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Product Liability and Legal Leverage: The Perverse Effect of Stiff Penalties

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The law-and-economics literature recognizes that the deterrent effect of stiffer tort penalties exists only so long as the tortfeasor would be solvent if a judgment were rendered against it. The literature further states that increasing the penalty past the point of insolvency would have no additional deterrent effect. In this Article, Professor Michael Knoll describes an important class of situa-

* Professor of Law, University of Southern California; John M. Olin Senior Research Scholar at Columbia University School of Law (1996-1997); Visiting Scholar at NYU School of Law (1996-1997). I thank Omri Ben-Shahar, Mitch Polinsky, and audiences at Columbia and Stanford Law Schools for their comments, and Joann Peters for her research assistance.
The intuition behind that result is as follows: When faced with a decision whether to continue producing a product that might be dangerous, a rational decisionmaker will compare its expected wealth if it continues production with its expected wealth if it ceases production.\footnote{Bankruptcy is governed by federal law; state law provides for limited corporate liability. See DOUGLAS G. BAIRD, THE ELEMENTS OF BANKRUPTCY 82-87 (1992).} Once penalties are stiff enough that the decisionmaker will be bankrupt if it continues production and is held liable, further increasing liability awards will have no effect on its expected wealth if production continues. However, if the manufacturer would not be bankrupt if it ceased production and is held liable, then further increasing liability awards will reduce its expected wealth if production ceases. In this range, the cost to the decisionmaker of continuing production decreases as liability awards increase. As a result, the decisionmaker might continue to produce a potentially dangerous product that it would have stopped producing if liability awards were smaller. This is the "perverse effect."

Part I of this Article provides a simple numerical example of the perverse effect, in which stiffer penalties encourage the production of riskier products in a strict liability regime. Part II generalizes that result and shows that when there are prior sales, there is always a range over which increasing the stiffness of tort penalties has the perverse effect. Part III discusses the factors that influence the magnitude of the effect and argues that the effect is very likely widespread because it can occur even at low penalty levels. Part IV extends the basic result to a more complex world that uses a negligence standard. Part V discusses avenues for further research, including several potential solutions to the perverse effect of high liability awards.

1. **A Simple Numerical Example of the Perverse Effect**

The perverse effect of stiffer tort penalties in products liability cases can be made more concrete through a simple numerical example. Consider the decision whether to continue to produce widgets in a strict liability regime. Assume that the manufacturer concludes that there is a 10% chance that widgets are dangerous, in which case previously sold widgets will cause $4 million in harm. Also, assume that if the manufacturer con-

\footnote{To simplify the discussion, I assume that the actors are risk neutral. Although this assumption is not necessary to derive the principal results, it substantially simplifies the mathematics. I also assume that the decision whether to continue production is made on the basis of the manufacturer's expected net equity. That is to say, the manufacturer will continue production when its expected equity is higher if it continues; otherwise, it will cease production.}
tinued production, it will earn a $1 million profit. Furthermore, if the manufacturer continues to produce and sell widgets, and if the widgets are dangerous, an additional $16 million in harm will occur. Assuming that the manufacturer is liable for the full amount of the harm caused by its widgets and has enough equity so it will not be bankrupt if its widgets are dangerous—at least $19 million when it makes the decision—the equity-holders will cease production.5

Alternatively, assume that the manufacturer’s equity is only $12 million when it makes the decision. If the manufacturer ceases production, and if its widgets are not dangerous, the manufacturer’s equity will be $12 million; but if the widgets are dangerous, the manufacturer’s equity will be $8 million after paying its liability. Because there is a 90% chance that its widgets are not dangerous, the manufacturer’s equity has an expected value of $10.8 million, which is $600,000 less than its expected value if production ceases. Thus, the manufacturer will continue production.

If, however, the manufacturer continues production, then its equity will be $20 million if its widgets are not dangerous and $0 if they are dangerous. Thus, if it continues production, the manufacturer’s equity has an expected value of $18 million ((0.9 x $20 million) + (0.1 x $0)), which is $600,000 less than its expected value if production ceases. Thus, the manufacturer will cease producing widgets. The result is illustrated in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Cease Production</th>
<th>Continue Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Dangerous</td>
<td>$19,000,000</td>
<td>$20,000,000</td>
</tr>
<tr>
<td>Dangerous</td>
<td>$15,000,000</td>
<td>$0,000,000</td>
</tr>
<tr>
<td>Expected Value</td>
<td>$18,600,000</td>
<td>$20,000,000</td>
</tr>
</tbody>
</table>

Although the manufacturer might now wish that it had never started production, the decision to begin production might have been rational when made, as illustrated by the following example. Assume that when the manufacturer first began to produce widgets, it thought there would be a 50% probability that the current situation—a 10% chance that the product is dangerous—would exist, and a 50% probability that the manufacturer would definitely know that the product was safe. Assuming further that, as expected, the manufacturer broke even on sales until this point. Thus, if the product had proven to be safe, the manufacturer would have earned a $1 million profit. Because there was a 50% chance of this occurring, this possibility had an expected value of $500,000. This value exceeds the manufacturer’s $400,000 expected cost of producing widgets if it had not already been proven safe, which had an expected cost of $200,000 when production first began. Thus, by beginning widget production, the manufacturer increased the expected value of its equity by $300,000.

The expected value of the manufacturer’s equity if production ceases is calculated as follows: Expected Value (Ceasing) = (0.9 x $12 million) + (0.1 x $8 million) = $11.6 million.

9. If its widgets are dangerous, the manufacturer will pay $2.8 million—70% of the total harm of $4 million. Because the manufacturer has equity of $12 million, it will have $9.2 million after it pays the judgment.

10. The expected value of the manufacturer’s equity if production ceases is calculated as follows: Expected Value (Ceasing) = (0.9 x $12 million) + (0.1 x $9.2 million) = $11.72 million.

11. The expected value of the manufacturer’s equity if it produces continues is calculated as follows: Expected Value (Continuing) = (0.9 x $13 million) + (0.1 x $0) = $11.7 million. This is exactly the same as in note 7, supra, because the manufacturer is bankrupt if production continues and the product is dangerous, regardless of whether the penalty is 100% or 70% of any harm.
facturer would have a $20,000 expected loss by continuing, it will discontinue widget production.12

The example, therefore, illustrates that increasing the severity of tort penalties does not always either increase deterrence or have no effect on the level of deterrence—the two possibilities recognized in the existing literature. Instead, raising the severity of tort penalties from 70% to 100% of any harm caused reduces deterrence: the manufacturer will continue producing widgets when the tort penalty requires full compensation, whereas it would have stopped producing widgets had the penalty been only 70%. This counterintuitive result, whereby stiffer tort penalties encourage manufacturers to produce potentially dangerous products that they would have otherwise withdrawn from the market, is an example of the perverse effect.

II. STRICT LIABILITY

This part generalizes the result set forth in the previous example. When there are prior sales, there is always a range within which increasing the stiffness of tort penalties produces the perverse effect. This is done in several steps. First, this part sets out the general problem of a manufacturer considering whether to continue producing a potentially dangerous product. Second, this framework is used to show that if there are no prior sales, then increasing the severity of tort penalties will discourage the production of riskier products until the point of bankruptcy is reached. After this point, there is no additional deterrent effect from raising penalties. Third, this same framework is used to show that when there are prior sales, the perverse effect will occur over a range as tort penalties increase.

To illustrate the perverse effect, this part presents the problem of a corporation manufacturing a product that might be dangerous.13 The probability that the product is dangerous, p, evolves over time as experience increases and evidence is collected and evaluated. In the face of this uncertainty, the manufacturer must decide whether to continue or cease producing the product.14

A. The General Problem

Consider a manufacturing company that has equity with a net value of E.15 If the manufacturer continues to produce, it will earn the profit from further production, G. If the product turns out not to be harmful, it will keep its original equity plus the profit from further production. If, however, the product is harmful, it will produce harm, H, and a liability award will be assessed against the manufacturer of θH, in which θ is a measure of the stiffness of tort penalties. If the liability award is equal to the harm (θ = 1), compensation is complete. If the liability award is less than the harm (θ < 1), compensation is incomplete; and if the liability award is more than the harm (θ > 1), compensation is more than complete. Thus, the higher θ is, the stiffer the liability regime becomes. Because the firm’s probability of being held liable is p, the firm’s expected liability, assuming it continues production, is pθH. Thus, the firm’s expected equity from continuing production, C, is given by:

\[ C = E + G - pθH. \]

If the manufacturer decides to discontinue production, it will not earn the profit from further sales. Nonetheless, with strict liability, the manufacturer will be liable for any harm caused by prior sales. Thus, if the product is dangerous and production ceases, there is less harm than if production continues because the firm does not sell the additional units.

12. The result is illustrated in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Cease Production</th>
<th>Continue Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ millions</td>
<td>probability</td>
</tr>
<tr>
<td>Not Dangerous</td>
<td>12</td>
<td>0.1</td>
</tr>
<tr>
<td>Dangerous</td>
<td>9.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Expected Value</td>
<td>11.72</td>
<td>0.1</td>
</tr>
</tbody>
</table>

13. I say "might" because I focus on the time before anyone really knows whether the product is dangerous.

14. In order to simplify the mathematics, I assume throughout this Article that there is only one date at which production can be stopped and that production, once discontinued, can never be restarted.

15. The value of the equity, E, is calculated before subtracting any liabilities due to the inherent dangerousness of the product, but after subtracting any other liabilities the firm might have. This simplification does not precisely follow the law, which, in bankruptcy, treats tort creditors on par with unsecured creditors. See BAIRD, supra note 1, at 79–87 (describing the treatment of lawsuits and subsequent judgments arising in bankruptcy law); David W. Leebron, Limited Liability, Tort Victims, and Creditors, 91 COLUM. L. REV. 1565, 1637 (1991) (stating that “(t)he holders of unsecured debt share pro rata with tort victims”). Adjusting the model to treat tort creditors on par with unsecured creditors would not change the principal results. However, it would substantially complicate the mathematics, thereby obscuring the intuition.

16. To simplify the discussion, I make the unrealistic assumption that G is independent of whether the product is actually harmful. The model could be adjusted to account for a lower value of G when the product is harmful by increasing H to reflect the reduction in G.
Considering this smaller harm, \( H_0 \), the firm's expected net equity from discontinuing production, \( D \), is given by:

\[
D = E - p \theta H_0 .
\]

Accordingly, the decision whether to continue production will depend upon whether \( C \) (equation 1) is larger than \( D \) (equation 2). If \( C \) is greater than \( D \), the manufacturer will continue production; otherwise, it will stop. Thus, the expected profit from continuing production, \( X \) (the difference between equations 1 and 2), is given by:

\[
X = C - D = G - p \theta (H - H_0) .
\]

The profit-maximizing decision is to continue production if \( X \) is positive, otherwise to discontinue it. Accordingly, the firm will continue production if the gain from additional sales, \( G \), exceeds the expected liability, \( p \theta (H - H_0) \); otherwise, it will stop.

Equation 3, however, ignores the impact of limited liability on the decision whether to continue production. The manufacturer's expected gain from continuing to produce (equation 3) changes in the presence of limited liability because its components (equations 1 and 2) change. With limited liability, the manufacturer will pay the lesser of the judgment against it or its total equity. Thus, if the manufacturer continues production and the product is dangerous, it will pay the lesser of its assessed liability, \( \theta H \), and the sum of its equity when it chose to continue, \( E \), and its profits from continuation, \( G \). \(^{17}\) Thus, the expected equity from continuing is:

\[
C = E + G - p \min(E + G, \theta H) .
\]

Similarly, if the manufacturer discontinues production and the product is harmful, the manufacturer will pay the successful tort claimants the lesser of their claim, \( \theta H_0 \) and its equity, \( E \). Thus, the manufacturer's expected equity from discontinuing production is given by:

\[
D = E - p \min(E, \theta H_0) .
\]

\(^{17}\) Thus, the Article assumes that the firm can intentionally externalize at least some risk. If it cannot, because consumers are as knowledgeable of the risks as are the firm's employees, the model would not apply.

It therefore follows that with limited liability, the expected gain to equityholders from continuing production (the difference between equations 4 and 5) can be written as follows:

\[
X = C - D = (1 - p)G - p \min(E, \theta H - G) - \min(E, \theta H_0) .
\]

Once again, the profit-maximizing decision is to continue production if \( X \) is positive and to cease production if \( X \) is negative.

### B. No Perverse Effect

Before examining the situation in which the perverse effect occurs, consider the situation in which it does not occur. When there are no prior sales (\( H_0 = 0 \)), the traditional view of stiffer penalties is accurate: increasing tort penalties discourages the production of less risky products until the defendant's wealth would be exhausted. \(^{19}\) Once this point is reached, stiffer penalties have no additional deterrent effect.

That result is established as follows: If there are no previous sales, the firm's equity if it ceases production, \( D \) (equation 5), is equal to \( E \), which is independent of \( \theta \). Thus, the expected gain from production (equation 6) becomes:

\[
X = (1 - p)G - p \min(E, \theta H - G) .
\]

In examining equation 7, there are two cases to consider depending upon the value of \( \theta \). These two cases are ordered by increasing values of \( \theta \).

#### 1. Two Cases

**Case I:** The firm is never bankrupt: \(^{19}\) \( E > \theta H - G \).

For small values of \( \theta \) (\( \theta < (E + G) / H \)), the firm will not be bankrupt if the product is dangerous. When the firm can pay the full liability if the product is dangerous, equation 7 becomes:

\[
X = G - p \theta H .
\]

\(^{18}\) The idea is that higher tort penalties eliminate the riskiest products that would have been produced if penalties were lower.

\(^{19}\) When the fair market value of the firm's debts exceeds the fair market value of its assets, the firm is bankrupt. See BAIRD, supra note 1, at 66 n.73.
The assumption that the liability will not bankrupt the firm does not imply that the firm will produce the product. Whether the firm begins production depends upon the sign of equation 8: if equation 8 is positive, the firm will begin production; if it is negative, the firm will not. Because equation 8 is a decreasing function of \( \theta \), there is a single critical value of \( p \), call it \( p' \), that is the highest value of \( p \) for which production will occur. That is to say, production will occur for all values of \( p \) below \( p' \), but for no values above \( p' \). Thus, the effectiveness of a liability system can be measured by \( p' \). As \( p' \) decreases, more potentially dangerous products are deterred. Setting equation 8 equal to 0 and solving for the critical value of \( p \), yields:

\[
p'(\theta) = \frac{G}{\theta H},
\]

where \( \theta \) in parentheses indicates that the critical probability is a function of \( \theta \).

Because the denominator in equation 9 is a multiple of \( \theta \), the critical value of \( p \) is a decreasing function of \( \theta \): as \( \theta \) increases, \( p' \) falls. For very low values of \( \theta \), \( p' \) is greater than 1. Because probabilities cannot be larger than 1, for very low values of \( \theta \), the firm will begin production even if it is certain that the product is dangerous. However, as \( \theta \) increases, \( p' \) will fall below 1, and it will continue to fall as \( \theta \) increases. For values of \( \theta \), such that \( p' \) is less than 1, higher penalties cause the firm not to produce less risky products that the firm would have produced with lower penalties. Thus, in Case I, higher penalties encourage the manufacturer to withdraw less dangerous products from the market.

Case F: The firm is bankrupt if it continues production and the product is dangerous: \( E < \theta H - G \).

For larger values of \( \theta \) (\( \theta > (E + G) / H \)), the firm will be bankrupt if production occurs and the product is dangerous. Thus, for larger values of \( \theta \) (\( \theta (H - G) > E \)), equation 7 becomes:

\[
X = (1 - p)G - pE.
\]

Equation 10 is independent of \( \theta \), indicating that the expected value of producing the product does not depend upon the stiffness of the tort penalties, but only upon \( p \), \( G \), and \( E \). The product will be produced if equation 10 is positive; otherwise, it will not be produced.

20. Once again, the idea is that the most dangerous products, which would have been on the market were penalties smaller, will not be produced.

The critical value of \( p \) that separates accepted and rejected projects can be derived by setting equation 10 equal to 0, and solving for the resulting value of \( p \). Thus, the corresponding critical value of \( p \), again denoted \( p' \), is given by:

\[
p' = \frac{G}{E + G}.
\]

Production will occur for values of \( p \) below \( p' \); it will not occur for values above \( p' \).

2. The Path

Neither Case I nor Case F fully describes what happens as tort penalties increase; the full picture comes from combining the two cases. For low values of \( \theta \), the manufacturer is in Case I; for high values it is in Case F. Thus, when there are no prior sales, the path of the critical probability, \( p' \), as a function of \( \theta \), is as illustrated in Figure 1:

\[
\begin{align*}
\text{Critical Probability, } p' \\
\text{Severity of Penalties, } \theta
\end{align*}
\]

**FIGURE 1: THE TRADITIONAL VIEW OF STIFFER TORT PENALTIES**

Figure 1 describes the traditional view of the deterrent effect of increasing tort penalties. As tort penalties increase, less risky products are
removed from the market. Once the defendant's wealth would be exhausted if the product were dangerous, then further increasing penalties has no additional deterrent effect.

C. The Perverse Effect

This section shows that the perverse effect occurs when the manufacturer has made prior sales. When there are prior sales, there is a range over which stiffer tort penalties will encourage the manufacturer to continue to produce riskier products that it would have withdrawn with less stiff penalties.

The previous section examined the special case in which there were no prior sales of the product ($H_0 = 0$). In this section, I return to the general case in which $H_0$ is positive. In examining equation 6, the general equation for the expected gain from continuing to produce a possibly defective product for a manufacturer with limited liability, there are four cases to consider depending upon the value of $\theta$. These cases are ordered roughly by increasing values of $\theta$.

1. Four Cases

Case I: The firm is never bankrupt: $E > \theta H - G$, $\theta H_0$.

For small values of $\theta$, the firm will never be bankrupt. When the firm can pay the liability in full if the product is dangerous, regardless of its decision to continue or cease production, the expected gain from continuing production is unchanged by the introduction of limited liability. Thus, equation 6 reduces to equation 3—the equation without limited liability.

Setting the net gain in equation 3 equal to 0, and solving for the critical value of $p$, yields:

$$p'(\theta) = \frac{G}{\theta (H - H_0)}.$$

As before, $p'$ is a decreasing function of $\theta$. For very low values of $\theta$, the firm will always continue production because probabilities are bounded above by 1. As $\theta$ increases beyond this range, stiffer penalties will reduce the critical value of $p$. Thus, in Case I, the standard view holds: higher penalties discourage production of less risky products.

If $\theta$ is large enough such that the firm will be forced into bankruptcy if the product is harmful, the firm's expected gain from continuing production cannot be reduced to equation 3. Obviously, when $\theta$ is very large, the firm will be bankrupt if the product is dangerous, regardless of whether it continues or ceases production. This is Case IV.

However, for intermediate values of $\theta$, assuming the product is dangerous, the firm will be bankrupt either if production continues but not if it ceases, or alternatively, if production ceases but not if it continues. As $\theta$ increases, the question whether the firm first becomes bankrupt when it continues or ceases production distinguishes Case II and Case III.

Case II: The firm is bankrupt if and only if the product is dangerous and production continues: $\theta H - G > E > \theta H_0$.

The second possibility is that if the product is dangerous, the firm can pay the full award if it ceases production, but not if it continues production. The assumption that the entire liability award can be paid if the product is dangerous and production ceases implies that $E > \theta H_0$. The assumption that the firm will be bankrupt if the product is dangerous and production continues implies that $E < \theta H - G$. Therefore, the expected gain from continuing production (equation 6) can be written as:

$$X = C - D = (1 - p)G - p(E - \theta H_0).$$

For values of $\theta$ such that the firm is in Case II, the expected gain from continuing production (equation 13) is a decreasing function of $p$. Thus, there is once again a single value of $p$ that represents the highest value for which production will continue. Setting equation 13 equal to 0 and solving for the critical value of $p$, yields:

$$p'(\theta) = \frac{G}{G + E - \theta H_0}.$$

Because $G$ and $E$ in equation 14 are independent of $\theta$, whereas $\theta H_0$ is an increasing function of $\theta$, $p'$ is an increasing function of $\theta$, indicating that as penalties become stiffer, production will continue for riskier products. Thus, the perverse effect occurs in Case II: stiffer penalties encourage manufacturers to keep producing riskier products that they would have withdrawn from production if penalties were lower. The intuition behind this result will be discussed after describing the remaining cases and the different possible paths for $p'$ as a function of $\theta$.

Case III: The firm is bankrupt if and only if the product is dangerous and production ceases: $\theta H - G < E < \theta H_0$.

22. See infra p. 112.
The third possibility is that if the product is dangerous, the firm can pay the full judgment if it ceases production ($E > \theta H$), but not if it continues production ($\theta H - G < E$). Under these circumstances, the expected gain from continuing production (equation 6) can be written as:

$$X = C - D = G - p(\theta H - E).$$

If the firm is in Case III, equation 15 is positive, even for $p = 1$. The intuition is that the equity is larger if production continues (whether or not the product is dangerous) than if it stops. Therefore, if the firm finds itself in Case III, it will continue production, even if the product is known with certainty to be dangerous. Thus,

$$p' = 1.$$  

Case IV: The firm is bankrupt if the product is dangerous: $E < \theta H - G, \theta H$.

The fourth and final possibility is that the firm will be bankrupt if the product is dangerous. In this case, $E$ is less than both $\theta H$, and $\theta H - G$. Under this assumption, the expected gain from continuing production (equation 6) becomes:

$$X = C - D = (1 - p)G.$$  

Equation 17 is positive for values of $p$ less than 1. Thus, once penalties are so stiff that the firm will be bankrupt if the product is dangerous, regardless of whether it continues or discontinues production, the firm will always continue, unless it knows with certainty that the product is dangerous. Thus,

$$p' = 1.$$  

The intuition is that when bankruptcy is inevitable if the product is dangerous, then the firm's owners risk nothing by continuing production, but they will receive the gain from further production if the product is not dangerous. Therefore, if there is any chance that the product is safe, they will continue production.$^{25}$

To summarize the above results, the expected gain from continuing production and the critical value of $p$ for each case are set out in the following table.

<table>
<thead>
<tr>
<th>Case</th>
<th>Expected Gain from Continuing Production, $X =</th>
<th>Critical Probability, $p'$ =</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>$G - p(\theta H - H_o)$</td>
<td>$\frac{G}{\theta (H - H_o)}$</td>
</tr>
<tr>
<td>II</td>
<td>$(1 - p)G - p(E - \theta H_o)$</td>
<td>$\frac{G}{G + E - \theta H_o}$</td>
</tr>
<tr>
<td>III</td>
<td>$G - p(\theta H - E)$</td>
<td>1</td>
</tr>
<tr>
<td>IV</td>
<td>$(1 - p)G$</td>
<td>1</td>
</tr>
</tbody>
</table>

2. The Two Paths

The preceding section derived the expected gain from continuing production and the maximum value of $p$ for which production will continue for each of the four cases. That section also described within each case how the value of $\theta$ affects the critical value of $p$. To get a complete understanding of how $\theta$ affects the critical value of $p$, it is necessary to take into account that changing the value of $\theta$ can change the case. Thus, this section considers how the cases can be combined to generate paths that distinguish between those products for which production continues and those for which production ceases as tort penalties become stiffer.

Case I applies to very low values of $\theta$, and Case IV applies to very high values. Either Case II or Case III, but not both,$^{24}$ applies to intermediate values. Thus, there are two alternative paths for the critical value of $p$ as

$$p'(\theta) = \frac{G}{\theta H - E}.$$  

This equation is always greater than 1 for manufacturers in Case III because in Case III, $\theta H - G < E$, which implies that $\theta H > \theta H - E$.

---

23. This follows from the assumption that $\theta H - G < E$. Rearranging terms, this assumption implies that $G > \theta H - E$, which in turn implies that $G - p(\theta H - E) > 0$ for $p \leq 1$.

24. The equation for the critical value of $p$ is derived by setting equation 15 equal to zero and solving for $p$:

$$p'(\theta) = \frac{G}{\theta H - E}.$$  

25. The above result does not depend on the relative values for $L$, $G$, and $p$; that is, production will continue regardless of their values.

26. Both Case II and Case III cannot apply to the same firm for the same risk because as $\theta$ increases, the firm will be bankrupt if it continues or if it ceases production. If the firm simultaneously becomes bankrupt in both states, which only occurs if $(E + G) / H = E / H_o$, then Case IV immediately follows Case I.
the value of $\theta$ increases. The first path will contain Cases I, II, and IV; the second path will contain Cases I, III, and IV.

If the former applies, then the path for the critical value of $p$ is as illustrated in Figure 2:

![Figure 2: The Perverse Effect](image)

The region above the bold line in Figure 2 represents the products that are discontinued; below the line are products that continue to be produced. The dotted line indicates that production will continue over the indicated range, even if the manufacturer knows with certainty that the product is dangerous ($p = 1$). The path depicted in Figure 2 first decreases and then increases as $\theta$ increases. Obviously, the liability regime has the maximum deterrent effect when $\theta$ is set at $(E + G) / H$, the boundary between Cases I and II.

If the latter applies, then the path is as illustrated in Figure 3:

![Figure 3: The Knife-Edge Version of the Perverse Effect](image)

Once again, the bold line separates products that continue to be produced from those that are discontinued, and the dotted line, this time throughout Case III as well as in the beginning of Case I, implies that the manufacturer will continue production in these ranges even if the probability that the product is harmful equals 1. As in Figure 2, $p'$ is a decreasing function of $\theta$ in Case I. However, as $\theta$ increases beyond Case I, $p'$ jumps, so that no risky projects will be deterred when the firm is in Case III. As in Figure 2, the maximum deterrent effect is achieved when $\theta$ is set at the end of Case I, which now occurs when $\theta = E / H$. However, if $\theta$ is set slightly larger, the liability regime will not deter any products from being sold. Thus, there is a knife-edge effect: when $\theta$ is set near the edge of Case I, a slight increase in the level of tort penalties can eliminate the entire deterrent effect of the tort system.

Obviously, only one path can apply for a given risk at any time. Whether Figure 2 or Figure 3 applies depends upon whether, as the value of $\theta$ increases, the manufacturer first becomes bankrupt when production...
continues or ceases. That, in turn, depends upon the relative size of the potential increase in equity to the potential increase in harm from continuing production. If the potential increase in equity is proportionally smaller, then the manufacturer is bankrupt first if production continues, and the effect of increasing tort penalties is described by Figure 2. Conversely, if the potential increase in equity from continuing production is proportionally larger than the increase in harm, then the manufacturer is bankrupt first if production ceases, and the effect of increasing tort penalties is described by Figure 3. Thus, if there are high start-up costs, profit margins are increasing, and the manufacturer has no other profitable products, then as θ increases, bankruptcy will first occur if production ceases, and so the path will resemble Figure 3. Alternatively, if start-up costs are low, profit margins are falling, and the manufacturer has other profitable products, then as θ increases, bankruptcy will first occur if production continues, and so the path will resemble Figure 2.

The paths described in Figure 2 and Figure 3 should be contrasted with the standard view of the effect of stiffer tort penalties. The standard view, portrayed in Figure 1, is that the critical probability at first falls and then levels off once the tortfeasor's wealth is exhausted. However, neither Figure 2 nor Figure 3 describes a decreasing function that reaches a floor at which it thereafter remains. In both Figures 2 and 3, the critical probability reaches a minimum. Once the minimum is reached, the critical probability rises continuously along the first path; with the second path, once the minimum is reached, the critical probability immediately jumps to 1. In both figures, it returns to a level at which production will stop only if \( p = 1 \).

As described in Section II.B, the standard view—that increasing the stiffness of tort penalties has no additional deterrent effect once the point of bankruptcy is reached—applies only when there are no prior potential liabilities that can be increased by raising penalties. That is likely to be true for many kinds of torts, such as accidents, but it is only true for products liability matters before any sales occur. Once sales have occurred, the situation is more complex and the results are different. When there are preexisting sales, stiffer tort penalties will increase deterrence to a point, but then they will reduce deterrence.

31. There is literature devoted to providing reasons why θ should not equal 1, to which this Article contributes. See, e.g., Jennifer H. Arlen, Reconsidering Efficient Tort Rules for Personal Injury: The Case of Single Activity Accidents, 32 WM. & MARY L. REV. 41, 81–86 (1990) (arguing that efficiency does not require the full compensation of damages in single-activity accidents that impose reciprocal risks). For the purpose of illustration, I ignore the rest of that literature. The results of that literature, however, could easily be incorporated. If, for reasons other than those provided in this Article, θ should have a value other than 1, then θ should be set at the lesser of that level or towards the end of Case 1.

32. See generally Polinsky & Shavell, supra note 2; Shavell, supra note 2.

33. The Article has thus far looked at the problem from the perspective of a manufacturer deciding whether to remove a product from the market. The Article has not considered the possibility of the manufacturer reducing the potential of harm by modifying the product. It is easy to apply the model to such decisions. Assume that the manufacturer is deciding whether to produce a different version of the product that, at some cost to itself, will produce less harm if dangerous. In this case, the decision to continue production described in the model becomes the decision not to modify the product. Similarly, the decision to discontinue production becomes the decision to modify the product. With this transformation, \( G \) represents the cost of modifying the product, and \( E \) is the equity after taking into account future sales. Assuming that the manufacturer would be bankrupt if it does not modify the product and the product proves to be dangerous, but would not be bankrupt if it modifies the product, then raising the penalty reduces the expected cost to the manufacturer if it chooses not to modify the product. Because raising the penalty lowers the cost to the manufacturer of not modifying the product, higher penalties will reduce the likelihood that the product will be modified.
downside—the liability award paid if the product is dangerous—is truncated by limited liability.\textsuperscript{34}

Regardless of whether production continues or ceases, raising tort penalties increases the penalty assessed against the manufacturer if the product is dangerous. So long as the manufacturer can pay the full penalty if the product is dangerous (Case I), then raising tort penalties increases the additional penalty the manufacturer pays if it continues production—the difference between the penalty the manufacturer pays if it continues production and the penalty if it ceases production. However, if the manufacturer is bankrupt only if it continues production, but not if it ceases production (Case II), then further increasing tort penalties reduces the additional penalty the manufacturer pays if production continues. This is because raising penalties only increases the penalty the manufacturer pays if production ceases.\textsuperscript{35} Thus, limited liability creates the perverse effect by reducing the additional penalty that the manufacturer pays if it continues production. This additional penalty falls as penalties rise, until the manufacturer is bankrupt if it ceases production. Once the manufacturer is at this point (Case IV), it pays the same penalty whether it continues or ceases production and so it always continues production.\textsuperscript{36}

\textsuperscript{34} It is worth emphasizing that the perverse effect is not eliminated by raising penalties only on firms that are not bankrupt. For example, imposing punitive damages only on solvent firms would discourage those firms from continuing production that would be solvent if the product is dangerous and if production continues. However, punitive damages would not discourage production by those firms that would be bankrupt if production continues and the product is dangerous. Indeed, punitive damages would encourage such firms to continue production if there is any chance that they will be subject to punitive damage in the event that they cease production. In this case, punitive damages reduce the current net equity of the corporation, thereby reducing what the equityholders stand to lose from continuing production. Thus, such punitive damages are more likely to exacerbate rather than eliminate the problem. Of course, punitive damages would discourage risk-taking activity if the manufacturer was still in Case I after taking the punitive damages into account.

\textsuperscript{35} The penalty the manufacturer will pay if production continues cannot increase because the manufacturer will be bankrupt if the product is dangerous.

\textsuperscript{36} An analogy can be drawn between the two paths presented here and the Laffer Curve, which relates federal tax revenues to tax rates. The endpoints of the Laffer Curve are well defined: there is no tax revenue if the tax rate is either 0\% or 100\%. (When the tax rate is 100\% there is no activity and therefore no revenue.) As the tax rate increases above 0\%, revenue initially increases. At some point, however, revenue starts to decline. Efficiency in tax collection requires that the tax system charge a rate that is not above the point at which tax revenue is at a maximum.

Figure 2 represents a similar path for liability awards. When the liability award is very low, production always continues because the penalty is not sufficient to deter the manufacturer from ceasing production, even if \( p = 1 \). When the liability award is very high, the manufacturer will be wiped out if the product is dangerous and will therefore continue production if \( p < 1 \), because it has nothing to lose by continuing. For intermediate values of \( p \), the tort system will discourage

This rationale also explains the difference between Figure 1 and Figure 2. When there are no prior sales on which the penalty can be assessed if the product is dangerous, the additional penalty the manufacturer pays if it starts production cannot fall as penalties rise. Instead, once the point of bankruptcy is reached (Case F), there is no additional deterrent effect from stiffer penalties. Accordingly, in Figure 1, the critical probability levels off. In contrast, in Figure 2, the critical probability falls and then rises.\textsuperscript{37}

The intuition behind Figure 3 is a more extreme version of that behind Figure 2. Once the firm is bankrupt if it ceases production of a dangerous product, but not if it continues production (Case III), then it can only gain by continuing production. This is because the manufacturer's equity if it continues production is higher when the product is not dangerous, and it is at least as high when it is dangerous.\textsuperscript{38} Accordingly, once the firm is in Case III, the deterrent effect of stiffer penalties disappears entirely and production always continues.

E. Summary

This part has shown that for a manufacturer with preexisting sales, there is a range within which stiffer tort penalties will lead the manufacturer to cease production (Case II), then further increasing tort penalties reduces the additional penalty the manufacturer pays if production continues. This is because raising penalties only increases the penalty the manufacturer pays if production ceases.\textsuperscript{35} Thus, limited liability creates the perverse effect by reducing the additional penalty that the manufacturer pays if it continues production. This additional penalty falls as penalties rise, until the manufacturer is bankrupt if it ceases production. Once the manufacturer is at this point (Case IV), it pays the same penalty whether it continues or ceases production and so it always continues production.\textsuperscript{36}

\textsuperscript{37} The perverse effect described in this Article is different than the one described by Professor Jennifer Arlen, who argues that strict vicarious liability might be counterproductive. Because the information gathered to monitor managers and deter fraud often ends up being used against the firm in a civil or criminal action, strict liability discourages monitoring. Professor Arlen has shown that this effect might outweigh the potential benefit to the firm of the additional fraud deterred. Therefore, this effect might lead firms to do less monitoring. See Jennifer Arlen, The Potentially Perverse Effects of Corporate Criminal Liability, 23 J. LEGAL STUD. 833 (1994).

\textsuperscript{38} The perverse effect described in this Article is also different from the one described by Professor Rohan Pitchford. See Rohan Pitchford, How Liable Should a Lender Be? The Case of Judgment-Proof Firms and Environmental Risk, 85 AM. ECON. REV. 1171 (1995). Professor Pitchford shows that increasing a lender's liability for its borrowers' environmental liabilities might increase the frequency of such accidents. See id. at 1173. The intuition behind that result is that increasing lender liability increases the interest rate on the lender's loan, which reduces the borrower's equity in the no-accident state. The less attractive the no-accident state is, the fewer precautions a borrower will take to avoid the risk of an environmental accident and, therefore, the greater the incidence of such accidents. See id. at 1177–78.

\textsuperscript{39} Assuming the product is dangerous, in Case III, the manufacturer's equity is higher if it continues production: in Case IV, the equity is the same (0) whether production continues or ceases.
facturer to continue producing a product that it would have removed from the market with less stiff penalties.

III. THE PREVALENCE OF THE PERVERSE EFFECT

Recognizing that a range exists in which the perverse effect occurs says nothing about where it occurs. Where that range begins is crucial to determining how widespread the perverse effect is. If the perverse effect occurs only at very high penalty levels, then few, if any, firms will be affected, and the problem is largely of academic interest. If, however, the perverse effect can occur at fairly low penalty levels, then potentially many firms will be affected and the problem is an important one with substantial real-world consequences. This part focuses on the question of how stiff penalties must be in order for the perverse effect to occur. The analysis reveals that the perverse effect is likely to occur at very low penalty levels, especially when the potential harm is great and when the manufacturer produces only one product.

This part is divided into three sections. The first section examines how the outer border of Case I, the point at which the perverse effect occurs, is affected by changing various parameters. The second section uses that analysis to show that the perverse effect is likely to occur for many manufacturers, even if penalties are weak. The third section extends the analysis to explain why the perverse effect is most closely related to mass torts.

A. Comparative Statics

This section examines how changing various parameters changes the outer boundary of Case I, the point at which the perverse effect appears. This exercise begins with the boundary conditions. The boundary between Cases I and II, denoted $\theta'$, occurs when $\theta H - G = E$. Thus,

$$\theta' = \frac{E + G}{H}. \tag{19}$$

This can be seen as follows: Case I occurs when $E > \theta H - G$, $\theta H_0$, and Case II occurs when $\theta H - G > E > \theta H_0$. Thus, the boundary between Cases I and II occurs when $\theta H - G = E$.

The boundary between Cases I and III, denoted $\theta''$, occurs when $\theta H_0 = E$. Thus,

$$\theta'' = \frac{E}{H_0}. \tag{20}$$

Consider first the border between Cases I and II (equation 19). That border is a function of three parameters: $E$ (the current equity), $G$ (the gain from continuing production), and $H$ (the total harm). Consistent with intuition, the border is further out the greater $E$ and $G$ are and the smaller $H$ is.

Recall that Case II begins at the point at which the firm would just be bankrupt if it continued production and the product were dangerous. Accordingly, the larger the equity, $E$, the more severe the level of penalties must be in order to force the firm into bankruptcy. Similarly, the greater the gain from continuing production, $G$, the more money the firm will have available to pay claims if production continues and the product is dangerous. Consequently, the greater the gain from continued sales, the more severe the penalty level must be in order to force the firm into bankruptcy. On the other hand, the greater the potential total harm from continued production, $H$, the less severe the level of penalties must be to push the firm into bankruptcy.

A similar analysis can be conducted for the border between Cases I and III (equation 20). The border between Cases I and III is extended by increasing $E$ and contracted by increasing $H_0$ (the harm if production ceases). This is also consistent with intuition. Case III begins at the penalty level at which the firm would just be bankrupt if it stopped production and the product were dangerous. The larger the equity, the stiffer penalties must be to drive the manufacturer into bankruptcy. In addition, the greater the level of harm caused, the less stiff penalties need be in order to force the manufacturer into bankruptcy.

B. The Prevalence of the Perverse Effect

This Article has described how stiff tort penalties can cause firms to keep products on the market that they would have withdrawn if penalties

39. This can be seen as follows: Case I occurs when $E > \theta H - G$, $\theta H_0$, and Case II occurs when $\theta H - G > E > \theta H_0$. Thus, the boundary between Cases I and II occurs when $\theta H - G = E$.

40. This can be seen as follows: Case I occurs when $E > \theta H - G$, $\theta H_0$, and Case III occurs when $\theta H_0 > E > \theta H - G$. Thus, the boundary between Cases I and III occurs when $\theta H_0 = E$. 

were lower. Although this perverse effect is possible, not all firms are at the point at which this effect occurs. Some firms are in the region in which stiffer penalties will have the usual effect of discouraging production of less risky products. Accordingly, the most important issue this Article raises is the prevalence of the perverse effect. 

Although the answer to such a question is ultimately empirical, the perverse effect is probably widespread because it can occur at very low penalty levels that are substantially below full compensation. The perverse effect occurs when the manufacturer would first become bankrupt, which would occur no later than when \( \theta = (E + G) / H \). Thus, when the potential harm exceeds the manufacturer's equity, including the profit from further sales, the perverse effect will occur below full compensation. The perverse effect is, however, deferred if the manufacturer has other profitable products, because the additional equity must be exhausted before bankruptcy occurs. Returning to the example in Part I (in which the equity is $12 million, the gain from additional sales is $1 million, the potential harm from prior sales is $4 million, and the potential harm from additional sales is $16 million), the perverse effect begins when \( \theta = 0.65 \). If the equity were only $6 million, the perverse effect would occur when \( \theta = 0.35 \). For the perverse effect not to set in until compensation is complete (\( \theta = 1 \)), the equity must be $19 million. Moreover, not only can the perverse effect occur at a low penalty level, it can also have a large effect on the critical probability. The tort system has the greatest deterrent effect when the manufacturer is at the end of Case I. Once penalties are raised high enough, so that the manufacturer is in Case IV, the entire deterrent effect disappears. Returning again to the example from Part I, tort penalties have their maximum deterrent effect when \( \theta = 0.65 \). In this case, the critical probability

41. The perverse effect begins in Case II. Substituting the parameter values into equation 19 yields:

\[
\theta' = \frac{12 + 1}{16 + 4} = \frac{13}{20} = 0.65.
\]

42. The substitution yields:

\[
\theta = \frac{6 + 1}{16 + 4} = \frac{7}{20} = 0.35.
\]

is 0.096. Increasing tort penalties from 65% to 300% of any harm caused will encourage the manufacturer to produce the product regardless of the probability that the product is dangerous. Thus, while the manufacturer would have removed the product had that probability been greater than 0.096 and the penalty had been 65% of any harm, when the penalty is three times the harm, the manufacturer will not withdraw the product if there is any chance it is not dangerous. Thus, it is clear from this simple example that the perverse effect can have a significant impact and has the potential to affect many firms. It is also clear that the problem is more likely to occur the less diversified that a manufacturer's product line is. In addition, the perverse effect is more likely to occur the greater the potential harm.

C. Application to Mass Torts

As described in Section III.A, the greater the harm caused if the product is dangerous, the lower the penalty level at which the perverse effect occurs. As described below, the potential harm is greatest when the risk of injury is highly correlated across users. This suggests that the perverse effect is most likely to occur with mass torts. With many goods, there is little uncertainty about the aggregate level of injuries that will occur. A common example from torts casebooks is soda bottles that either blow up or contain animal parts. Based on past experience, a large company can predict with reasonable confidence both the number of such occurrences and the magnitude of the resulting injuries. Today, the same thing can be said for tobacco, silicone breast implants, and asbestos, except that the numbers are much higher. There was a time, however, when such connections were less clear. At that time, the difference between soda bottles and asbestos existed in the variance of possible

43. The critical probability at the end of Case I is given by substituting \( \theta = (E + G) / H \) into equation 12. Thus,

\[
p' \left( \frac{E + G}{H} \right) = \frac{GH}{(E + G)(H - H')}.
\]

Substituting for the parameters yields 0.096:

\[
p(0.65) = \frac{120}{(12 + 1)(20 - 4)} = 0.096.
\]
injuries. If asbestos were not harmful, there would be no or very few injurie.

Conversely, if it were harmful, the number of people affected would be staggering. Thus, there was a lot of aggregate product risk from asbestos.

Because of the high correlation of risk across users. On the other hand, soda bottles produced much less aggregate uncertainty from the manufacturer's standpoint. Only a few bottles would be defective, and the total number of defects could be predicted with considerable accuracy, even if the defective bottles could not be identified in advance. Thus, the bottles had low volatility, whereas asbestos had high volatility.

When there is little aggregate risk, because the manufacturer is fairly sure of having to make some payments, E is smaller. However, H is also smaller because it is unlikely that the manufacturer will have to make many large payments. On the other hand, when there is high aggregate product risk, both E and H are higher. For risks with equal expected liability judgments, the manufacturer is generally more likely to produce a product for which the risks are highly correlated. Thus, the perverse effect is more likely to occur with products whose risk is highly correlated than with products whose risk is weakly correlated.

The level of tort penalties at which the perverse effect occurs is also affected by technological and economic developments. With soda bottles, the manufacturer will quickly learn the rate of failures. However, with asbestos, it might take many years to learn whether the product is harmful. The longer it takes to determine whether the product is dangerous, the more sales will occur before the issue is resolved. More sales implies greater profits from additional sales, G, but, it also implies a larger potential liability if the product is dangerous, H. Thus, the longer it takes to resolve the uncertainty, the stronger the incentive to continue production.

Economic developments might also have reduced the level at which the perverse effect occurs. Larger and more competitive markets have the tendency to increase sales proportionally more than profits. This suggests that G has probably declined relative to H, which would cause the perverse effect to occur at lower levels of \( \theta \). The implication is that there is reason to believe that economic and technological developments have increased the number of firms subject to the perverse effect. Thus, it is possible that today there are more products on the market that would be withdrawn if penalties were not as stiff than there were in the past.

**D. Summary**

This part has revealed what features characterize those firms that are most likely to be subject to the perverse effect. The perverse effect is most likely to occur when equity and profitability are low and the potential harm is high. The latter is most likely to take place when risks are correlated, which occurs most obviously with mass torts. In addition, this part has shown that many firms might be subject to the perverse effect, which can occur at low penalty levels.

**IV. NEGLIGENCE**

Part II showed that under a strict liability regime, stiffer tort penalties will, over some range, encourage firms to continue to produce risky products that they would withdraw from the market if penalties were less stiff. This part extends that result to a negligence regime. This discussion is

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quality of experience goods requires use (for example, the relative amounts of fruit and syrup in canned fruit); and the quality of credence goods might not be revealed even after substantial use (for example, the health consequences of pesticides used on fruit). See Michael R. Darby & Edna Karmi, Free Competition and the Optimal Amount of Fraud, 16 J.L. \\& ECON. 67, 68-69 (1973). Compared with 100 years ago, there are many more experience and credence goods today. See William M. Landes \\& Richard A. Posner, The Economic Structure of Tort Law 284-85 (1987). The growth in credence goods is responsible for the increased time it often takes to determine whether a product is dangerous.

47. Increasing both G and H by the same proportion, \( k \), contracts the border between Cases I and II. That is, \( (E + G) / H > (E + G) / H_k \), for \( E > 0 \) and \( k > 1 \) if \( E + G > (E + G) / H_k \). For \( k > 1 \) and \( k' < k \).

48. Increasing \( H > G \) contracts the border between Cases I and II. That is, \( (E + G) / H > (E + G) / H_k \).
more complicated than the discussion of strict liability because there is an added level of uncertainty with negligence. When enforcement is imperfect, there is, in addition to uncertainty about whether the product is dangerous, uncertainty about whether the defendant will be found negligent and will be held liable.

The first section illustrates that when the negligence regime is perfectly enforced, so that there are no mistakes in assessing liability, the perverse effect does not occur. The second section then shows that the perverse effect does occur when enforcement is imperfect, such that a party might be held negligent when it is not negligent or might not be held negligent when it is. The third section then compares strict liability and negligence in terms of the stiffness of the tort penalties required to produce the perverse effect and shows that the perverse effect will require higher penalties in a negligence regime.

A. Perfect Enforcement

Negligence differs from strict liability in that the manufacturer is liable for injuries caused by its product only if the manufacturer has been negligent in some way. As applied to the decision whether to continue producing a product that might be dangerous, the manufacturer is liable only for injuries resulting from negligent sales. Assume, for example, that the manufacturer has not been negligent in selling the product so far, but it would be negligent if it continued to sell the product. Consequently, if the manufacturer ceases production, it will not be liable for any injuries that might be caused by its product.

The negligence rule can be made operational by assuming that there is a minimum probability of the product being dangerous, \( p_n \), below which continuing to sell is not negligent but above which it is. Thus, the negligence rule creates three possibilities: (1) the earlier, lower probability and the current, higher probability are both below the negligence threshold; (2) both probabilities are above the negligence threshold; and (3) the probabilities straddle the threshold.

The first possibility, in which both probabilities are below the negligence threshold, is easy to examine: because the manufacturer faces no liability by continuing production, production will continue. The second possibility, in which both probabilities are above the negligence threshold,
that the product is dangerous when the decision to continue was made. If the probability that the manufacturer is held liable, assuming that the product is dangerous, is denoted as \(q(p, p_n)\), with \(q' > 0\), then \(1 - q\) is the probability that the manufacturer will not be held liable.

To simplify the model and parallel the strict liability discussion, assume there is no possibility that the manufacturer will be held liable if the product is not dangerous. Accordingly, the manufacturer will pay a judgment only if: (1) the product is dangerous, which has probability \(p\); and (2) the manufacturer is adjudged negligent, which has conditional probability \(q\). Thus, the probability that the manufacturer will be held liable is \(pq\).

In calculating the manufacturer's expected gain from continuing production, there are two values of \(q\) that must be taken into account. The conditional probability of being held liable if production ceases is \(q_o\), and the conditional probability if production continues is \(q_1\), with \(q_1 > q_o\). Accordingly, the firm's expected equity from continuing production can be written as:

\[
(21) \quad C = E + G - pq_{\min}(E + G, \theta H) .
\]

Similarly, the expected equity from ceasing production is given by:

\[
(22) \quad D = E - pq_{\min}(E, \theta H) .
\]

Thus, the expected net gain from continuing production (the difference between equations 21 and 22) is given by:

\[
(23) \quad X = C - D = (1 - pq_o)G - p[q_{\min}(E, \theta H) - G - q_{\min}(E, \theta H)].
\]

I. Four Cases

As with strict liability, there are four cases to consider depending upon the value of \(\theta\). For each case, the expected gain from continuing production and the critical value of \(p\) are set out in the following table.

<table>
<thead>
<tr>
<th>Case</th>
<th>Expected Gain from Continuing Production, (X = )</th>
<th>Critical Probability, (p^* = )</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>((1 - pq_o + pq_1)G - \theta(pq_o - pq_1H_o))</td>
<td>(G)</td>
</tr>
<tr>
<td>II</td>
<td>((1 - pq_o)G - p(q_o + \theta H_o))</td>
<td>(G)</td>
</tr>
<tr>
<td>III</td>
<td>((1 - pq_o + pq_1)G - pq_o\theta H + pq_1E)</td>
<td>(G)</td>
</tr>
<tr>
<td>IV</td>
<td>((1 - pq_o)G - p(q_o - q_1)E)</td>
<td>(G)</td>
</tr>
</tbody>
</table>

**Case I:** The manufacturer is never bankrupt.

In this case, the critical probability falls as \(\theta\) increases, just as it did with strict liability.\(^{51}\) The intuition is similar to what it was with strict liability: increasing the value of \(\theta\) increases the expected penalty by a larger amount if production continues than if production ceases.

**Case II:** The manufacturer is bankrupt when the product is dangerous and it is held liable, but only if production continues and not if production ceases.

In this case, the critical probability rises as the value of \(\theta\) increases, just as it did with strict liability.\(^{52}\) This is the perverse effect, whereby stiffer penalties encourage the production of riskier products. Under the assumption that the negligence standard is imperfectly enforced, the

\(^{51}\) In Case I, the critical probability in a negligence regime is a decreasing function of \(\theta\), because \(\theta\) enters positively into the denominator.

\(^{52}\) In Case II, the critical probability in a negligence regime is an increasing function of \(\theta\), because \(\theta\) enters negatively into the denominator.
intuition for the perverse effect in Case II is similar to what it was with strict liability: increasing the stiffness of tort penalties reduces the manufacturer's expected equity if production ceases but has no effect if production continues. Thus, increasing tort penalties, by reducing the amount the manufacturer risks by continuing production, encourages continued production of potentially dangerous products.

Case III: The manufacturer is bankrupt when the product is dangerous and it is held liable, but only if production ceases and not if production continues.

Unlike Cases I or II, the effect of increasing tort penalties in Case III is very different with negligence than with strict liability. In a strict liability regime, a manufacturer in Case III will always continue production. In contrast, in a negligence regime, increasing tort penalties reduces the critical probability throughout Case III. The intuition behind the latter effect is that the conditional probability of being held liable (assuming the product is dangerous) is greater if production continues, $q_i$, than if it ceases, $q_o$. Thus, unlike a strict liability regime, in which there is no cost to the manufacturer from continuing production in Case III, because the manufacturer is bankrupt if production ceases and the product is dangerous, there is such a cost in a negligence regime. The cost of continuing production in a negligence regime is that the manufacturer is more likely to be held liable if it continues production than if it ceases production. Moreover, the assumption that the manufacturer can pay the liability if it continues production but not if it ceases production implies that the penalty paid if production is continued increases as penalties stiffen. Thus, the critical probability is a decreasing function of $\theta$, and there is no perverse effect.

Case IV: The manufacturer is bankrupt if it is held liable, regardless of whether it continues or ceases production.

The effect of increasing the value of $\theta$ on the critical probability in Case IV is also different with negligence than with strict liability. In a strict liability regime, a manufacturer will continue production unless the product is certain to be dangerous. In a negligence regime, the critical probability in Case IV is fixed and independent of $\theta$. That probability might be greater than 1, in which case production will always continue, or it might be a fixed value between 0 and 1. Once again, the intuition is that the cost to the manufacturer of continuing production is the larger conditional probability of being held liable (assuming the product is dangerous) if production continues than if production ceases. $^3$ Thus, in Case IV, the manufacturer balances the higher probability of bankruptcy if production continues and it is held liable, against the higher equity if production continues and it is not held liable. Because the manufacturer's equity in every possible state is independent of $\theta$, the critical probability is also independent of $\theta$.

2. The Two Paths

As with strict liability, there are two possible paths for the critical probability. As the value of $\theta$ increases, the path will consist of either Cases I, II, and IV; or Cases I, III, and IV. When the path contains Case III, the path is similar to the traditional view of increasing tort penalties, as illustrated by Figure 4:

Figure 4 shows that the critical probability decreases continuously throughout Cases I and III. At the end of Case III, it reaches a floor at which it remains throughout Case IV. Thus, when the path contains Case III, there is no perverse effect. This is very different from the path with strict liability, which exhibited a knife-edged perverse effect at the beginning of Case III.

$^3$ That is, $q_i > q_o$.

$^4$ See supra p. 109.
In contrast, when the path contains Case II, the path exhibits the perverse effect as it did with strict liability, as illustrated by Figure 5:

![Figure 5: THE PERVERSE EFFECT WITH NEGLIGENCE](image)

When the path contains Case II, the critical probability is a decreasing function of \( \theta \) throughout Case I until the minimum critical probability is reached at the end of that case. Once that point is reached, the critical probability is an increasing function of \( \theta \) throughout Case II. At that point, the critical probability reaches a plateau, at which it remains throughout Case IV. In Case IV, increasing tort penalties has no additional deterrent effect, although tort penalties have some deterrent effect. Thus, with negligence, as with strict liability, the critical probability is a U-shaped function of \( \theta \). Once again, therefore, this time in a negligence regime, stiffer penalties might encourage firms to continue to produce increasingly dangerous products that they would have withdrawn from the market were penalties less stiff.

C. Comparing Liability Regimes

When the path contains Case III, the perverse effect occurs with strict liability but not with negligence. This is one way in which the perverse effect is more likely to occur with strict liability than with negligence. There is also a second way in which the perverse effect is more likely to occur with strict liability. When the path contains Case II, the outer border of Case I occurs at a lower level of \( \theta \) with strict liability than with negligence. The rest of this section compares the border between Cases I and II with strict liability and negligence.

In order to make this comparison, it is useful to consider, in addition to the standard negligence rule that imposes liability only on injuries that

result from the tortfeasor's negligent conduct, a modified negligence rule that assesses liability on earlier, nonnegligent sales if the tortfeasor is later negligent. The difference in the harm from nonnegligent sales for which the tortfeasor is liable with these two versions of the negligence rule, \( H_w \), is assumed to be a constant that is independent of whether production is continued or discontinued.

Because both \( H \) and \( H_w \) are reduced by \( H_w \), a negligence rule that does not assess liability on any nonnegligent sales extends Case I further out than a negligence rule that looks back to the first sale. Similarly, the far border for Case II is also extended by a negligence rule that assesses a penalty only on negligent sales. The boundaries are the same with strict liability and with a negligence rule that looks back to the first sale. The boundaries are extended if the negligence rule does not look back to the first sale. Moreover, the more
sales that escape liability, the further out are the boundaries. Thus, with a negligence rule that assesses liability only on negligent sales, there are values of \( \theta \) for which the firm would be in Case I, whereas with strict liability or a negligence rule that looks back to the first sale, it would be in Case II. Thus, for a given level of \( \theta \), the perverse effect is more widespread when liability is assessed only on negligent sales. Thus, it seems likely that because of the tendency over the past thirty-five years for courts to replace negligence with strict liability in products liability matters, the perverse effect is more widespread today than it was a generation ago.

D. Summary

Part IV has shown that the perverse effect also exists in a negligence regime with imperfect enforcement. Unlike with strict liability, the perverse effect exists only if the path contains Case II. Moreover, the knife-edged perverse effect, which existed with strict liability, does not exist with negligence. This part has also shown that the perverse effect will occur at the same level of \( \theta \) with both strict liability and a negligence rule that looks back to the first sale. However, the perverse effect will require a higher level of \( \theta \) when liability is assessed only on negligent sales.

V. Avenues for Further Research

There are several ways to modify the analysis in this Article. For example, throughout this Article I have looked at just one actor, the owner of the firm. Most firms, however, are run by managers, whose interests do not always coincide with those of the equityholders. Management is often thought to be more risk averse than equityholders because more of their wealth is tied up in the firm. They might also be more committed to maintaining production because they will be unemployed if production stops. The first effect would tend to encourage firms to cease producing risky products, whereas the second would have the opposite effect. A more thorough understanding of the perverse effect would require taking into account the ability of equityholders to control their agents—the managers who make these decisions. However, scholarly work on the introduction of agency theory into tort law is only at the earliest stages.

A related complication that has been ignored thus far is the possibility of equityholders withdrawing capital from the firm. Such withdrawals are attractive to the equityholders because they will generally not have to repay these amounts to the corporation's creditors if the product is dangerous and the corporation becomes insolvent. The possibility of such withdrawals has an ambiguous effect on the decision whether or not to continue production. The possibility of withdrawing funds from the corporation will increase the value to the equityholders of ceasing production because the owners will receive more. Such a possibility will also increase the value of continuing, because if the product is dangerous, the equityholders will still receive something. If the entire equity could be stripped out of the corporation before the victims obtained a judgment, production would continue indefinitely. Of course, in this case, stiffening tort penalties would have no effect on the decision whether to continue production, because no liability awards would ever be paid. If everything could be stripped out of the firm only if it ceased production, because of the need for working capital or otherwise, then this possibility would encourage ceasing production. If, however, the equityholders could strip money out from the firm only by continuing production, perhaps because ceasing production would lead courts to impose a constructive trust and wait for a resolution of the claims, the possibility of withdrawing funds would encourage continuing production. Moreover, under these last circumstances, higher penalties will encourage continuation. In any event, a

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59. This also follows from supra notes 56 and 57. The larger \( H_w \) is, the larger are \( 9^1 \) and \( 9^2 \).
60. The results are ambiguous as to whether strict liability or a negligence rule that looks back to the first sale has a higher critical value of \( p \) when in Case II. This is because the expected values of the equity if production ceases and if production continues are both higher with negligence than with strict liability. Accordingly, because the decision whether to continue production is made by comparing the expected value of the equity under the two circumstances, neither rule necessarily has a higher or lower critical probability than the other.
61. See Louis R. Frumer & Melvin I. Friedman, Products Liability § 1.02 (1997) (describing the history of products liability law); Landes & Posner, supra note 46, at 284–86 (identifying strict liability supplanting negligence as one of the two most important developments in the history of products liability law and dating that development as beginning roughly around 1960).
62. See Mark J. Roe, Corporate Strategic Reaction to Mass Tort, 72 Va. L. Rev. 1, 10–17 (1986) (arguing that managers are likely to maintain production in the face of mass tort risks for a variety of reasons, including job security).
63. Managers also have their reputations, which are tied to the success of their firms. It is unclear in which direction this cuts: managers might discourage production to avoid association with the harmful product; conversely, managers might encourage production because of the higher profits in the short run and possibly over the long run.
64. Among the few such examples are the articles by Professors Arlen and Roe. See Arlen, supra note 37; Roe, supra note 62.
more complete model would consider the possibility of withdrawing funds from the corporation and, in the extreme, liquidating the corporation.\footnote{Professor Mark Roe argues that a liquidation is an unlikely response to a mass tort. See Roe, supra note 61, at 59 (considering strategic responses to mass torts and concluding that the complete avoidance of liability is "untested, unproven, and seems unlikely to be uniformly successful").}

A related issue, not previously discussed, is the effectiveness of other mechanisms in eliminating the perverse effect by restraining the manufacturer's ability to externalize risk. Such mechanisms can be divided between private and public.

One private mechanism that might prevent manufacturers from selling many potentially dangerous products is the decision by retailers as to what products to carry. Under long-standing products liability doctrine, the retailer is jointly and severally liable with the manufacturer for any harm caused by a product it sells. Thus, for retail goods, it is not sufficient for the manufacturer to produce the goods; retailers must also sell them. Hence, the perverse effect will not occur when stiffer penalties cause so many retailers to drop out of the market that the manufacturer can no longer sell enough products for it to be worthwhile to continue production.

Another private mechanism that might restrain manufacturers from producing many potentially dangerous products is the intervention of outside investors. Although equityholders might see the decision to continue to produce a potentially dangerous product as a good gamble, the firm's debtholders, who have a smaller potential gain and a larger potential loss, might regard the decision otherwise. The strong incentive equityholders have to externalize risk under certain circumstances is well recognized, both in the academic literature and in practice.\footnote{See e.g., Michael C. Jensen & William H. Meckling, Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure, 3 J. FIN. ECON. 305, 334–37 (1976).}

To restrain equityholders from transferring risk to debtholders, capital structures are designed and bond covenants are often included into trust indentures.\footnote{Examples of such covenants include requiring bondholder approval of certain decisions or requiring the firm to purchase insurance or to maintain certain financial ratios.} Of course, assuming such covenants are effective, there is a point at which the gamble looks good to the debtholders and so they would not seek to prevent it. More generally, the presence of other investors in the firm only changes the point at which the perverse effect occurs, not its existence.

There are also public mechanisms to restrain manufacturers from externalizing risk. Managers who impose outrageous risks on the public face the possibility of personal liability and criminal sanctions. In theory, at least, these sanctions can prevent managers from pursuing risky projects that they as stockholders, as well as employees, might want to pursue. That mechanism, however, is probably not very effective when the probability that the product is injurious is low because, under those circumstances, almost any decision can be defended as reasonable. However, when the probability that the product is dangerous is very high, sanctions are much more likely, and so these mechanisms might be effective. Thus, the efficacy of these and perhaps other mechanisms in restraining the perverse effect warrants additional attention.\footnote{There are also social pressures and moral obligations that might affect the decision whether to continue production.}

Assuming that the perverse effect is widespread, the question arises as to what, if anything, should be done about it. One possibility is to reduce penalties. If tort penalties are excessive, this Article has provided an additional reason for reducing them—increasing penalties might actually encourage manufacturers to maintain riskier products on the market, whereas reducing penalties might have the opposite effect. Moreover, this Article suggests that one cannot infer from an observation that there are many dangerous products on the market that tort penalties are too low, because stiff penalties might be responsible for the most dangerous products. Obviously, reducing penalties might create its own problems. For firms in Case I, in which stiffer penalties have the usual deterrent effect of causing manufacturers to withdraw less risky products, reducing tort penalties will encourage manufacturers to maintain less safe products on the market. Moreover, reducing penalties is likely to encourage firms to introduce less safe products.

A second possible response is to establish minimum corporate equity requirements. Although the United States has no such general requirements, balance sheet regulation is common in several industries, especially financial services.\footnote{See generally Joseph Jude Norton, Capital Adequacy Standards: A Legitimate Regulatory Concern for Prudential Supervision of Banking Activities?, 49 OHIO ST. L.J. 1299 (1989) (describing the history of bank capital regulation in the United States).} Although requiring greater equity would reduce the perverse effect, such a requirement would impose large costs on manufacturers, which would be passed along to consumers. Capital is expensive to hire, and doing so on the off chance that it would later be required to pay a judgment would impose large and otherwise avoidable costs.\footnote{In addition, some commentators believe that equity is an especially costly form of capital because debt is much more effective at disciplining managers. See Michael C. Jensen, Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers, 76 AM. ECON. REV. 123, 124–25 (1986).} Thus, before concluding that there should be minimum corporate equity require-
ments, it would be worthwhile to consider eliminating the existing tax incentives that encourage corporations to increase debt and reduce equity. The largest of these is the preferential tax treatment of debt relative to equity.71

Another possible response is to require corporations to obtain liability insurance. Requiring manufacturers to carry complete liability insurance would not only protect tort creditors, it would also internalize the full cost of the harm. Thus, returning once again to the example from Part I, assuming $\theta = 1$, full insurance would cost $1.6$ million if the manufacturer continued production. Because that amount would exceed the gain from additional sales by $600,000, the manufacturer would cease production if it were required to purchase full insurance.72 Thus, at least in theory, the perverse effect could be eliminated by requiring full insurance. In practice, however, there are problems with requiring full insurance, because insurance creates problems of adverse selection and moral hazard. Most notably, it dampens the incentives for other parties to take precautions that could reduce the probability or magnitude of the harm.

A fourth possible response is to reverse the trend from negligence to strict liability in products liability matters. Replacing strict liability with negligence would ameliorate the perverse effect of stiffer penalties by extending the region in which stiffer penalties have their usual effect. However, the debate as to whether strict liability or negligence is the appropriate standard in products liability matters involves many issues in addition to the perverse effect, and as yet is unresolved.73 Thus, if negligence is the appropriate standard for reasons unrelated to the perverse effect, then the amelioration of that effect is a further advantage of

71. See Jane G. Gravelle, Congressional Research Service, Corporate Tax Integration: Issues and Options 11 (1991) (estimating that the total tax rate on debt is about half of that on equity).

72. There is a 10% chance that the widgets are dangerous. If they are dangerous and production continues, the new sales will cause $16$ million of harm. Thus, the expected harm, the product of the probability that widgets are dangerous (0.1) and the harm if they are dangerous ($16$ million), is $16$ million. Thus, an insurance company would require the manufacturer to pay $1.6$ million to provide $16$ million in coverage if the widgets are dangerous. Because the manufacturer would only make a $1$ million profit by continuing production, it would lose $600,000 if it continued production and purchased the insurance policy.


returning to a negligence standard. Alternatively, if strict liability is the appropriate standard, then the need to find another response to the perverse effect remains as strong as ever.

Still another possible response to the perverse effect is to improve the position of tort creditors in bankruptcy by paying their claims before the claims of unsecured creditors.74 Although improving the priority of tort creditors would increase their likely recoveries in bankruptcy, it would not eliminate the perverse effect. This is because equityholders and voluntary unsecured creditors together would still have an incentive to externalize risk to tort creditors. Once the point is reached at which the unsecured investors' investments in the tortfeasor corporation would be wiped out, the risk of loss is borne by tort creditors. Under these circumstances, neither the equityholders nor the unsecured voluntary creditors have a strong incentive to prevent the continued production of a potentially dangerous product. Thus, improving the position of tort creditors in bankruptcy does not eliminate the perverse effect, it only changes the point at which it occurs.

A sixth possible solution is to rely more heavily on regulations. In principle, the entire ability of manufacturers to externalize risk to consumers because of limited liability can be eliminated by direct regulation: regulators can remove those products that are "too risky" and that manufacturers are unwilling to withdraw from the market. In actuality, regulation is likely to be of limited efficacy. This is because the regulator must have a lot of knowledge to regulate effectively, which is unlikely to be true, and because the regulator must be able to make an independent decision free of political influences, which is open to question. Thus, although the possibility of manufacturers externalizing risk to consumers might justify some regulations, it is unlikely that regulation can eliminate that possibility.

A seventh possible response is to eliminate limited corporate liability and the discharge of debts in bankruptcy.75 Although academics have made proposals along both these lines,76 none of these proposals has met with
much support, and modifying limited liability would also impose costs.77 Thus, if the problem described in this Article is widespread, as it appears to be, there will be a need to craft a response, either from the list above or elsewhere, that eliminates or at least reduces the problem, without imposing too many other costs.

CONCLUSION

The economic approach to tort law is based on the premise that individuals respond to incentives.78 The most basic result in that literature is that stiffer penalties discourage less risky activities.79 Previous commentators have shown that larger penalties have no additional deterrent effect once a tortfeasor's wealth is exhausted.80 This Article has shown that for the important example of products liability cases, the deterrent effect of stiffer penalties does not merely disappear, but is actually reversed once a tortfeasor's wealth is exhausted. Stiffer penalties then encourage tortfeasors to keep riskier products on the market that they would have withdrawn with less stiff penalties. The explanation for this perverse result is that the manufacturers' decision whether to continue production depends on a comparison of its expected equity from continuing and ceasing production. Initially, raising penalties reduces the expected value of the equity from both continuing and discontinuing production. But, once penalties have been raised to the level at which the manufacturer would be bankrupt if the product is dangerous and production continues, further raising penalties only reduces the expected value of the equity from discontinuing production. Thus, in products liability matters, the usual logic—that higher awards and tougher rules (strict liability over negligence) will discourage the production of risky products—is at some point reversed. Moreover, the perverse effect is likely to be widespread, even at low penalty levels, especially for firms that do not have a diversified product line and whose products have the potential to cause great harm. It is therefore possible that reducing tort penalties in products liability cases will encourage manufacturers to withdraw their riskiest products from the market. If that is true, the concerns of proponents and opponents of products liability reform, encouraging the introduction of new products and removing dangerous products from the market, can both be met by reducing the stiffness of tort penalties.

78. See COOTER & ULEN, supra note 73, at 11 (stating that "the rules created by law establish implicit prices for different kinds of behavior, and the consequences of those rules can be analyzed as the response to those implicit prices") (emphasis omitted); LANDES & POSNER, supra note 46, at 9–14 (defending the assumption).
79. This is a simple application of the law of demand—raise the price and less will be purchased.
80. See generally Polinsky & Shavell, supra note 2; Shavell, supra note 2.