In this document, we analyze two alternative assumptions from the model discussed in the main text: heterogeneous base valuations for the product (§1) and a salvage value less than the production cost (§2).

1 Heterogeneous Base Valuations

In this section, we allow consumers’ base valuations for the product to be uniformly distributed on the interval \([v_l, v_h]\), independent of consumer type (socially conscious or non-socially conscious), where \(V = v_h - v_l\) is defined as the width of the consumer valuation distribution. Socially conscious consumers are assumed to have homogenous, additive willingness-to-pay for responsibility equal to \(r\), i.e., a socially conscious consumer with base valuation \(v \in [v_l, v_h]\) is willing to pay \(v + r \in [v_l + r, v_h + r]\) for a responsibly sourced product. Our goal is to demonstrate that two of our key results from the main paper continue to hold under this alternative assumptions, specifically:

1. An increase in consumer WTP for responsibility or the size of the socially conscious segment can lead to a decrease in responsible sourcing and an increase in risky sourcing

2. Mechanisms penalize the buyer such as increased detection probability, increased consumer willingness-to-punish, and increased penalties always lead to more responsible sourcing and less risky sourcing.

We refer to these as results 1 and 2 throughout this document. We first derive the firm’s optimal profit under each of the four sourcing strategies discussed in the main text of the paper, and then we confirm the two key results listed above. In what follows, we focus on interior solutions (i.e., points at which the optimal price lies in the interior of the consumer valuation distribution’s support); boundary solutions are similar to the case of homogenous consumer valuations (i.e., if the optimal price is the lower bound of the consumer valuation distribution, \(v_l\), the results are similar to the results in the main text of the paper with the homogenous valuation


In a transparent supply chain, it is easy to see that the same four sourcing strategies are feasible as in the case of homogenous base valuations. However, we note that when consumers have heterogeneous valuations, the line between the RN and RM strategies is less discrete. Indeed, 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 analysis below, 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 \( v_h \)). The low cost and dual sourcing strategies are defined analogously to the base model.

We begin our analysis with the low cost sourcing strategy, i.e., sourcing all product from the risky supplier:

**Proposition 1.** With heterogeneous base valuations in the low cost sourcing strategy,

(i) The buyer’s optimal selling price is \( p^{LC} = \frac{v_h + \epsilon_{NR}}{2} \).

(ii) The buyer’s optimal sourcing quantity is \( q^{LC} = \frac{v_h - \epsilon_{NR}}{2V} \).

(iii) The buyer’s optimal expected profit is \( \Pi^{LC} = (1 - \phi \alpha \theta) \frac{(v_h - \epsilon_{NR})^2}{4V} - \phi \epsilon_V P \).

Proof. The buyer’s expected profit in strategy LC as a function of price is

\[
\Pi^{LC}(p) = (1 - \phi \alpha \theta) \left( \frac{v_h - p}{V} (p - \epsilon_{NR}) \right) - \phi \epsilon_V P.
\]

Maximizing over \( p \) leads to part (i). The quantity as a function of price is \( q(p) = \frac{v_h - p}{V} \), which leads to part (ii). Part (iii) follows from substituting the optimal price in part (i) to the above profit function.

With dual sourcing, the buyer’s pricing decision is slightly more complicated than in the low cost sourcing strategy due to potential issues of product line design and cannibalization (Moorthy 1984): socially conscious consumers might purchase either the responsibly sourced or non-responsibly sourced product, depending on the prices of each. Let \( p_R \) be the price of the responsible product, and let \( p_{NR} \) be the price of the non-responsible product in a dual sourcing strategy. A socially conscious consumer with valuation \( v \) will purchase the responsible product if \( v + r - p_R \geq v - p_{NR} \), i.e., if \( r \geq p_R - p_{NR} \). Noting that this condition is independent of the individual valuation of the consumer, it is clear that all socially conscious consumers who are willing to purchase a product
will purchase the responsibly sourced product, provided \( r \geq p_R - p_{NR} \). Thus, to dual source and achieve market segmentation, the buyer must set \( r \geq p_R - p_{NR} \); if this condition is violated, all socially conscious consumers want to buy the non-responsible product, hence the buyer should use strategy LC. This observation leads us to the following result:

**Proposition 2.** With heterogeneous base valuations in the dual sourcing strategy, if \( r < \Delta \), market segmentation cannot be profitably achieved and low cost sourcing dominates dual sourcing. If \( r \geq \Delta \), dual sourcing dominates low cost sourcing and:

(i) The buyer’s optimal selling prices are \( p_{DS}^{NR} = \frac{v_h + c_{NR}}{2} \) for the non-responsibly sourced product and \( p_{DS}^{R} = \frac{v_h + r + c_{R}}{2} \) for the responsibly sourced product.

(ii) The buyer’s optimal sourcing quantities are \( q_{DS}^{NR} = (1 - \theta) \frac{v_h - c_{NR}}{2V} \) and \( q_{DS}^{R} = \theta \frac{v_h + r - c_{R}}{2V} \).

(iii) The buyer’s optimal expected profit is \( \Pi_{DS} = (1 - \alpha \phi) \theta \frac{(v_h + r - c_{R})^2}{4V} + (1 - \theta) \frac{(v_h - c_{NR})^2}{4V} - \phi c_{VP} \).

**Proof.** The buyer’s expected profit in strategy DS as a function of the product prices is

\[
\Pi_{DS}(p_R, p_{NR}) = (1 - \theta) \left[ \frac{v_h - p_{NR}}{V} (p_{NR} - c_{NR}) \right] + (1 - \phi \alpha) \theta \left[ \frac{v_h + r - p_R}{V} (p_R - c_R) \right] - \phi c_{VP}.
\]

This function is separable in \( p_R \) and \( p_{NR} \) (provided \( r \geq p_R - p_{NR} \)) and is maximized at \( p_{NR} = \frac{v_h + c_{NR}}{2} \) and \( p_R = \frac{v_h + r + c_{R}}{2} \). Observe that \( p_R - p_{NR} = \frac{r + \Delta}{2} \). Hence, if \( r \geq \Delta \), the condition \( r \geq p_R - p_{NR} \) is satisfied, leading to parts (i) - (iii) of the proposition. Moreover, it is easy to see that buyer profit exceeds the profit in strategy LC in this case. Conversely, if \( r < \Delta \), the buyer cannot achieve segmentation at the unconstrained optimal prices. This implies that the buyer’s profit is bounded above by

\[
\Pi_{DS} < (1 - \alpha \phi) \theta \frac{(v_h - c_{NR})^2}{4V} + (1 - \theta) \frac{(v_h - c_{NR})^2}{4V} - \phi c_{VP} = \Pi_{LC}^0,
\]

i.e., the buyer prefers LC in this regime.

\[\square\]

In the responsible niche strategy, the buyer ignores the non-socially conscious consumer segment and sources only from the responsible supplier, selling only to socially conscious customers at a premium price greater than \( v_h \), the upper bound of the normal consumer segment valuation distribution. To follow this strategy, the firm forgoes sourcing for and selling to the normal consumer segment, hence leading to the following proposition:

**Proposition 3.** With heterogeneous base valuations in the responsible niche sourcing strategy,
The buyer’s optimal selling price is
\[ p_{RN} = \frac{v_h + r + c_R}{2}. \]

The buyer’s optimal sourcing quantity is
\[ q_{RN} = \frac{\theta (v_h + r - c_R)}{2V}. \]

The buyer’s optimal expected profit is
\[ \Pi_{RN} = \theta \frac{(v_h + r - c_R)^2}{4V}. \]

Proof. The buyer’s profit in strategy RN is, given that \( p > v_h \),
\[ \Pi_{RN}(p) = \theta \left[ \frac{v_h + r - p}{V} (p - c_R) \right]. \]
Optimizing over price leads to the results in the proposition.

Note that this strategy is only potentially optimal if consumer willingness-to-pay for responsibility is sufficiently high (i.e., if \( r > v_h - c_R \)); otherwise, at the optimal price for the socially conscious segment, some normal consumers are willing to purchase the product. In this case, selling only to socially conscious consumers is clearly not an optimal strategy as the firm can, at no cost, also sell to non-socially conscious consumers at the same price; this observation leads us to the fourth and final sourcing strategy, the responsible mass market strategy, in which the firm sources responsibly and sets a single price less than \( v_h \), selling to both consumer segments:

Proposition 4. With heterogeneous base valuations in the responsible mass market strategy,

(i) The buyer’s optimal selling price is
\[ p_{RM} = \frac{v_h + \theta r + c_R}{2}. \]

(ii) The buyer’s optimal expected selling quantity is
\[ q_{RM} = \frac{v_h + \theta r - c_R}{2V}. \]

(iii) The buyer’s optimal expected profit is
\[ \Pi_{RM} = \frac{(v_h + \theta r - c_R)^2}{4V}. \]

Proof. The buyer’s profit in strategy RM is, given that \( p < v_h \),
\[ \Pi_{RM}(p) = \left[ (1 - \theta) \frac{v_h - p}{V} + \theta \frac{v_h + r - p}{V} \right] (p - c_R) \]
\[ = \left[ \frac{v_h + \theta r - p}{V} \right] (p - c_R). \]
Optimizing over price leads to the results in the proposition.

Having derived the firm’s optimal price, sourcing quantity, and profit in each strategy, we may now move to confirming the key results of our main analysis. The results of the propositions are summarized in Table 1.
Sourcing Strategy

<table>
<thead>
<tr>
<th>Sourcing Strategy</th>
<th>( q_{NR} )</th>
<th>( q_R )</th>
<th>Buyer’s Expected Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Cost (LC)</td>
<td>( \frac{v_l-c_{NR}}{2V} )</td>
<td>0</td>
<td>((1-\alpha\theta)\left(\frac{v_l-p-c_{NR}}{V}\right) - \phi v_{VP} )</td>
</tr>
<tr>
<td>Dual Sourcing (DS)</td>
<td>( (1-\theta)\frac{v_l-c_{NR}}{2V} )</td>
<td>( \theta \frac{v_R+r-c_{NR}}{2V} )</td>
<td>((1-\alpha\theta)\theta \left(\frac{(v_l+r-c_{NR})}{V}\right)^2 ) + ((1-\theta)\left(\frac{v_l-c_{NR}}{V}\right)^2 ) - \phi v_{VP}</td>
</tr>
<tr>
<td>Responsible Niche (RN)</td>
<td>0</td>
<td>( \theta \frac{v_{NR}+r-c_{NR}}{2V} )</td>
<td>( \theta \left(\frac{(v_{NR}+r-c_{NR})}{V}\right)^2 )</td>
</tr>
<tr>
<td>Responsible Mass Market (RM)</td>
<td>0</td>
<td>( \frac{v_R+r-c_{NR}}{2V} )</td>
<td>( \left(\frac{v_R+r-c_{NR}}{V}\right)^2 )</td>
</tr>
</tbody>
</table>

Table 1. The four sourcing strategies when consumers have heterogeneous valuations for the product.

Figure 1. An example of the buyer’s profit in strategies DS, RN, and RM with heterogeneous valuations for the product, as a function of \( \theta \).

We begin by confirming that result 1—that it is possible for the quantity sourced from the risky supplier to increase and the quantity sourced from the responsible supplier to decrease as either the size of the socially conscious segment or their willingness-to-pay for responsibility increases—continues to hold with heterogeneous valuations. Deriving precise conditions for this event is cumbersome given the quadratic form of the buyer’s profit function with heterogeneous valuations hence; hence, we simply show by example that this result can occur.

From Table 1, it’s clear that within a given sourcing strategy, the quantity sourced from the risky supplier is (weakly) decreasing in \( \theta \), while the quantity sourced from the responsible supplier is (weakly) increasing in \( \theta \) and \( r \). Hence, result 1 only occurs at the transition between two strategies. Note that the responsibly sourced quantity is greater in RM than in DS, and the risky quantity is greater in DS than in RM, so a transition from RM to DS as either \( r \) or \( \theta \) increases is sufficient to generate the result. We focus on the case when \( r > \Delta \) and, as a result, DS dominates LC, and to show that this behavior can occur we provide examples of the RM to DS transition both as a function of \( \theta \) and \( r \).

Beginning with \( \theta \), Figure 1 (a) provides an example of result 1, using parameters \( v_l = 3 \), \( v_R = 10 \), \( c_R = 6 \), \( c_{NR} = 5 \), \( c_{VP} = 3 \), \( \phi = 0.2 \), \( \alpha = 0 \), and \( r = 10 \). The figure illustrates that the optimal strategy for low \( \theta \) is RM, for intermediate \( \theta \) is DS, and for high \( \theta \) is RN. Hence, the buyer’s optimal sourcing strategy progresses from RM to DS as \( \theta \) increases, leading to result 1. Moving to \( r \), Figure 1 (b) illustrates result 1 using the same
parameters as Figure 1 (a), except as a function of \( r \) with \( \theta \) fixed at 0.15. As the figure shows, the optimal strategy transitions from RM to DS as \( r \) increases, which illustrates that result 1 can occur.

Moving next to result 2, we note that LC is preferred to DS if and only \( r > \Delta \), the same condition as in the base model. Moreover, profit in strategies LC and DS is unambiguously decreasing in \( \alpha, c_{VP} \), and \( \phi \). As these two strategies are the only ones that involve sourcing from the risky supplier, and only one of these strategies is optimal given a particular value of \( r \) (and this is independent of \( \alpha, c_{VP} \), and \( \phi \)), we see that an increase in \( \alpha, c_{VP} \), and \( \phi \) can only decrease the attractiveness of these strategies and hence the quantity sourced from the risky supplier. Similarly, an increase in \( \alpha, c_{VP} \), and \( \phi \) can only (weakly) increase the quantity sourced from the responsible supplier, proving that result 2 continues to hold.

\section{Costly Salvaging}

In this section, we return to our base model with homogenous valuations for the product and willingness-to-pay for responsibility, but allow unsold inventory to be salvaged for less than the buyer’s procurement cost at the end of the season. Specifically, we assume that excess inventory is salvaged for a fraction \( \gamma \leq 1 \) of the procurement cost. Because demand is only stochastic if the buyer sources from the risky supplier (due to random responsibility violations), this generalization only impacts the buyer’s profit in the LC and DS strategies. Expected profit as a function of the sourcing quantity in the low cost sourcing strategy is

\[
\Pi^{LC}(q) = (v - \gamma c_{NR})[(1 - \phi) \min(q, 1) + \phi \min(q, 1 - \alpha\theta)] - c_{NR}(1 - \gamma)q - \phi c_{VP}.
\]

This is a newsvendor profit function with a two point demand distribution; as such, the optimal sourcing quantity is either equal to 1 (high demand; if there is no responsibility violation) or \( 1 - \alpha\theta \) (low demand; if there is a violation and some socially conscious consumers exit). Comparing profit under each strategy, it can be seen that sourcing a large quantity is preferred if and only if \( \phi \leq \frac{v - \gamma c_{NR}}{v - c_{NR}} \). Hence,

\begin{proposition}
In the low cost sourcing strategy, the buyer’s optimal profit is:
1. \( \Pi^{LC} = (v - c_{NR})(1 - \theta) + [(v - \gamma c_{NR})(1 - \alpha\phi) - c_{NR}(1 - \gamma)]\theta - \phi c_{VP} \) if \( \phi \leq \frac{v - c_{NR}}{v - \gamma c_{NR}} \).
2. \( \Pi^{LC} = (v - c_{NR})(1 - \theta) + (v - c_{NR})(1 - \alpha)\theta - \phi c_{VP} \) otherwise.
\end{proposition}
The buyer’s profit as a function of the sourcing quantities under the dual sourcing strategy is

\[ \Pi^{DS}(q_{NR}, q_R) = v \min(q_{NR}, 1 - \theta) - c_{NR}q_{NR} - c_R(1 - \gamma)q_R - \phi c_V P + (v + r - \gamma c_R) [(1 - \phi) \min(q_R, \theta) + \phi \min(q_R, (1 - \alpha)\theta)]. \]

It is clearly optimal to source \( q_{NR} = 1 - \theta \) from the risky supplier for the non-socially conscious consumers. For the socially conscious segment, the buyer should source either \( \theta \) or \((1 - \alpha)\theta\). Comparing profits under both sourcing quantities,

**Proposition 6.** In the dual sourcing strategy, the buyer’s optimal profit is:

1. \( \Pi^{DS} = (v - c_{NR})(1 - \theta) + [(v + r - \gamma c_R)(1 - \alpha \phi) - c_R(1 - \gamma)] \theta - \phi c_V P \) if \( \phi \leq \frac{v + r - c_R}{v + r - \gamma c_R} \)

2. \( \Pi^{DS} = (v - c_{NR})(1 - \theta) + (v + r - c_R)(1 - \alpha)\theta - \phi c_V P \) otherwise.

Profit in the RN and RM strategies is identical to that in the base model, i.e., \( \Pi^{RN} = \theta(v + r - c_R) \) and \( \Pi^{RM} = (v - c_R) \). Clearly, profit in the LC and DS strategies is lower when \( \gamma < 1 \) than when \( \gamma = 1 \) (as in the main text). Hence, a smaller salvage value favors responsible sourcing via the RN and RM strategies over the LC and DS strategies. Conversely, this implies that higher salvage values can lead to less responsible sourcing, because increasing \( \gamma \) increases the buyer’s profit in the LC and DS strategies without affecting profit in the RN and RM strategies.

To see how this generalization impacts key base model results (results 1-2 listed in §1 of this document), we focus on the special case of \( \phi \leq \min\left(\frac{v + r - c_R}{v + r - \gamma c_R}, \frac{v - c_{NR}}{v - \gamma c_{NR}}\right) \), i.e., case (1) in both of the above propositions, and \( \gamma = 0 \) (this is the extreme case of unsold inventory having zero value).\(^1\) Under these two assumptions, the optimal profit and sourcing quantities for each strategy are depicted in Table 2. First, we note that the buyer’s profit in the DS strategy can be increasing in \( r \) and \( \theta \). This is clearly true in case (2) of the above proposition.

\(^1\)This is reasonable if responsibility violations are not very likely, i.e., the probability of a violation is less than the percentage margin on the product. The alternative case in which the probability of a violation is large follows in a similar manner.
Figure 2. An example of the buyer’s optimal strategy as a function of $\alpha$ and $r$. In the example, $v = 10$, $c_R = 5$, $c_{NR} = 3$, $c_{VP} = 4$, $\theta = 0.1$, $\phi = 0.2$, and $\gamma = 0$.

(under some conditions), and is also true in case (1), since:

$$\frac{d\Pi_{DS}}{d\theta} = r - \Delta - \alpha \phi (v + r) > 0 \text{ if } r > \frac{\Delta + \alpha \phi v}{1 - \alpha \phi}$$

$$\frac{d\Pi_{DS}}{dr} = (1 - \alpha \phi) \theta > 0$$

Hence, a transition in the buyer’s optimal strategy from RM to DS is possible as both $\theta$ and $r$ increase. Since the risky sourcing quantity is 0 in RM and $1 - \theta$ in DS, and the responsible sourcing quantity is 1 in RM and either $\theta$ or $(1 - \alpha) \theta$ (both less than 1) in DS, this implies that result 1 can still occur even with costly salvaging.

Next, observe that DS is preferred to LC if and only if

$$r(1 - \alpha \phi) > \Delta.$$ 

Note that this is a stronger condition than in our base model, i.e., DS is preferred less frequently, because costly salvaging makes dual sourcing less attractive as unsold inventory in a dual sourcing strategy (procured at cost $c_R$) is more expensive than unsold inventory in a low cost sourcing strategy (procured at cost $c_{NR}$). Note that an increase in $\alpha$ or $\phi$ makes the buyer less likely to use dual sourcing than low cost sourcing, i.e., an increase in $\alpha$ or $\phi$ could conceivably lead to a strategy transition from DS to LC. This implies that result 2 may not continue to hold—that is, an increase in $\alpha$ or $\phi$ could lead to more risky sourcing and less responsible sourcing.

To see that this is true, consider the numerical example depicted in Figure 2. In the plotted region, only LC and DS are ever optimal, and for moderate $r$ (around $2 - 2.5$ in the figure), an increase in $\alpha$ from zero leads to a transition from DS to LC. Similar examples can also be found for the buyer’s strategy as a function of $\phi$. Hence, the surprising counterintuitive result that greater external pressure can cause the buyer to source less responsibly also extends to pressure from punishment by consumers ($\alpha$) and detection effort from NGOs ($\phi$) when salvaging is costly. Numerically, we observe that this only happens when $\gamma$ is sufficiently small, i.e.,
when products have a very low salvage value, and the parameter region over which it occurs is typically narrow (meaning the phenomenon is not encountered with especially large frequency), but nevertheless the result that greater punishment efforts always lead to less risky sourcing and more responsible sourcing is no longer strictly true.

Note that an increase in $c_{VP}$, on the other hand, does not impact the buyer’s preferences between LC and DS, and thus can only decrease the relatively attractiveness of both of these strategies equally, leading to an unambiguous decrease in risky sourcing and increase in responsible sourcing.

References