c in our model.

However, Proposition 5 shows that under the backfiring condition (6′), a buyer should reduce the price p and increase the supplier's production cost c. To increase a supplier's production cost in practice, the buyer could require the supplier to raise wages to achieve Fair Trade certification or could pressure government to raise the minimum wage, as prominent apparel buyers have done in Bangladesh (Al-Mahmood 2013, Cheng 2013).

Proposition 5. *If* (6′) *holds, then the supplier's equilibrium responsibility effort e_r^* and the buyer's expected profit $\pi_b|_{(e_a, e_r, e_h)=(e_a^*, e_r^*, e_h^*)}$ increase with the supplier's production cost c and decrease with the price p.*

The intuition for Proposition 5 parallels that for Proposition 1, because increasing the supplier's margin $p - c$ has the same effect on the supplier's incentives for responsibility and hiding effort as does increasing the buyer's auditing effort e_a, as is evident in (3) and (4).

Proposition 5 (and the propositions in §§4.4–4.6 and 4.8) implicitly assume that the supplier will not shut down in response to a marginal reduction in its expected profit. Jacobs and Singhal (2014) provide empirical evidence of the validity of that assumption by documenting that a large sample of Bangladeshi garment suppliers are highly profitable, more so than their buyers.

In most buying firms, as documented in §2, decisions regarding price and auditing are made separately. Harney (2008, p. 213) quotes an executive at a branded apparel firm saying, "The sourcing group

and the compliance group could almost be on different planets." The next result suggests that by coordinating the price and auditing decisions—namely, by accounting for how price affects the costs of auditing and sourcing from a potentially unsafe facility—a buying firm might resolve the problem that auditing backfires by reducing responsibility. The corollary follows from the result of Proposition 5 that if the backfiring condition (6′) holds, then the buyer increases her expected profit by reducing the price p.

Corollary. *If the price p maximizes the buyer's expected profit $\pi_b|_{(e_a, e_r, e_h)=(e_a^*(p), e_r^*(p), e_h^*(p))}$, then (6′) does not hold.*

A caveat is that a supplier may command a higher price than would maximize the buyer's expected profit. Another caveat is that the buyer may pay the supplier a high price p to motivate investments in quality, capacity, or relationship-specific assets that are not represented in the profit function π_b defined in (1).

4.4. Engaging Governments or Other Buyers to Penalize the Supplier for Harm

To increase a supplier's expected damage from operating an unsafe facility d_S, buyers could pressure governments to increase the penalty for a supplier that harms workers or the environment. For example, Disney ceased to source garments from Bangladesh because of safety concerns, then reinstated Bangladesh after successful negotiations with the government. In 2015, for the first time in the history of Bangladesh, a garment factory owner will undergo trial for criminal negligence leading to the death of workers (Motlagh 2014). Alternatively, buyers might negotiate an industry accord to ensure that no buyer sources from a supplier following a major harm to workers or the environment. Proposition 6 confirms that increasing d_S makes the supplier more responsible.

Proposition 6. *The supplier's equilibrium responsibility effort e_r^* and buyer's expected profit $\pi_b|_{(e_a, e_r, e_h)=(e_a^*, e_r^*, e_h^*)}$ increase with the supplier's expected damage from operating an unsafe facility d_S.*

4.5. Contracting to Penalize the Supplier for Harm to Workers or the Environment

The literature surveyed in §1 proposes mechanisms by which a buyer can extract a limited payment from a supplier that delivers a defective product. Suppose the buyer adapts one of those mechanisms to penalize a supplier for harm to workers or the environment. Let y denote the expected value of that penalty for a supplier operating an unsafe facility. In the buyer's expected profit (1), $(d_B - y)$ replaces d_B; in the supplier's expected profit (2), $(d_S + y)$ replaces d_S. For example, the buyer might delay payment for a contractually specified period of time after the supplier produces and withhold payment upon obtaining evidence of a major harm to workers or the environment. In that scenario, y reflects the probability that a supplier operating an unsafe facility will cause major harm to workers or the environment, the probability that the buyer will obtain evidence of that harm within the specified time period, and the magnitude of the withheld payment. The expected penalty y that the buyer can practically impose will be small in that the magnitude of the payment the buyer can withhold is small relative to the damage the buyer incurs from its supplier's major harm to workers or the environment.

In contrast to Proposition 6—although the contractual penalty y has the same effect on the supplier's expected profit (2) as increasing d_S, as well as the additional benefit of directly increasing the buyer's expected profit—instituting the contractual penalty y can *decrease* the supplier's responsibility effort and the buyer's expected profit.

Proposition 7. *As the expected penalty the supplier pays the buyer when operating an unsafe facility y increases, the supplier's equilibrium responsibility effort e_r^* decreases if and only if*

$$\begin{aligned} &K_a''(e_a^*)K_h''(e_h^*) - [(1-e_h^*)K_h''(e_h^*) - K_h'(e_h^*)] \\ &\quad \cdot [e_a^* K_a''(e_a^*) + K_a'(e_a^*)(p-c-d_S-y)/(d_B-v+p)] \\ &\quad + (1-e_r^*)^2(p-c-d_S-y)(d_B-v+p) < 0. \end{aligned} \tag{12}$$

For some parameters, instituting a penalty $y > 0$ decreases the buyer's equilibrium expected profit,

$$\pi_b|_{(e_a, e_r, e_h)=(e_a^*, e_r^*, e_h^*),\, y>0} < \pi_b|_{(e_a, e_r, e_h)=(e_a^*, e_r^*, e_h^*),\, y=0},$$

and increases the supplier's equilibrium expected profit,

$$\pi_s|_{(e_a, e_r, e_h)=(e_a^*, e_r^*, e_h^*),\, y>0} > \pi_s|_{(e_a, e_r, e_h)=(e_a^*, e_r^*, e_h^*),\, y=0}.$$

To develop intuition for (12), consider a no-hiding scenario in which $(\grave{e}_a, \grave{e}_r)$ denotes the equilibrium in auditing and responsibility efforts, the solution to (3) and (5) with $e_h = 0$, $(d_S + y)$ replacing d_S and $(d_B - y)$ replacing d_B. In that scenario, condition (12) simplifies to

$$\frac{K_a'(\grave{e}_a)}{K_a''(\grave{e}_a)} > \frac{(1-\grave{e}_a)(d_B - v + p)}{p - c - d_S - y}. \tag{13}$$

As y increases, the buyer's equilibrium auditing effort $\grave{e}_a$ decreases, because the buyer has greater expected profit when sourcing from an unsafe supplier. The decrease in auditing effort is large when (13) holds, which causes the supplier to exert less responsibility effort $\grave{e}_r$, despite the increase in the expected penalty from operating an unsafe facility.

Condition (13) resembles (6′). Auditing effort is sensitive to a change in y when the marginal cost of auditing effort is high, the cost of auditing effort is not too convex, and the auditing effort is low, for qualitatively the same reasons, presented after Proposition 1, that the supplier's hiding effort is sensitive to a parameter change when (6′) holds. In general, with hiding, (12) holds—meaning that increasing y reduces the supplier's equilibrium responsibility effort e_r^*—when the buyer's auditing effort is sensitive and the supplier's hiding effort is insensitive to a parameter change. If the backfiring condition (6′) holds, then condition (12) is violated, because the supplier responds to the reduced auditing that accompanies an increase in y by reducing hiding and increasing responsibility effort.

Contracting for the supplier to pay a penalty to the buyer in the event that the supplier causes a major harm to workers or the environment can reduce the buyer's expected profit and increase the supplier's expected profit in equilibrium by reducing the buyer's auditing effort and the supplier's responsibility effort. The proof of Proposition 7 provides a numerical example.

4.6. Penalizing the Supplier for Hiding

Buyers are beginning to partner with NGOs that oversee the buyers' audits (Ma 2012). NGO oversight might enable the buyer to make a credible commitment to terminate the supplier in the event that the buyer obtains evidence of hiding effort by the supplier. One might conjecture that the buyer should make that commitment and take complementary actions to increase the probability of detecting hiding effort by the supplier. To the contrary, Proposition 8 shows that doing so can decrease the supplier's responsibility effort and the buyer's expected profit.

Proposition 8. *Suppose that with probability θe_h, where $\theta \in [0,1]$, the buyer detects hiding effort and does not source from the supplier. As θ increases, the supplier's equilibrium responsibility effort e_r^* decreases if and only if*

$$[e_a^* K_a''(e_a^*) + K_a'(e_a^*)](p-c)(p-c-d_S) - d_S\{K_a''(e_a^*)[e_h^* K_h''(e_h^*) + K_h'(e_h^*)] + (1-e_r^*)^2(d_B - v + p)(p-c-d_S)\} < 0. \quad (14)$$

For some parameters, instituting the penalty of termination for detected hiding $\theta > 0$ decreases the buyer's equilibrium expected profit,

$$\pi_b|_{(e_a,e_r,e_h)=(e_a^*,e_r^*,e_h^*),\,\theta>0} < \pi_b|_{(e_a,e_r,e_h)=(e_a^*,e_r^*,e_h^*),\,\theta=0}.$$

Increasing the supplier's expected damage from operating an unsafe facility d_S, as recommended in §4.4, tends to cause (14) to hold. The supplier is motivated to exert responsibility effort to avoid those damages in the event that she wins the buyer's business. Increasing θ, and hence the likelihood that the buyer will detect hiding effort and terminate the supplier, reduces that motivation for responsibility effort. Conversely, if $d_S = 0$, then (14) is violated.

Commitment to terminate the supplier for detected hiding effort can reduce the buyer's expected profit through two mechanisms: reduced supplier responsibility effort and failure to source from a supplier that is safe. The proof of Proposition 8 provides a numerical example.

In contrast to Propositions 7 and 8, Proposition 9 shows that instituting a financial penalty for detected hiding effort increases the supplier's responsibility effort and the buyer's expected profit.

Proposition 9. *Suppose that with probability θe_h, where $\theta \in [0,1]$, the buyer detects hiding and the supplier pays a penalty $z \geq 0$ to the buyer. Increasing θ or z increases the supplier's equilibrium responsibility effort e_r^* and the buyer's expected profit $\pi_b|_{(e_a,e_r,e_h)=(e_a^*,e_r^*,e_h^*)}$.*

Intuitively, instituting a financial penalty for detected hiding effort discourages hiding, which increases the marginal value of responsibility effort. The buyer benefits from the supplier's reduced hiding effort and increased responsibility effort, as well as from the direct financial payment.

Implementing a penalty for detected hiding will be challenging and will require that θ and z be sufficiently small. The evidence of hiding must be verifiable, which will tend to make θ small. In the event that the buyer detects hiding and the supplier passes the audit, the buyer could deduct the penalty (pay the supplier $p - z$ instead of p), but forcing the supplier to pay z in the event of a failed audit could be impossible for the reasons explained in Babich and Tang (2012). Imposing the financial penalty for detected hiding only in the event that the supplier passes the audit can reduce the supplier's responsibility effort and the buyer's profit, similar to Proposition 8. Conceivably, the buyer could require the supplier to pay z in advance (in the hope of future business) and could commit to refund z unless hiding is detected. That commitment could be enforced by the buyer's reputational concerns, if z is sufficiently small. Suppliers are often cash constrained, which would limit the magnitude of z in the up-front payment.

4.7. Publicizing Negative Audit Reports

Suppose that, in the event of a failed audit, the supplier sells to an alternative buyer at expected price $\underline{p} \in [c + d_S, p]$; the supplier operates—and incurs expected damage d_S if the facility is unsafe—regardless of

whether she passes the audit. Hence, the supplier's expected profit becomes

$$\pi_s = [1-e_a(1-e_r)(1-e_h)](p-c) - e_a(1-e_r)(1-e_h) \cdot (\underline{p}-c) - (1-e_r)d_S - K_r(e_r) - K_h(e_h). \quad (15)$$

The buyer can reduce $\underline{p}$ by publishing, in the event of the failed audit, the evidence that the supplier is unsafe. In reality, NGOs are pressuring buyers to publish their negative audit reports (Walsh and Greenhouse 2012); Apple, Walmart, and signatories to the Accord on Fire and Building Safety in Bangladesh have committed to do so (Duhigg and Wingfield 2012, Accord on Fire and Building Safety in Bangladesh 2013, Wohl 2013). However, Proposition 10 suggests that this might reduce the buyer's expected profit.

Proposition 10. *Suppose that the supplier sells to an alternative buyer following a failed audit. If (6′) holds, then the supplier's equilibrium responsibility effort e_r^* and the buyer's expected profit $\pi_b|_{(e_a, e_r, e_h)=(e_a^*, e_r^*, e_h^*)}$ increase in the expected price paid by the alternative buyer $\underline{p}$.*

The intuition is that under the backfiring condition (6′), increasing the penalty for a failed audit (reducing $\underline{p}$) leads to greater hiding and hence lower responsibility effort.

Similarly, reporting safety and environmental violations to government authorities following a failed audit reduces the supplier's responsibility effort and the buyer's expected profit, if the backfiring condition (6′) holds and the supplier faces a government-imposed penalty for such violations.

4.8. Making Hiding More Difficult

A buyer could engage an NGO to monitor the audit; a supplier has greater difficulty deceiving or bribing an auditor while an NGO monitor is present (Ma 2012). A buyer could commit to finding a new job or paying severance for any worker in a supplier's facility that loses a job because of a failed audit, as do signatories to the Accord on Fire and Building Safety in Bangladesh (Accord on Fire and Building Safety in Bangladesh 2013). That would eliminate the strong incentive for workers to hide problematic practices during the audit (Esbenshade 2004, Egels-Zandén 2007) and thus make it more difficult for the supplier to train workers to do so.

However, Proposition 11 shows that making hiding more difficult can reduce the supplier's responsibility effort. Empirical literature on the relationship between time in training and job performance (see Liu and Batt 2007 and references therein) suggests that the cost to train employees to deceive an auditor is well represented by a convex power function $\alpha e_h^{-\gamma}$, with $\gamma < -1$, $\alpha > 0$, and e_h the success probability. One may interpret γ as the difficulty of hiding because $\alpha e_h^{-\gamma}$ increases with γ.

Proposition 11. *Suppose that the supplier's hiding cost function is of the form $K_h(e_h) = \alpha e_h^{-\gamma}$. The supplier's equilibrium responsibility effort e_r^* and the buyer's expected profit $\pi_b|_{(e_a, e_r, e_h)=(e_a^*, e_r^*, e_h^*)}$ decrease in the supplier's difficulty of hiding γ if and only if*

$$e_h^* > \exp(1/\gamma). \quad (16)$$

The rationale is that increasing γ simultaneously increases the hiding cost $K_h(e_h)$ for all $e_h \in (0, 1)$ and reduces the marginal cost $K_h'(e_h)$ for $e_h > \exp(1/\gamma)$, which causes the supplier to exert more hiding effort and less responsibility effort when (16) holds. Therefore, buyers should proceed cautiously with actions aimed at making hiding more difficult and costly for suppliers and should focus on increasing the effective marginal cost of hiding.

Whereas this section evaluates various actions for the buyer individually, a buyer might, in practice, implement several of those actions simultaneously. However, most of the actions that increase the supplier's responsibility effort also decrease the supplier's expected profit. To avoid causing the supplier to shut down, a buyer may be constrained to adopt only a subset of those actions or only to a limited extent (e.g., imposing only small penalties for detected hiding and for causing harm).

5. Unauthorized Subcontracting

In Bangladesh, apparel buyers H&M, Carrefour, and Next invested to make their suppliers' factories safe and subsequently suffered brand damage from publicity of deadly fires in unauthorized subcontractors' facilities (Strauss et al. 2013). This motivates the following alternative interpretation of our model.

Suppose that the supplier has a safe facility. Let e_r denote the fraction of the buyer's order that the supplier plans to produce in-house, and let $1 - e_r$ be the fraction for which it subcontracts, paying $K_s(1 - e_r)$ to the unauthorized subcontractors. Correspondingly, the supplier plans to use its own limited capacity to produce $1 - e_r$ for other buyers during the time period in which the supplier is supposed to dedicate its capacity to production for the buyer. During that time period, the buyer audits the supplier for unauthorized subcontracting at random times with a frequency proportional to e_a. At each time that the auditor arrives, the likelihood that the supplier is cheating by producing for a different buyer is $1 - e_r$. The auditor can detect unauthorized subcontracting by seeing that the supplier is cheating by producing for a different buyer. However, the supplier attempts to hide that from the auditor: e_h is the likelihood of successfully doing do. Therefore, the probability that the buyer's auditing detects unauthorized subcontracting is $e_a(1-e_h)(1-e_r)$. We assume that the

buyer takes delivery and pays the supplier if and only if it does not detect unauthorized subcontracting. In the event that the buyer detects unauthorized subcontracting and so refuses to take delivery from the supplier, the supplier sells the units that it subcontracted or produced for the buyer at some lower price $\underline{p} < p$. Moreover, after failing an audit, the supplier uses any residual capacity that it had allocated for the buyer to produce units that sell at that same lower price $\underline{p}$. By contrast, through advance commitments, the supplier earns an expected profit of $R(1-e_r)-(1-e_r)c$ on the quantity $1-e_r$ that it plans to produce for other buyers, where $R(\cdot)$ is increasing and satisfies $R(1-e_r) \geq (1-e_r)\underline{p}$. Hence, the supplier's objective function is

$$\begin{aligned}\pi_s &= [1-e_a(1-e_h)(1-e_r)]p+e_a(1-e_h)(1-e_r)\underline{p}-e_rc\\ &\quad -K_s(1-e_r)+R(1-e_r)-(1-e_r)c-K_h(e_h)\\ &= p-c-e_a(1-e_h)(1-e_r)(p-\underline{p})\\ &\quad -K_r(e_r)-K_h(e_h), \end{aligned} \tag{17}$$

where $K_r(e_r) \equiv K_s(1-e_r)-R(1-e_r)$ is increasing in e_r.

To understand the buyer's objective, observe that the expected quantity that the buyer purchases (indirectly) from unauthorized suppliers is $(1-e_r)[1-e_a(1-e_h)(1-e_r)]$. We assume that the buyer's expected damage increases, linearly, with the quantity that it purchases (indirectly) from unauthorized subcontractors, for two reasons. The first is that if a buyer purchases a larger quantity from an unauthorized supplier, it is more likely to be discovered to be linked to that supplier in the event of a major publicized violation by that supplier, e.g., because an item labeled for the buyer is on-site at the time of a fire or building collapse, remains intact, and is found by activists afterwards (Motlagh 2014). The second reason is that unauthorized subcontractors tend to be very small, with much less capacity than the direct supplier, so that as the aggregate quantity from unauthorized subcontractors increases, the direct supplier engages a larger number of unauthorized subcontractors on behalf of the buyer (Lahiri and Passariello 2013), which increases the expected number that will have a major publicized harm to workers or the environment linked to the buyer. Therefore, the buyer's objective function is

$$\begin{aligned}\pi_b &= [1-e_a(1-e_h)(1-e_r)](v-p)\\ &\quad -(1-e_r)[1-e_a(1-e_h)(1-e_r)]d_B-K_a(e_a); \end{aligned} \tag{18}$$

this is the same as (1), except for the substitution of $[1-e_a(1-e_h)(1-e_r)]$ for $[1-e_a(1-e_h)]$ in (1).

Proposition 12 shows that both of the propositions in §3 and most of the relevant propositions in §4 hold in this setting with unauthorized subcontracting. Propositions 6 and 7 are not relevant in this setting because the supplier's facility is safe. The proofs of Propositions 5, 10, and 11 employ the plausible assumption that at the equilibrium effort levels, the buyer's expected profit is increasing in the supplier's responsibility effort.

Proposition 12. *Propositions 1–3 and 9 hold as stated. Propositions 5, 10, and 11 hold under the assumption that the buyer's equilibrium expected profit increases in the supplier's responsibility effort,* $\partial\pi_b/\partial e_r|_{(e_a,e_r,e_h)=(e_a^*,e_r^*,e_h^*)} > 0$.

Some anecdotal evidence from the Bangladesh apparel industry suggests that the backfiring condition (6′) is prevalent or increasingly so. Because

$$K_h'(e_h^*) = e_a^*(1-e_r^*)(p-\underline{p}),$$

(6′) tends to hold when the auditing effort e_a^* is large, the volume of unauthorized subcontracting $1-e_r^*$ is large, and the price p paid by the buyer is large relative to the supplier's salvage value $\underline{p}$. In response to publicized deadly fires in unauthorized subcontractors' facilities, buyers are increasing their auditing efforts e_a^* (Biraj 2013). Unauthorized subcontracting is "pervasive" (Lahiri and Passariello 2013); in a "typical example," a supplier accepts orders for 10 times the volume it can produce and subcontracts the rest (Labowitz and Baumann-Pauly 2014). This suggests that $1-e_r^*$ is large for many suppliers. The Bangladeshi government and banks give financial rewards for increased export sales to suppliers that directly export goods to multinational buyers (Labowitz and Baumann-Pauly 2014). In effect, that increases both p and $R'(1-e_r)$. Moreover, a buyer's investment to make a supplier's facility safe makes the supplier more desirable to other "free-riding" buyers (Greenhouse 2013), which further increases $R'(1-e_r)$. Increasing $R'(1-e_r)$ increases the volume of unauthorized subcontracting $1-e_r^*$. Hiding unauthorized subcontracting is straightforward, in that a supplier can pay subcontractors in cash based on verbal agreements, falsify records of production and shipments, display inventory made by the subcontractor as its own production, and train employees to appear to be producing for one buyer while cheating by serving another (Clifford and Greenhouse 2013, Lahiri 2013, Labowitz and Baumann-Pauly 2014), which suggests that e_h^* is large, the sufficient condition for backfiring (7′).

Under the backfiring condition (6′), Proposition 12 shows that to mitigate unauthorized subcontracting, a buyer should squeeze the supplier's margin $p-c$ and impose a financial penalty for evidence of effort to hide subcontracting. The buyer should *not* increase auditing effort to detect unauthorized subcontracting, publicize failed audits for unauthorized subcontracting, or provide loans to suppliers.

Table 1 Buyer Actions That Increase or Decrease Supplier Responsibility Effort

Increase responsibility effort		Decrease responsibility effort	
Under backfiring condition	Always	Sometimes	Under backfiring condition
• Decrease auditing • Increase supplier's wages for workers (by pressuring government) • Decrease price	• Penalize supplier for harm: Government fine • Penalize supplier for hiding effort: Payment to buyer	• Penalize supplier for harm: Payment to buyer • Penalize supplier for hiding effort: Terminate sourcing • Make hiding more difficult for supplier	• Increase auditing • Reduce supplier's production cost (by providing technical assistance to supplier) • Increase price • Lend to supplier • Publicize failed audit

6. Concluding Remarks

This paper is the first in the supply chain management literature to model a supplier's effort to hide information during a buyer's audit. Nike executives inspired the research by expressing concern that increased auditing and financial incentives for responsibility caused suppliers to hide information rather than become more responsible.

The paper shows that, consistent with the Nike executives' concern, a variety of well-intentioned buyer actions (listed in the right half of Table 1) can decrease the supplier's responsibility effort. The actions in the rightmost column of Table 1 decrease the supplier's responsibility effort under the "backfiring condition." Under that condition, the actions that a buyer should take to increase the supplier's responsibility effort (listed in the leftmost column of Table 1) are contrary to the usual prescription. The buyer should commit to do less auditing or should squeeze the supplier's margin, either by paying a lower price or by pressuring the government to increase wages for workers in the supplier's facility.

Plausible penalties for hiding or harm can be counterproductive; see the center-right column of Table 1. By contrast, the penalties in the center-left column are more difficult for a buyer to implement (requiring influence over the government or a mechanism to extract money from a supplier even after a failed audit and termination of sourcing) but reliably increase supplier responsibility effort.

Our analysis also provides guidance for NGOs wanting to encourage suppliers' efforts to prevent harm to workers and the environment. Under the backfiring condition, increasing NGO pressures on buyers (to pay higher prices, to publish negative audit reports, shaming buyers for harm caused by suppliers and subcontractors) reduces suppliers' efforts to prevent harm. NGOs should directly penalize the owners and managers of factories that harm workers or the environment, e.g., by publishing their names in local newspapers and online, to shame them in their communities.

The paper has provided anecdotal evidence that the backfiring condition is prevalent or increasingly so, but empirical tests are needed. One approach would take advantage of any external event that motivates a buyer to increase auditing efforts across all suppliers. A contemporaneous increase in the frequency of audit failure and incidence of harm to workers or the environment, following an increase in supplier auditing, would indicate that the backfiring condition holds for some suppliers; the proof is provided in the online supplement. A second empirical approach would be to survey factory managers about the efficacy of hiding unsafe conditions. As explained in Jayaraman and de Véricourt (2013), one cannot ask a respondent to self-incriminate but must instead enable respondents to implicate others. For example, one might ask, how likely are your competitors to pass audits through deceptive or corrupt practices? A high incidence of "very likely" responses would suggest that the backfiring condition holds.

Supplemental Material

Supplemental material to this paper is available at http://dx.doi.org/10.1287/msom.2015.0550.

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Appendix

Conditions for the Existence of a Unique Equilibrium. The following conditions ensure the existence of a unique equilibrium and that the equilibrium efforts are interior $e_i^* \in (0,1)$ for $i \in \{a, r, h\}$:

$$(v-c)^2[1+d_B/K_a''(e_a)] < K_r''(e_r)K_h''(e_h), \tag{19}$$

$K_i'(0)=0$ for $i \in \{a,r,h\}$, $K_j'(1) \geq v-c$ for $j \in \{r,h\}$, $K_a'(1) \geq d_B$, $d_S < p-c$, $\pi_b|_{(e_a,e_r,e_h)=(e_a^*,e_r^*,e_h^*)} \geq 0$ and $\pi_s|_{(e_a,e_r,e_h)=(e_a^*,e_r^*,e_h^*)} \geq 0$.

Inequality (19) holds if the total supply chain margin is sufficiently small or if the costs of auditing, hiding, and responsibility efforts are sufficiently convex.

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