Should policy be concerned with objective or subjective risks?

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Abstract

Much psychological evidence suggests that people's risk-perceptions are biased. This paper assumes that public policy should intrinsically be concerned with people's expected welfare, rather than their preferences, which sometimes implies a degree of paternalism. Still, expected welfare depends on both objective and subjective risks. The latter are important through mental suffering associated with the risk, and through second-best considerations in decentralized markets where people make their own choices between risky alternatives. Optimality rules for both public provision of risk-reducing investments, and for provision of (costly) information to reduce people's risk-perception bias, are presented.

Key words: Subjective risk, risk management, risk regulation**,** risk-perception, information provision, cost-benefit analysis, paternalism

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1. Introduction

Insights from psychological research are gaining increased attention and respect within mainstream economics, which has recently been manifested by the 2002 Nobel Prize in Economics awarded to Daniel Kahneman and Vernon Smith. These insights are particularly useful in order to improve the behavioral assumptions of economics (see e.g. Rabin 2002). Probably the most consistent and well researched conclusion of economic psychology is that people's responses to risk tend to deviate systematically from what is predicted by the conventional rationality assumptions in economics (Kahneman et al. 1982, Kahneman and Tversky 2000, Gilovich et al. 2002). Much less work has so far been devoted to the normative policy implications of these findings, however. This is the task of the present paper, which assumes that people's subjective risk perceptions are systematically biased (positively or negatively), and analyzes appropriate policy measures in terms of both direct investments to reduce the risk, and (costly) information provision to reduce people's risk-perception biases.

Given equal actual risk, most people (including the author) seem to feel much more unsafe when traveling by air-plane compared to traveling by car. Similarly, there is much evidence that people severely overestimate risks associated with outdoor air pollution compared to indoor pollution (Breyer 1993, Margolis 1996). Further, many European smokers were recently found to be much more afraid of eating beef, due to the so-called mad-cow disease, than of smoking, even though all experts considered the risk of the former negligible compared to the latter. Does this imply that the government should apply a higher value of a statistical life in air transport compared to other modes, for outdoor compared to indoor air pollution, and for consumption of meat compared to smoking; or should the same valuation per safety unit be used irrespective of the subjective risk perception?

According to Pollak (1998), most analysts would agree with Breyer (1993) that such

discrepancies do not reflect differences in *values* but in *understanding* of the risk-related facts, and that public policy should be based on these facts rather than on people's (mis)perceptions. However, Pollak himself seems to be quite agnostic on this issue and he concludes the paper by saying that "utilitarians --and most welfare economists and policy analysts approach public policy from a utilitarian perspective -- should consider whose beliefs (the public's or the experts') should be used to calculate expected benefits" (Pollak, 1998, p. 380). Similarly, Diamond (2002) recently stated in this journal: "It is easy to do normative analysis in terms of an attributed utility function. What is an open arena is how to do normative analysis that reflects both reactions to choice, as well as to outcomes [...] That is, people show concern about outcomes and people show concerns about choices that are not adequately captured in descriptions solely of outcomes. How should both of these reactions be incorporated in normative analysis?" Here it will be argued that it is welfare in terms of individual well-being that should matter *intrinsically* for public decision-making, rather than utilities as a reflection of choice. Nevertheless, this does not imply that one can focus solely on the actual risks rather than the subjective ones; indeed, as will be shown, optimal investments should typically reflect the subjective risks as well.

Although there is a large body of literature on both risk perception (see Slovic 2000) and risk regulation (Hahn 1996, Viscusi 1992), systematic analysis based on the combination of the two appears to be an almost empty field, which is somewhat surprising given its obvious policy relevance. The purpose of this paper is to provide a simplified framework for such analysis. More precisely, we will only focus on the case where we know with certainty that the experts and policy-makers (which have access to the experts' views) are right, and correspondingly, that the general public is wrong, when the risk perceptions differ. This is not an assumption made for its realism, since the real risk is often difficult to estimate even for experts, but because it constitutes a natural and

important benchmark case.

Harsanyi (1982, 1995, 1997) and others have repeatedly argued that what should matter in social decision making is *informed* or *true* preferences, i.e., the preferences a rational individual equipped with perfect information would have. It is difficult to argue against this standpoint when it is obvious that people simply make mistakes due to limited information or cognitive capacity. Indeed, since people know that they make mistakes for various reasons they often delegate their rights to choose to others, or they may vote to support systems where official experts make many choices for them. Based on this assumption, Section I derives the optimal rule for a public safety investment in a stylized representative consumer model, basically implying that we should apply the objective risks. However, as we will see, it is less clear whether this implies that the investment should be over or under supplied relative to the conventional efficiency rule for public investments.

Still, returning to the air travel example, it appears natural to think that passengers' mental sufferings associated with the (subjective) risk is just as real as other kinds of suffering. It does seem strange then if this would not be taken into account by our economic model. Further, in addition to safety investments, the government may directly try to decrease the discrepancy between the objective and the subjective risk by providing more information. If so, how much information should it provide, and at what cost? Finally, most risky decisions are made by individuals themselves, implying that the actual risk is determined both by public investments in risk reduction and by people's actual behaviors, including their consumption choices. How should the government use this information when deciding how much to invest in safety and information provision? In Section 3 we generalize the model to deal with these issues, while Section 4 summarizes and draws conclusions.

2. The basic model: levels versus marginal effects

Assume that a representative consumer's expected utility function is given by $U = u(x, r)$, where *x* is (net) income and *r* is the objective risk of an accident, and where $u_x > 0, u_r < 0$; subscripts denote partial derivatives. The risk can be reduced by a public investment *G*, so that *r* = *r*(*G*), where $r_G < 0$. Hence, we assume here for simplicity that the risk is independent of individual actions, or that individual actions are independent of the public investment. Given a budget restriction $M = x + G$, where *M* is the available public budget,[2] the standard condition for a Pareto efficient investment in *G* is given by:

$$r_G \, u_r / u_x = 1 \qquad (1)$$

The left hand side of (1) is equal to the individual benefit, in terms of the marginal willingness to pay (*MWTP*), for the risk reduction caused by an additional dollar spent on *G*.[3] This is of course not very surprising, since as long as the benefits from the last dollar spent on *G* are larger than from private consumption it is optimal to invest more. If we have biased risk-perceptions, the individual instead perceives the risk *s* at the true risk *r*. Assume that the government uses some method, e.g. a so-called stated preference method, to elicit the individual preferences for risk-reduction. If *s* > *r*, does this imply that the regulator should under-provide *G* so that, at optimum, the individual *MWTP* for an additional unit of risk reduction is larger than the costs? As we will see, this need not be the case.

The individual *MWTP* for a certain change in *r* at the risk level *s* is given by $s_r \left. \frac{u_r}{u_x} \right|_{r=s}$.

[2] *M* can be interpreted to be net of other predetermined public expenditures.

[3] In terms of fatal accidents, u_r/u_x is equal to the value of a statistical life .

Hence we have that *r* should be under-provided relative to the efficiency rule (1) *in terms of preferences* for Pareto efficiency if $s_r \frac{u_r}{u_x}\Big|_{r=s} > \frac{u_r}{u_x}$, and vice versa.

If $s > r$, it seems perhaps reasonable to believe that $s_r > 1$, but this is not at all clear, as illustrated in Figure 1. For example, people may view the subjective risk to be much larger than the actual risk, but consider the possibilities to affect the risk to be lower than the actual possibilities.

[Figure 1 about here]

In case *A* the subjective risk *s* is simply a proportional amplification of the actual risk *r*, clearly implying that $s_r > 1$, i.e. that a change in the real risk implies a larger subjective risk change. In *B*, where *s* is parallel to *r*, we have instead $s_r = 1$. In case *C*, which is often seen as the standard picture (e.g. Viscusi 1992, p. 117), we have instead that $s_r < 1$, also where $s > r$, i.e., to the left of the crossing point. It is possible, however, that a relation similar to case *D*, as proposed e.g. by Tversky and Kahneman (1992), is more realistic. Here we have that $s_r > 1$ when *r* is sufficiently small, and that $s_r < 1$ for higher risk levels. Taken together, we can conclude that it is certainly not obvious that $s > r$ implies that $s_r > 1$. In other words, the fact that the subjective risk is larger than the objective one does not necessarily imply that the *change* in the subjective risk is perceived as higher than the change in the objective one.

Furthermore, the marginal WTP for a risk reduction may also depend on the *level* of the actual risk. It is often assumed that the WTP for a risk reduction increases with the actual baseline risk ceteris paribus, i.e. that $\frac{u_r}{u_x} < \frac{u_r}{u_x}\Big|_{r=s}$. If so, even if $s_r < 1$, the

MWTP for the risk reduction may (but of course need not) still be overstated relative to what the individual would have answered without risk misperception.

3. Mental suffering, public information and the second-best

So far it has been assumed that expected utility is solely a function of consumption and actual risk, even if this risk may be misperceived. But this is clearly quite restrictive, and it is possible that the perceived risk affects utility directly, i.e. independently of the actual risk. Obvious examples include fear related to a perceived risk while flying, or health-risk anxiety due to the use of certain chemicals in food, even though the actual risks might be fairly low. Following Broome (1998), Ng (1999) and Johansson-Stenman (2002), we should be fundamentally interested in welfare that reflects individual well-being, rather than preferences that reflect choices, when these differ. It is then hard to see why such mental suffering should count less compared to other determinants of individual well-being. Furthermore, Carlsson et al. (2002) presents empirical evidence that people are aware of their own subjective suffering from certain risky activities, and that they are willing to pay to reduce it. In addition, it is also clear that most risk-related decisions are made by individuals themselves, and not directly by the government. Hence, the government can only indirectly affect these decisions. The model below is generalized to encompass these aspects.

Expected utility for the representative consumer can now be written as $U = u(x, y, s, r)$ where x is a composite risk-free good, y is a risky good, and s and r are the subjective and objective risks, respectively. The third element thus reflects mental suffering. Assume further that u is strictly quasi-concave in x and y, $u_x > 0, u_y > 0, u_r < 0$ and $u_s < 0$. The latter means that for a given objective risk, (expected) utility decreases with the subjective risk. As before, it is assumed that the subjective risk depends on the objective

one.

One may argue that when the discrepancy between objective and subjective risk is due to imperfect information the appropriate task for the government is to provide information in order to eliminate, or at least reduce, this discrepance, rather than to try to correct for possible mis-perceptions. Although this argument may seem convincing, it is often found that large differences persist even after intensive public information campaigns, sometimes partly due to a limited governmental credibility. Further, providing information is typically costly and can therefore not be seen as a free lunch. Hence, there is a trade-off between the gains that could be achieved by providing more information, and the corresponding costs. The subjective risk s is therefore modeled as a function both of r and a public information investment I. The objective risk r is now a function both of the consumption of the risky good y and of public investments to reduce the risk G. Thus, we have: $s = s(r(y, G), I)$. Assuming for simplicity a linear budget restriction $M = x + y + G + I$, where all prices without loss of generality are normalized to one, we have that individual utility can be written as:

$u(M - y - G - I, y, s(r(y, G), I), r(y, G))$.

Assuming a decentralized market economy, the regulator cannot directly choose the combination of x and y for the consumer. And if the consumers would act perfectly rational, in the sense of maximizing their own expected well-being, the regulator would have no reason to do so. But in a situation where the consumers' perception of the risk of consuming one more unit of y, r_y, is biased, indirect effects on the choice of x and y should typically, as we will see, be taken into account in the regulator's second-best maximization problem with respect to G and I. The regulator's corresponding first-order conditions for an interior solution are given by:

$$-u_x - u_x \frac{dy}{dG} + u_y \frac{dy}{dG} + u_s s_r r_y \frac{dy}{dG} + u_s s_r r_G + u_r r_y \frac{dy}{dG} + u_r r_G = 0$$

and

$$-u_x - u_x \frac{dy}{dI} + u_y \frac{dy}{dI} + u_s s_r r_y \frac{dy}{dI} + u_s s_I + u_r r_y \frac{dy}{dI} = 0$$

which can be re-written as:

$$\left(\frac{u_s}{u_x} s_r + \frac{u_r}{u_x}\right) r_G + \frac{dy}{dG}\left(-1 + \frac{u_y}{u_x} + \frac{u_s}{u_x} s_r r_y + \frac{u_r}{u_x} r_y\right) = 1 \qquad (2)$$

and

$$\frac{u_s}{u_x} s_I + \frac{dy}{dI}\left(-1 + \frac{u_y}{u_x} + \frac{u_s}{u_x} s_r r_y + \frac{u_r}{u_x} r_y\right) = 1 \qquad (3)$$

where dy / dG is the overall marginal effects on consumption of *y* from an increase in public investment *G*, including indirect effects from changes in safety and income; dy / dI is the corresponding effect on *y* from a change in information *I*.

From individual utility maximization we have that consuming one more unit of the risky good *y* must give the same utility as consuming one more unit of the risk-free good *x*. In the absence of perception bias, the consumption choice would imply: $u_y + u_s s_r r_y + u_r r_y = u_x$. But when consumers misperceive r_y, so that they instead perceive $\hat{r}_y$, we have instead: $u_y + u_s s_r r_y + u_r \hat{r}_y = u_x$ [4] or

[4]Thus, we allow for the possibility that individuals can separate the mental-suffering component from the risk component. The mental-suffering component cannot be misperceived (people feel what they feel) but the risk component obviously can.

$$\frac{u_y}{u_x} - 1 + \frac{u_s}{u_x} s_r r_y + \frac{u_r}{u_x} \hat{r}_y = 0 \qquad (4)$$

Substituting (4) into (2) implies:

$$\frac{u_r}{u_x} r_G + \frac{u_s}{u_x} s_r r_G - \frac{u_r}{u_x} \left(\hat{r}_y - r_y \right) \frac{dy}{dG} = 1 \qquad (5)$$

Whereas the terms on the left-hand side reflect components of the marginal benefits, the term on the right-hand side reflects the marginal costs (the per unit price) of Q in terms of the numeraire x, which is normalized to one. The first term on the left-hand side represents the *MWTP* for the increased actual safety that a person with correct risk-perception would have. The second term reflects the *MWTP* for the correspondingly decreased mental suffering from a slight increase in the safety-enhancing investment G (and hence decrease in r and s). These two terms would also arise in a first-best economy, i.e. in an economy where x and y could be chosen directly by the regulator. These two terms would also comprise the optimality expression in the absence of risk-perception biases.

The third term, on the other hand, reflects second-best considerations, and the intuition behind it is straightforward: Assume for example that $\hat{r}_y < r_y$ so that people underestimate the risk of consuming one more unit of y (they may simply be ignorant about a certain risk). This means that they on the margin would consume too much of the risky good y for their own interest, and hence that it would be a welfare improvement if one, through some kind of public intervention, could reduce y. The size of that welfare effect per unit of G equals the welfare effect per unit of y, which is given by : $u_r / u_x \left(\hat{r}_y - r_y \right)$, times the change in y per unit of G, which is given by dy / dG .

Assume further that $dy / dG > 0$, so that public investments in safety are partly

crowded out by people making more risky individual choices (cf. Peltzman, 1975). This implies that a unit increase in *G* causes negative indirect second-best welfare effects; people consume too much of *y*, and larger public safety investments would cause them to consume even more.

To be more concrete: Assume that a policy-maker has estimated people´s WTP for a (small) risk-reducing investment. Should the fact that people underestimate the (marginal) risk of choosing good *y* instead of *x* then affect the regulator's safety investment away from the standard comparison of costs and benefits in terms of WTP? Perhaps the first guess would be that if people under-invest in safety, the government should compensate for that by over-investing and push the safety investment beyond the first-best efficiency rule. This is however not necessarily true. First note that the fact that people value their own subjective suffering is no reason for deviation; people feel what they feel and there is no inefficiency involved with taking that into account. But there are still two potential reasons for deviations:[5] The first reason is the same as in Section 2, i.e. that people's WTP for the risk reduction, corrected for risk suffering, is based on an inaccurate risk perception, which can bias the stated WTP in either direction (as discussed). Further, the second reason, which is due to indirect second-best effects, goes in the opposite direction compared to the likely first guess, given that private and public measures to reduce the risk are substitutes, as seems reasonable in most cases. If people under-invest in safety, increased public safety investment would then cause them to under-invest even more.[6]

If, on the other hand, the government provides sufficient information to the consumers

[5]Possible biases related to the elicitation method *per se* are neglected here. In practice it is far from straightforward to quantify such preferences; see e.g. Beatty et al. (1998) and Kahneman et al. (1999).

[6]Still, the *level* at the first-best rule can of course be affected by the private behavior due to the risk mis-perception.

so that all risk misperceptions disappear, then there would of course be no second-best problem left. But, as mentioned, such corner solutions are in most cases unlikely in reality, since the cost can be anticipated to increase dramatically when risk misperceptions become sufficiently small, and it may indeed be impossible to eliminate them totally. If we therefore assume an interior solution with respect to the optimal amount of information provided by the authorities, we get the following rule by substituting (4) into (3):

$$\frac{u_s}{u_x} s_I - \frac{u_r}{u_x}\left(\hat{r}_y - r_y\right)\frac{dy}{dI} = 1 \qquad (6)$$

Here, the first term represents the *MWTP* the individual would have for the decreased subjective risk due to a unit increase in public information *I*. This term represents a changed mental suffering, since the discrepancy between the true and the subjective risk decreases due to increased information. Note that when $s < r$ this term is actually negative! This reflects the fact that in a first-best world, when the consumption of *x*, *y* and *I* is optimal, providing better information about the actual risk would reduce utility, since the only difference this information would make would be an increase in the mental suffering associated with the subjective risk. Hence, if the authorities can ensure that consumers make an appropriate choice, informing them about the (higher) true risks would be welfare-decreasing. Still, from a policy perspective, the most important motive for providing better information is presumably that consumers would be able to make better informed decisions related to risky activities, and such effects are reflected in the second term of (6). The intuition is again straightforward: Assume again that $\hat{r}_y < r_y$. The additional *MWTP* an individual with perfect information would have had for the risk decrease associated with a unit decrease in *y*, is then equal to $u_r/u_x\left(\hat{r}_y - r_y\right)$. Hence, this is equal to the welfare increase per unit decrease of *y*. Consequently, to instead get the

welfare increase per unit of information I provided, we must multiply by dy / dI. The intuition behind the case where $\hat{r}_y > r_y$ follows the same logic.

4. Discussion and Conclusions

This paper has analyzed normative implications of biased risk perceptions, for which there is ample empirical evidence. In Section 2 it was shown that the fact that people under or overestimate a certain risk does *not* imply that they, correspondingly, would under or overestimate a risk *change*, resulting from either their own actions or measures taken by others such as the authorities. Indeed, empirical evidence of the opposite, from the risk literature, was presented. And, of course, it is the reaction of a risk change that typically matters for policy.

Results from a model with a decentralized market were also presented. Here people choose between risky and non-risky alternatives, and they may suffer mentally due to the subjective risk; the government can invest in both safety and in public information to reduce people's risk misperceptions. It was shown that a public risk-reducing investment should not only reflect the expected welfare increase of a reduction of the objective risk; it should also reflect the reduced mental suffering, based on the subjective risk. Furthermore, second-best considerations due to induced changed consumption of the public investment should also be taken into account. These effects may be either positive or negative, depending on whether increased public investments induce people to make decisions that increase their expected welfare, or the opposite.

Consider for example the recent European experience of many people being afraid of eating beef due to the so-called mad-cow disease, even though most leading medical experts considered the risks to be negligible compared to many other risks that we cannot, or do not want to, avoid in our daily life. Applying the subjective risk would presumably

imply far-reaching import restrictions on beef, whereas applying the objective (assuming that the experts were right in their judgements) would not.[7] The results from this paper suggest that no restrictions should have been imposed unless one would have expected non-negligible mental suffering from the risk, or unless people would have largely adjusted their behaviors. But in reality we know that many people were very scared, and there were quite large consumer adjustments. Therefore, the import-restrictions actually undertaken may after all have been well-motivated in a second-best perspective, since both the mental sufferings, and the welfare loss of poor consumer choices, may have been much larger otherwise.

For analytic simplicity, the theoretical model was based on consumer choices between two goods, but it is straightforward to extend the model to also encompass private risk-reducing investments. The public policy needs then to take into account the indirect welfare effects of private safety investments that are induced by public policy. It is easy to think of relevant examples here as well. Consider the case when people are irrationally afraid of poor drinking water, and they therefore invest large amounts of money to improve the quality. Should the authorities improve the water quality despite the fact that, based on the objective risk, the measure is cost-ineffective? Well, maybe if the public investment would crowd-out much of the private investments. Of course, if the government could provide information to eliminate the risk misperception at modest costs, that would be preferred. In reality that is often unlikely, and an optimality condition, that also included second-best considerations, for public information provision was therefore provided in this paper.

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[7] It is implicitly assumed that higher subjective risk also increases the WTP for a risk *change*, which seems reasonable here since the objective risk is close to zero. Note also that we only discuss import restrictions on *beef*; there would of course be good reasons for stringent import restrictions on cattle in either case.

Finally, it is of course important to bear possible *instrumental* considerations in mind when discussing policy recommendations based on paternalism. Indeed, we have clearly seen terrible consequences of *excessive* paternalistic decision making in many countries. Nevertheless, it seems that all governments, including those who declare themselves as liberals, sometimes in some areas apply a certain degree of paternalism, and there is no good reason for neglecting systematic analysis of such decisions and their motives. For example, most democratic governments try, in various ways, to foster democratic values, and most people appear to be happy with that. As expressed by Wilson (1994, 71): "The great puzzle for a free society is how it can encourage those traits of character on which the wise exercise of freedom depends."

As far as the author knows, the current paper provides the first attempt to analytically analyze normative policy implications of risk misperceptions, and there are of course many possible extensions as well as applications. Still, the main conclusion regarding the question posed in the title of this paper seems fairly robust: Policy-makers cannot simply choose between being concerned with the subjective or the objective risk; they need to be concerned with both.

References

Beattie, J. et al. (1998) On the contingent valuation of safety and the safety of contingent valuation: Part 1-Caveat Investigator, *Journal of Risk and Uncertainty* 17, 5-25.

Breyer, S. (1993) *Breaking the Vicious Circle: Toward Effective Risk regulation*, Cambridge: Harvard University Press.

Broome, J. (1999), *Ethics out of Economics*, Cambridge: Cambridge University Press.

Carlsson, F., O. Johansson-Stenman and P. Martinsson (2002), Is transport safety more valuable in the air?, working paper, Department of Economics, Göteborg University.

Diamond P. (2002), Public finance theory - Then and now, *Journal of Public Economics*,

86(3), 311-17.

Gilovich, T., D. Griffin and D. Kahneman (2002), *Heuristics and Biases: The Psychology of Intuitive Judgement*, Cambridge: Cambridge University Press.

Hahn, R.W. (ed.) (1996), *Risks, Costs, and Lives Saved: Getting Better Results from Regulation*, New York and Oxford: Oxford University Press.

Harsanyi, J.C. (1982), Morality and the theory of rational behavior, in Sen and Williams (1982).

Harsanyi, J.C. (1995), A Theory of Prudential Values and a Rule Utilitarian Theory of Morality, *Social Choice and Welfare*, 12(4), 319-33.

Harsanyi, J.C. (1997), Utilities, Preferences, and Substantive Goods, *Social Choice and Welfare*, 14(1), 129-45.

Johansson-Stenman, O. (2002), What should we do with inconsistent, non-welfaristic and underdeveloped preferences? in Bromley and Paavola (eds.) *Economics, Ethics, and Environmental Policy: Contested Choices*, Blackwell.

Kahneman, D., I. Ritov, and D.A. Schkade (1999). Economic preferences or attitude expressions?: An analysis of dollar responses to public issues. *Journal of Risk and Uncertainty*, 19(1-3), 203-242.

Kahneman, D., P. Slovic, and A. Tversky (1982), *Judgement under Uncertainty: Heuristics and Biases*, Cambridge: Cambridge University Press.

Kahneman, D. and A. Tversky (2000), *Choices Values and Frames*, Cambridge: Cambridge University Press.

Kahneman, D., P. P. Wakker and R. Sarin (1997) Back to Bentham? Explorations of Experienced Utility, *Quarterly Journal of Economics*, 112(2), 375-405.

Margolis, H. (1996), *Dealing With Risk: Why the public and the experts disagree on environmental issues*. Chicago, University of Chicago Press.

Ng, Y.-K. (1999), Utility, Informed Preference, or Happiness: Following Harsanyi's Argument to Its Logical Conclusion, *Social Choice and Welfare*, 16(2), 197-216.

Peltzman, S. (1975), The Effects of Automobile Safety Regulation, *Journal of Political Economy* 83(4), 677-725.

Pollak, R. A. (1998), Imagined Risks and Cost-Benefit Analysis, *American Economic Review*, 88(2), 376-80.

Rabin, M. (2002), A Perspective on Psychology and Economics, *European Economic Review*, 46(4-5), 657-85.

Slovic, P. (2000), *The Perception of Risk*, London: Earthscan.

Tversky, A. and Kahneman, D. (1992) Advances in Prospect Theory: Cumulative Representation of Uncertainty, *Journal of Risk and Uncertainty* , 5:297-323.

Wilson, J. Q. (1994), Culture Incentives and the Underclass, in H. J. Aaron, T. E. Mann, and T. Taylor (eds.) Values and Public Policy, Washington, DC: The Brookings Institution, pp. 54-80.

Viscusi, W.K. (1992), *Fatal Tradeoffs*, Cambridge: Cambridge University Press.

Figure 1. Possible relations between subjective and objective risk.