Risks to Selves, Risks to Others

By Christopher Avery, S. Jody Heymann, and Richard Zeckhauser*

Economists have given considerable attention to trade-offs between risks and benefits, but they have usually focused on two polar cases. In the first, all risks and benefits return to the decision-maker. This approach was pioneered by Thomas Schelling's (1984) "The Life You Save May Be Your Own," and pursued in the vast willingness-to-pay literature. At the opposite extreme, the risks fall almost overwhelmingly on individuals external to the decision-maker, as when a power plant's emissions create health risks for the surrounding population.

Between these extremes, individuals frequently take actions that impose risk on themselves and on others. For example, having sex without a condom may spread disease to others, and all drivers impose risks on other drivers and pedestrians. Many of the activities that impose personal and external risks are lifestyle choices, habits, or practices such as smoking, drinking, and sex.[1]

Many health risks are imposed by others, both inside and outside the family. The absence of prenatal care hurts both mothers, who are 5.7 more likely to die of pregnancy-related causes, and their infants, who are 1.5 times as likely to die (J. Tyson et al., 1990; L. M. Koonin et al., 1991). The reproductive rate estimates the number of infections caused, in the absence of preventive measures, by each person who has an infectious disease and lives in a susceptible community. The estimated reproductive rate of diseases targeted by childhood immunizations range from 4 to 18 (R. M. Anderson and R. M. May, 1982); the estimated reproductive rate of HIV is 5 (Anderson and May, 1991).

A number of health behaviors place the community at risk. For smoking, the comparable magnitude of risk to selves and to others are indicated by relative risk ratios. Taking nonsmokers as 1, smokers have a relative risk ratio of 1.6–3.0 for heart diseases and 12–22 for lung cancer (J. M. Shultz et al., 1991). Nonsmokers who are regularly exposed to cigarette smoke have a relative risk ratio of 1.4–2.9 for heart disease compared to nonexposed nonsmokers (A. J. Wells, 1994) and 1.1–2.4 for lung cancer (A. Woodward and A. J. McMichael, 1991). Drinking can impose risks on others in several ways. While most people who drive after drinking drive alone, a significant number drive with passengers. A survey of 3,100 drivers on weekend nights found that 3.7 percent of those driving alone had a blood alcohol concentration (BAC) greater than 0.1, and 2.9 percent of drivers with passengers had a BAC greater than 0.1 (A. K. Lund and A. C. Wolfe, 1991). In addition, students at colleges with a higher prevalence of binge drinking were significantly more likely to be assaulted (H. Wechsler et al., 1994).

What happens when rational individuals make decisions that impose health risks on others? Assuming self interest, they will ignore these impositions unless they are somehow required to pay. One way to extract payment is through the tort system.

[1] Victor Fuchs (1974 pp. 52–54) observes that death rates, averaged over all ages, are roughly 35-percent higher in Nevada than in neighboring Utah. "The answer almost surely lies in the different life-styles of the residents of the two states.... Devout Mormons do not use tobacco or alcohol...[and] in general lead stable, quiet lives. [In] Nevada...high rates of cigarette and alcohol consumption...[suggest] very high indexes of marital and geographic instability."

Steven Shavell (1987) argues for a tort system based on strict liability. When victims have the ability to mitigate losses, the strict liability rule should be modified so that "the level of losses...[equals] the optimally mitigated level of losses plus the costs of mitigation" (Shavell, 1987 p. 145).[2] The transactions costs of assessing the mitigation costs of many people would likely render the tort system ineffective.[3] Many imposers, moreover, would be judgment-proof, and mandatory insurance would be impossible to implement or monitor. For many externally imposed risks, the tort system simply could not work at all. Asking C to sue A for not wearing a condom while having sex with B, who ultimately infected C is no way to prevent AIDS.

When the risks are all borne within a small group, especially within one's family, decision-makers may internalize the costs to others in their decisions. However, since some women abuse drugs during pregnancy, and parents may drive drunk with their children, we can hardly assume full internalization even within a family.[4]

Social norms and peer pressure can also serve to reduce risky behavior. We are careful to cover our mouths when coughing in public as well as at home, in part from habit or to be polite, but also to avoid censure.[5] We could take protective action when the

risk is inconspicuous as well; in collectively oriented Japan, people often wear face masks to protect others from catching their cold. But if others are unaware of his contagious condition, a purely self-interested person would take no pains to protect them. An extreme case in which others were unaware of a risk is described in *And the Band Played On* (Randy Shilts, 1987). Gaetan Dugas, one of the first identified HIV-positive patients, spread the infection by frequenting dimly lit bathhouses where his lesions were not visible. If a social norm is tied to an action (covering your mouth when coughing) rather than to the desired outcome (preventing the spread of disease), it is not likely to be effective outside of routine situations.

This paper looks at situations where individuals, not corporations or governments, are creators of risk, and where those risks fall on others as well as the decision-makers themselves. Section I models the outcomes that result when rational individuals take actions that create such risks. Section II informally tests the predictions of our model using data on how much is spent per life saved on various interventions, depending on whether or not the intervention also substantially reduces risks to others.

I. The General Model

The decision-maker (DM) chooses the level of a risky activity, indexed by x, where x takes a particular value. That action provides benefits $b(x)$ and imposes an aggregate risk of $r(x)$, where b is increasing and concave and r is increasing and convex in x. A portion e of this risk is imposed externally, that is, on others. For any choice $x, er(x)$ is the quantity of injury to others and $(1-e)r(x)$ is the quantity of injury to the DM. To simplify, we assume that all risks are converted to some common numeraire; it could be money, utiles, or some measure of health benefit. The cost per unit of personal risk is c; in many instances this might represent the probability of a specific health loss or accident. The DM weights risks to others at the amount a, $0 \le a \le 1$, relative to risks to himself. Thus, the DM

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[2] If the losses are only received probabilistically before the accident, the imposer must pay the mitigation costs of all potential victims, not just those for actual victims. For example, with 100 victims, each at 1-percent risk, the cost of an accident will be 100 times the expected cost to any one person, but the mitigation cost to each victim will reflect only his costs, not those of the 99 others.

[3] In the malpractice context, Paul C. Weiler et al. (1993) estimate that only 1 out of 30 individuals seek compensation for injuries caused by negligence.

[4] Though they may be less aware of the risk, substance-abusing fathers impose risks on their future children at conception.

[5] Fear of censure probably explains why most littering is surreptitious and why, despite vast litter in the streets, we are shocked when someone blatantly drops a candy wrapper in front of us.

seeks to maximize net benefits

$$(1) \quad b(x) - c[(1-e)r(x) + aer(x)].$$

When $a = 1$, the DM is completely altruistic. Examples are the parent who dashes in front of a car to push his child out of the way, and the soldier in a foxhole who throws himself on a grenade. When $a = 0$, we find complete selfishness, as with an intoxicated solo motorist who pays no heed to those he endangers on the highway. We assume that the degree of concavity and convexity of $b(x)$ and $r(x)$ are sufficient to yield an interior solution for x in the DM's maximization problem. This in turn implies that the benefits and risks produced by the DM's choice of x are bounded.

PROPOSITION 1: *When $a < 1$ and $e > 0$, the laissez-faire risk, r, is greater than the social optimum, r^*.*

PROOF:
   The first-order condition for maximizing net benefits to DM, (1) above, is

$$(2) \quad b'(x) = c[1-(1-a)e]r'(x).$$

The social optimum, which weights the outcomes to all people equally, requires that x^* satisfy $b'(x^*) = cr'(x^*)$. For $a < 1$ and $e > 0$, the right-hand side (RHS) of (2) is less than $cr'(x)$. Hence, the individual maximization sets $b'(x) < b'(x^*)$; since b is concave and r is convex, $x > x^*$.

This result is the standard outcome with a negative externality. If the risk is not fully internalized ($a < 1$), the market produces too large an externality r, in this case, risk to others due to the choice of x.

As e increases, more of the risk falls on others and less on the DM. He therefore adjusts x according to the function $x(e)$. We now demonstrate the intuitive result that the greater the proportion of risk to others relative to self, the more risk the DM will impose.

COROLLARY 1: *For a fixed aggregate risk function, $r(x)$, the laissez-faire risk level $r(x(e))$ is increasing in e.*

PROOF:
   In the first-order condition (2) above, the RHS is decreasing in e. Therefore, an increase in e requires a corresponding increase in x to maintain the equality in (2). Hence, $r(x(e))$ is increasing in e.

The term $(1-a)e$ represents the distortion from the socially optimal condition due to the externality in (2). As e increases, both the distortion and the induced aggregate risk level, r, also increase. The larger the externality (either from a lower a or a larger e), the greater is the discrepancy between laissez-faire and optimal risk levels.

A. Special Concerns: Symmetry, Asymmetry, and Averting Possibilities

If two people symmetrically impose risks on one another, they have a mutual interest in agreeing to accept lower benefits in order to reduce the risk each bears. This is similar to the way that nations mutually agree to lower their tariffs.

Frequently, however, risk imposition is not symmetric. A speeding or drunk driver does not drive along roads populated with like drivers, just as the person with a cold does not wander around in a world of cold sufferers. As Jordan Baker from F. Scott Fitzgerald's *The Great Gatsby* observed in justifying her careless driving,

> "Well, other people are [careful]," she said lightly.... "They'll keep out of my way.... It takes two to make an accident." [Ch. 3].

Barring Coase-like bribes that might change the imposer's behavior, or effective centralized policing action, the best way for a potential victim to decrease risk is to take averting behavior. Thus, nonsmokers avoid areas dense with smoke, and motorists drive defensively, or stay off the roads Saturday night because of drunk drivers. Such averting actions are likely to be a highly inefficient way to reduce risks. Sometimes, dozens or hundreds of people must take expensive actions because one imposer does not; many homeless people have avoided staying in

shelters even during the winter because of the threat of violent crime in the shelter. The result is that the net benefits achieved at any level of aggregate risk are substantially reduced.

We now enrich our model to allow for potential victims' actions to reduce risk, indexed by their cost $s \geq 0$. To simplify the discussion, we assume that there are just two actors: a risk-imposer and a risk-bearer. The bearer's actions do not affect risk to the imposer, $(1-e)r(x)$, as with a pedestrian and motorist, or a nonsmoker and a smoker. Fix e and let the function $g(x,s)$, which incorporates e, denote the risk to the risk-bearer where $g_1 > 0$ and $g_2 < 0$. We assume that $g_{11} > 0$ (convexity of risk in x), $g_{22} < 0$ (decreasing marginal effect of s), and $g_{21} = g_{12} < 0$ (the greater is r, the greater the effect of s). For s sufficiently large, $g_2(1,\bar{s}) > -1/c$; otherwise, the bearer's risk will eventually turn negative, thus guaranteeing a finite solution for s.

The social optimum maximizes the total of benefits:

$$(3) \quad b(x) - s - c[r(x) + g(x,s)].$$

For each choice s there is a socially optimal choice $x^*(s)$. Similarly, for each choice x there is a socially optimal choice $s^*(r)$. The overall social optimum occurs where the two functions cross.

PROPOSITION 2: *There is a laissez-faire outcome (Nash equilibrium) such that the imposer chooses $x > x^*$ and the bearer chooses $s > s^*$.*

PROOF:

The benefit to the imposer is now $b(x) - c[r(x) + ag(x,s)]$. The risk-bearer suffers costs of $s + cg(x,s)$.

For x fixed, the bearer chooses $s(x)$ such that

$$(4) \quad g_2(x,s) = -1/c.$$

Since g_2 is increasing in s and decreasing in x, hence also in r, the bearer's response $s(b)$ is increasing in r. As the imposer places more risk on the bearer, the bearer takes

more precautions. Since there is no externality from the bearer's action, the function $s(b)$ is identical to the socially optimal choice $s^*(x)$ for a fixed x.

For a fixed s, the imposer chooses $x(s)$ such that

$$(5) \quad b'(x) = c + ag_1(x,s).$$

In contrast, the socially optimal choice $x^*(s)$ (for fixed s) satisfies

$$(6) \quad b'(x^*) = c + g_1(x^*,s).$$

For $a < 1$, the RHS of (6) is greater than the RHS of (5) at $x^*(s)$. Therefore, since b is concave and r is convex in x, $x(s) > x^*(s)$. With b and s bounded, there will be a stable Nash equilibrium with $s > s^*$, $b > b^*$.

Without regulation, the Nash equilibrium leads to too much of the risky activity and therefore more precautions than at the social optimum. Yet, the Nash equilibrium may actually produce less *risk* than the social optimum. For example, suppose that all of the risk is imposed as an externality, from motorists to pedestrians walking along a country road. As b rises, pedestrians suffer more accidents and dodge more cars. These costs increase until eventually pedestrians exercise a shutdown option—they stop walking. This cuts marginal costs to zero. That is, there is a nonconvexity in the imposed-costs curve. The outcome (bad drivers, no pedestrians) might have lower risks but higher costs than if there were good drivers and some pedestrians. Reduced risk may also result if there are discrete choices for averting behavior; a small increase in imposed risk can lead to a jump in precautions. For example, the country pedestrian might take a long footpath rather than walk on the road.

B. Cost – Benefit-Based Regulation

There are two actors in this situation, one choosing b and the other choosing s, but there is only one externality. The first actor imposes risk on the second, but there is no reciprocal effect from the second person's

action. As a result, it is possible to restore the social optimum by regulating the actions of the imposer alone. Suppose that the government conducts a cost–benefit analysis and determines that the optimal combination of actions is (b^*, s^*). Then by setting an upper limit of b^* (such as a rigorously enforced speed limit), the government assures that the imposer will choose exactly b^*. In equilibrium, the imposer's utility will be strictly increasing up to at least b^*. The risk-bearer simply chooses the best response to b^*, which is s^* by definition, since there is no externality.[6]

The cost–benefit system of regulation will also be efficient when there are many people who impose risk and many who bear it. So long as there is only a one-sided externality. a single standard for b produces optimality.

The cost–benefit system, however, is not immune to manipulation by a group of risk-bearers. If they expect the government to set a more stringent standard for b if the general situation is more dangerous. then they have little incentive to take substantial precautions until the standard is chosen. Thus, for example, by encouraging its members to wander throughout the town common, Pedestrians United may be able to get ballplaying banned, even though an outcome with ballplaying and pedestrians on the peripheral footpath would be superior.

II. Society's Spending to Reduce Risks

Society spends vastly disparate amounts to save lives, depending on the technologies with which they are saved. Drawing on the literature, Tammy Tengs (1994) identifies the dollar cost per life-year saved for 259 medical interventions. The median amount saved per life-year for all interventions (medical and nonmedical) is $41,708; for primary preventions it is $78,702.[7] For
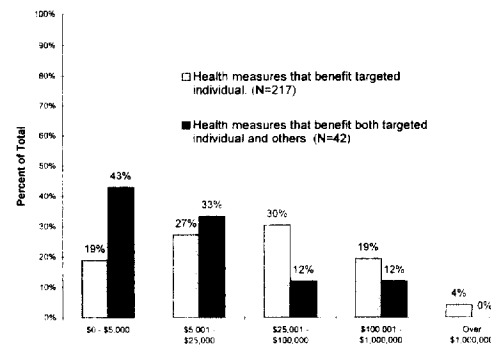

FIGURE 1. SAVINGS DUE TO RSO AND SELF INTERVENTIONS

regulatory-agency interventions, which are designed primarily to reduce the health risks to others, the median amount is $725,806 (Tengs, 1994 pp. 85–86). In each of these categories, the range of costs is huge, implying that some interventions are highly cost-effective and others are highly cost-ineffective.

We employed these data to determine the dollar cost per life-year saved when the intervention reduces risks both to selves and others (RSO). For comparison, we looked at all other health interventions—those that reduced only risk to selves (SELF).

Our 42 RSO interventions, 32 of which were prevention measures, tend to have a much lower cost per unit of benefit than the 217 SELF interventions (see Fig. 1). The medians for these categories are $8,266 and $27,959, respectively.[8] This suggests that decision-makers take less than optimal account of the risks that they impose on others (as our model predicts), that the distribution of cost-effectiveness is more favorable for RSO than for SELF interventions, or both.

This analysis may understate the differential between the cost-effectiveness of RSO and SELF interventions. Some of the original RSO intervention studies accounted for

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[6] If, as with careless driving, action by the averter reduces risk to the imposer, efficiency will require averting behavior above the laissez-faire level.

[7] The nonmedical treatments follow a higher distribution of cost per life-year than the medical treatments.

[8] The two highest values for RSO interventions involved AIDS treatment. This may reflect effective advocacy politics.

benefits to others; some did not. Accounting for any additional longevity benefits would make the cost per life-year saved even lower.

Situations in which individuals' choices impose risks to selves and others offer a challenge to policy. Efficiency, in theory, could be achieved through carefully calibrated social sanctions or regulation based on cost–benefit analysis. However, such measures would raise significant ethical and practical problems relating to the monitoring and regulation of individual behavior.

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