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Responsible Sourcing in Supply Chains

Ruixue Guo, Hau L. Lee, Robert Swinney

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Ruixue Guo

Management Science & Engineering, School of Engineering, Stanford University, Stanford, California 94305, rguo@stanford.edu

Hau L. Lee

Graduate School of Business, Stanford University, Stanford, California 94305, haulee@stanford.edu

Robert Swinney

Fuqua School of Business, Duke University, Durham, North Carolina 27708, robert.swinney@duke.edu

We analyze the sourcing decision of a buyer choosing between two supplier types: responsible suppliers are costly but adhere to strict social and environmental responsibility standards, whereas risky suppliers are less expensive but may experience responsibility violations. A segment of the consumer population, called socially conscious, is willing to pay a higher price for a product sourced from a responsible supplier and may not purchase in the event of a responsibility violation from a risky supplier. We identify four possible sourcing strategies that a buyer might employ: low cost sourcing (sourcing from the risky supplier), dual sourcing, responsible niche sourcing (sourcing from a responsible supplier and selling only to socially conscious consumers), and responsible mass market sourcing (sourcing responsibly and selling to all consumers). We determine when each strategy is optimal and show that efforts to improve supply chain responsibility that focus on consumers (by increasing their willingness to pay for responsibility or increasing the number of consumers that are socially conscious) or increasing supply chain transparency may lead to unintended consequences, such as an increase in risky sourcing. Efforts that focus on enforcement and penalizing the buyer, however, never backfire and always lead to more responsible sourcing and less risky sourcing.

1. Introduction

Controlling the social and environmental responsibility of extended supply chains has become one of the most challenging issues in modern management. Recent history is replete with examples of unethical, incompetent, and even criminal behavior from suppliers, with serious implications that ripple through supply chains and potentially affect dozens of firms. Athletic apparel company Nike experienced intense media scrutiny and public backlash following revelations of low wages, excessive working hours, and child labor employed by suppliers in the 1990s (Nisen 2013). Toy company Mattel discovered damaging product safety and environmental violations by suppliers in the early 2000s (Roosevelt 2011). In 2010, a series of high-profile worker suicides at Taiwanese electronics contract manufacturer Foxconn drew an enormous amount of attention to poor working conditions at the firm's vast manufacturing facilities in mainland China (Barboza 2010a), embroiling prominent customers such as Apple, Dell, Hewlett-Packard, and Sony in a scandal that lasted several years (Barboza 2010b, Duhigg and Wingfield 2012). Most tragically, in 2013, the eight-story Rana Plaza building in Dhaka, Bangladesh, collapsed suddenly, killing 1,129 people

and injuring more than 2,500 others. The building primarily housed garment factories producing goods for high-profile Western apparel brands such as Benetton, El Corte Inglés, Primark, and Walmart. The accident—caused by substandard construction and compounded by inadequate safety protocols at the factories housed within—proved to be the deadliest in the history of the garment industry, and in the aftermath of the disaster, media attention focused on a long record of unsafe working environments in the Bangladeshi garment industry and on the firms that knowingly sourced products from companies that maintained such poor conditions (Al-Mahmood et al. 2013).

In many cases, the suppliers at the center of these events were known in advance to have a poor record of responsibility; for example, in a *Wall Street Journal* article published six months before the Rana Plaza incident (Bustillo 2012), Nike's vice president of sustainable business explicitly mentioned the risk of sourcing from Bangladeshi garment factories and described how the company was seeking to minimize its exposure to such suppliers. Yet, as the examples show, many firms choose to source from risky suppliers despite these warning signs; when these suppliers commit negligent or criminal actions, which we refer

to as social and environmental *responsibility violations*, significant consequences result both for the buying firm and for society.

Although the most egregious responsibility violations may result in the incalculable cost of the loss of human life, even less disastrous violations can be enormously costly to firms in the supply chain. For example, the customers of electronics manufacturer Foxconn were forced to respond to reports of poor working conditions by bringing in a third-party labor auditor and investing to improve wages and working conditions at the supplier's factories. In addition, the negative press surrounding some violations can lead consumers to switch to competitors or to boycott a firm's products. Because of these potential costs, companies have focused increasing attention on managing responsibility in the supply chain. There are many aspects of this problem that are of clear importance in practice, including which suppliers to source from, how to contract with and compensate them, how to work with them to improve social responsibility, how to monitor them to ensure compliance with social and environmental standards, and how to punish them in the event of a violation. In this paper, we focus on the first of these issues: how firms choose suppliers when they potentially cause damaging responsibility violations.

Given the serious negative repercussions of a supplier responsibility violation, a crucial point to understand is precisely why firms choose suppliers at risk of a violation in the first place. The obvious answer is because they are frequently cheaper than other suppliers, i.e., those that are less likely to have violations. This may be directly because of their lack of responsibility; clearly, if a supplier underpays its workforce or fails to follow environmental protocol such as properly disposing of industrial waste, it faces lower costs and therefore may charge downstream firms less, undercutting more responsible suppliers. Consequently, suppliers that are less expensive are, very often, precisely the suppliers that are more likely to experience a responsibility violation. Thus, as with any dimension of sourcing, there is a trade-off: firms may choose an expensive supplier that is highly likely to be responsible or they may select a cheaper supplier that risks a potentially damaging responsibility violation (Bustillo 2012, Banjo 2014).

We consider this trade-off as we seek to understand the drivers of responsible sourcing in supply chains. We analyze a stylized model of supplier selection in which a firm (the buyer) sources a product from upstream suppliers. Before production begins, the buyer chooses one or more suppliers from between two types: responsible and risky suppliers. There is zero probability that a violation occurs with a responsible supplier because, e.g., the supplier follows all social

and environmental protocol, is frequently monitored, or is located in a country with strict labor and environmental laws; these suppliers, however, are expensive. Risky suppliers are cheaper but may experience a responsibility violation. We study the buyer's sourcing decision in this setting, focusing on three key features of the responsible sourcing problem observed in practice:

1. *Responsibility violations by suppliers may increase costs.* Increased costs may come from additional monitoring efforts, wage increases, expanding the workforce to reduce overtime, repairing environmental damage, product recalls, or investing to improve facilities. For example, Foxconn ultimately raised employee pay by 30%, an increase partly funded by Foxconn's customers (Maisto 2010), and Mattel incurred approximately $110 million in recall and marketing costs as a result of a controversy concerning the lead content in its products (Lefevre et al. 2010). A recent industry analysis of a small sample of such incidents (Lefevre et al. 2010) estimates that major responsibility violations lead to direct costs equal to, on average, 0.7% of firm revenue.

2. *Responsibility violations by suppliers may decrease revenue.* Decreased revenue may come from brand and reputation damage resulting from customers abandoning the firm or from regulatory actions to ban the trade of affected goods. In the apparel industry, organized boycotts by universities affiliated with the Worker's Rights Consortium in 2000 threatened up to 20% of the revenue of Gear for Sports, an athletic apparel provider, and up to 1% of the revenue of Nike, following the revelation of labor violations by suppliers (Doorey 2011); in 2006, Palm was forced to withdraw the Treo 650 from the European market because suppliers failed to meet hazardous substance directives (Lefevre et al. 2010), resulting in extensive loss of revenue and a 14% decrease in stock value. We label this effect a "willingness to punish" by consumers for responsibility violations.

3. *Consumers may be willing to pay for responsibility.* Some segment of the consumer population, which we refer to as socially conscious, may be willing to pay a premium for a product sourced from a socially responsible supplier. For example, 10% of consumers are willing to pay a small premium for fair-trade coffee (De Pelsmacker et al. 2005), which ensures some minimum level of responsibility has been met (e.g., no child labor was used to produce the coffee). This allows the buying firm to link its sourcing strategy with its selling strategy: sourcing from a responsible supplier not only reduces risk but may also allow the firm to extract additional profit from some segment of the population. We label this a "willingness to pay" by consumers for responsibility.

The buyer in our model chooses one or more suppliers to maximize its profit, given the features described above. Within this context, we seek to answer three key questions. First, what sourcing strategies are possible, and when are they optimal? Second, what role does each of the three factors described above—the cost of violations, a willingness to punish for violations, and a willingness to pay for responsibility—play in the buyer's optimal sourcing strategy, and what actions by regulators, consumers, and nongovernmental organizations (NGOs) are most effective in increasing the incidence of responsible sourcing? And third, how does supply chain transparency—whether consumers can credibly observe the firm's sourcing decisions—impact the firm's choice of sourcing strategy and the overall level of social responsibility in the supply chain?

2. Related Literature

Our model lies at the intersection of three streams of literature: the supply chain sourcing literature, the literature on market segmentation and quality, and the literature on social and environmental responsibility in supply chains. We discuss each of these below.

2.1. Supply Chain Sourcing Literature

We study the optimal sourcing strategy of a firm choosing between suppliers with different capabilities: a costly supplier that minimizes risk and a cheaper supplier that results in greater risk. As a result, our work is related to the extensive literature on sourcing in supply chains and, in particular, to the supply disruption literature, which considers optimal sourcing and supply chain strategies when suppliers face the risk of catastrophic disruptions caused by random events such as earthquakes and floods. In the seminal paper on the topic, Tomlin (2006) provides a detailed description of the supply chain disruption problem and introduces a variety of strategies for the mitigation of supply risk. Recent books by Kouvelis et al. (2011) and Gurnani et al. (2012) provide extensive overviews of this topic.

There are two key differences between the supply disruption literature and our model. First, with responsibility violations, disruption occurs on the demand side rather than the supply side. This implies that the strategies a firm might use to mitigate the impact of a disruption change significantly—for example, holding safety stocks and using emergency sources of back-up supply, both valuable strategies when facing supply disruptions (Tomlin 2006), have no value when disruption occurs on the demand side. Consequently, many disruption management strategies designed to buffer against supply shortages will not work when a firm faces demand disruptions caused by supplier responsibility violations.

The second key difference between supply disruptions and responsibility violations is that, with the latter, consumers might be willing to pay a premium for products sourced in a responsible manner; by contrast, consumers would never pay a premium for a product sourced from a supplier that faces lower supply disruption risk from earthquakes or floods. Hence, the supplier responsibility problem allows the firm to link its sourcing strategy with its selling and marketing strategy, adding a new facet to the sourcing problem. As a result, new sourcing and selling strategies (which we describe below) emerge when a firm faces a responsibility problem that are not possible when facing supply disruption risk.

2.2. Quality and Market Segmentation Literature

In our model, some segment of the customer population values responsibility and might pay a premium for it. As a result, the firm must choose whether to source some or all of its product from a responsible supplier and what price to charge customers. This is reminiscent of the marketing literature on heterogeneous quality preferences, market segmentation, and product line design; see, for example, Moorthy (1984), Moorthy and Png (1992), and Desai (2001). Unlike the work in this area of the literature, "quality" (responsibility) in our model is intertwined with risk resulting from random responsibility violations, and as a result, the firm's segmentation strategy must be linked to its sourcing strategy in a way that accounts for multiple factors impacting profit.

2.3. Social and Environmental Responsibility in Supply Chains

There is a growing literature on responsibility issues in supply chains in general and responsible sourcing decisions in particular. The vast majority of the work in this area focuses on ways to induce incumbent suppliers to behave responsibly, such as contracts, monitoring or inspection policies, or regulation. Cho et al. (2015), for example, analyze mechanisms to combat the use of child labor by suppliers. Kraft et al (2013) discuss how NGOs can influence firms to eliminate hazardous substances from their products. Kraft and Raz (2013) examine how regulation impacts manufacturer incentives to eliminate toxic substances in competitive markets. Galbreth and Ghosh (2013) discuss how consumer awareness can influence firms competing on sustainability. Chen and Lee (2015) analyze innovative contracts that induce suppliers to behave responsibly. Kim (2015) considers optimal inspection policies to induce self-reporting of environmental violations. Plambeck and Taylor (2014) investigate various mechanisms to induce responsibility from suppliers. Huang et al. (2014) consider the management of responsibility risk in multitier supply

chains. Belavina and Girotra (2014) examine the role of long-term relationships in fostering supply chain responsibility. None of these papers considers the supplier selection issue or the impact of consumer behavior on a firm's incentives to source responsibly, which is the focus of our paper. Aral et al. (2014) do study supplier selection, analyzing optimal procurement auctions when the level of responsibility of the supplier base is unknown. Unlike in Aral et al., the level of responsibility of each supplier is perfectly known in our model, and moreover, they do not consider the impact of consumer behavior on the adoption of responsible sourcing as we do.

3. Model

A single downstream firm (the "buyer") sells a product to a market of fixed total size normalized to 1. The buyer sources the product from one or more suppliers, and before the selling season begins, the buyer must select those suppliers. We use the terms "buyer" and "supplier" generically to evoke the flow of material in the supply chain—the buyer in our model may, for instance, be a manufacturer sourcing a component from a supplier that will later be assembled by the buyer into a finished good or a brand such as Nike with no manufacturing capability of its own sourcing a complete product from the supplier.

In practice, firms have access to a diverse set of suppliers, each with different cost and responsibility characteristics. To focus our analysis, we assume that available suppliers are exogenously fixed to two extreme types: a supplier with zero probability of a responsibility violation (the responsible supplier, denoted R) and a supplier with a nonzero probability of a violation (the risky supplier, denoted NR for "not responsible"). The responsible supplier is assumed to verifiably follow responsible production practices. This high degree of compliance may occur, for instance, because the supplier is located in a country with strictly enforced labor and environmental regulations, or because the supplier has tight internal controls and opens its doors to public audits from NGOs or other entities. The type R supplier produces at marginal cost c_R. The risky supplier is less expensive, charging marginal production cost $c_{NR} < c_R$, but may experience a random responsibility violation (e.g., excessive overtime, poor working conditions, an industrial accident, improper disposal of waste). The probability that a violation occurs at the risky supplier is $\phi \in [0, 1]$, and violations are exogenous events.

Assuming that one supplier type has zero chance of a violation is a simplification made for ease of exposition—our results continue to hold if both supplier types have a nonzero probability of a violation, so long as one supplier type is less "risky" and more

costly than the other. The supplier types are known with certainty to the buyer; there is no uncertain or asymmetric information regarding supplier responsibility in the model.[1] We make this assumption for two reasons. First, there are many factors that play a significant role in determining supplier responsibility that are clearly public information, e.g., the location of the supplier and the number and degree of enforcement of local labor and environmental regulations. Second, many buyers exert significant effort to reduce information asymmetry before adding suppliers to an approved list; supplier vetting is a long and costly process designed specifically to help eliminate any information asymmetry before the contractual phase. Third parties such as the Fair Factories Clearinghouse in the apparel industry, which is used by brands such as Adidas, Nike, and Levi Strauss to share supplier responsibility compliance information (Porteous et al. 2012), and the United Nations via its Better Work Program (Better Work Program 2015) perform this function as well. Our model can be thought of as taking place after this process has occurred, when the buyer has significantly reduced any information asymmetry concerning the level of responsibility of its potential suppliers and is in the execution phase of selecting suppliers given known risk profiles.

We do not explicitly model supplier actions related to behaving responsibly or any efforts by the buyer to monitor or induce the supplier to behave responsibly. In other words, the suppliers in our model have exogenous levels of responsibility; we make this assumption to keep our modeling focus on the supplier selection problem, and moreover, as Doorey (2011) points out, few firms have sufficient pull over individual suppliers to ensure conformance with social and environmental responsibility principles. For instance, because Nike typically sources only 10%–15% of the volume of particular factories, the company found it difficult to unilaterally change working conditions in the facilities. If the level of social responsibility in a supplier is (more or less) fixed, the issue of which suppliers to source from becomes of key importance.

The two suppliers are equivalent in all other operational dimensions (quality, capacity, etc.). In practice, a buyer may source from a risky supplier for many reasons, such as the supplier possessing unique expertise or capabilities, because the buyer is expanding into a new market or new type of production with which it has little experience, or because switching from an incumbent risky supplier to a responsible

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[1] Qualitatively, our results continue to hold if the supplier types are random, e.g., a supplier is type R with some probability and type NR with complementary probability, so long as this information is not asymmetric and one supplier has a higher "mean" level of responsibility and higher cost than the other; this is equivalent to a model of two risky suppliers, with one "less risky" than the other.

supplier would incur excessive costs that the buyer must bear. For instance, Apple is tied very closely to Foxconn in large part because of the incomparable scale and flexibility offered by the manufacturer, and because switching would be enormously costly. By assuming the suppliers are operationally identical, that there is no uncertainty about responsibility, and that there are no switching costs or incumbent suppliers, we are focusing the model on the sourcing decision when "all else is equal," i.e., when there are no differences between the suppliers except in the responsibility and cost dimensions. This allows us to analyze these dimensions sharply without complicating the buyer's problem with other well-known drivers of sourcing decisions. Let $\Delta = c_R - c_{NR}$ be the cost premium of the responsible supplier, and let q_R and q_{NR} be the quantities sourced from the responsible and nonresponsible suppliers, respectively.

In the main portion of our analysis, consumers have homogeneous baseline valuations, or willingness to pay (WTP), for the product equal to v. We discuss the impact of heterogeneous valuations for the product in §7.2. A fraction $\theta \in [0, 1]$ of consumers are assumed to be "socially conscious" and obtain an additional homogeneous valuation r for a product that has been responsibly sourced; heterogeneous willingness to pay for responsibility is discussed in §7.1. All remaining consumers (a fraction $1 - \theta$ of the total population) are "non–socially conscious" consumers that are oblivious to responsible sourcing. Empirical studies on consumer willingness to pay for responsibility have demonstrated that a fraction of the consumer population is indeed willing to pay a premium for a responsibly made or sourced product, e.g., 10% of consumers for fair-trade coffee in De Pelsmacker et al. (2005) (see also Laroche et al. 2001, Mohr et al. 2001, Mohr and Webb 2005, and references therein for further examples), although evidence also shows that a large portion of the population is unwilling to pay such a premium even if they state they prefer a responsibly made product, e.g., 40% of consumers for fair-trade coffee in De Pelsmacker et al. (2005)—hence, our model comprises a heterogeneous consumer population in which some consumers have a positive willingness to pay for responsibility and some do not.

If the buyer sources from the risky supplier and that supplier experiences a violation, there are two potential consequences: an increase in cost and a decrease in demand. The former results from recovery or mitigation efforts such as subsidizing the supplier's labor costs, contributing to environmental clean-up efforts, or recalling tainted products. This increase in cost is modeled by introducing an additional fixed cost c_{VP} (for violation penalty) that is incurred only

Table 1   Consumer Types

Consumer type	WTP for the product	WTP for responsibility	Fraction of population	Exit market if violation occurs
Socially conscious	v	r	θ	$\alpha\theta$
Non–socially conscious	v	0	$1 - \theta$	0

if a responsibility violation occurs at a supplier.[2] The latter consequence derives from consumers abandoning the buyer in the wake of a violation. Specifically, we assume that a fraction $\alpha \in [0, 1]$ of the socially conscious consumers, aside from their willingness to pay for responsible sourcing, respond to the discovery of a violation in the firm's supply chain by exiting the market (e.g., to forgo consumption entirely or to purchase from competitors or on secondary markets). By varying α, we can vary the "willingness to punish" of the socially conscious segment; for example, if $\alpha = 0$, no consumers exit the market if there is a responsibility violation, but if $\alpha = 1$, all socially conscious consumers exit in the wake of a violation.[3]

Consumer types are summarized in Table 1. We note that although we refer to the buyer's customers as "consumers" throughout the paper, these customers can just as easily be companies (e.g., retailers) themselves. For instance, some retailers, such as "responsible" grocery chain Whole Foods Market, might be willing to pay for responsibly sourced products because their clientele values responsibility, and willing to punish in the event of violations via "zero tolerance" sourcing policies stating that if a supplier is found to have experienced a violation, they will terminate their relationship or reduce future business with that supplier. Hence, our model is also appropriate if we consider "consumers" to be businesses, though we will continue to use the consumer interpretation in our discussion below.

There are three stages in the model. In the first stage, the buyer selects a supplier(s) and determines sourcing quantities. In the second stage, production

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[2] Although we focus on fixed costs incurred in the wake of a violation for concreteness, a marginal cost penalty results in qualitatively similar insights.

[3] Note that all socially conscious consumers are willing to knowingly purchase a nonresponsibly sourced product in the absence of a violation; it is only following an egregious responsibility violation, such as a catastrophic factory accident, that some socially conscious consumers will exit the market. However, these same consumers prefer a responsibly sourced product and will pay a premium to purchase such a product. Hence, one may equivalently think of socially conscious consumers having a three-point valuation distribution: $v + r$ for a responsibly sourced product, v for a nonresponsibly sourced product from a supplier that experiences no severe violations, and 0 for a product sourced from a supplier that has experienced a violation.

occurs on the buyer's order, and responsibility violations from the risky supplier randomly occur and are revealed to all parties (i.e., the buyer and consumers); if there is a violation, socially conscious consumers who are willing to punish (a fraction $\alpha\theta$ of the total market) exit, and the firm incurs a fixed penalty cost c_{VP}. In the third stage, the firm determines the price and sells to the consumer market.[4] Given our sequence of events, because the production quantity is determined before the realization of random responsibility violations (and hence random demand), a supply/demand mismatch may occur. This means that the quantity decision in the first stage of the game is nontrivial: the buyer effectively faces stochastic demand if it sources from a risky supplier and so must optimize its production quantity decision accordingly. For ease of exposition and to focus our discussion on sourcing (rather than inventory) strategy, throughout our main analysis we assume that unsold inventory is salvaged for exactly the procurement cost, implying that the optimal quantity decision in the first stage is the maximum market size given the buyer's sourcing strategy, and no supply/demand mismatch costs are incurred by the buyer. This might be the case if a secondary channel exists that allows the buyer to dispose of excess inventory for (more or less) zero net profit, such as a discount outlet or developing market. We discuss the impact of salvaging excess inventory at a loss, which complicates the buyer's inventory decision, in §7.3.

We assume that the buyer cannot switch suppliers or change production quantities after a violation has occurred in the second stage and before the selling season begins in the third stage. Neither assumption is restrictive. In practice, firms may be unable to switch suppliers because of switching/process setup costs or lead times. Many suppliers have specific expertise that takes time and significant investment to develop, especially in an emergency fashion following the revelation of a responsibility violation, when alternative capacity may be scarce or already

purchased by competitors. However, even if a buyer can switch suppliers after a violation, it is unlikely that this switching fully eliminates the negative consequences of a violation—direct costs and reduced demand—although it may alter them somewhat. For example, the ability to switch suppliers may result in reduced α (reduced customer abandonment because, e.g., some customers forgive the buyer after it demonstrates commitment to responsibility by switching suppliers) and increased c_{VP} (increased costs resulting from changing suppliers in an expedited fashion), but as long as some portion of these negative consequences is still felt by the buyer, our results will qualitatively continue to hold; hence, for simplicity, we assume that no switching is possible. Similarly, in practice, one might reasonably argue that if a supplier's actions lead to a responsibility violation, the buyer may no longer be beholden to its committed purchase quantity from the first stage and thus may be able to adjust the procurement quantity to match the realized demand level. If the buyer can costlessly change the procurement quantity after a violation occurs, this is mathematically equivalent to our assumption that excess inventory is salvaged for the procurement cost in the third stage. Hence, the assumption that the buyer cannot adjust the procurement quantity following a violation is without loss of generality when unsold inventory is salvaged at the procurement cost.

Finally, we initially assume that the sourcing decisions of the buyer are truthfully revealed to consumers. Because of this, the buyer cannot "lie" to consumers, e.g., by trying to market a nonresponsibly sourced product as responsible or a responsibly sourced product as nonresponsible. We refer to this as a "transparent" supply chain, which may be enabled either via sophisticated consumer behavior or via buyer or third-party (e.g., retailer) disclosure of the provenance of the buyer's goods, a practice that is increasingly taking hold in many industries. However, in some cases the supply chain may be "nontransparent"; i.e., consumers may be unable to observe the buyer's true sourcing strategy. We discuss this issue further and determine the impact of nontransparency on the buyer's optimal sourcing strategy in §6.

4. Sourcing Strategies

Given the supply chain and consumer model described above, there are four possible sourcing strategies that the buyer could adopt in a transparent supply chain. In this section, we describe these strategies and derive the expected profit associated with each.

1. *Low-Cost Sourcing* (*LC*). The buyer could choose to source all inventory from the risky (but low-cost)

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[4] The key assumption in this sequence is that production is finished and violations are revealed before the selling season begins. In practice, these events potentially overlap; i.e., violations might occur during production, which also may overlap with the selling season and consumer purchasing decisions. We assume instead that these events occur in a sequential nature to maintain sharp insights; however, if violations randomly occurred during the selling season, then one would have to account for the timing of violations and its impact on demand from the moment of violations onward. As a result, violations would have a stochastic impact as well as a stochastic occurrence; for instance, if a violation occurs at the start of the selling season, then all $\alpha\theta$ consumers that are willing to punish might exit the market, whereas if a violation occurs at the midpoint of the selling season and consumers purchase continuously throughout the selling season, only $\alpha\theta/2$ consumers might exit the market.

supplier, NR, resulting in sourcing quantities $q_{NR} = 1$ and $q_R = 0$. Because the firm does not source responsibly, all consumers have willingness to pay equal to v; hence the optimal price in this sourcing strategy is v. If the supplier experiences a responsibility violation, which occurs with probability ϕ, the buyer will lose a fraction $\alpha\theta$ of its customers and incur an extra fixed cost c_{VP}. Hence, expected profit in the low-cost sourcing strategy is $\Pi^{LC} = (1 - \alpha\phi)\theta(v - c_{NR}) + (1 - \theta)(v - c_{NR}) - \phi c_{VP}$. The first term represents profit from the socially conscious segment, the second term represents profit from the non–socially conscious consumer segment, and the third term represents any direct costs resulting from a responsibility violation.

2. *Dual Sourcing (DS).* Rather than source all its product from the risky supplier, the buyer could source from both suppliers simultaneously. If the buyer adopts this strategy, it is clearly optimal to allocate responsibly sourced units to socially conscious consumers (who have positive willingness to pay for responsibility) and nonresponsibly sourced units to non–socially conscious consumers, charging socially conscious consumers a higher price for the responsibly sourced product. This implies that the optimal sourcing quantities under a dual sourcing strategy are $q_{NR} = 1 - \theta$ and $q_R = \theta$. We assume that socially conscious consumers, if indifferent between the two products, choose the responsibly sourced product. This is without loss of generality; the firm could simply lower the price by an infinitesimal amount to induce consumers to buy the more expensive responsibly sourced item. Hence, the optimal prices in the dual sourcing strategy are v for products sourced from the risky supplier and $v + r$ for products sourced from the responsible supplier. Examples of firms using such a mixed strategy include Starbucks in the recent past (e.g., in 2007, the firm sold less than 5% of its coffee as "fair trade" at a premium price; see Locke et al. 2010); grocery chain Whole Foods Market (which sells meats graded on a numerical "responsibility scale" with ratings from 1 to 5; see Whole Foods Market 2015); and apparel manufacturers Patagonia, Levi's, and New Balance, all of whom sell a small selection of items labeled as either "fair trade," "responsibly produced," or "made in the USA" at a premium price relative to the majority of their other offerings.

Because the firm sources some units from a risky supplier, we must make an assumption about the response of socially conscious customers to a responsibility violation by that supplier. Because these consumers intend to purchase a product sourced from the responsible supplier, they may ignore a violation from the risky supplier and continue to buy from the firm. Alternatively, consumers may be incensed at the fact that *any* part of the firm's supply chain exhibits poor social and environmental responsibility, and they may choose not to buy from the firm despite the fact that the product they intended to buy was sourced responsibly. In reality, consumers likely exhibit a mixture of both behaviors; in our model, we assume the latter behavior (that consumers exit the market if any supplier to the firm experiences a violation), although most of our results hold qualitatively under either assumption. Consequently, firm profit under the dual sourcing strategy is $\Pi^{DS} = (1 - \alpha\phi)\theta(v + r - c_R) + (1 - \theta) \cdot (v - c_{NR}) - \phi c_{VP}$. Note that the second and third terms in this expression—expected profit from the non–socially conscious consumer segment and direct costs resulting from a violation—are identical to the second and third terms in the low-cost sourcing profit expression. The difference lies in the first term—profit from the socially conscious segment—which differs under the dual sourcing strategy because the firm can extract a premium r from these consumers for a responsibly sourced product while also paying a greater sourcing cost, c_R.

3. *Responsible Niche Sourcing (RN).* In the dual sourcing strategy, profit from the socially conscious consumer segment is limited by the fact that the firm sources some units in a nonresponsible way, potentially leading to a violation that will cause socially conscious customers to leave the firm. One way to mitigate this risk is to ignore the non–socially conscious consumer segment (i.e., $q_{NR} = 0$) and source a quantity $q_R = \theta$ from the responsible supplier, selling only to socially conscious customers at a price equal to $v + r$. In other words, the buyer positions itself as a "niche" responsible firm that has no chance of a violation, allowing the firm to extract all surplus from socially conscious consumers with zero chance of a violation. Examples of firms that appear to have adopted the responsible niche strategy include brands focused on the responsibility of their production and supply chains, with efforts to market that responsibility directly to consumers and elicit willingness to pay, such as Everlane (clothing), Pachamama Coffee Cooperative (coffee), TOMS (shoes), and Tundra (down-insulated sleeping bags). To follow this strategy, the firm forgoes sourcing for and selling to the non–socially conscious consumer segment; hence the firm's profit is $\Pi^{RN} = \theta(v + r - c_R)$. Observe that compared with the dual sourcing strategy, profit from the socially conscious segment is greater (because there is no random violation in the responsible niche strategy) whereas profit from the non–socially conscious consumer segment has been lost.

4. *Responsible Mass Market Sourcing (RM).* Last, the firm can source all product from the responsible supplier ($q_R = 1$ and $q_{NR} = 0$) and sell at a single price (v) to both consumer segments. In this strategy, there

is no chance of a violation (and hence no chance of a demand reduction or cost increase), but the firm also forgoes the opportunity to segment the market and extract additional surplus from the socially conscious consumers with a higher selling price. Examples of firms following this strategy include firms that target the broader consumer market and price competitively while still sourcing in a responsible manner and avoiding the riskiest suppliers. Nike, for instance, assessed that the risk of a violation from Bangladeshi contract manufacturers was too high to justify the cost savings from these suppliers, and even before the Rana Plaza factory collapse, the company cut ties with most of its Bangladeshi suppliers and sourced instead from more expensive, but less risky, firms (Bustillo 2012); similarly, the Walt Disney Company avoids sourcing from Bangladesh and 43 other "at-risk" countries (Walt Disney Company 2013). In recent years, Starbucks instituted its Coffee and Farmer Equity (C.A.F.E.) Practices program with the goal of sourcing 100% of its coffee in an ethical manner by 2015 (achieving 95.3% in 2013, from less than 5% in 2007, when they followed something more closely resembling a dual sourcing strategy), even though this cost the coffee chain more and did not result in higher retail prices (Starbucks Corporation 2013). Firm profit in the responsible mass market strategy is $\Pi^{RM} = v - c_R$. Note that this strategy results in the lowest profit margin but may still be desirable to the buyer because of the elimination of the dual risks of demand reduction and cost increase.

Having derived the possible sourcing strategies for the buyer, we may now characterize when each of these strategies is optimal. In what follows, we define $[x]^+ = \max(x, 0)$.

PROPOSITION 1. *The buyer's optimal sourcing strategy is as follows.*

(i) *Low-cost sourcing if $r < \Delta$ and $\phi[\alpha\theta(v - c_{NR}) + c_{VP}]$ $< \Delta - [\theta r - (1-\theta)(v - c_R)]^+$.*

(ii) *Dual sourcing if $r > \Delta$ and $\phi[\alpha\theta(v + r - c_{NR}) + c_{VP}]$ $< \Delta(1-\theta) + \theta r - [\theta r - (1-\theta)(v - c_R)]^+$.*

(iii) *Responsible niche sourcing if $r > (v - c_R)(1-\theta)/\theta$, and neither low-cost sourcing nor dual sourcing are optimal.*

(iv) *Responsible mass market sourcing if $r < (v - c_R) \cdot (1-\theta)/\theta$, and neither low-cost sourcing nor dual sourcing are optimal.*

Consider first the case when consumer willingness to pay for responsibility is low ($r < \Delta$). The proposition shows that, in this case, if the expected costs of a violation—the loss in revenue as a result of customer abandonment and the direct costs of a violation—are small (part (i)), low-cost sourcing is optimal. If the expected costs of a violation are high, responsible niche sourcing is optimal if consumer willingness

to pay for responsibility is large (part (iii)); otherwise, responsible mass market sourcing is optimal (part (iv)). Notably, dual sourcing is never optimal when the incremental cost of responsible sourcing is greater than the consumer willingness to pay for responsibility ($r < \Delta$), because a greater profit margin could be reaped from the socially conscious segment via a low-cost sourcing strategy. Instead, the firm follows an all-or-nothing strategy: either all product is sourced from a risky supplier or all product is sourced from a responsible supplier. Observe that the firm may source from a responsible supplier even if consumer willingness to pay for responsibility is zero because of the reduction in risk associated with responsible sourcing. When consumer willingness to pay for responsible sourcing is greater than the incremental cost of responsible sourcing, the qualitative behavior is similar, except that the firm always prefers dual sourcing to low-cost sourcing (part (ii)). This is because serving the socially conscious segment with a responsibly sourced product is profitable, even absent a reduction in risk, as long as $r > \Delta$. Consequently, if $r > \Delta$, the buyer always seeks to source at least partially from the responsible supplier and never follows a strategy of single sourcing from the risky supplier.

5. The Drivers of Responsible Sourcing

We now consider how the various forces in the model influence the buyer's incentives to source responsibly. Specifically, we focus on the impact of outside pressure from three categories of external stakeholders: consumers, governments, and NGOs. Each of these entities can influence the buyer's strategy in different ways. Consumers, for example, affect the buyer via the fraction of the population that is socially conscious (θ), the willingness to pay for responsibility (r), and the willingness to punish for responsibility violations (α). Governments would be most likely to influence the buyer's actions by imposing fines or penalties for violations, i.e., for adding to the direct cost of a violation (c_{VP}). NGOs have most commonly focused on influencing buyer behavior by inspecting risky suppliers and attempting to discover violations, either with the cooperation of the buying firms (e.g., as a part of industry organizations such as the Fair Labor Association) or of their own accord (e.g., by surreptitiously investigating a firm's suppliers and publicizing any violations in an effort to elicit greater responsibility in the supply chain). In our model, this is tantamount to increasing the probability of a violation (ϕ), not because NGOs make violations more likely via their efforts but because they make the discovery of latent violations more likely. In this section, we seek to understand how these various stakeholders impact the buyer's sourcing strategy—or more

Table 2   The Four Sourcing Strategies in a Transparent Supply Chain

Sourcing strategy	q_{NR}^*	q_R^*	Buyer's expected profit
Low cost	1	0	$(1 - \alpha\phi)\theta(v - c_{NR}) + (1 - \theta)(v - c_{NR}) - \phi c_{VP}$
Dual sourcing	$1 - \theta$	θ	$(1 - \alpha\phi)\theta(v + r - c_R) + (1 - \theta)(v - c_{NR}) - \phi c_{VP}$
Responsible niche	0	θ	$\theta(v + r - c_R)$
Responsible mass market	0	1	$v - c_R$

precisely, the quantities sourced from the risky and responsible suppliers—via their efforts. Throughout this section, we refer to an increase in any of these parameters—θ, r, α, c_{VP}, and ϕ—as "greater pressure" on the buyer from external stakeholders.

We define q_{NR}^* and q_R^* to be, respectively, the optimal quantities sourced from the risky and responsible suppliers. Table 2 provides a summary of the four possible sourcing strategies, along with the sourcing quantities and expected buyer profit in each strategy. Clearly, within a given sourcing strategy, the quantity sourced from the risky supplier (q_{NR}^*) is decreasing,[5] and the quantity sourced from the responsible supplier (q_R^*) is increasing, in the size of the socially conscious segment; moreover, the sourcing quantities are independent of consumer willingness to pay, willingness to punish, the direct cost of a violation, and the probability of a violation. Hence, within a particular sourcing strategy, the firm's behavior aligns with our expectations: greater pressure from external stakeholders leads (weakly) to less product sourced from risky suppliers and more from responsible suppliers. This is not the case, however, when the buyer's optimal choice of sourcing strategy, derived in Proposition 1, is taken into account. Changes in parameters such as the size of the socially conscious segment may lead the firm to not only adjust sourcing quantities within a given strategy but also switch strategies entirely; at the boundaries between strategies, the sourcing quantities may move in precisely the opposite direction that one would expect.

To see this, consider first the case when consumer willingness to pay for responsibility is low ($r < \Delta$), in which the optimal sourcing strategies are given in cases (i), (iii), and (iv) of Proposition 1. Examining the profit expressions given in Table 2 for the three potentially optimal sourcing strategies, we note that profit in the low-cost strategy is decreasing in θ, profit in the responsible niche strategy is increasing in θ, and profit in the responsible mass market strategy is independent of θ. Moreover, when $\theta = 0$, RM is preferred to RN, but when $\theta = 1$, RN is preferred to RM. Thus, depending on the problem parameters, there are four possible progressions of the optimal sourcing strategy as θ increases: (i) LC is optimal

for all θ, (ii) LC → RN, (iii) LC → RM → RN, and (iv) RM → RN. In the first two cases, the behavior of the optimal sourcing quantities is consistent with naïve intuition: q_{NR}^* decreases and q_R^* increases in θ. In the latter two progressions, however, the optimal sourcing strategy transitions from responsible mass market to responsible niche for sufficiently high θ (specifically, at the point $\theta = (v - c_R)/(v + r - c_R)$). In these cases, at the transition between sourcing strategies, the quantity sourced responsibly decreases as the size of the socially conscious consumer segment increases. A similar effect occurs as a function of r, the consumer willingness to pay for responsibility, for analogous reasons. The following proposition formalizes both of these observations.

PROPOSITION 2. *If consumer willingness to pay for responsibility is low ($r < \Delta$) and the optimal sourcing strategy progresses from responsible mass market to responsible niche as θ or r increase, q_R^* strictly decreases as r crosses $(v - c_R)(1 - \theta)/\theta$ from below and as θ crosses $(v - c_R)/(v + r - c_R)$ from below.*

In other words, if consumer willingness to pay for responsibility is low, it is possible for the quantity sourced responsibly to decrease as there are more socially conscious consumers or as their willingness to pay for responsibility increases. The explanation for this counterintuitive result is that, if θ or r are very small, the buyer may choose a responsible mass market strategy purely as a risk mitigation measure, i.e., to eliminate the risk of direct costs and customer abandonment from a responsibility violation. As either θ or r increase, segmenting the market and selling to socially conscious consumers at a premium price becomes attractive to the buyer. However, to achieve this, the buyer must raise the price on the product and exclude non–socially conscious consumers; in doing so, the buyer will reduce the quantity it sources from the responsible supplier.

When $r < \Delta$, even though the quantity sourced responsibly can go *down* if consumers have a greater appetite for responsibility, the quantity sourced from the risky supplier cannot go *up*. Surprisingly, this exact phenomenon can occur if consumer willingness to pay for responsibility is high ($r > \Delta$). When this condition holds, dual sourcing dominates low-cost sourcing. From Table 2, although profit in responsible niche sourcing is increasing in θ and profit in

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[5] Throughout the paper, unless noted otherwise, we use the terms "increasing" and "decreasing" in the weak sense.

responsible mass market sourcing is independent of θ, profit in the dual sourcing strategy may be decreasing or increasing in θ. If the former, the outcomes are qualitatively similar to the low willingness-to-pay case (replacing LC with DS). If the latter, however, there are two new possible progressions of the optimal sourcing strategy as a function of θ in addition to those already described above: (i) RM → DS and (ii) RM → DS → RN. If either of these two progressions occurs, at the transition between responsible mass market and dual sourcing, per Table 2, the quantity sourced from the risky supplier will increase and the quantity sourced from the responsible supplier will decrease. As before, this same effect occurs as a function of consumer willingness to pay for responsibility (r), leading to the following result.

PROPOSITION 3. *If consumer willingness to pay for responsibility is high ($r > \Delta$),*

(i) *If the optimal sourcing strategy progresses from responsible mass market to responsible niche as θ or r increase, q_R^* strictly decreases as r crosses $(v - c_R)(1 - \theta)/\theta$ from below and as θ crosses $(v - c_R)/(v + r - c_R)$ from below.*
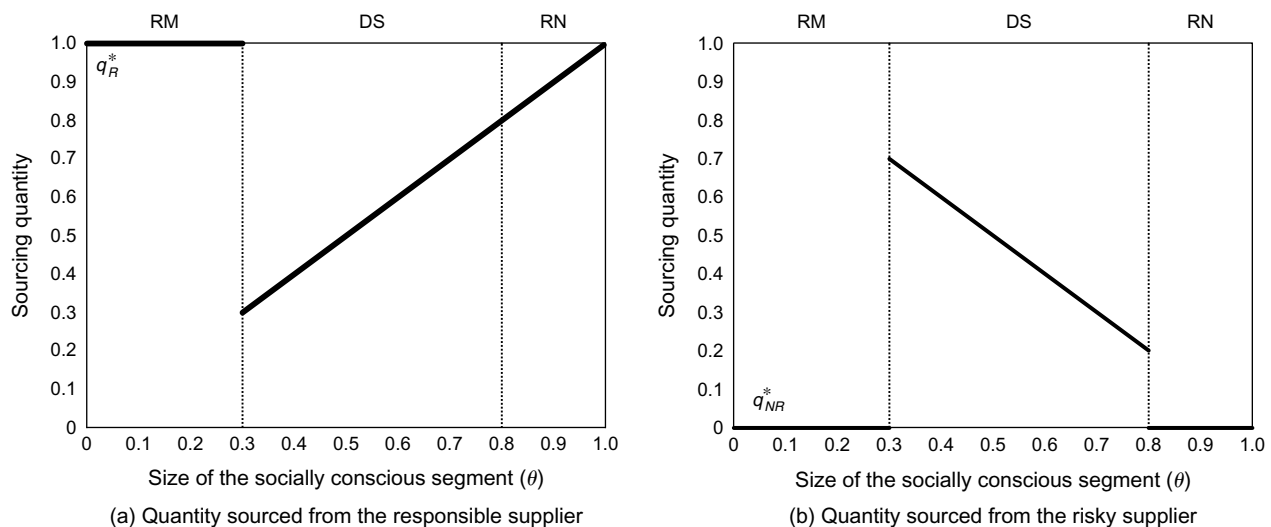
(ii) *If the optimal sourcing strategy progresses from responsible mass market to dual sourcing as θ or r increase, q_R^* strictly decreases and q_{NR}^* strictly increases as r crosses $(\phi c_{VP} - (1 - \theta)\Delta + \theta\alpha\phi(v - c_R))/\theta(1 - \alpha\phi)$ from below and as θ crosses $(\phi c_{VP} - \Delta)/(r - \Delta - \alpha\phi(v + r - c_R))$ from below.*

Part (i) of the proposition is similar to the previous result; part (ii), however, shows that increases in either the size of the socially conscious segment or consumer willingness to pay for responsibility can lead to an increase in risky sourcing as well as

a decrease in responsible sourcing. This is graphically illustrated in Figure 1. As the figure shows, for low θ, the responsible mass market strategy is optimal, whereas for moderate θ, dual sourcing is optimal, and for high θ, responsible niche sourcing is optimal. As θ increases above 0.3 in the figure, the quantities sourced from both the risky and responsible suppliers experience jump discontinuities: the quantity sourced from the risky supplier, q_{NR}, jumps up from 0 to $1 - \theta$, and the quantity sourced from the responsible supplier jumps down from 1 to θ, as the buyer switches strategies from responsible mass market to dual sourcing.

The intuition behind Proposition 3, part (ii) is similar to Proposition 2: as the size of the socially conscious segment or their willingness to pay for responsibility increases, it becomes profitable to market specifically to these consumers, and so the buyer switches to a market segmentation strategy, raising the price on responsibly sourced products to sell them exclusively to socially conscious customers. To exploit the willingness to pay of the socially conscious segment, the buyer must either abandon the non–socially conscious consumer segment (adopt a RN strategy) or serve the segment using the risky supplier at a lower price (adopt a DS strategy, which is preferred to LC only if $r > \Delta$). Either approach results in a decrease in q_R^*, whereas the latter also results in an increase in q_{NR}^*. Figure 2 further illustrates this effect by plotting the optimal sourcing strategy of the firm as a function of θ and r. In panel (a) of the figure, only the result in Proposition 2 occurs. In panel (b), the results of both Propositions 2 and 3 occur. The key difference between the two cases is that sourcing from the risky supplier is significantly cheaper in panel (a);

Figure 1 **An Example of the Firm's Optimal Sourcing Quantities as a Function of the Size of the Socially Conscious Segment When $r > \Delta$**

(a) Quantity sourced from the responsible supplier

(b) Quantity sourced from the risky supplier

Note. The optimal sourcing strategy is denoted at the top of the figure.

Figure 2 The Firm's Optimal Sourcing Strategy as a Function of the Fraction of Socially Conscious Consumers and Their Willingness to Pay for Responsible Sourcing

(a) $c_{NR} = 3$ ($\Delta = 2$)

(b) $c_{NR} = 4$ ($\Delta = 1$)
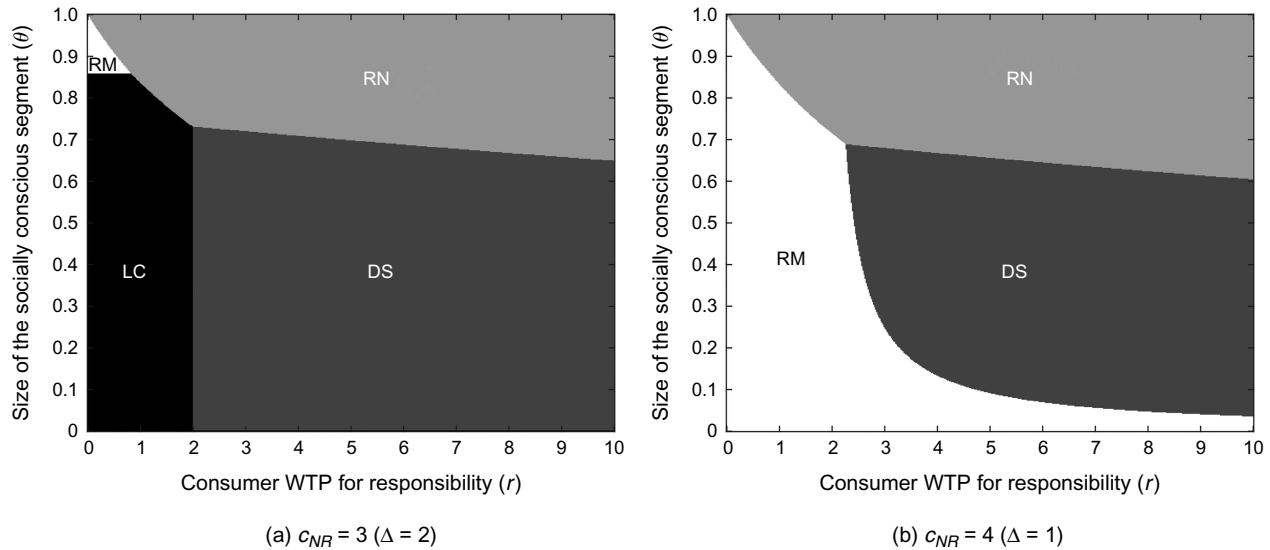
Note. In the example, $v = 10$, $c_R = 5$, $\alpha = 0.5$, and $c_{VP} = 5$, and $\phi = 0.25$.

hence the buyer prefers a low-cost sourcing strategy when both r and θ are small (specifically, when $r < \Delta = 2$ in the figure). In panel (b), the cost advantage of the risky supplier is reduced, meaning the buyer prefers a responsible mass market strategy when r and θ are small to minimize the risk of responsibility violations. This leads to the buyer pursuing a segmentation strategy (either responsible niche or dual sourcing) as either r or θ grow, resulting in an increase in risky sourcing and a decrease in responsible sourcing.

Consequently, increasing the number of socially conscious consumers in the population or their willingness to pay for responsibility may lead to unintended consequences, backfiring and causing the firm to follow a *less* responsible sourcing strategy. This counterintuitive behavior occurs because of three interacting features of our model. First, the firm is optimally responding to the characteristics of the consumer market by adjusting its sourcing strategy. Second, the presence of costs of a violation (both direct costs and a loss of revenue from consumer willingness to punish) can lead responsible mass market sourcing to be optimal at low θ or low r purely as a risk mitigation tool. And third, consumer willingness to pay for responsibility can lead market segmentation to be a profitable strategy at higher θ or higher r, which makes the sourcing strategies that cater to the socially conscious segment (responsible niche and dual sourcing) more attractive to the buyer. These three forces combined lead to the phenomenon of a more socially conscious consumer population inducing less quantity sourced from the responsible supplier and more sourced from the risky supplier.

We note that to generate these results, it is not necessary for consumers to be willing to punish in the event of a violation so long as there are some direct costs of a violation, nor is it necessary for the buyer to experience direct costs of a violation so long as consumers are willing to punish if there is a violation. This is a valuable observation to make because, in certain practical settings, some of these effects may dominate others; for instance, consumers might be willing to pay for responsibility but may be unwilling to leave the firm if there is a violation, e.g., because they have no alternatives for the product they require. For example, boycotts and consumer willingness to punish for poor responsibility do not always have an appreciable impact on firm profits or decisions (Diermeier 2012, Jacobs and Singhal 2014). There are also examples to the contrary; e.g., New Balance exploited the negative press centered around Nike's responsibility violations by advertising the responsibility of their supply chain and, in particular, the domestic manufacturing of many of their products, likely a contributing factor in New Balance's share of the athletic shoe market expanding from 3.7% in 1999 to 9.4% in 2000 (Business Wire 2000), and Mohr et al. (2001) describe how consumers are willing to boycott firms that exhibit especially irresponsible behavior. Nevertheless, there is ongoing debate about the prevalence and effectiveness of such behavior by consumers, and our results show that significant willingness to punish is not strictly necessary to generate responsible sourcing or many of the interesting effects that we identify.

Although the propositions show that supply chain responsibility *can* decrease as either r or θ increase, the propositions do not offer any guidance about

Table 3   Average Parameter Values When Greater θ or r Can Lead to a Less Responsible Sourcing Strategy

Cases where $\uparrow \theta$ or $\uparrow r$ leads to...	Average parameter values						Fraction of cases (%)
	c_R	c_{NR}	v	ϕ	α	c_{VP}	
$\downarrow q_R^*$ or $\uparrow q_{NR}^*$	12.4	10	25.1	0.20	0.52	10.4	88.2
Neither	13.3	10	24.2	0.17	0.38	7.06	11.8

how likely it is that this counterintuitive result would occur in practice. The conditions dictating precisely when this occurs are complicated and, as a result, do not convey much practical insight; these conditions are provided in Propositions 7 and 8 in the appendix. Rather than discuss those conditions here, to gain a deeper understanding of this result, we performed a numerical study of 54,000 parameter combinations chosen to represent reasonable scenarios one might encounter in practice.[6] For each parameter combination, we determined whether any of the conditions listed in Propositions 7 and 8 in the appendix—which dictate whether q_R^* decrease or q_{NR}^* increase at some point as either r or θ increase—held. We found that in 79% of this sample, the conditions that led to q_R^* decreasing in θ held; in 59% of the sample, conditions that led to q_{NR}^* increasing in θ held. Similarly, in 85% of this sample, the conditions that led to q_R^* decreasing in r held; in 53% of the sample, conditions that led to q_{NR}^* increasing in r held. Hence, these results occur in a significant number of cases. Table 3 provides the average parameter values when this behavior occurs and when it does not. As one would expect, and as the table illustrates, higher θ or r leading to a less responsible sourcing strategy is most likely to occur when (i) responsible sourcing is less expensive, (ii) consumers have higher valuations for the product, (iii) the probability of a violation is higher, (iv) consumers are more willing to punish, and (v) the direct cost of a violation is higher. These conditions ensure that responsible mass market sourcing is optimal for low θ or r (to minimize the risk of violations) and that either dual sourcing or responsible niche become optimal for higher θ or r (to exploit the value of segmentation), thus leading to the optimal sourcing strategy transitions discussed in Propositions 2 and 3.

Taken in sum, these results show that two commonly discussed ways to encourage responsible sourcing—educating consumers about social responsibility and encouraging them to pay more for responsible products—may produce unexpected and, in some cases, detrimental results. The reason for this is that a change in the consumer population characteristics alters the profitability of *all* sourcing strategies, and in particular might improve the profit of strategies that source from risky suppliers (e.g., dual sourcing). We stress that these results need not always occur, as our numerical analysis shows; however, the mere fact that a seemingly sound strategy to encourage a firm to source responsibly—customers "voting with their wallets"—can produce precisely the opposite of the intended result is worrisome, and indicates that efforts to encourage consumers to pay more for responsible products (e.g., marketing campaigns by the firm or by third parties such as environmental or labor groups) may be unsuccessful because they cause the firm to focus more on segmentation of the consumer market than on affecting widespread change in the responsibility level of the supply chain.

Conversely, the following proposition shows that factors that punish the buyer for responsibility violations—consumer willingness to punish for violations, direct costs of violations, and the probability of detecting violations—all have an unambiguous effect on the optimal sourcing quantities.

PROPOSITION 4. *Under the optimal sourcing strategy, q_{NR}^* is decreasing and q_R^* is increasing in consumer willingness to punish (α), the direct cost of a violation (c_{VP}), and the probability of a violation (ϕ).*

Combining the results of Propositions 2–4, we conclude that although strategies that impact the value of segmentation—i.e., increasing the number of socially conscious consumers or their willingness to pay for responsibility—can backfire and result in less responsibility in the supply chain, strategies that impact the expected costs of responsibility violations never backfire and always lead to greater supply chain responsibility. Hence, consumers, governments, and NGOs might have better success with punishment strategies than reward strategies.

This is an intriguing observation because some activists and NGOs make precisely the opposite recommendation, arguing that consumers should *not*

boycott firms that source from risky suppliers, despite the fact that the goal of these entities is, ostensibly, to improve the welfare of workers at suppliers (McManus 2014). A key reason for this is the fear that significant boycotts would lead risky suppliers to go out of business, putting workers—many of whom are already impoverished—in even worse conditions than what they experience with an irresponsible supplier. As a result, consumers may be urged not to boycott offending firms, but instead to "vote with their wallets" by shopping for responsibly sourced products and being willing to pay a premium for responsibility. Our results suggest that this approach, although well-intentioned, may not have the desired effect on the firm's optimal sourcing strategy, and a punishment-focused approach would be more effective in encouraging supply chain responsibility.

Our final observations in this section relate to the impact of sourcing strategy on the firms in the supply chain and consumers, beginning with the impact on the buyer's profit.

PROPOSITION 5. *Buyer profit under the optimal sourcing strategy is*

(i) *decreasing in the probability of a violation, the cost of a violation, the incremental cost of responsible sourcing, and consumer willingness to punish (ϕ, c_{VP}, Δ, and α);*

(ii) *increasing in consumer willingness to pay for the product and for responsibility (v and r); and*

(iii) *convex in the fraction of socially conscious consumers (θ).*

Parts (i) and (ii) of the proposition are intuitive; however, part (iii) shows that the buyer does best with either a very small or very large number of socially conscious consumers; intermediate numbers of socially conscious consumers, in fact, lead the firm to the lowest level of profit under the optimal sourcing strategy.[7] This happens because of the counteracting forces of consumer willingness to punish and willingness to pay for responsibility. For low θ, increasing θ can only hurt the buyer's profit as it increases the number of consumers that will abandon the firm after a violation without impacting the buyer's optimal sourcing strategy; however, as θ increases and the buyer switches to strategies that segment the market, increasing θ improves the buyer's profit by increasing the number of high value consumers in the market. Hence, the firm prefers either to sell to consumers that completely ignore social responsibility or sell to an entire market of consumers that care about social

responsibility. This implies that a firm may resist initial efforts to educate a largely ignorant consumer population about social responsibility, as its profit decreases when θ increases from zero; however, after some critical "tipping point" in the size of the socially conscious consumer population, the firm might prefer and even encourage a fully socially conscious customer market.

Next, we note that our results concerning the behavior of the buyer's sourcing quantities have immediate implications for the revenue of the risky and responsible suppliers, which are directly proportional to q_{NR}^* and q_R^*, the quantities sourced from those suppliers. In other words, the responsible supplier's revenue can decrease and the risky supplier's revenue can increase as the number of socially conscious consumers or consumer willingness to pay for responsibility increases, because the buyer switches to a less responsible sourcing strategy to exploit segmentation.

Finally, we observe that the customer market is also affected by the firm's optimal sourcing strategy. Per Figure 2, when the fraction of socially conscious customers is small, non–socially conscious customers are always served (via low-cost sourcing, dual sourcing, or responsible mass market sourcing). As the fraction of socially conscious customers increases, however, non–socially conscious customers may not be served at all as the buyer pursues a responsible niche strategy. Hence, influencing r and θ not only directly affects the buyer's sourcing strategy but also affects which customer segments are served. This implies, for example, that as a customer population "matures" and becomes more socially conscious (e.g., in a developing country in which the population becomes more affluent and attuned to social issues over time), firms target their sourcing and selling strategies to exploit this blossoming willingness to pay for responsibility, and after some critical threshold, non–socially conscious customers will no longer find buyers willing to serve them and will be priced out of the market, despite the fact that they do not consider social responsibility—positively or negatively—when making purchasing decisions. Although this is relatively benign if the product in question is a fashion good, it can be more detrimental if the product is, for instance, a food product, drug, or other critical good. Thus, increasing responsibility of the socially conscious segment can deprive the normal consumer segment of the product as the firm adjusts its sourcing strategy, which may have adverse consequences on overall social welfare. The driver of this result is the risk of responsibility violations, in conjunction with the socially conscious segment's willingness to pay for responsibility, which together imply that the buyer is willing to forgo selling to an entire customer segment—customers who do not value responsibility—to minimize risk and maximize revenue from the socially conscious customers.

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[7] Although there are many possible transitions of the firm's optimal strategy as a function of θ, as discussed above, and each is convex, one clear example of convexity occurs in the progression LC → RM → RN. Because firm profit in the LC strategy is decreasing in θ, while it is independent of θ in RM and increasing in θ in RN, profit under the optimal strategy is decreasing, then flat, then increasing as θ increases.

6. Sourcing in a Nontransparent Supply Chain

In our analysis thus far, we have assumed that the supply chain is transparent—that is, consumers can view the sourcing decisions of the buyer, and thus they know whether a product has truly been sourced responsibly. Although transparency in supply chains is increasingly common (Doorey 2011, Kalkanci et al. 2012), many supply chains are still nontransparent, meaning consumers have no direct knowledge of the sourcing decisions of the buyer (Chen and Slotnick 2015). When this information asymmetry occurs, it is possible for the buyer to mislead consumers, i.e., to market a product as responsibly sourced (and to sell it to socially conscious consumers at a premium price) when it is in fact sourced from a nonresponsible supplier.

In this section, we investigate the consequences of such nontransparency and the buyer's ability to lie about the provenance of its products. We make the following assumptions. First, consumers cannot view the sourcing decisions of the firm. Second, the firm may freely represent a product as "responsible" or "not responsible," regardless of its sourcing decisions, and consumers naïvely believe whatever the firm claims regarding the responsibility of its products—in other words, the branding and marketing of the firm's products are completely divorced from its sourcing decisions. And third, lying is costless to the buyer—there is no direct cost from misrepresenting the responsibility level of a product, and if the firm does choose to lie and that lie is discovered, there is no additional cost of consequence incurred by the buyer. These three assumptions are designed to make lying about the responsibility level of its products as easy as possible for the buyer; in turn, naïve intuition suggests that this should maximize the firm's incentives to source from a risky supplier, as the buyer no longer needs to source from the responsible supplier in order to exploit consumer willingness to pay for responsibility.

In a nontransparent supply chain, one strategy that the buyer can employ is to source all products from the responsible supplier but maintain two distinct brands with a price premium levied on the socially conscious customers. The firm sells an identical product to non–socially conscious consumers at a lower price, and it does not claim that this product is responsible, leading socially conscious consumers to choose the responsibly branded product at the higher price. We call this strategy the *responsible dual branded* (RDB) strategy. In this case, the buyer's expected profit is $\Pi^{RDB} = v + \theta r - c_R$. It is clear that such a strategy dominates responsible mass market (as the two distinct brands allow the company to extract extra profit from the socially conscious customers)

and responsible niche (as the company can sell to non–socially conscious consumers instead of just the niche market). Note that if consumers were sophisticated and could discern that the products possessed identical levels of responsibility, socially conscious consumers would never pay a premium price, and hence this strategy is not supportable in a transparent supply chain.

Alternatively, the company could source all its product from the risky supplier and still maintain two distinct brands with a price premium levied on the socially conscious consumers, marketing a responsible product to that segment that is, in fact, sourced from a nonresponsible supplier. We assume that, as in our base model, socially conscious consumers who are willing to punish abandon the firm if a violation is found, but otherwise, there are no additional ramifications to the buyer (i.e., the occurrence of a violation does not invalidate the buyer's claims that some of its products are responsibly sourced). We call this strategy the *low-cost dual branded* (LCDB) strategy. The expected profit of the LCDB strategy is $\Pi^{LCDB} = (1 - \alpha\phi)\theta(v + r - c_{NR}) + (1 - \theta)(v - c_{NR}) - \phi c_{VP}$, and this strategy clearly dominates low-cost sourcing, as the company is also able to extract extra value from the price premium to the socially conscious consumers even though the product was sourced from nonresponsible suppliers, and dual sourcing, since the company is able to achieve the same stochastic demand and cost outcomes at a lower marginal procurement cost.

Consequently, when the supply chain is nontransparent, RDB and LCDB dominate all of the strategies that were feasible in a transparent supply chain. Hence, the buyer's optimal sourcing strategy is either RDB or LCDB. Let Ω_{NR}^t be the set of parameter values for which sourcing any positive quantity from the risky supplier is optimal under a supply chain of type $t = \{T, NT\}$, where T stands for transparent and NT stands for nontransparent. In a nontransparent supply chain, this corresponds to the region in which LCDB is optimal, whereas in a transparent supply chain, it includes the regions in which either LC or DS is optimal. Then we have the following result.

PROPOSITION 6. (i) *In a nontransparent supply chain, low-cost dual branding is optimal if the expected cost of a violation is small, i.e., if $\phi[\alpha\theta(v + r - c_{NR}) + c_{VP}] < \Delta$, and responsible dual branding is optimal otherwise.*

(ii) *If $r < (v - c_R)((1 - \theta)/\theta)$, sourcing from a risky supplier is optimal for a larger set of parameter values when the supply chain is transparent than when it is nontransparent, i.e., $\Omega_{NR}^{NT} \subset \Omega_{NR}^T$.*

Part (ii) of the proposition shows that transparency does not necessarily make the buyer source more responsibly. In fact, the effect of transparency can

Figure 3   Optimal Sourcing Strategies in Transparent (a) and Nontransparent (b) Supply Chains

(a) Transparent

(b) Nontransparent
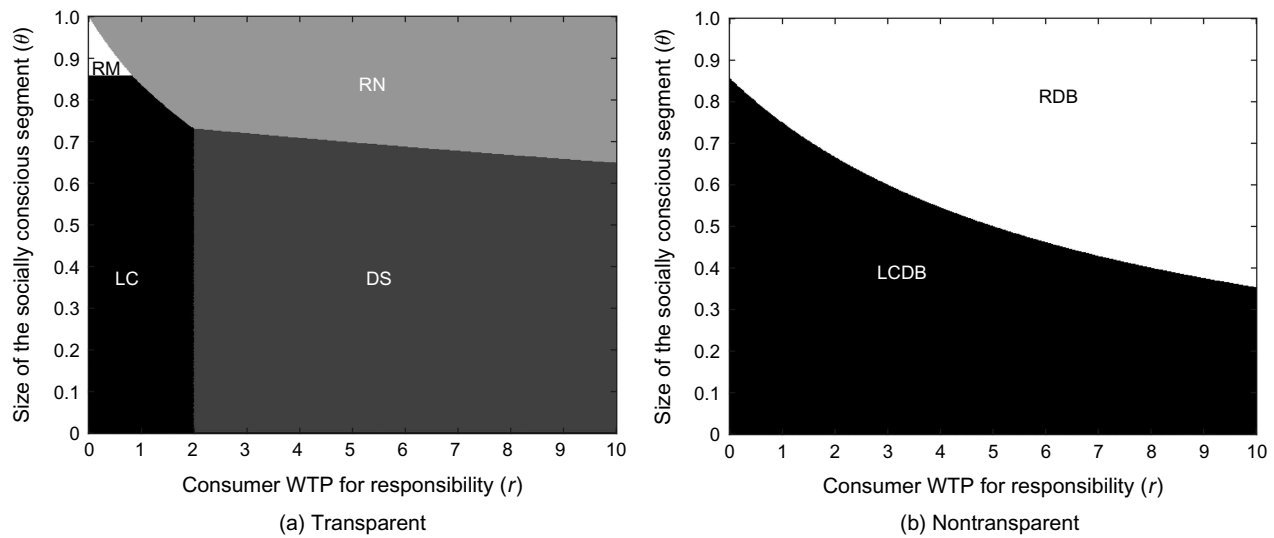
Note. In the example, $v = 10$, $c_R = 5$, $c_{NR} = 3$, $\alpha = 0.5$, $c_{VP} = 5$, and $\phi = 0.25$.

be precisely the opposite: it can *increase* the buyer's incentives to source from the risky supplier. There are two reasons for this surprising result. First, a lack of transparency divorces the firm's sourcing strategy from its market segmentation strategy. Because, as we saw in the previous section, the profitability of segmentation can drive the buyer to source less responsibly, eliminating the segmentation benefit of responsible sourcing removes this perverse incentive and thus increases the prevalence of responsible sourcing. Second, because segmentation is always employed, the cost of lost sales from a responsibility violation is greater in a nontransparent supply chain, as the firm is always earning a high revenue from its socially conscious consumers. Thus, we find that a nontransparent supply chain can be less likely to source from the risky supplier than a transparent one, despite setting the assumptions of the nontransparent model in a way that was designed to maximize the buyer's incentives to source from the risky supplier (e.g., by making it costless for the buyer to lie about its products).[8] Although this is a very surprising result, it again arises as a result of the fundamental interaction of the three key forces of our model: the buyer's optimal sourcing decision, direct and indirect costs of a violation, and consumer willingness to pay for responsibility.

This result is graphically depicted in Figure 3. As the figure shows, the size of the optimality region for the LCDB strategy in a nontransparent supply chain (Ω_{NR}^{NT}) is smaller than the regions employing

a risky supplier (the combined LC and DS optimality regions, Ω_{NR}^{T}) in a transparent supply chain. We note that although the proposition and the figure both show that the buyer can be more likely to source from a risky supplier in a transparent supply chain, they do not make any claims about the *quantity* sourced from the risky supplier. For instance, note that when consumer WTP for responsibility is high and the size of the socially conscious segment is small, a transparent supply chain uses DS whereas a nontransparent supply chain uses LCDB. Although the risky supplier is used in both cases, the quantity sourced from the risky supplier is smaller in the transparent supply chain. Thus, transparency does improve responsibility, conditional on the risky supplier being engaged in both types of supply chains; however, the transparent supply chain may use the risky supplier more frequently than the nontransparent supply chain. This suggests that transparency, as a tool to improve responsibility, can sometimes fail in the sense that it increases risky sourcing and decreases responsible sourcing.

There are a number of issues surrounding this result that bear further discussion. First, the sourcing strategies required to generate this surprising result both involve explicitly lying to the consumer population, which is ethically and legally ill-advised. Many companies, rightly, may refuse to lie to consumers even if there is no transparency in the supply chain and lying is costless. In these cases, the model essentially reduces to our model of a transparent supply chain, thereby eliminating any perverse impact of transparency on supply chain responsibility. In addition, the type of lying necessary in the RDB and LCDB sourcing strategies is not the same. In RDB, this lie is

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[8] Although the result of Proposition 6, part (ii) always holds if $r < (v - c_R)(1 - \theta)/\theta$, it can also hold if this inequality is violated, provided that α and ϕ are not too small; in Figure 3, for instance, it holds over the entire range of r.

in some ways benign: the firm markets a responsibly sourced product as "nonresponsible" in an effort to segment the market, meaning socially conscious consumers pay an unnecessary premium, but the firm is lying in such a way that it is underrepresenting its level of responsibility.[9] The lying required for LCDB is more nefarious: the firm markets a nonresponsible product as responsibly sourced. There may be asymmetric legal issues, costs, and consequences to these two different types of lying that, in practice, complicate the buyer's decision.

Second, there may be other reasons why transparency increases the responsibility of a supply chain that are outside of our present model. For example, transparency may increase demand by attracting socially conscious consumers from competing (nontransparent) firms. Alternatively, transparency may provide increased information to governments and NGOs, allowing them to more effectively inspect and regulate a firm's suppliers, thereby increasing the responsibility level of the suppliers and the probability of detection of any responsibility violations. These reasons—and doubtless many more—all may, in practice, overwhelm the interactions that we study in our model. Despite this, our results suggest that the firm may not respond to transparency the way we would expect, all else being equal.

Third, we have assumed that consumers are uniformly ignorant of the firm's sourcing strategy and are naïve in their response to the firm's claims of responsibility. In practice, it is likely true that some consumers are ignorant about the firm's policies, whereas some are sophisticated and have investigated the responsibility level of the firm's suppliers (e.g., checking whether they are affiliated with trusted third-party organizations such as the Fair Labor Association); similarly, some consumers likely believe whatever a firm claims about responsibility, whereas others are more skeptical. More sophisticated consumer behavior would require modeling the beliefs and communication between the firm and rational consumers, e.g., via signaling or cheap-talk models, issues that are outside the scope of our current analysis. This heterogeneous mixture of consumer sophistication likely plays a role in the supportability of any strategies that involve exploiting the ignorance

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[9] Note that the firm need not necessarily state that the lower-priced product is nonresponsible; rather, it may simply certify the premium product as responsible and omit any such certification on the lower-priced product, thereby leading customers to believe that the lower-priced product is of a lower responsibility level. Although not related to responsibility, a similar type of allegedly misleading marketing to achieve segmentation of the market occurred in the 1990s when Johnson & Johnson settled a lawsuit claiming the firm sold identical contact lenses for two-week use (at a high price per lens) and one-day use (at a low price per lens).

of the consumer population in practice. Nevertheless, although our model of a nontransparent supply chain does not involve detailed modeling of the dynamics of the communication between the buyer and consumers, it suggests a startling consequence of the three key forces in our model: that transparency does not necessarily make the supply chain more responsible. The potential for supply chain transparency to influence both consumer purchasing and firm sourcing decisions suggests that this area might be a fruitful avenue for future work.

7. Extensions

In this section we analyze the impact of relaxing three potentially restrictive assumptions—homogeneous willingness to pay for responsibility within the socially conscious segment, homogeneous consumer valuations for the product, and the buyer's ability to salvage unsold inventory for the procurement cost—on the buyer's sourcing behavior.

7.1. Heterogeneous Willingness to Pay for Responsibility

Although our base model incorporated heterogeneous willingness to pay for responsibility by modeling two consumer segments (socially conscious and non–socially conscious), within each segment consumers possessed homogeneous valuations for a responsibly sourced product. In reality, although it is true that a large fraction of the consumer population has zero willingness to pay for responsibility (validating our model of two consumer types), it is also true that for socially conscious consumers, willingness to pay can vary substantially (De Pelsmacker et al. 2005, Galbreth and Ghosh 2013). Hence, in this section, we consider the impact of heterogeneous willingness to pay for responsibility within the socially conscious segment. Specifically, we assume that socially conscious consumers have willingness to pay for responsibility that is uniformly distributed in the interval $[r_l, r_h]$. Because the firm does not price to extract a premium from socially conscious consumers, the firm's profits in the low-cost and responsible mass market strategies are unchanged by this extension: in both cases, the firm continues to set a price equal to v. However, the firm's profits in the responsible niche and dual sourcing strategies are affected by heterogeneous willingness to pay for responsibility, as the following argument shows.

Consider first the responsible niche strategy, in which the firm sells exclusively to socially conscious consumers. The firm's profit as a function of the selling price, $p \geq v + r_l$, is $\Pi^{RN}(p) = ((r_h - p + v)/(r_h - r_l))\theta(p - c_R)$. The optimal price is thus $p^{RN} = (r_h + v + c_R)/2$, assuming an interior solution is

optimal.[10] Observe that this can be thought of as the nonresponsible price v plus a fixed responsibility premium $(r_h - v + c_R)/2$. In other words, this is equivalent to our base model of the responsible niche strategy, with $r = (r_h - v + c_R)/2$, and with a correspondingly adjusted market size for the socially conscious segment that is less than θ. Similarly, in the dual sourcing strategy, the firm sets the price of the responsibly sourced product to maximize profit; however, since socially conscious consumers are heterogeneous, in general, some socially conscious consumers will be unwilling to purchase the responsible product at its posted selling price because their valuations are too low. To maximize their own utility, these consumers will purchase the nonresponsible product. Hence, the buyer's profit as a function of the price of the responsible product p is

$$
\begin{aligned}
&\Pi^{DS}(p) \\
&= (1 - \alpha\phi)\theta\left[\frac{r_h - p + v}{r_h - r_l}(p - c_R) + \frac{p - v - r_l}{r_h - r_l}(v - c_{NR}) \right] \\
&\quad + (1 - \theta)(v - c_{NR}) - \phi c_{VP}.
\end{aligned}
$$

The optimal price of the responsible product (again assuming that it is interior) is thus $p^{DS} = v + (r_h + c_R - c_{NR})/2$. Observe that this can be thought of as the normal nonresponsible price v plus a fixed responsibility premium $(r_h + c_R - c_{NR})/2$; thus, this is equivalent to our base model of dual sourcing, with a fixed responsibility premium equal to $(r_h + c_R - c_{NR})/2$ and market sizes for the socially conscious and non–socially conscious segments correspondingly adjusted to values that are less than θ and greater than $1 - \theta$, respectively.

Consequently, our base model is almost exactly the same as a model with heterogeneous willingness to pay for responsibility, with one key difference: the responsibility premiums in the responsible niche and dual sourcing strategies differ when consumers have heterogeneous WTP. Because $c_{NR} < v$, the responsibility premium in dual sourcing is *larger* than in responsible niche. This impacts both the price of the responsible product and the quantity of responsible product sold by the firm, and it has two further consequences. First, it implies that the quantity sourced responsibly is smaller under dual sourcing than responsible niche, but this does not qualitatively impact our results. Second, it implies that with heterogeneous willingness to pay for responsibility, dual sourcing is relatively more valuable (and responsible niche sourcing is relatively less valuable) than with homogeneous willingness to pay for responsibility.

This is because the firm cannot extract surplus as efficiently if consumers have heterogeneous willingness to pay, but with dual sourcing, the presence of a second product (the nonresponsibly sourced product) allows the firm to segment socially conscious consumers and capture some value from consumers who are unwilling to purchase the responsibly sourced product. Finally, note that because the (endogenous) responsibility premiums depend only on r_h, v, c_R, and c_{NR} and are not dependent on θ, α, ϕ, or c_{VP}, the general behavior identified in our base model persists; e.g., an increase in r_h or θ can lead to a transition from RM to DS and hence an increase in risky sourcing and a decrease in responsible sourcing. Thus, our key results from Propositions 2–4 continue to qualitatively hold when socially conscious consumers have heterogeneous willingness to pay for responsibility. This can be seen in Figure 4, which plots the buyer's optimal strategy as the willingness-to-pay distribution becomes more and more dispersed (holding the average constant). In addition, as the heterogeneity of willingness to pay increases, the region of dual sourcing optimality grows while the region of responsible niche optimality shrinks. Thus, we expect that in markets where consumer willingness to pay for responsibility is highly heterogeneous, we would observe relatively more dual sourcing and relatively less responsible niche sourcing; otherwise, our qualitative insights persist.

7.2. Heterogeneous Consumer Valuations

In our main analysis, we assumed that consumers have homogeneous base valuations for the product equal to v. In this case, the buyer finds it optimal to extract all surplus from consumers (i.e., to set a price equal to v or $v + r$, depending on the sourcing strategy and the targeted consumer segment), which implies that the procurement cost does not directly impact the selling price of the product. In practice, consumers likely have heterogeneous valuations, and the firm will set some optimal price that is a function of both the consumer valuation distribution and the procurement cost of the product. This interaction affects how the firm values each sourcing strategy, a dynamic that we explore in this section. For formal derivations of the buyer's expected profit in each sourcing strategy, we refer interested readers to the supplemental appendix (available as supplemental material at http://dx.doi.org/10.1287/mnsc.2015.2256). In what follows, we focus on managerial insights about the impact of consumer heterogeneity using qualitative discussion and selected numerical examples.

Specifically, we assume that consumers have valuations for the product uniformly distributed in the interval $[v_l, v_h]$ independent of consumer type (socially conscious or non–socially conscious). Socially

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[10] Throughout this section, we assume that interior solutions are optimal; otherwise, the optimal selling price for the responsibly sourced product is simply $v + r_l$, i.e., equivalent to our base model with homogeneous WTP for responsibility equal to r_l.

Figure 4 The Impact of Heterogeneous Willingness to Pay for Responsibility on the Firm's Optimal Sourcing Strategy

(a) $r_l = r$, $r_h = r$ (b) $r_l = 0.75r$, $r_h = 1.25r$ (c) $r_l = 0.5r$, $r_h = 1.5r$
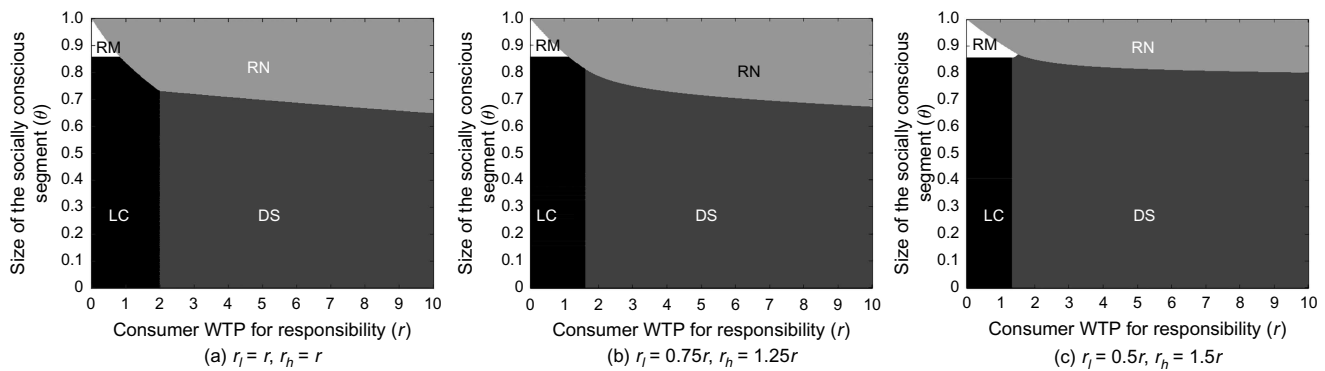
Note. In the figures, $v = 10$, $c_R = 5$, $c_{NR} = 3$, $c_{VP} = 5$, $\alpha = 0.5$, and $\phi = 0.25$.

conscious consumers are assumed to have an additional homogeneous willingness to pay for responsibility r; i.e., a socially conscious consumer with valuation $v \in [v_l, v_h]$ has valuation $v + r$ for a responsibly sourced product. The model is otherwise identical to the primary model analyzed in §§3–6. This valuation structure leads to a linear demand curve for the buyer, and ignoring the socially conscious consumer segment, if the procurement cost is c, the optimal selling price is $(v_h + c)/2$. Hence, with heterogeneous valuations, the price in each sourcing strategy potentially differs—for example, the price the buyer sets in the low-cost sourcing strategy is lower than the price the buyer sets in the responsible mass market strategy, even though the selling prices in these two strategies were identical with homogeneous valuations. We call this the "price effect" of consumer heterogeneity, and it causes heterogeneity to decrease the value of responsible sourcing strategies relative to the homogeneous valuation benchmark, as higher procurement costs lead to higher prices and less demand.

At the same time, greater heterogeneity (holding the average valuation constant) leads to higher prices and a higher margin, which in turn implies that the firm suffers more during responsibility violations because of demand loss from socially conscious consumers abandoning the firm. This implies that there is a counteracting force to the direct price effect described in the previous paragraph: heterogeneity makes risky sourcing more costly by giving the buyer more to lose during a responsibility violation, a phenomenon that we call the "lost sales" effect of consumer heterogeneity. Thus, although the same four sourcing strategies are potentially optimal when consumers have heterogeneous valuations for the product, because of the opposite nature of the price and lost sales effects, the impact of heterogeneity on the firm's choice of sourcing strategy is ambiguous.[11]

[11] We note that when consumers have heterogeneous valuations, the line between the RN and RM strategies is less discrete. Indeed,

To gain further insight, we consider a numerical example depicted graphically in Figure 5. In the example, we determine the optimality regions for each sourcing strategy as a function of consumer willingness to pay for responsibility (r) and willingness to punish for responsibility violations (α), holding the average consumer valuation ($(v_h + v_l)/2$) constant and increasing the width of the consumer valuation distribution ($V \equiv v_h - v_l$) to create a more and more heterogeneous consumer population. As the example shows, initially (as V grows from zero) either the price or lost sales effects may dominate depending on the parameter values, and hence the low-cost sourcing region grows for some parameter values (very low r and high θ) and shrinks for others; however, as V continues to increase, the lost sales effect dominates at all parameter values, and the low-cost and dual sourcing regions shrink, eventually to zero.

The example shows that although the impact of consumer valuation heterogeneity on the firm's sourcing strategy is ambiguous, if heterogeneity is very large the lost sales effect dominates, implying that responsible sourcing strategies (responsible mass market and responsible niche) are relatively more preferred when consumer valuations are highly heterogeneous. Hence, we conclude that in markets where consumer valuations are very dispersed, one

there is a continuum of strategies corresponding to each possible price between v_l (the lowest valuation of the non–socially conscious consumers) and $v_h + r$ (the highest valuation of the socially conscious consumers for a responsibly sourced product) where, in our base model, there were only two; that is, as the firm progressively sets a higher price, it excludes more non–socially conscious consumers and captures more of the surplus of socially conscious consumers. In our discussion here and our analysis in the supplemental appendix, we thus define a "responsible niche" strategy to be a strategy in which the price is so high that no non–socially conscious consumer is willing to purchase (i.e., greater than v_h); a "responsible mass market" strategy, by contrast, is a strategy involving any price such that some non–socially conscious consumers will purchase the product (i.e., less than v_h).

Figure 5   The Impact of Heterogeneous Valuations on the Firm's Optimal Sourcing Strategy

(a) $v_l = 10$, $v_h = 10$ (b) $v_l = 8.5$, $v_h = 11.5$ (c) $v_l = 7$, $v_h = 13$
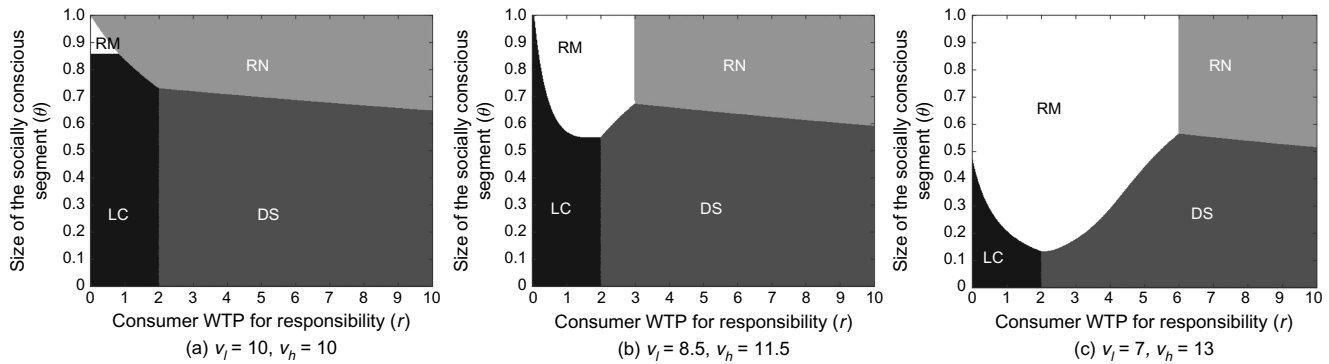
Note. In the figures, $c_R = 5$, $c_{NR} = 3$, $c_{VP} = 5$, $\alpha = 0.5$, and $\phi = 0.25$.

would expect more responsible sourcing, whereas in markets with very narrow consumer valuations, one would expect less responsible sourcing and more risky sourcing. Importantly, our key results from Propositions 2–4 continue to qualitatively hold under consumer heterogeneity, as the figure and our more formal analysis in the supplemental appendix both show.

7.3. Salvaging Excess Inventory at a Loss

In §§3–6, we assumed that any inventory unsold at the end of the selling season could be salvaged for exactly the procurement cost. This had the effect of simplifying the buyer's quantity decision (it is always optimal to source enough inventory to cover the entire market), which in turn simplified comparisons between the various sourcing strategies. In practice, however, it is likely that unsold inventory must be salvaged for less than the procurement cost, which may complicate the firm's inventory decision and, ultimately, the choice of sourcing strategy. In this section we consider this extension. Specifically, we assume that excess inventory is salvaged for a fraction $\gamma \leq 1$ of the procurement cost at the end of the season; that is, inventory sourced from the risky supplier is salvaged for γc_{NR} and inventory sourced from the responsible supplier is salvaged for γc_R. In our main analysis, we implicitly assumed $\gamma = 1$; in what follows, we consider the impact of allowing $\gamma < 1$. As with our discussion of heterogeneous consumer valuations, we include the analysis of this extension in the supplemental appendix and briefly discuss the key insights of this generalization below.

Because the size of the market is deterministic, demand uncertainty is only generated by the firm's sourcing decision and potential exposure to random responsibility violations. Thus, if the firm single-sources from the responsible supplier, as in the RN and RM strategies, there is no unsold inventory, and hence profit is equal to the expressions derived in our

main analysis. There may be unsold inventory if the firm sources from a risky supplier, as in the LC and DS strategies. Intuitively, smaller γ will decrease the buyer's profit in the LC and DS strategies as a result of a combination of a direct decrease in revenue on unsold inventory when there is a responsibility violation and, potentially, a decrease in sales even when there is no responsibility violation because the firm sources a smaller quantity because of lower salvage values.

Consequently, unlike heterogeneous consumer valuations, the impact of salvaging excess inventory at a loss is unambiguous: smaller salvage values (smaller γ) favor the responsible sourcing strategies (RN and RM) over the strategies that use the risky supplier (DS and LC), meaning the regions of optimality of RN and RM grow while the regions of optimality of DS and LC shrink as γ decreases. This implies that if products are difficult to salvage or if the supply chain is "slow" (resulting in more supply/demand mismatches and more salvaging), one would expect more responsible sourcing and less risky sourcing. Put another way, efforts to improve supply chain responsiveness and/or increase the salvage value of products may actually result in *less* responsible sourcing, because these efforts help profit more in strategies that use the risky supplier (LC and DS) than in strategies that use only the responsible supplier (RN and RM).

In addition, the result that an increase in θ or r can lead to more risky sourcing and less responsible sourcing remains true when unsold inventory is salvaged at a loss, as shown in the supplemental appendix. However, in addition to this phenomenon, when γ is sufficiently small, it is also true that an increase in either consumer willingness to punish (α) or the probability of a violation (ϕ) can lead to an increase in the quantity sourced from the risky supplier and a decrease in the quantity sourced from the responsible supplier. This happens when the

buyer's optimal strategy transitions from dual sourcing to low-cost sourcing as either parameter increases, something that could not occur when $\gamma = 1$ because the buyer's preference between DS and LC was independent of these parameters. In essence, an increase in either α or ϕ makes demand more volatile by either increasing the probability of a violation or decreasing the demand level if there is a violation; in turn, this means that the LC strategy (in which all inventory is procured at a low cost, meaning unsold inventory results in a smaller loss in profit to the buyer) can become more attractive than the DS strategy (in which inventory for the socially conscious segment is procured at a high cost, leading to large excess inventory losses if there is a violation). Put another way, the DS strategy is less robust to demand volatility because it faces a higher procurement cost for the socially conscious segment than the LC strategy; by increasing α or ϕ, demand volatility is increased, which can make the buyer switch to an LC strategy.

Because of this result, costly salvaging can lead to an even more problematic scenario for the overall level of supply chain responsibility: the surprising phenomenon that greater external pressure can cause the buyer to source less responsibly not only holds for the size of the socially conscious segment (θ) and consumer willingness to pay for responsibility (r) but also extends to pressure from punishment by consumers (α) and detection effort from NGOs (ϕ). Numerically, we observe that this only happens when γ is very small, i.e., when products have a very low salvage value, and the parameter region over which it occurs is typically narrow (meaning that the phenomenon is not encountered with especially large frequency), but nevertheless, this shows that external pressure is even more likely to backfire when unsold inventory is salvaged at a heavy loss. This suggests that for products that have a high fashion element (meaning that excess inventory has very little value), consumer willingness to punish and increased detection effort might be less effective in influencing the buyer's sourcing strategy than for products that have a low fashion element. Importantly, the direct costs of a violation (c_{VP}) continue to unambiguously decrease risky sourcing and increase responsible sourcing, implying that direct fines or penalties are less susceptible to backfiring than other inducement efforts.

8. Conclusion

Social and environmental responsibility are becoming increasingly critical aspects of supply chain management for both firms and the general public. Within this broad topic, a key issue is how sourcing decisions should be made when suppliers are heterogeneous with regard to responsibility. It is this topic

that we have explored, with a focus on understanding the drivers of responsible sourcing in supply chains. We find that each of four possible sourcing strategies—low-cost sourcing (sourcing all product from the risky supplier), dual sourcing (sourcing from both supplier types), responsible niche sourcing (sourcing from a responsible supplier and selling the product only to socially conscious consumers), and responsible mass market sourcing (sourcing responsibly and selling to all consumers)—may be optimal under different circumstances, and we examine the role of supplier, consumer, and operational characteristics in determining the optimal sourcing strategy.

Our results provide guidance to firms on the trade-offs underlying responsible sourcing and help to illustrate when different sourcing strategies are optimal. When consumers have low willingness to pay for responsibility, it is optimal to either source all product from the risky supplier or source all product from the responsible supplier; when consumers have high willingness to pay, it may be optimal to dual-source from both suppliers. Moreover, because firm profit is convex in the fraction of socially conscious consumers, firms may wish to embark on education campaigns to increase consumer awareness of responsibility issues while simultaneously adjusting their sourcing strategy. Taken as a whole, our results show that responsibility risk differs from other types of supply chain risk—such as demand uncertainty or supply risk—and this necessitates thinking about both sourcing and selling strategies in a unified way. Although this conclusion seems to be gaining increasing traction in practice (Porteous et al. 2012), less attention has been focused on these interactions in the academic community. Given the increasing frequency and consequences of responsibility violations in modern supply chains, it is clear that the value of an integrative approach to supply chain management that considers both operational performance and responsibility will continue to grow.

In addition, our results offer actionable recommendations for policymakers, NGOs, and consumers on how best to encourage increased social and environmental responsibility from firms. We find that an increase in either the number of socially conscious consumers or consumer willingness to pay for responsibility may lead to a decrease in responsible sourcing and an increase risky sourcing. These counterintuitive behaviors occur when a change in the consumer population causes the firm to switch sourcing strategies, potentially abandoning a more responsible sourcing strategy for a less responsible one. Supply chain transparency may also result in an increase in risky sourcing. By contrast, as long as inventory salvage values are not too low, increases in consumer

willingness to punish for violations (α), the probability of a violation (ϕ), or the cost penalty incurred during a violation (c_{VP}) unambiguously *reduce* the profitability of strategies using the risky supplier, and hence they increase the incidence of responsible sourcing. Third parties such as NGOs might increase the probability of detecting a violation by, for example, inspecting factories more frequently or initiating undercover investigations; governments might increase the cost of a violation by establishing harsher fines for companies purchasing from violating suppliers. Our results suggest that such efforts to increase responsible sourcing by focusing on detection or penalties are less likely to produce unintended consequences than efforts that influence the consumer market characteristics, which might cause the buyer to negatively respond by adjusting its sourcing strategy.

Our study is not without limitations. We assumed that the level of responsibility of suppliers is exogenous, but in practice, suppliers may themselves alter their responsibility practices in response to the buyer's sourcing policies. Hence, endogenous responsibility—and competition between suppliers on responsibility—may be a fruitful direction for future work. In addition, we assumed that all information about supplier responsibility is known to the buyer; although this is justified if the buyer is capable of exerting effort before the contracting phase to discover information about its potential suppliers, in many cases, suppliers are likely to know more about their own level of responsibility than potential buyers despite the buyers' best efforts. Hence, an exploration of the impact of asymmetric information on the buyer's sourcing strategies—and the efforts of external stakeholders to improve responsibility—may prove interesting. Last, we modeled a monopolistic buyer; exploring the interplay between competition in the consumer market and the sourcing behavior of multiple buyers may yield further insight into both the optimal sourcing strategies for buyers and the most effective ways for external stakeholders to improve responsibility in supply chains comprising many firms.

Although there are many aspects of social responsibility in supply chains that we have not explored here, our results illustrate the key roles that consumers, firms, and policymakers all take in determining whether a firm sources responsibly. As supply chains continue to grow in both length and breadth, exposing firms to risks from an ever-expanding number and type of suppliers, the importance of these effects will only increase. It is thus our hope that this work serves a first step in helping firms understand when to source responsibly and helping consumers and policymakers understand how to encourage firms to do so.

Supplemental Material

Acknowledgments

Appendix. Proofs and Additional Results

PROOF OF PROPOSITION 1. Comparing profit expressions, we see that low-cost sourcing is preferred to dual sourcing if and only if $r < c_R - c_{NR} = \Delta$; hence we may ignore dual sourcing in this case. Low-cost sourcing is preferred to the responsible mass market strategy if $(v - c_R) < (v - c_{NR})(1 - \phi\alpha\theta) - \phi c_{VP}$, which is equivalent to $\phi[\alpha\theta(v - c_{NR}) + c_{VP}] < c_R - c_{NR} = \Delta$. Further, low-cost sourcing is preferred to the responsible niche strategy if $\theta(v + r - c_R) < (v - c_{NR})(1 - \phi\alpha\theta) - \phi c_{VP}$, which is equivalent to $\phi[\alpha\theta(v - c_{NR}) + c_{VP}] < (v - c_{NR}) - \theta(v + r - c_R)$. If both conditions are satisfied, low-cost sourcing is optimal. Conversely, if $r > (v - c_R)((1 - \theta)/\theta)$, responsible niche sourcing dominates responsible mass market sourcing. Thus, if low-cost sourcing is not optimal, the above inequality determines whether responsible niche or mass market is preferred. Conversely, dual sourcing is preferred to low-cost sourcing if and only if $r > c_R - c_{NR} = \Delta$; hence low-cost sourcing is dominated in this regime and may be excluded from the analysis. Dual sourcing is further preferred to responsible niche sourcing if $(1 - \alpha\phi)\theta(v + r - c_R) + (1 - \theta)(v - c_{NR}) - \phi c_{VP} > \theta(v + r - c_R)$. This can be written as $\phi[c_{VP} + \alpha\theta(v + r - c_R)] < (1 - \theta)(v - c_{NR})$. Dual sourcing is preferred to responsible mass market sourcing if $(1 - \alpha\phi) \cdot \theta(v + r - c_R) + (1 - \theta)(v - c_{NR}) - \phi c_{VP} > (v - c_R)$, which can be written as $\phi[c_{VP} + \alpha\theta(v + r - c_R)] < \theta r + (1 - \theta)\Delta$. If both conditions are satisfied, dual sourcing is optimal. Conversely, if $r > (v - c_R)((1 - \theta)/\theta)$, responsible niche sourcing dominates responsible mass market sourcing. Thus, if dual sourcing is not optimal, the above inequality determines whether responsible niche or mass market is preferred. □

PROOF OF PROPOSITION 2. The proof follows immediately from Proposition 1, where the critical values of θ and r can be found by solving for the points at which expected profit in strategies RM and RN are equal. □

PROOF OF PROPOSITION 3. The proof of part (i) is identical to Proposition 2. Part (ii) follows immediately from Proposition 1, where the critical values of θ and r can be found by solving for the points at which expected profit in strategies RM and DS are equal.

PROOF OF PROPOSITION 4. If $r < \Delta$, the only optimal strategies are LC, RN, and RM. Profit in RN and RM is independent of α, c_{VP}, and ϕ, whereas profit in LC is decreasing in these parameters. Hence, an increase in any of these

parameters only decreases the attractiveness of LC relative to the other two sourcing strategies, meaning q_{NR}^* can only decrease and q_R^* can only increase. If $r > \Delta$, LC is replaced by DS as an optimal strategy, and profit in DS is decreasing in α, c_{VP}, and ϕ. Hence, an increase in any of these parameters only decreases the attractiveness of DS relative to the other two sourcing strategies, meaning q_{NR}^* can only decrease and q_R^* can only increase. $\square$

PROOF OF PROPOSITION 5. Parts (i) and (ii) follow because firm profit is monotone (with the same sign) in each parameter under any given sourcing strategy and hence must be monotone in the optimal strategy as well. Part (iii) follows because firm profit is decreasing in θ under the low-cost and dual sourcing strategies, independent of θ in the responsible mass market strategy, and increasing in θ in the responsible niche strategy. Given the sequence of these optimal strategies in Proposition 1, it follows that profit in the optimal strategy is convex in θ. $\square$

PROOF OF PROPOSITION 6. For part (i), $\Pi^{RDB} = v + \theta r - c_R$ and $\Pi^{LCDB} = (1 - \alpha\phi)\theta(v + r - c_{NR}) + (1 - \theta)(v - c_{NR}) - \phi c_{VP}$, and as noted in the discussion, these strategies dominate the four strategies derived for a transparent supply chain. Hence, LCDB is optimal if $\phi[\alpha\theta(v + r - c_{NR}) + c_{VP}] < \Delta$, and RDB is optimal otherwise. For part (ii), suppose $r < (v - c_R) \cdot ((1 - \theta)/\theta)$. Note that if $r < \Delta$, low-cost sourcing is optimal in a transparent supply chain if $\phi[\alpha\theta(v - c_{NR}) + c_{VP}] < \Delta$. Rewriting $\phi[\alpha\theta(v + r - c_{NR}) + c_{VP}] < \Delta$ as $\phi[\alpha\theta(v - c_{NR}) + c_{VP}] < \Delta - \phi\alpha\theta r$, we see that low-cost sourcing happens more often in a transparent supply chain if $r < \Delta$; i.e., the condition for LC to be optimal in a transparent supply chain is weaker than the condition for LCDB to be optimal in a nontransparent supply chain. Conversely, if $r > \Delta$, in a transparent supply chain, the buyer only sources from the risky supplier if DS is optimal, which happens if $\phi[\alpha\theta(v + r - c_{NR}) + c_{VP}] < \Delta(1 - \theta) + \theta r$, where $\Delta(1 - \theta) + \theta r > \Delta$. In a nontransparent supply chain, the buyer only sources from the risky supplier if $\phi[\alpha\theta(v + r - c_{NR}) + c_{VP}] < \Delta$; i.e., sourcing from a risky supplier is less likely in a nontransparent supply chain as the condition is stronger than in a transparent supply chain, implying $\Omega_{NR}^{NT} \subset \Omega_{NR}^T$. However, we note that if $\phi[\alpha\theta(v + r - c_{NR}) + c_{VP}] < \Delta$, in a transparent supply chain, the firm sources partially from the responsible supplier, whereas in a nontransparent supply chain, the firm sources entirely from the risky supplier. $\square$

PROPOSITION 7. *When $r < \Delta$,*
(i) *The buyer's optimal sourcing strategy as a function of θ transitions from RM to RN if and only if*

$$\frac{v - c_{NR} - \phi c_{VP}}{\alpha\phi(v - c_{NR}) + (v + r - c_R)} < \frac{v - c_R}{v + r - c_R}.$$

(ii) *The buyer's optimal sourcing strategy as a function of r transitions from RM to RN if and only if $\phi[\alpha\theta(v - c_{NR}) + c_{VP}] > \Delta$.*

PROOF. For part (i), because profit in strategy LC is decreasing in θ, profit in RM is independent of θ, and profit in RN is increasing in θ, the RM to RN transition happens if and only if the intersection of LC and RN is at a smaller θ than the intersection of RM and RN. The former intersection point is $\theta' = ((v - c_{NR}) - \phi c_{VP})/(\alpha\phi(v - c_{NR}) + (v + r - c_R))$,

whereas the latter is $\theta'' = (v - c_R)/(v + r - c_R)$; $\theta' < \theta''$ if and only if the condition in the proposition holds. Because the denominator on the left-hand side is greater than the denominator on the right-hand side, a sufficient condition for this to hold is $\Delta < \phi c_{VP}$, which implies that LC is never optimal regardless of the value of θ, ensuring a transition from RM to RN must occur as θ increases. For part (ii), because profit in strategies LC and RM are both independent of r, and profit in RN is increasing in r, the optimal strategy transitions from RM to RN if and only if RM is preferred to LC given all other problem parameters. This happens if $\Delta < \phi[\alpha\theta(v - c_{NR}) + c_{VP}]$. Note that if $\Delta < \phi c_{VP}$, then this holds for any θ; hence $\Delta < \phi c_{VP}$ is also a sufficient condition to ensure part (ii) of the proposition. $\square$

PROPOSITION 8. *When $r > \Delta$,*
(i) *The buyer's optimal sourcing strategy as a function of θ transitions from RM to RN if and only if*

$$\frac{(v - c_{NR}) - \phi c_{VP}}{(v - c_{NR}) + \alpha\phi(v + r - c_R)} < \frac{v - c_R}{v + r - c_R}.$$

(ii) *The buyer's optimal sourcing strategy as a function of r transitions from RM to RN if and only if $(1 - \theta)(v - c_{NR}) < \phi[c_{VP} + \alpha(v - c_R)]$.*

(iii) *The buyer's optimal sourcing strategy as a function of θ transitions from RM to DS if and only if*

$$\frac{\Delta - \phi c_{VP}}{(v - c_{NR}) - (1 - \alpha\phi)(v + r - c_R)} < \frac{v - c_R}{v + r - c_R}.$$

(iv) *The buyer's optimal sourcing strategy as a function of r transitions from RM to DS if and only if $\phi[c_{VP} + \alpha(v - c_R)] < (v - c_{NR})(1 - \theta)$.*

PROOF. For part (i), the RM to RN transition happens if and only if the intersection of DS and RN is at a smaller θ than the intersection of RM and RN. The former intersection point is $\theta' = ((v - c_{NR}) - \phi c_{VP})/((v - c_{NR}) + \alpha\phi(v + r - c_R))$, whereas the latter is $\theta'' = (v - c_R)/(v + r - c_R)$; $\theta' < \theta''$ if and only if the condition in the proposition holds. Note that $\Delta < \phi c_{VP}$ is no longer a sufficient condition for this inequality to hold. For part (ii), profits in DS and RN are both increasing in r (but DS increases more slowly), whereas profit in RM is independent of r. Hence, the RM to RN transition happens if and only if the intersection of DS and RN occurs at smaller r than the intersection of RN and RM. The former intersection point is $r' = ((1 - \theta)(v - c_{NR}) - \phi c_{VP})/\theta\alpha\phi - (v - c_R)$, whereas the latter is $r'' = (v - c_R)((1 - \theta)/\theta)$. $r' < r''$ if and only if the condition in the proposition holds. For part (iii), the transition from RM to DS happens if the intersection of RM and DS is at smaller θ than the intersection of RM and RN. The former intersection point is $\theta' = (\Delta - \phi c_{VP})/((v - c_{NR}) - (1 - \alpha\phi)(v + r - c_R))$, whereas the latter is $\theta'' = (v - c_R)/(v + r - c_R)$. $\theta' < \theta''$ if and only if the condition in the proposition holds. For part (iv), the transition from RM to DS happens if the intersection of RM and DS is at smaller r than the intersection of RM and RN. The former intersection point is $r' = (\phi[c_{VP} + \alpha\theta(v - c_R)] - (1 - \theta)\Delta)/(1 - \alpha\phi)\theta$, whereas the latter is $r'' = (v - c_R)((1 - \theta)/\theta)$. $r' < r''$ if and only if the condition in the proposition holds—precisely the opposite of

the condition in part (ii)—which implies that there is either a transition from RM to DS or a transition from RM to RN as r increases if $r > \Delta$. □

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