KYKLOS Vol 41, 1988, Fasc 3, 379 395

Disaster-Prone Technologies, Environmental Risks, and Profit Maximization

RICHARD W. ENGLAND *

The adoption of modern industrial technologies has resulted in dramatic improvements in labor productivity during recent decades, but these methods of production also frequently require the processing, storage and transportation of explosive or toxic chemicals, radioisotopes and other hazardous materials[1]. As tragic events in Brazil, Mexico and India have vividly illustrated, substantial risks of major industrial disasters accompany the adoption of these productivity-enhancing techniques (see *Table 1*)[2].

Although some commentators have concluded that modern technology is intrinsically fatal, I would like to argue that the probability of industrial disasters is determined only in part by the physical characteristics of particular techniques. Another determinant of the degree of accident risk is how those methods are managed by the individual enterprise. In particular, installation of safety devices, better training and more frequent monitoring of operating personnel,

* Associate Professor of Economics, University of New Hampshire, Durham, U.S.A. This paper is based on research supported by a Faculty Development Grant from the University of New Hampshire. The author would like to thank Professors MARGRIET CASWELL, JAMES HORRIGAN, DONALD KING, RICHARD MILLS, and PAUL WENDT for their helpful suggestions.

1 According to one estimate, 1 5 billion tons of 'dangerous cargo' is transported annually in the United States The substances being shipped range from gasoline to nuclear wastes [see *Wall St. Journal*, 8 July 1986, p 62]

2 The reader might ask why the Soviet nuclear accident at Chernobyl is not included in *Table 1* or my subsequent discussion The reason is that I believe the causes of industrial disasters differ between centrally-planned economies and corporate-oriented economies The analysis in this paper is meant to apply to the latter set of countries. For some comments on environmental conditions in the socialist world, see ENGLAND [1987]

use of less hazardous materials, and more frequent inspection and maintenance of equipment can lower the probability of major industrial accidents. Hence, the likelihood of industrial disaster is influenced by a variety of management practices as well as by the technology utilized.

In the first section of this paper, I specify a microeconomic model of disaster risk and its relationship to profit maximization in the short run by the individual firm [3]. The second section discusses the optimal accident probability from the firm's perspective and how that probability might be influenced by the magnitude of prospective accident losses to the firm itself. The concluding section offers several reasons for believing that the accident probability chosen by a profit-maximizing firm will be greater than the socially desirable level in the absence of public regulation of firm behavior.

Table 1

Recent Industrial Disasters

Site	*Date*	*Event*	*Immediate Fatalities*
Cubatão (Brazil)	February 25, 1984	explosion of oil pipeline	508 deaths [1]
Mexico City (Mexico)	November 19, 1984	explosion of storage tanks containing 3 million gallons of liquefied gas [2]	at least 450 deaths [3]
Bhopal (India)	December 2–3, 1984	discharge of 50,000 pounds of methyl isocyanate vapor [4]	2374 deaths (official) 5000 deaths (unofficial) [5]

Sources 1. *1985 Reader's Digest Almanac*, p 44
2. *Facts on File*, November 23, 1984, p 866
3 *The Nation*, April 27, 1985, p 488
4. *Environment*, September, 1985, p. 34
5 *Ibid*, p 12, *Wall Street Journal*, April 3, 1987, p 3

3. For other models which bear some similarity to the one proposed in this paper, see VISCUSI [1983] and OPALUCH and GRIGALUNAS [1984]

I MODEL SPECIFICATION

Let us begin by assuming that a one-plant firm faces a linear demand function for its single product:

$$p = a + bQ, \ a > 0, \ b < 0, \tag{1}$$

where p is product price and Q is the quantity demanded (and produced). That is, assume that the firm is an imperfect competitor in its single product market.

Suppose, furthermore, that this enterprise has already adopted a specific industrial technology and that it has made fixed investments in a certain capacity to produce, call it Q_k. Its total production costs are then the sum of its fixed and variable costs, F and V respectively. Note, however, that although F and V are fixed and variable with respect to the firm's output rate *both* categories of cost can be expected to rise if the firm's management undertakes extra measures to reduce the probability of a major accident. (More frequent inspection of chemical storage tanks at a pesticide plant, for example, could lower the chance of a Bhopal-style disaster whether the plant is shut down or operating at capacity. These inspection costs would therefore appropriately be regarded as additional *fixed* costs of owning the plant.)

Consequently, let us assume that

$$F = F_o \ r^{\beta}, \ F_o > 0, \ \beta < 0 \tag{2}$$

and

$$V = v_o \cdot r^{\beta} \cdot Q, \ v_o > 0, \ 0 \leqslant Q \leqslant Q_k, \tag{3}$$

where r is the probability of a major accident at the firm's plant and β is the elasticity of both fixed costs and variable costs with respect to the firm's decision, whether explicit or implicit, about the magnitude of r[4]. Hence, both production cost categories are minimized if the firm's management is willing to accept the inevitability of an accident,

4 The assumption that these two elasticities are equal is somewhat restrictive, but the analysis which follows would not differ dramatically unless the two elasticities were substantially different from one another. It should also be noted that (3) implies that both average variable cost and marginal cost are constant and equal to $v_o r \beta$ so long as $0 < Q < Q_k$.

and both costs approach infinity if management attempts to eliminate the chance of an accident altogether.

It should be noted that this specification of the firm's production costs embodies several important premises. One is that opportunities exist to manage, but not eliminate, the probability of major accidents within firms utilizing disaster-prone techniques of production. The second premise is that firm managements face risks of, and not uncertainty about, prospective accidents. That is, they are assumed to be able to choose a specific accident probability based on information gathered from sources such as probabilistic risk assessment studies by engineering staffs or historical loss data recorded by insurers.

This does not complete our specification of the firm's cost conditions, however, since its management will also take account of its own accident-related losses should an accident occur. Let us assume that A is the present value of the firm's prospective accident losses (e.g. equipment and inventory damages, extra liability insurance premia, etc.) and that A has a particular magnitude determined by the firm's past technological and fixed capital investment decisions, legal liability rules, etc. Hence, the firm faces a lottery with respect to its overall costs, but a lottery in which it chooses the odds and in which the payoffs vary with the odds! The expected value of the firm's overall costs, E(C), is thus given by

$$E(C) = F(r) + V(Q, r) + r \cdot A. \qquad (4)^{5}$$

How a firm's management might react to this risky cost situation is unclear. Some recent experimental research apparently contradicts the expected-utility maximization hypothesis and risk-aversion assumption which have dominated economic analyses of choices involving risk since the 1940's [ARROW, 1984; SCHOEMAKER, 1982; VISCUSI, 1985]. In order to close my model, then, I shall simply assume that the firm's management seeks to maximize the expected value of its total profit, E(Π), where

5 Of course, firm decisions actually result in a probability distribution of accidents of various magnitudes at any particular output rate Equation (4), therefore, embodies a simplifying assumption.

$$E(\pi) = p \cdot Q - F(r) - V(Q, r) - r \cdot A \qquad (5)$$
$$= aQ + bQ^2 - F_0 r^\beta - v_0 r^\beta Q - rA.$$

That is, I shall assume risk-neutral preferences on the part of the firm's management.

II IMPLICATIONS FOR FIRM BEHAVIOR

Let us now consider what requirements must be satisfied to maximize expected total profit and what those requirements imply for firm behavior under alternative situations. Differentiating (5) with respect to the firm's two decision variables, one finds the following pair of first-order conditions for a maximum:

$$\partial E(\pi)/\partial Q = [a + 2bQ] - v_0 r^\beta = 0 \qquad (6)$$

and

$$\partial E(\pi)/\partial r = -\beta \cdot [F_0 + v_0 Q] \cdot r^{\beta - 1} - A = 0. \qquad (7)$$

The first equality can be interpreted as the usual requirement that the output rate be such that marginal revenue equals short-run marginal cost. The second equality, which is less transparent, requires that the marginal benefit to the firm in the form of reduced production cost via accepting an incremental chance of industrial disaster equals the marginal expected accident losses of the firm associated with acceptance of that incremental probability[6].

Alternatively, one can conceive of these first-order conditions for maximization of expected total profit as a pair of equations generating (Q, r) pairs which satisfy those marginal conditions:

$$Q = -\frac{a}{2b} + \left[\frac{v_0}{2b} \cdot r^\beta\right], \qquad (8)$$

and

$$Q = -\frac{F_0}{v_0} - \left[\frac{A}{\beta v_0} \cdot r^{1-\beta}\right]. \qquad (9)$$

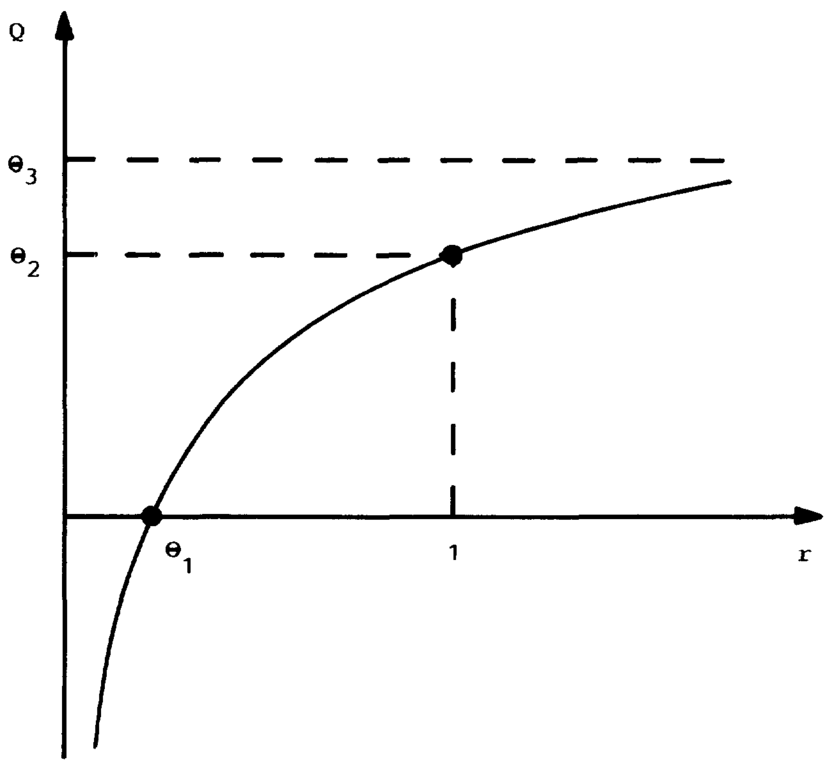
6 Note that the first term of (7) is equal to $-\partial(F + V)/\partial r > 0$, which must equal $d(r \cdot A)/dr > 0$

In both instances, Q increases monotonically with r but at a decreasing rate in (8) and an increasing rate in (9). Given the earlier restrictions on parameter signs and magnitudes and the further plausible assumption that $v_0 < a$ (which amounts to assuming that the highest possible demand price exceeds the lowest possible marginal or average variable cost), one can graph (8) and (9) as depicted in *Figures 1* and *2*, respectively. (Graphical intercepts are defined in the appendix.)

With this graphical apparatus in place, one can then ask whether there exist unique values of the firm's decision variables, call them Q* and r*, which satisfy (8) and (9) simultaneously with $Q \geq O$ and

Figure 1

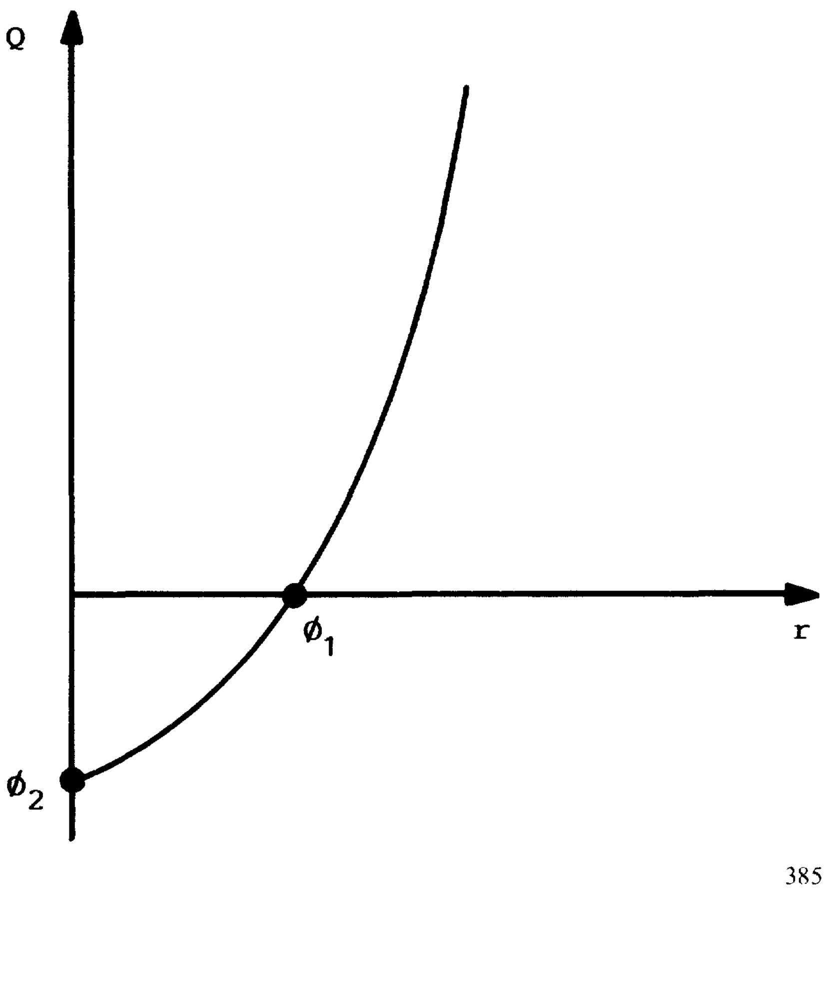
Equality of Marginal Revenue and Marginal Production Cost



$O < r \leq 1$. Inspection of equation (8) suggests that current demand conditions and the firm's past choice of technology and plant size jointly determine the position of its graph in *Figure 1*. Equation (9), however, implies that the position of its graph in *Figure 2* is determined by both past investment decisions *and* by prospective accident losses borne by the firm should a disaster occur. In particular, that graph rotates upward about point Φ_2 as the magnitude of A increases.

Figure 2

Equality of Marginal Benefit of Risk-Bearing and Marginal Expected Accident Loss



As outlined in the appendix, simultaneous satisfaction of equations (8) and (9) at a profit-maximizing equilibrium with a positive output rate and a positive, but less than unitary, accident probability is by no means assured. That is, operation of the firm's production facility without the inevitability of a major accident is problematic. However, if the firm's cost, demand and risk parameters do permit such an equilibrium, it is interesting to speculate how a firm's management might react to differences in those conditions.

For a firm of a particular size, for example, the obligation to pay more compensation to victims should a disaster actually occur would tend to result in a lower output rate and smaller chance of disaster. That is, for higher magnitudes of A, the graph of (9) rotates about point Φ_2 and towards the vertical axis, thereby indicating lower equilibrium values of Q* and r*, *ceteris paribus*.

What influence might plant size *per se* have on disaster risk? Given the level of product demand and the potential accident costs faced by a firm, larger firm size (as measured by F_0) indicates a downward and rightward shift of the graph of (9). This shift in the equilibrium requirement of equal incremental costs and benefits of additional accident risk implies, in turn, higher output and greater risk of an industrial disaster. Hence, *ceteris paribus*, a firm with a lower capacity utilization ratio might be willing to accept a greater risk of an industrial disaster of a particular magnitude. Finally, note that this model suggests that a firm's decision about its output rate will depend upon fixed cost considerations as well as product demand and short-run marginal cost once issues of risk management are taken into account.

III PROFIT MAXIMIZATION AND PUBLIC SAFETY

So far, I have addressed how management of disaster risk is linked to the private profit calculations of the industrial enterprise. A further issue is whether the management practices of the individual firm will tend to result in an adequate level of public safety. The major theme of this section is that industrial corporations probably do impose excessive risks of major accidents on society as a whole. This excessive risk is not because of intrinsic recklessness on the part of individual managers but because of various features of their legal and economic environment.

Let us begin to construct this argument by noting that the privately discounted costs of an accident from the firm's perspective are not necessarily equal to the socially discounted costs of that accident to the whole of society. If the latter magnitude (call it $\bar{A}$) is greater than the former sum (which we have denoted as A), then our model implies that Q* will exceed the socially optimal output rate, $\bar{Q}$, and r* will exceed the socially optimal degree of disaster risk, $\bar{r}$[7].

There are a number of institutional reasons for believing that the social magnitude of accident losses will indeed exceed that sum borne by the individual firm in the event a major disaster does occur. First, there is likely to be *substantial undercounting of accident victims* in the wake of an industrial disaster. Although it is relatively simple to count those immediately killed and injured by an explosion, it is far more difficult to identify and enumerate the victims of exposure to toxic chemicals, heavy metals, asbestos fibers, and radioactive materials. Latency periods of years, even decades, may elapse between exposure to hazardous substances during an accident and later diagnosis of consequent diseases [HATTIS and KENNEDY, 1986, p. 62]. As a result, some accident victims will not even claim compensation because they are unaware of the harm which they have suffered in the remote past. In addition, long latency periods make it difficult for the individual victim to legally claim compensation. As GOFMAN [1981, p. 108] has noted in a similar context:

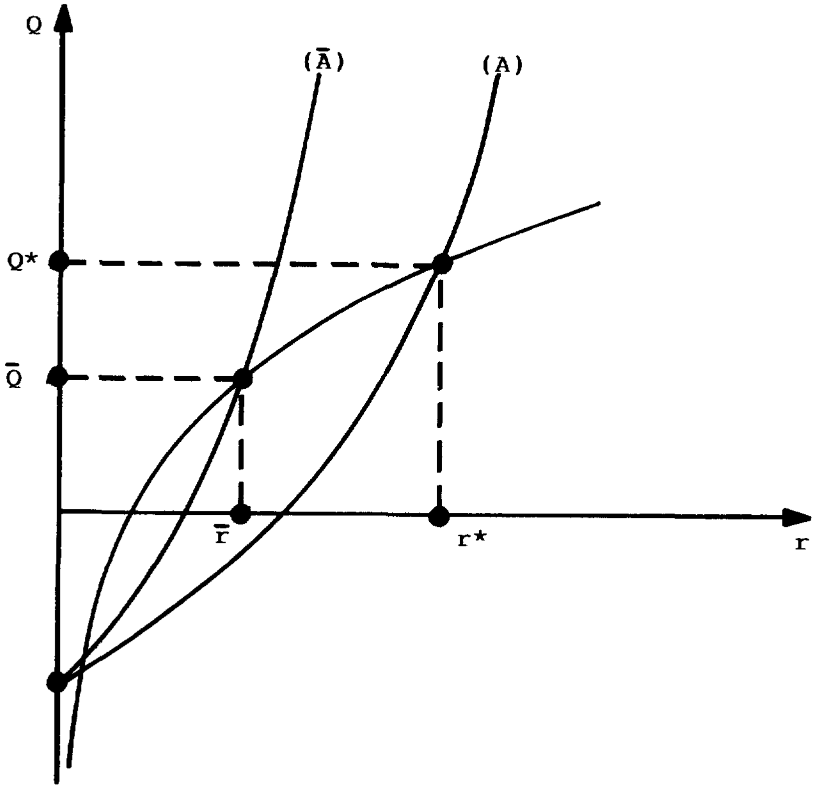
> An industrial worker can be very unfairly treated as a result of a long latent period between radiation insult and development of a clinical cancer if he [or she] is asking for worker's compensation. Lawyers, judges, juries, and physicians have all tended to disbelieve that present cancers can result from radiation exposures twenty years ago Even today, .. the worker making a claim of occupationally induced cancer has a tough time winning .

Another factor which tends to result in undercounting of accident victims is the widespread legal and administrative presumption that there are threshold levels of exposure to hazardous substances below

7 To see this point, insert the values of A and $\bar{A}$ in (9) and note that the graph of (9) is closer to the Q-axis when $\bar{A} > A$, as depicted in *Figure 3*, thereby indicating a difference between the social optimum and the private equilibrium of the firm

Figure 3

Private Risk versus Public Safety



which no health effects will be felt. This presumption implies that a portion of the exposed population which has received relatively low doses during an accident does not deserve to be compensated. In fact, however, the existence of threshold exposure levels is problematic since those thresholds are often inferred by linear extrapolation of data from high-dose animal studies [HATTIS and KENNEDY, 1986, pp. 63–65]. After an exhaustive study of radiation exposure data, GOFMAN [1981, p. 411] concluded that 'cancer and leukemia induction by radiation is proportional to dose right down to the lowest conceivable doses'[8]. Hence, because of an erroneous legal presump-

8. After surveying epidemiological evidence on low-dose radioactive exposures, ARCHER [1980] reaches a similar conclusion.

tion that threshold exposure levels exist, a substantial number of accident victims may not receive any compensation as a result of the civil litigation which inevitably follows any industrial disaster.

A second major reason for believing that social losses will exceed firm losses is that those accident victims who are *successful plaintiffs* in tort suits are likely to be *inadequately compensated*. This results, in part, from the frequent use of the discounted-future-earnings criterion in civil suits to assess damages for wrongful deaths and injuries. This human-capital-loss criterion has been widely rejected within the economics profession, and willingness-to-pay-for-reduced-risk has been offered as a superior criterion [BAILEY, 1980; MISHAN, 1976][9].

Even though the willingness-to-pay (WTP) criterion normally implies greater generosity when compensating accident victims, however, some authors are skeptical about its appropriateness as a norm for legal compensation. As MENDELOFF [1983, p. 557] has noted:

> 'Like the human capital approach, willingness to pay raises the dilemma that preventing harm to the rich confers greater benefits than preventing harm to the poor.'

In other words, WTP advocates implicitly accept existing inequalities in earnings and wealth distributions and then search for Pareto improvements within that inherited distribution scheme. It is surely debatable, however, whether social welfare judgments should take current earnings and wealth distributions for granted, thereby condemning poor victims of industrial disasters to meager compensation. To value the lives of the already poor neighbors of disaster-prone plants in this manner is to risk reproducing and even intensifying their state of poverty.

Additional reasons for rejecting the WTP criterion for accident compensation purposes can be found in GREGORY and MCDANIELS [1987]. First, numerous empirical studies have suggested that individuals' compensation demanded for losses incurred exceeded their reported willingness to pay in order to avoid those losses. Furthermore, the WTP criterion is theoretically grounded in the notion of

9 Consider, once again, the case of Bhopal. BESHAROV and REUTER [1985] have reported that the discounted-future-earnings criterion justifies payment of only $8,500 per fatality to the survivors of those slumdwellers who died in that pesticide-plant disaster.

voluntary bilateral exchange. Hence, 'asking a person the maximum amount they willingly would pay to avoid ... something they don't want ... gives (at best) an odd meaning to the term "welfare" ...' [p. 20]. For these and other reasons, the authors conclude that the WTP criterion 'could dramatically underestimate the social costs of environmental losses in certain contexts' [p. 24].

Not just the proper amount of compensation per plaintiff, however, but also the timing of its receipt by the accident victim is relevant in this context. Legal principles of due process and right of appeal are certainly to be cherished, but they also tend to result in a protracted process of civil litigation after a major accident, thereby delaying the date of actual victim compensation. (As *Table 2* verifies, the legal process stemming from the Bhopal disaster has already been quite lengthy but victims have not yet been compensated.) Unless the courts require corporate offenders to pay substantial interest charges on top of damage awards, victims will be undercompensated.

Still another major reason for believing that corporate firms will choose excessive degrees of disaster risk is that the total potential compensation owed by shareholders to accident victims is capped by

Table 2

Chronology of Bhopal Litigation

toxic gas discharge	December 1984
filing of private suits against Union Carbide in U S. federal court	January 1985
filing of suit by Indian government in U.S court	April 1985
$ 350 million offer by Union Carbide to settle damage claims	March 1986
dismissal of Indian suits in U S court	May 1986
filing of suit in Bhopal court by Indian government	September 1986
demand by Indian government that Union Carbide pay in compensation $ 3000 million	November 1986
plea by Indian judge for immediate relief payments by Union Carbide and Indian Government	April 1987
order by Indian judge that Union Carbide pay $ 270 million in interim relief	December 1987
appeal of interim relief order by Union Carbide	December 1987
full payment of compensation to Bhopal victims	???

bankruptcy and limited liability provisions of corporate law. As ARROW [1971, pp. 138-141] has suggested, these provisions may serve as (imperfect) instruments for sharing risk within society. However, I must agree with HOWARD [1980, p. 105], who states:

Today corporations have the same limited liability to third parties (like the victim of the risk) that they have to second parties, their knowing creditors. This means that if a corporation is so structured that its assets are insufficient to satisfy a claim, the victim's estate cannot reach beyond those assets to the stockholders for the settlement of the claim. While I have no objections to the limited liability to creditors because they entered into the credit arrangement with knowledge of the limited liability. I see no reason why this limit should extend to third parties.

Regardless of the ethical questions involved, however, limiting corporate liability in multi-billion dollar disasters to the amount of shareholders' equity tends to promote excessive risk taking by corporate executives and managers [10].

What, if anything, might be done to reduce the risks of industrial disasters to socially acceptable levels? KATZMAN [1986] has suggested that statutes requiring corporate purchase of liability insurance might help, although he concedes that such disasters might be uninsurable by private insurers since they are intrinsically rare events and hence there is little loss experience on which to base the computation of insurance premia. Alternatively, one might promote greater civil-suit damage awards by eliminating limited-liability to third parties, requiring adequate interest payments on deferred compensation to victims, and so forth. This tort approach to deterring industrial disasters is limited, however, by the difficulty of judging the damage claims of hundreds, even ten of thousands, of victims in civil court, even when individual claims have been consolidated by class-action suits.

IV CONCLUSION

I have argued in the preceding sections that some industrial technologies are disaster-prone, that is, can result in major accidents involving

10. This general point is compounded in the specific case of commercial nuclear power in the United States by the Price-Anderson Act, which limits the liability of U.S. electric utilities to $665 million per nuclear accident [LEVIN, 1986]

serious property damage and heavy loss of human life. The probability of such accidents is not determined by technology alone, however, but also by the management practices within the enterprises utilizing those technologies.

The model developed in this paper implies that a profit-maximizing management will seek to reduce the likelihood of an industrial accident the greater are its own prospective financial losses associated with such an accident. This suggests, in turn, that tort liability for off-site damages can play a role in deterring industrial disasters.

I have also argued, however, that there are various institutional reasons for believing that profit-maximizing, risk-neutral managements might tolerate disaster probabilities in excess of socially optimal levels. I would conclude, then, that safety regulations enforced by government agencies must also play a role in preventing industrial disasters. One might even want to entertain the suggestion of one legal scholar [Savoy, 1981] that executives who knowingly manage their plants with a substantial probability of loss of human life be subject to criminal penalties [11].

APPENDIX

The intercepts in *Figures 1* and *2* are defined as follows:

$$\theta_1 = (a/v_o)^{1/\beta},\ 0 < \theta_1 < 1$$
$$\theta_2 = (v_o - a)/2b > 0$$
$$\theta_3 = -a/2b > 0$$
$$\varphi_1 = (-\beta F_o/A)^{1/(1-\beta)} > 0$$
$$\varphi_2 = -F_o/v_o < 0$$

Ceteris paribus, if A is sufficiently small, the graphs of (8) and (9) intersect when Q^* equals Θ_2 and when $r^* = 1$. That is, the firm will accept the certainty of modest accident losses of a routine nature, e.g. breakage of display items in a retail shop. At the other extreme, if A is sufficiently large, the graphs or (8) and (9) intersect when $Q^* = 0$ and $r^* = \Theta_1 = \Phi_1$. In other words, the short-term response of a firm facing truly catastrophic accident losses will be to cease operations.

11. The Indian government has recognized this possibility by filing homicide charges against nine former officials of Union Carbide, including its ex-chairman, because of the Bhopal disaster [*Wall St. Journal*, 2 December 1987]

Within these extremes, $Q^* > 0$ and $0 < r^* < 1$ if and only if $\Theta_1 < \Phi_1 < 1$ and, in addition, the two graphs intersect when $r < 1$. That is, the existence of a profit-maximizing equilibrium with risky operation by the firm requires that

$$-(\delta/\beta)\cdot A < F_0 < -(1/\beta)\cdot A, \tag{10}$$

and

$$F_0 < \gamma - (1/\beta)\cdot A, \tag{11}$$

where $\gamma = -\dfrac{v_0 \cdot (v_0 - a)}{2b}$ and $\delta = (a/v_0)^{(1-\beta)/\beta}$

These inequalities, in effect, restrict the range of firm sizes which are consistent with maximization of expected profit, given the magnitudes of product demand and variable cost facing the firm.

REFERENCES

ARCHER, V.: 'Effects of Low-Level Radiation. A Critical Review', *Nuclear Safety*, Vol. 21 (1980), pp. 68–82

ARROW, K.: *Essays in the Theory of Risk-Bearing*, Chicago: Markham, 1971

ARROW, K.: *Collected Papers of Kenneth J. Arrow*, Vol. 3. Cambridge: Harvard University Press, 1984, pp 261–270.

BAILEY, M.: *Reducing Risks to Life: Measurement of the Benefits*, Washington American Enterprise Institute, 1980

BESHAROV, D. and REUTER, P.: 'Averting a Bhopal Legal Disaster', *Wall Street Journal*, 16 May 1985.

ENGLAND, R.: 'Ecology, Social Class, and Political Conflict', in ENGLAND, R (ed.), *Economic Processes and Political Conflicts: Contributions to Modern Political Economy*, New York. Praeger, 1987

GOFMAN, J.: *Radiation and Human Health*, San Francisco: Sierra Club, 1981.

GREGORY, R. and MCDANIELS, T. 'Valuing Environmental Losses: What Promise Does the Right Measure Hold?', *Policy Sciences*, Vol 20 (1987), pp 11–26.

HATTIS, D. and KENNEDY, D.: 'Assessing Risks from Health Hazards. An Imperfect Science', *Technology Review*, Vol 89 (1986), pp. 60–71

HOWARD, R.: 'On Making Life and Death Decisions', in: SCHWING, R. and ALBERS, W (eds.), *Societal Risk Assessment*, New York Plenum, 1980

KATZMAN, M.: 'Pollution Liability Insurance and the Internalization of Environmental Risks', *Policy Studies Review*, Vol. 5 (1986), pp 614–623

LEVIN, S: 'Who'll Pay for a U.S. Chernobyl?', *The Nation*, 14 June 1986, pp. 815–818.

MENDELOFF, J: 'Measuring Elusive Benefits: On the Value of Health', *Journal of Health Politics, Policy and Law*, Vol 8 (1983), pp. 554–580

MISHAN, E J.: *Cost-Benefit Analysis*, New York Praeger, 1976 ed.

OPALUCH, J. and GRIGALUNAS, T.: 'Controlling Stochastic Pollution Events Through Liability Rules: Some Evidence from OCS Leasing', *Rand Journal of Economics*, Vol 15 (1984), pp. 141–151.

SAVOY, P.: 'Legalizing Corporate Murder', *The Nation*, 20 June 1981, pp. 761–764

SCHOEMAKER, P. 'The Expected Utility Model Its Variants, Purposes, Evidence and Limitations', *Journal of Economic Literature*, Vol 20 (1982), pp. 529–563.

VISCUSI, W. K. 'Frameworks for Analyzing the Effects of Risk and Environmental Regulations on Productivity', *American Economic Review*, Vol 73 (1983), pp 793–801.

VISCUSI, W K.: 'Are Individuals Bayesian Decision Makers?', *American Economic Review*, Vol. 75 (1985), pp. 381–385.

SUMMARY

This paper presents a model of short-run profit maximization by an industrial firm utilizing a disaster-prone technology. The firm's decisions about output rate and accident prevention activities are shown to be jointly determined by market demand, production cost and prospective accident loss data. Various institutional reasons are given for believing that, in the absence of government safety regulations, even a risk-neutral management is likely to choose an excessively high probability of a Bhopal-style disaster.

ZUSAMMENFASSUNG

In diesem Beitrag wird ein Modell der kurzfristigen Gewinnmaximierung für Industrieunternehmungen entwickelt, deren Technologie die Gefahr von Katastrophen birgt Die Entscheidungen der Unternehmung hinsichtlich Produktion und Unfallvorbeugung werden bestimmt durch Nachfrage, Produktionskosten und erwartete Folgekosten von Unfällen. Aus verschiedensten institutionellen Grunden dürfte sogar ein risikoneutrales Management – bei Absenz staatlicher Sicherheitsvorschriften – dazu neigen, eine aus gesellschaftlicher Sicht zu hohe Wahrscheinlichkeit einer bhopalartigen Katastrophe zu wahlen

RÉSUMÉ

Cet article présente un modèle de maximisation du profit pour une entreprise industrielle qui met en œuvre une technologie à très hauts risques. Les auteurs montrent que les décisions de l'entreprise concernant le taux de production et les activités de préven-

tion des accidents sont déterminées conjointement par la demande du marché, les coûts de production et les données prospectives de pertes d'exploitation consécutives aux accidents.

Cet article fournit différents raisons institutionnelles pour penser qu'en l'absence de règlementations officielles de la sécurité, une direction d'entreprise neutre envers le risque choisira vraisemblablement une probabilité extrêmement élevée vis-à-vis d'un désastre du style de celui de Bhopal