

Increasing Uncertainty About High-Stakes Risks: The Impetus for Radical Change?

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Abstract – Most of us recognize that when society’s collective trends expose us to disasters which may threaten our survival, some rather radical, i.e., fundamental, actions may be necessary to forestall such untoward events. Yet, what signals might trigger such action? Pronouncements that the “end is near” have not proven to be very effective, and rightfully so. We suggest rather that the impetus for action may come from increased uncertainty, or fuzziness, about large scale disaster, arising from *knowledge imperfections*. This uncertainty itself may therefore provide the tipping point for action, assuming however that such action does not come too late.

Keywords – risk; catastrophe; fuzzy uncertainty; precautionary risk management

I. INTRODUCTION

The modern industrial age has brought with it concerns about human survival. Many believe that the complexities of the technological and industrial trappings of progress, along with related social responses, bring with them excessive risks. To drive home their point that such risk can only be avoided through significant changes in the way we view progress, some revert to prognostications about how and when such untoward events may occur (“doomsaying”). Given the uncertainties surrounding these unfortunate occurrences, any such prognostications are bound to be very imperfect. Errors in such predictions, however, are often taken by society as falsifying the proposition that progress-induced disaster is a genuine threat. As a result, these pronouncements of impending doom are unlikely to bring about any meaningful change.

Most arguments for and against the potential for disaster in the modern world are based on a simplistic view of the world. This view ignores the true importance of fundamental uncertainties that result from knowledge imperfections. The real question is not whether such disasters *will* happen, but rather are they sufficiently *possible*? The prudent course in the face of extinction requires radical (i.e., fundamental) change to our social and economic systems to reduce or eliminate the possibility. On this basis, the mounting uncertainties about disaster that we face today could act to provide the impetus for radical change, *in and of themselves*.

II. UNCERTAINTY MATTERS

Possibility defines a unique form of uncertainty due to *imperfect knowledge* [1]. We may have sufficient information to narrow a set of possible outcomes, yet only to some degree. A one dimensional set of these outcomes, say, the outside air temperature the next day, may be expressed as an interval estimate - in the case of tomorrow’s temperature, between 65 and 75 degrees Fahrenheit. Intervals are not estimated from data directly, but rather instrumentally, as judged by how well they let us cope with an uncertain world. Nonetheless, these uncertainties are real. They define a region which we may describe as the *evidently unknown*.

We often assess the probability and loss characteristics of some exposure to risk only imperfectly. In such cases, uncertainty due to randomness and the natural variability it entails combines with knowledge imperfection. This is especially the case with high stakes (catastrophic) risks for which little reliable data is available. In Figure 1 we show an interpretation of the uncertainty surrounding the risk associated with accumulating exposures. While the figure is meant to convey an intuitive sense of uncertainty, as our acceptance goes from no risk to “too many” risks, this analysis can be formalized using the theory of *fuzzy sets* [2].

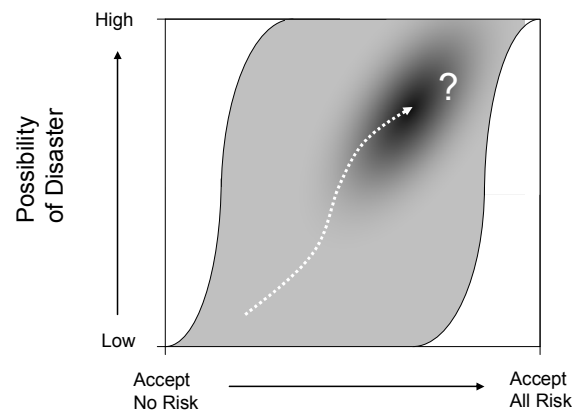


Fig. 1 A Fuzzy Representation of Risk Accumulation

The uncertainty that surrounds risk estimates can influence the way critical decisions about risk are made [3]. Say, for

example, that you must go in for a serious medical operation. Two options are available. Procedure A has a proven track record based on hundreds of clinical trials, plus a statistically documented success rate over many years of actual results. On the basis of these results, the suggested effectiveness carries a likelihood of .90. Procedure B, on the other hand, is fairly new. Based on some limited clinical trials, and its similarity to other successful procedures, the doctor that invented it suggests that it should have a success rate of “about 90 percent”. If we had to give a precise estimate of the procedural effectiveness of A and B it would probably be .90 for both (the “best guess” estimate in each case). Yet, all other things being equal, we would certainly prefer procedure A. Procedure B presents us with the unknown possibility that effectiveness may turn out to be considerably lower than .90.

When dealing with existential risks we need to consider the possibilities as well as the probabilities of loss. The fundamental problem of catastrophe is that *in the long run, there may be no long run*. We simply do not get a second chance to get things right. The mere *possibility* of existential risk must then be a sufficient indicator for action. As a result, this uncertainty will have a significant impact on how we manage such risks.

III. MISUNDERSTOOD WARNINGS

Warnings concerning possible adverse side-effects of technological and industrial progress have been around since the beginning of the modern industrial era. The same uncertainties that shroud the associated complexities, however, have complicated the nature, and effectiveness, of these warnings. The 1960’s spawned a new era of concern, as both the potential magnitude and related uncertainties of these threats were becoming more strongly perceived by both experts, and the general public. Among the first of such warnings to reach the wider social audience was Barry Commoner’s *Science and Survival* [4], published in 1966. Commoner’s work was unique in that in that it was perhaps the first to challenge the ability of modern science and technology to foresee and solve the problems its application could create.

Such warnings were almost immediately labeled as overly pessimistic by critics, who for the most part consisted of scientists, technologists and industrialists themselves. Proponents of a more cautious approach were labeled as “doomsayers”, and charged with a lack of understanding of the very science they criticized. The problem, while perhaps driven at its root by a great deal of self-interest (on both sides of the debate), was that a cogent articulation of a science of uncertainty that went beyond randomness had not yet been formally developed.

As a result, these warnings suffered from the fact that those who made them were only intuitively aware of the implications this deeper uncertainty had for the management of high-stakes risks. As such, the uncertainties were not presented formally. In cases where results were shown numerically, uncertainties were obscured by adherence to a

unduly precise framework of representation of outcomes. An example was the formal assessment of large-scale environmental threats presented in the study *Limits to Growth*, based on the concepts of system dynamics [5]. As precision was then, and in many cases still is, viewed as the *lingua franca* of traditional science, it is not surprising that the results of these studies were cast as very exact looking predictions. The impression of undue precision as to magnitude and timing of threats was an easy target of critics who used similarly precise criteria to dismiss these predictions. The most simple response, and that which has proven the most convincing to the general public, is that these predicted disasters did not occur.

The underlying force of the arguments these radical re-thinkers made, however, lies in pointing out the potential for *false negatives* (so-called “type 2 errors” of scientific hypotheses testing). The presence of uncertainty beyond randomness (i.e., knowledge imperfection) significantly compounds the problems associated with recognizing and avoiding such errors. As a result, by relying on unduly precise estimates we gain a false sense of security.

So, where are we now? The focus of warnings today is on a group of world-wide threats that we might call the “Unlucky 7” (Figure 2). The characteristics of these warnings is not only the magnitude of the potential damage, but also the great uncertainties involved. This uncertainty in turn follows from the complexity of these modern risks. While maintaining the utmost respect for science, we might naturally wonder if we are simply asking science to do *too much*. In addition, there is considerable evidence that the uncertainties may not be uniformly distributed among the world’s population. The world’s poor and otherwise socially and economically disadvantaged are subject to even greater uncertainties of existence.

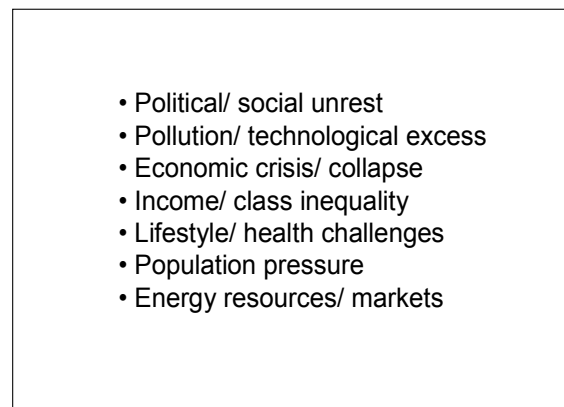
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- Political/ social unrest
 - Pollution/ technological excess
 - Economic crisis/ collapse
 - Income/ class inequality
 - Lifestyle/ health challenges
 - Population pressure
 - Energy resources/ markets

Fig. 2 Global Risks: The “Unlucky 7”

Are these risk really any different than society faced one hundred, or even a thousand years ago? For example, Agricola warned of the potential environmental dangers of “new” mining techniques in his 1556 treatise on metallurgy, *De Re Metallica* [6]. While perhaps not qualitatively different, in

terms of breath and scope the risks of today are undeniably so. One hundred years ago the cannonball was the “weapon of mass destruction”. Today we face the potential for global annihilation from a variety of nuclear, chemical and biological weapons. Writing at the turn of the last century, Wilhelm Meyer assessed the risk of global destruction from an assortment of perils – all what we might consider today as essentially “natural” ones [7]. His argument against worry was one of reasoned fatalism toward the potential for the “end of the world”, based on the fact that despite these natural threats, human-kind has been blessed with a rather remarkable streak of evolutionary survival. Human induced risks have, arguably, changed that picture.

The issue of this paper with respect to our concern for high-stakes risks is ultimately an empirical one: Are the uncertainties involved right now, or will they be in the near future, enough to trigger the need for action in the face of such risks? If we genuinely feel otherwise – that existential risks are as they have always been, and we can’t do anything about them - then our focus should return to the management of the more mundane, statistical risks whose direct influence is fairly easily within reach. A deeper look might suggest, however, that the threats are not “all in our heads”, and that tending to only to statistical risks within our direct control may itself be a prescription for disaster – sooner than later.

IV. THE NEED FOR A PRECAUTIONARY APPROACH

Uncertainty subsumes the possibility of disaster, while at the same time adding the complications of not knowing what will happen next, and when. The remedy for such risks? Either increasing our knowledge, or not continuing to incur them. The proper response to uncertain existential risk then is some sort of *precautionary* action, that avoids unknown, potentially catastrophic risk accumulation [8].

When faced with the prospect of fuzzy uncertainty about possibly catastrophic risks, the only decision criteria that make sense are simply ignoring the possibility of disaster (“fatalism”), or exercising precaution based on the *minimax* principle – minimize maximum possible loss. Unlike statistical (non-catastrophic) losses, where decisions can be based on expected or *average* outcomes, existential decisions face the catastrophe problem: *In the long run, there may be no long run*. The infinite, or near infinite, nature of the stakes makes any such cost/ benefit balancing irrelevant. It calls instead for some sort of absolute prohibition.

To be effective, however, the precautionary approach must take into account the fuzzy nature of risks involved. For example, it is not feasible to demand the complete elimination of risk. The laws of physics suggest that there is a non-zero probability, albeit tiny, that air molecules will randomly coalesce to re-inflate a flattened automobile tire. No one would sensibly wait for them to do so, in lieu of calling for a tow truck. This implies the only safe risk is no (“zero”) risk. The logical conclusion of demanding a strictly zero level of risk is that precaution suggests that we avoid every action,

since anything we do has some nonzero probability of unintended, possibly disastrous, results.

In fact, the history of human evolution teaches us that this precautionary level need not be strictly zero. A logical candidate is reducing risk to some natural background level, that has been consistent with the long history of survival that humans (and other life forms) have experienced through time. Reducing risks to a level consistent with the natural course of the world helps assure survival, while at the same time reducing uncertainties. Progress is then measured by how far we can get beyond some mere level of subsistence *safely*.

This natural level of risk can itself only be assessed very imperfectly, necessitating a fuzzy threshold. Application of absolute prohibitions is therefore tempered by the uncertainty inherent in the process. Any way we look at it, the result is still a strong prohibition against existential risk. Once established, perhaps through means of democratic participation of the affected public, the fuzzy threshold can be used to test various exposures. Uncertainty inherent in complex risk exposures will itself be reflected in a fuzzy estimate of likelihood of damage. The degree of danger associated with any given exposure is then determined by matching its probability characteristics to the fuzzy natural risk threshold.

Proper application of the precautionary principle therefore requires that *both* the definition and measurement of acceptable risk recognize the deeper uncertainties involved. By recognizing the natural fuzziness involved in the process, we can place what seem like very intuitive criteria for the management of high-stakes risks on a strong formal footing.

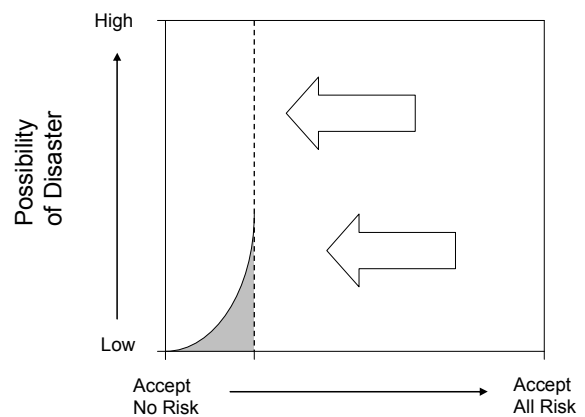


Fig. 3 Precautionary “Hold-back” of Risk

As shown in Figure 3, avoidance therefore provides a precautionary “hold-back” (or, applied later in time, a “push-back”) of risk. By implementing properly precautionary strategies, we can reduce *both* the threat to existence, and the uncertainty surrounding it. What hope we have for reducing worry about our existence, the true aim of risk management, comes from our ability to achieve and maintain this level of security.

V. BEYOND THE “TIPPING POINT”

We have suggested that fuzziness affects the way we make decisions. It is plausible therefore that such uncertainty can have a *collective* influence, especially when it comes to risks of our existence. It is also likely then that this uncertainty will drive *responses* on a social level. The social and technical risk we face today are in this way intertwined. That is, technological risks may drive social risks, via increasing uncertainty, and perhaps *vice versa* as well. The threat of global pollution for example, may influence responses in terms of geopolitical strife, even warfare, in an attempt to protect national interests. This suggests that some critical *tipping point* (or perhaps, from a possibilistic standpoint, *tipping region*) may exist, such reactions to uncertainty having dire consequences in and of themselves.

When dealing with growing uncertainties that follow from increasing complexity we need to cope with two effects. One is the direct effect that uncertainty obscures the growth of existential risks. The indirect, or secondary, effect is that growing uncertainty causes a psychological distress which may ultimately promote very strong reactions. In the theory of fundamental change that spurs strong action in the political, social or economic arena, a widening spread between expectations and actuality is often cited as a key impetus for action [9]. The increasing uncertainty surrounding the high-stakes risks we face provides an added dimension of dissatisfaction, and hence the potential for significant action on the part of those affected. Today's socio-technological systems are volatile, as a direct result of their complexity. Just like highly combustible physical substances, all it takes is one spark to ignite a massive explosion. Growing uncertainty may create the spark that sets our social system into upheaval.

How do we cope with such massive upsets? Most modern democratic societies have some provisions for sovereign *emergency powers*. In situations of pending societal disintegration or chaos, brought on by man-made perils such as war, or the threat of war, or natural ones such as natural disasters, concerted control and planning is looked to for relief. In such times, we recognize the need for a strong coordinated effort to fight some human or natural foe. Sometimes such efforts of last resort are successful, sometimes not [10]. To the extent they are not, there is little hope of starting over from nothing. Are we approaching a *state of emergency* with respect to the risks we face? If so, then crisis planning may or may not help avert disaster. We need to plan ahead, *before* it is too late.

Proactive strategies based on the assessment of safe alternatives (the precautionary principle) eliminate both the potential of locking us in to risk dilemmas (“doomed if we do, doomed if we don’t”), and the ability to reduce the adverse side effects of the increasing accumulation of uncertainties these dilemmas commit us to. As part of a cogent risk management strategy, proper risk planning - on a social scale - helps assure us survival in the widest sense, both in terms of reducing the likelihood of bad things happening, and the uncertainties that surround them. Such plans may themselves require radical changes in institutions. The impetus

for such change is recognition of the increasing uncertainties about risk.

VI. CONCLUSIONS

Progress has brought increasing complexity, along with the uncertainty about high-stakes risk this complexity entails. As these risks can be catastrophic (i.e., terminal), we don't get a second chance to make the right decisions about managing them. To make the point that our survival may depend on real change in our definition and measurement of “progress”, some critics of the status quo suggest that we will meet our doom if we ignore the issues. We have suggested here that the problem is not so much that the “end is near”, but rather that *the future is becoming so uncertain*. Uncertainty due to knowledge imperfection about high-stakes risk potentials is real, and as such it has real effects on the way we make decisions. Recognizing this uncertainty can help us make better decisions about high-stakes risk, thereby aiding us in continuing a rather remarkable streak of natural survival.

Under extreme uncertainty about catastrophic risks, only a properly precautionary approach to risk, based on prudent avoidance of existential threats, makes sense. The upshot then of increasing uncertainty about risk is the need to integrate a comprehensive system of risk control into a coordinated social and economic planning effort that recognizes these uncertainties. While such far-reaching changes to our economic and social systems may be perceived as radical, increasing uncertainty about risk will push us into such actions sooner or later. It is better to anticipate such actions, rather than be forced into them - especially after it becomes too late.

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