ON THE RELEVANCE OF RISK-RISK ANALYSIS TO POLICY EVALUATION

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In recent years a number of economists and public policy analysts have strongly advocated the use of a new approach for evaluating proposed regulations to supplement conventional cost-benefit and economic impact analyses. Commonly known as risk-risk or health-health analysis, this approach is most often applied to environmental, safety, and other rules that seek to protect human health. The essence of risk-risk analysis, as it will be referred to here, is the assertion that regulations seeking risk-reduction benefits may also unintentionally increase risks, and by enough in some cases to outweigh the intended benefits.

This could occur, for example, if individuals choose even more risky alternatives when a particular action or product is prohibited or made more expensive through regulation. One such situation currently of concern is the possibility that parents with young children might elect the more risky option of driving a long distance instead of the less risky alternative of flying if the latter alternative is rendered much more expensive by a requirement to purchase a seat on the aircraft for the child instead of sharing a seat with the parent. Similarly, if regulations governing small drinking system quality are sufficiently costly, individuals might elect to use private wells, which could pose even more risks to their health than the public water supply in the absence of the costly rules.

A slightly different version of risk-risk analysis is predicated on the observation that people's wealth and health status, as measured by mortality, morbidity, and other metrics, are positively correlated. Hence, those who bear a regulation's compliance costs may also suffer a decline in their health status, and if the costs are large enough, these increased risks might be greater than the direct risk-reduction benefits of the regulation.

Advocates of risk-risk analysis emphasize its use as an important commonsense screen to ensure that proposals that actually impose higher risks -- because compliance costs and activities raise risks indirectly more than the regulations decrease risks directly -- are rejected in the policy evaluation process. It does seem eminently reasonable not to promulgate costly rules that actually increase risks rather than decrease them, so what motivates risk-risk analysis seems quite appealing.

While risk-risk analysis has been discussed for some time in the literature and policy circles, the recent surge of interest in the approach stems in large part from the many years some of its supporters have spent unsuccessfully arguing against regulatory proposals that they and others believed offered insufficient risk-reduction benefits to justify their monetary costs. These debates were often lost because many environmental, health, and safety rules are authorized under statutes that do not allow or do not require direct comparisons of dollar costs and risk-reduction benefits in setting standards for human health protection.

What risk-risk analysis appears to offer, consequently, is a change in the terms of these debates. The hope is that one can use this approach to trace from compliance costs and activities mandated by a regulation to various sources of increased risks that can then be weighed against the same sorts of reduced risks on the benefits side of the analysis, thus side-stepping any restrictions on, or reluctance to consider, comparing risk-reduction benefits with monetary costs. Furthermore, a finding of negative net benefits in purely risk terms also carries great moral and logical force, for no rational person would impose positive costs to secure negative benefits.

But talking about changing the terms of a debate is not the same as actually doing so in a theoretically convincing and empirically sound way in practice. It is one thing to say that the goal of risk-risk analysis is to try to translate regulatory burdens and impacts into associated risk increases that can be directly weighed against the benefits claimed for a regulation, but quite another to actually accomplish that.

Indeed, a casual reading of the risk-risk literature suggests that many analytical and empirical issues are outstanding. For example, in many cases, it is not at all clear that the risk increases computed on the cost-side of a regulation's ledger are directly comparable to those on the benefit-side in a social welfare context, and the usual focus on human mortality risk to the exclusion generally of all other risk categories is problematic. Further, one gets the distinct sense that in practice, tracing from regulatory costs and activities to risks of any type coherently and accurately involves a great deal more effort than the literature currently seems to acknowledge. These and other questions and concerns are part of the motivation for this assessment of risk-risk analysis.

The evaluation is not only important, but timely as well. It is likely that current efforts to raise the profile and influence of cost-benefit and related policy assessment procedures in the regulatory arena may result in new or stronger requirements for regulatory evaluations. If risk-risk analysis is a candidate for inclusion on a list of mandatory steps in a revised and sharpened regulatory policy making process, it is important to understand exactly what the approach claims to accomplish, its limitations, and its practical ability to produce valuable and accurate results for decision makers.

Before proceeding, however, readers should be aware that this assessment is narrowly focused on the question of the policy usefulness of risk-risk analysis in practical applications, so that the possible impact of the approach on the outcomes of deliberations about future environmental and other rules is not relevant here. Instead, the questions posed and addressed in this paper revolve around issues of theoretical interpretation and practical feasibility. Furthermore, the author is in fundamental agreement with proponents of risk-risk analysis that numerous environmental, health, and safety regulations have been promulgated over the past years that hardly seem justifiable on economic grounds.

But empathizing with the frustration that is felt by many participants in recent health and safety policy debates should not cloud one's judgement concerning the viability of risk-risk analysis as a practical quantitative tool for evaluating regulations. Thus, for the remainder of this paper, one should lay aside broader concerns related to the appropriate degree of stringency of environmental and other risk-management rules in the past, present, or future, and focus instead on analytical coherence and empirical tractability.

The body of this paper is organized as follows:

- Section 1 provides a more in-depth and systematic summary of the risk-risk concept and its application to assessing environmental and safety regulations.

- Section 2 evaluates risk-risk analysis on theoretical grounds, focusing on the nature and comparability of different types of risks possibly targeted using the approach.

- Section 3 examines the empirical challenges that risk-risk researchers face in applying the method in practice.

- Section 4 concludes the paper with a summary of the prospects for conducting accurate risk-risk analysis at practical levels of effort, and briefly explores some implications of this evaluation for other areas of public policy.

1. What is Risk-Risk Analysis?

Risk-risk analysis has been present in policy debates for quite some time in a variety of different forms. The purpose of this section, however, is not to provide an in-depth summary of the literature and the many regulatory issues to which the approach has been applied. There already are several comprehensive sources for that sort of review. For example, an entire issue of the Journal of Risk and Uncertainty (Volume 8, 1994) is devoted to the topic. Instead, what is necessary for purposes of this assessment is risk-risk analysis is an overview of the several forms the approach has taken over the years and a firm grasp of the types of situations and risks typically addressed using this type of analysis.

First of all, the approach goes by several names. Some refer to it as risk-risk analysis, while others call it health-health analysis. The term risk-risk is used here primarily because it is the least restrictive. That is, health-health analysis would seem to focus attention only on analyzing health risks, and probably human health at that. It is true that much of the risk-risk literature has targeted human health effects, mortality risks in particular. But as will become clear presently, at least some proponents of this approach argue that there is no obvious reason why matters should be confined to health risks, since regulations presumably can affect many resources and outcomes of concern in health and safety policy making. It therefore seems better to refer to the overall approach as risk-risk analysis, and to place specific applications into three broad categories: "direct" risk-risk analysis, "indirect" risk-risk analysis, and "health-health" analysis.

Direct Risk-Risk Analysis

Viscusi (1994) suggests that risk-risk analyses traditionally have focused on what Lave (1981) termed "direct" risk tradeoffs. A classic instance is the case of saccharine, an artificial sweetener. FDA sought to ban the substance as a potential carcinogen based on a study of rats that were fed saccharin. But because of the strong public resistance to this action, Congress sidestepped the issue by mandating health warnings instead of allowing an outright ban. In this case, the risks of cancer presumably were outweighed by the health risks and other considerations related to obesity.

Drinking water regulations provide other examples of direct risk-risk analysis. Chlorinated water poses some cancer risk, but the practice prevents a wide variety of waterborne illnesses. Most people seem satisfied with opting for chlorination rather than facing these other health risks. But water quality mandates can be taken too far in some cases, according to this approach, as the case of the possibly perverse health consequences of stringent regulation of small drinking water utilities mentioned above suggests.

Other instances of direct risk-risk analysis include the flying versus driving decision for parents of very young children described earlier, and the very similar case of mandating fuel economy standards for automobiles, where the reduced human health and other impacts resulting from less air pollution are weighed against the increased risks of more severe injuries due to accidents in smaller cars. Yet another

popular application of direct risk-risk analysis is the assertion that banning certain agricultural pesticides could raise the prices of vegetables and other health-promoting natural products by enough to cause more deaths due to poorer diet than these restrictions save in the form of reduced worker and consumer exposures to hazardous chemicals.

A slightly different branch of the traditional direct form of risk-risk tradeoffs consists of cases in which individuals toward whom safety regulations are targeted engage in offsetting behavioral changes. Peltzman's (1975) famous study of the influence on seat belts on driving speeds is one example. The possibility is that not only will higher speeds reduce the direct benefits of seat belt for drivers, but that benefits could actually be negative if more motorcyclists and pedestrians are also killed. Another example Viscusi (1994) offers of these perverse-response risk-risk tradeoffs is childproof medicine caps, which might result in greater risks if the caps are so onerous for some adults that they leave them off, or if the accessibility of medicines to children increases precisely because adults view the caps as impossible for children to open.

Finally, another manifestation of direct risk-risk analysis arises frequently in real-world regulatory deliberations concerning environmental regulation of particular substances and certain practices. In many cases, policy makers are very interested in exactly what substitute chemicals or activities will be employed after a fairly restrictive regulation is promulgated, not only because this helps to define the compliance costs, but also because some of these alternatives in practice can be worse than the risks the rule seeks to reduce. Thus, the conventional environmental policymaking process has included at least limited forms of direct risk-risk analysis for some time, although it has not normally been referred to as such.

Indirect Risk-Risk Analysis

In addition to the traditional direct risk-risk analysis, two newer versions of the basic approach have received considerable attention in recent years. Lave (1981) refers to one of these as "indirect" risk-risk analysis, where the object is to locate and measure risk increases associated with regulatory costs and mandates that might occur in a wide variety of industries and occupations even remotely connected to the activities directly regulated. Attempts to do so normally involve first tracing from regulatory activities and costs to changes in the levels of activity in other sectors of the economy, and then applying mortality experience factors on an industry-specific basis to arrive at the implied cost-side regulatory risk burden.

Viscusi and Zeckhauser (1994) pursue this indirect form of risk-risk analysis by calculating the costs of occupational mortality for different industries using an input-output model to compute intermediate and final output risks. Using a value of avoiding an occupational death of $5 million, they estimate that total mortality costs overall are on the order of 3% to 4% of total expenditures. They also find that mortality costs as a percentage of total costs vary quite dramatically across industries, from say less than a tenth of 1% for the financial, insurance, and real estate sector, to nearly 6% for the furniture and fixtures industry. Viscusi (1994) uses these detailed results to compute the implied occupational mortality associated with Superfund site cleanups, which, when valued at $5 million per life, he adds to the explicit costs of the cleanups.

From a theoretical perspective, this version of risk-risk analysis seeks simply to expand the scope of the traditional analysis. As a result, the approach encompasses not only increased risks caused by changes in the choices of the directly-affected parties, but also any additional risks associated with

activities in potentially far-flung locations that are ultimately causally connected with the activities the regulation governs.

Recent suggestions in the risk-risk literature appear to call for enlarging even further the scope and detail of risk-risk analyses, whether direct or indirect. Specifically, some have pointed to the possibility that the set of concerns that logically should be explored using this approach extends beyond human mortality risks to all forms of human and non-human environmental risks, such as human morbidity, natural resources damages, endangered species, and habitat destruction. Keeney (1994), for example, appears to favor entertaining a large list of policy concerns from human mortality and morbidity, jobs gained or lost, and technologies spawned, to human convenience and matters of equity.

Portney and Stavins (1994) also note the possibility that the list of social concerns that could be included in risk-risk assessments is potentially quite long, and go on to argue that a regulation's impact on any given category of environmental or other concern could well be positive, so that not just negative outcomes should be expected. Hence, these authors maintain, applying risk-risk analysis to a larger set of health, safety, and other policy end-points may produce a mixed bag of results. The caution raised by these authors proves to be an important one in this paper's assessment of risk-risk analysis.

Health-Health Analysis

The other new version of risk-risk analysis recently advanced purports to offer an alternative way to calculate the induced risks of regulations. Referred to by many as either health-health or wealth-health analysis, the essence of this approach, as alluded to in the introduction, is to argue that regulations' costs adversely affect human health because of the correlation between economic well-being and health status. Those who bear these costs -- workers, consumers, even stockholders one supposes -- may suffer declines in their health status that should be weighed against a regulation's direct benefits.

Lutter and Morrall (1994) attribute to Aaron Wildavsky, see for example Wildavsky (1980), the general proposition that government programs tend to reduce economic growth, thereby interfering with the primary mechanism by which human health has improved over time. According to Lutter and Morrall, the first to apply this principle quantitatively was Keeney (1990), who calculated that an additional death occurs for roughly each $3.14 million to $7.25 million of income lost (1980 dollars).

OMB on several occasions has brought health-health analysis to bear both in its review of OSHA regulations related to worker safety, and in examining regulations of other agencies, such as EPA and FDA. For example, using a finding that $7.5 million of costs induces one additional statistical death, OMB argued that although OSHA's proposed permissible exposure limits for a large number of workplace air contaminants would offer the benefit of preventing 8 to 13 deaths per year, the regulatory costs of $163 million per year would indirectly cause some 22 deaths annually. On that basis, OMB suspended its review of the proposed regulation and OSHA agreed to study the issue further.

Health-health analysis has gained a considerable following in environmental, health, and safety policy circles during the past several years. Indeed, as currently formulated, this approach appears to provide a much easier way to convert regulatory costs into implied risk increases than the more traditional forms of risk-risk analysis: simple multiplication of regulatory costs by a single number reflecting the deaths per dollar of lost income. Probably for that reason, researchers continue to further refine this estimated relationship between income and mortality risk. For example, Viscusi (1994) reports various estimates of the lost income that induces an additional statistical death ranging from $1.9

million to $33.2 million, and indicates that his own research (in press at the time) places this number at about $30 million to $70 million.

Finally, as with the direct and indirect forms of risk-risk analysis, researchers have recently observed that there is no necessary reason to limit health-health analysis to human mortality risk. Human morbidity, damages to non-human resources, and ultimately a whole host of environmental, safety, and other concerns could conceivably be affected by the income reduction caused by regulatory cost burdens. And, as Portney and Stavins (1994) point out, many elements of social concern could be positively affected by changes in expenditure flows that result from a regulation. Thus, health-health analysis also faces the possibility that the list of social concerns to be measured could be very long indeed, and individual components could either increase or decrease.

Summary

In all of its different forms, risk-risk analysis at its core seeks to look behind the costs of regulatory interventions to identify and measure particular health or other consequences, in most cases human mortality risk, that may unintentionally result. As such, the primary objective is to trace from regulatory compliance costs and mandates to their consequences, and preferably to risks that are reasonably comparable to the units in which the explicit benefits of regulations are measured.

It is worth noting in passing that one possible variation on risk-risk analysis is not explicitly reviewed and evaluated here. This is a version that seeks to compare the outcomes that would be generated by a proposed regulation with those could result if the sums of money spent on complying with the rule were devoted instead to other socially-desirable purposes, say, more programs improving the health and well-being of inner-city residents. While such an inquiry is logically legitimate, it is very different from the question policy makers face in evaluating the social benefits of a proposed regulation, which is to weigh the baseline no-regulation conditions against those that would occur with the policy.

Thus, the usual comparison is anchored in which would occur without the rule, not what could occur if the policy makers were free to appropriate private sector resources and apply them in other ways as they might see fit. Of course, if alternative policy actions yield greater social gains then the contemplated regulation, this suggests that an overall reordering of regulatory or governmental priorities should be considered. But this is not the policy issue in standard regulatory deliberations, which is the context of this assessment.

From a purely analytical perspective, therefore, a central question for this evaluation of risk-risk analysis is whether the approach successfully translates regulatory compliance costs and mandates into other risk-based units that can be directly, or at least coherently, weighed against the benefits of regulations. That is, do (or can) the different types of risk-risk analysis really arrive at risks that are identical in kind (or close enough) from a social perspective to the benefit categories embodied in most health and safety regulations? To the degree that they do not, what impact does this have on the policy relevance of risk-risk analysis?

An obvious extension of this question flows from the suggestions in the risk-risk literature to widen the traditional scope of the analysis beyond human mortality risk to other human and non-human risks, as well as to a potentially large set of other social concerns. After broadening the set of socially important end-points, how should these be traded off against one another? The comparability of risk categories in risk-risk analysis, and the call for a significant expansion of the environmental and other

social concerns to be incorporated by the approach, both prove to be central to assessing the theoretical policy relevance of risk-risk analysis, as discussed in Section 2.

A second evaluation criterion for this assessment of risk-risk analysis is suggested by the recent evolution of empirical research using this approach, particularly the emergence of the indirect and health-health versions. Traditional risk-risk tradeoffs have been confined largely to the direct form, in which the induced risk increases are the result of the actions and choices of the regulated or directly-affected entities themselves. The newer variants, however, branch out to the actions of many individuals in their capacities as workers and consumers in sectors of the economy not directly targeted by a regulation, but affected indirectly through one mechanism or another.

The remoteness of some of the activities that researchers using the indirect and health-health forms of risk-risk analysis may be obliged to measure should give one pause, especially in light of the suggestions that the list of concerns should be a very long one encompassing a host of human and non-human environmental and safety issues, and even non-risk end points. It may be much easier to suggest the need for incorporating these far-flung risks of various types than it is to actually do so in practice. Of particular concern here, therefore, is the level of effort necessary to produce accurate results that can be used with confidence by policy makers. These and other issues related to the feasibility of conducting risk-risk analyses for specific regulatory proposals that yield useful and durable results at practical levels of effort are explored in Section 3.

2. Theoretical Evaluation of Risk-Risk Analysis

This section focuses on the fundamental nature of the risks targeted by risk-risk analysis, and whether and how policy makers can take these into account in weighing the social impacts of proposed regulatory interventions. The following section continues this assessment by examining practical issues and considerations with which risk-risk researchers must contend in order to provide accurate results for decision makers at reasonable costs. Hence, assume for the moment that the process of actually locating and measuring any of the risks of interest in risk-risk analyses is costless and empirically straightforward. This is contrary to fact, but it does allow one to consider theoretical and implementation concerns separately.

"Apples-to-Apples" Comparisons

Recalling the original motivation of risk-risk analysis, it is obvious that when one measures regulation-induced risks that are identical in kind to the rule's risk-reduction benefits, one has an "apples-to-apples" comparison. These comparisons could involve involuntarily-assumed dangers of exposure to toxic substances, voluntarily-assumed occupational risks for workers, or any type of damage of relevance in environmental, health, and safety regulation, as long as all of the effects of concern are understood to be socially identical.[1] In this case, the risk-risk approach can proceed immediately to

[1] One caveat is important here. For risks to be identical from a social perspective, they must be viewed as such by policy makers (or perhaps by the affected individuals) according to whatever criteria normally used to evaluate and weigh environmental risks. Thus, if equity or other social concerns are deemed to be important, these are subsumed in the assumption that the risks are the same from a social perspective. This caution applies throughout this analysis.

determining whether a regulation induces more risks than it saves, and hence, whether it does more harm than good.

The power of risk-risk analysis in these apples-to-apples situations stems from the fact that using a single measure for risks and finding that actually more risks are produced than saved by a regulation proves that the unregulated baseline dominates the proposed intervention. This dominance finding does not rely on valuing risk reduction benefits or any other method of comparing dissimilar outcomes and effects, such as weighing monetary costs against risk-reduction benefits. It is simply a matter of the unregulated baseline possessing "more of everything" than the situation that would obtain under the regulation.

Generally speaking, any of the different forms of risk-risk analysis identified earlier could arrive at true apples-to-apples risk comparisons, but the direct version is more likely to do so. For example, the analysis of the impact of drivers increasing their speed after being required to wear seat belts is a case in which highway deaths are both the explicit benefits sought and the induced risks that unintentionally result. The analysis of small children's mortality risk in automobile accidents instead in airline crashes also fits this mold.

To some extent, the tendency for the direct form of risk-risk analysis to arrive at truly comparable risks on both sides of the equation stems from the fact that this variant of the approach focuses fairly closely on a well-defined set of individual's actions and on consequences that primarily affect them. In many cases, the proposition is often of the "if this safety requirement is imposed, people affected will then choose some alternative course that will expose them to even greater risk" form. Moreover, many actual applications of direct risk-risk analysis appear to be motivated by a strong suspicion that a plausible and persuasive case can be made for induced risk increases of the same order of magnitude as the explicit benefits.

Of course, direct risk-risk analyses need not necessarily result in apples-to-apples comparisons, for it is easy to imagine cases in which the reduced risks on the benefit-side are very different from the risks increased by the costs and other aspects of a regulation. For example, a rule that seeks to avoid human cancer risks among the general population by reducing air pollution might cause higher risks to wildlife through water pollution if the air emissions are controlled and the toxic constituents are eventually released as effluent into waterways. But at least in many of the traditional applications of the direct form of risk-risk analysis, comparable risks are fairly common.

As for the indirect and health-health versions of risk-risk analysis, matters are also not clear-cut. Of course, it goes without saying that if one heeds the recent suggestions that the list of environmental risks and other social concerns to be incorporated into this approach could (and perhaps should) be quite extensive -- extending to human morbidity, damages to non-human resources, and even other outcomes only remotely connected to environmental issues -- clearly the resulting collection of risks will not be identical in nature. Hence, applications of such generalized forms of risk-risk analysis clearly cannot hope to result in a set of risks induced by a regulation directly comparable to its risk-reduction benefits, so some method of weighing the social importance of the risk end points identified and measured will be required.

But this is too narrow a conclusion since the original versions of indirect risk-risk and health-health analysis had as their explicit or implicit objective the goal of matching human mortality risks on the benefits side of particularly costly health and safety regulations with the implied occupational and

other sources of human mortality risks induced on the cost-side. Hence, it is perhaps more probable that fairly circumscribed applications of these two variants of the approach might arrive at apples-to-apples comparisons.

Consider indirect risk-risk analysis first. One can well imagine cases in which a regulation seeking to reduce occupational mortality risks also results in other occupational mortality risks caused in industries directly or indirectly connected to the activities targeted by the rule. In these instances, it is reasonable to argue that the social value of the risks on either side of the equation is the same, so that policy makers can proceed directly to evaluating the net risk reduction offered by the regulation.

But it is also easy to see that the risks avoided by a regulation, while still being denominated in terms of human mortality, might not quite the same as occupational mortality risks also unintentionally increased. The Superfund site clean-up example described earlier is a case in point. There, the risk-risk balancing is presumably in terms of involuntary human mortality risks due to exposure to toxic substances that leak from contaminated sites, and occupational risks in the industries that in one way or another are called upon to actually accomplish the remediation. It is not at all clear that risks foisted on an innocent and perhaps unknowing public are the same in social terms as the implied occupational lives statistically lost in the process of the clean-up. The former are thought to be involuntarily assumed and hence uncompensated, while the latter are viewed as voluntarily assumed, compensated, and the inevitable and socially-acceptable result of economic production activities.

Similar questions about the direct comparability of the regulatory cost-induced risks measured by the health-health form of risk-risk analysis also arise, where the ability to state the results in terms of a single risk measure turns on whether the two types of risks are deemed to be the same from a social perspective. This may or may not be the case.

It thus seems that no matter what particular version of risk-risk analysis is considered, particular examples can be classified into those that are performing, or hope to perform, truly apples-to-apples comparisons of risks avoided to risks induced, and those whose risks on opposing sides are not identical in kind from a social perspective. The former are analytically clear-cut in that weighing socially-identical risks can be accomplished directly and simply. This is not to say that focusing narrowly on true apples-to-apples comparisons also ensures a high probability that the risks caused by a regulation will be larger than the risks avoided, for this depends on the specific details and circumstances of the particular regulation under study. It also does not make the empirical task necessarily easy, as will be seen in Section 3 below. But apples-to-apples cases are at least conceptually unambiguous.

Heterogeneous Risks

For risk-risk studies that involve multiple types of risks and varying levels of concern to society, matters are quite different. Here, the risks on each side of the ledger cannot be weighed directly against each other without some measure of their relative social importance. For example, in the case of saccharin, policy makers confronted the prospect of deciding between reducing the population's exposure to a carcinogen on the one hand, and increasing the many health risks (or other negative outcomes) caused by obesity on the other. Similarly, a risk-risk analysis demonstrating that Superfund remedial actions induce voluntary and compensated occupational deaths forces policy makers to trade those off against the involuntarily-assumed risks experienced by the surrounding population if cleanup does not occur. And the need for decision rules for weighing different sorts of risks is painfully obvious when risk-risk analyses include both human health end-points and other environmental damages and

concerns, such as protecting endangered species, preserving natural habitats, and preventing the degradation of air and water resources for reasons other than direct human health consequences.

One answer to the need for balancing heterogeneous risks in these situations is to assume that policy makers are capable of weighing various different risk outcomes -- along with the direct costs of a regulation -- and deciding the ultimate social value of a regulation. This is the provide-the-information-and-policy-makers-will-decide approach that is a last resort when technical analysis cannot produce further empirical refinements to assist decision makers. For example, the appropriate social discount rate to be used in policy analyses is thought by many to be beyond economists' ability to determine with any accuracy. Hence, cost-benefit analyses often use several discount rates, leaving it up to the policy makers to accommodate this inherent uncertainty in their decision making.

But acquiescing in this "send-it-to-the-jury" approach as the solution to the need for ways to trade off different types of risks is a bit premature, at least from an economic perspective. Indeed, for years economists have worked to assist policy makers in evaluating the consequences of regulatory actions by trying to place monetary values on the many human and non-human damages their interventions have sought to remedy.

Furthermore, the fact that risk-risk analyses often encompass both involuntarily- and voluntarily-assumed risks to human health should give one pause. Traditionally, the economic view of the social importance of these two types of risk, particularly of mortality, has made a fairly sharp distinction. Occupational mortality risks are normally thought to be compensated, so that a premium paid to workers in riskier lines of work makes these statistical deaths the result of voluntary choices on the parts of those who assume such risks. Economists have thus viewed worker protection regulations with some considerable skepticism when examined in purely social cost-benefit terms.[2] Uncompensated mortality risks, on the other hand, those resulting to consumers due to unperceived exposure to environmental contaminants for example, have traditionally been classified as externalities whose costs are properly the concern of public sector decision makers charged with protecting human health and the environment.

Thus, it seems worthwhile to explore briefly where conventional economic assessments of the social importance of various human and non-human environmental damages lead when applied to risk-risk analyses that seek to weigh heterogeneous risks.

Conventional Externalities:

At least conceptually, risks that fall squarely into the category of traditional externalities, such as involuntary human exposure to carcinogens and damage to natural resources, are the easiest to evaluate in the risk-risk framework for two reasons. First, economists have studied externalities for years, seeking to provide monetary values to assist policy makers in weighing alternative pollution control remedies. The large and diverse literature on valuing a host of different human health and environmental damages presumably would be relevant to policy makers confronting a variety of externalities that are increased or reduced by a regulation's impact beyond its monetary cost and explicitly-calculated risk-

[2] Of course, some might argue that these regulations are socially beneficial if workers are unaware of, or do not bear the full costs of, the relevant risks, or if the market for some other reason fails to achieve an efficient result. While these arguments may have merit, they are modifications of the basic proposition that occupational risks tend generally to be handled adequately and efficiently by informed market participants.

reduction benefits. Decision makers may also wish to incorporate other social welfare criteria in this process, such as equity considerations, but the existing body of empirical results regarding the social costs of environmental harms is at least a coherent point of departure.

Perhaps more important, however, is the fact that those who bear externalities are not compensated for the resulting harms. Of course, these are situations in which private and social costs of market and non-market activities are not equal, which is the classical rationale for environmental and other types of regulation. But this also means that any increase or decrease in risks of this sort uncovered by a risk-risk analysis, if they have not already been examined and incorporated into the evaluation of a regulation, should be considered as additional costs or benefits beyond those already measured.

For example, a regulation that reduces air emissions of a toxic substance may produce direct human mortality risk-reduction benefits and impose monetary control costs, both measured in conventional policy assessment process. But another externality might be generated indirectly by the regulation, say; increased water pollution caused by manufacturing the equipment needed to control the air emissions. If this is discovered by a risk-risk analysis, it would then be an additional source of social cost of the regulation.

In general, cases in which other externalities, whether positive or negative, are caused by an intervention are simply traditional second-best policy scenarios where social and private costs that attach to changes in activities somewhere else in the economic system are not equal. Strictly speaking, precise measurement of the net social impact of a regulation in these circumstances requires policy makers to evaluate changes in all markets (and non-market activities) where social and private costs differ and then to weigh these consequences along with the direct benefits and monetary costs using whatever criteria, valuations, and other social concerns they believe are relevant.

In cases of true externalities, therefore, the goal of risk-risk analysis of comparing risks caused by a regulation with the risk benefits it provides is conceptually clear, assuming that the various heterogeneous risks can be added and subtracted or otherwise compared. Presumably this process would involve monetary valuations of social cost, or perhaps other measures of value that facilitate weighing different risks against one another.

Assuming the essential step of trading off heterogeneous risks is accomplished, a test of the net risk-reduction benefits of a regulation is far more stringent that conventional cost-benefit hurdles, as proponents of risk-risk analysis argue. Indeed, here the additional externalities sought (whether positive or negative) are thought to be excluded from conventional cost-benefit assessments. Hence, if the net social value of all of the risk increases and decreases caused by a regulation is negative, and then obviously the intervention is not worthwhile -- regardless of its explicit monetary cost.

Some might argue that the need for policy makers to find ways to trade off all of the increased and decreased risks of a regulation, including the explicitly targeted benefits, ultimately will require them to use monetary values for these heterogeneous social damages. They might then argue further that this is at cross purposes with the point of departure of risk-risk analysis in that the goal is to trade risks against risks -- to avoid debating whether a certain amount of risk reduction benefits is worth a given sum of monetary regulatory costs.

This is not exactly correct however. While many economists tend to be more comfortable with structuring decision making around explicit monetary values, this is not a necessary condition for making policy choices. The case of saccharine is an extreme example. Decision makers did not have to resort to measuring and valuing cancer risks and the myriad effects of obesity because the affected parties expressed their choice directly, indeed there was a public at the prospect of banning this artificial sweetener. In general, of course, policy makers will not have the benefit of conducting a referendum to reveal the affected individuals' preferences, but it is still possible to imagine making choices about collections of increased and decreased risks without explicit dollar values, although they would help.

But even if policy makers resort to monetary values to weigh heterogenous risks in a risk-risk analysis, this is still consistent with the spirit of this approach, where the object is to measure the net change in risk caused by a regulation. That risks are valued does not change the fact that it is still increased externalities being weighed against decreased externalities, not risk-reduction benefits against monetary compliance costs. Moreover, the social cost of any increased externalities caused by a regulation are distinct from, and perhaps have no obvious relationship with, its monetary compliance costs. Hence, if risk-risk analyses focus only on conventional externalities, they can succeed in weighing risks against risks, either monetarily or otherwise.

Voluntary Risks:

While the policy relevance of risk-risk analyses that focus on conventional externalities is clear, it is far less so for studies that target risk outcomes that are the result of voluntary choices on the parts of workers and consumers. The primary problem with focusing on non-externality "risk" outcomes is that it is not immediately obvious what special social concern they pose, unlike traditional externalities. Occupational mortality risks that are compensated through wage premiums, for example, are normally thought to be already accounted for from a social perspective because of the higher costs of activities requiring employment in risky occupations. Similarly, the fact that poorer people are likely to be less healthy than financially better-off individuals is the result of the choices people make in spending their lower incomes and in conducting their lives. Moreover, richer people may also engage in riskier recreational activities, by choice of course.

In all of these cases, no one would argue that the higher probabilities of negative outcomes are good in some overall moral framework. Nevertheless, it is not clear how policy makers should weigh these outcomes in making decisions about regulatory policy or in conducting or evaluating the results of risk-risk analyses that target these sorts of risks. Indeed, at a minimum it is evident that using term "risks" to refer to the probabilistic outcomes of voluntary choices does not have the same meaning or force from a social perspective as it does when it is used to describe traditional externalities.

This ambivalence about the significance of voluntarily-assumed risks in the larger framework of social policy making can be accommodated easily in the risk-risk analysis framework as long as apples-to-apples comparisons are the goal, so that the question of policy relevance regarding these sorts of risks "nets out". But when these voluntarily-assumed risks and conventional externalities are mixed, the issue of what the former mean from a social perspective cannot be avoided, for comparisons must be made.

Many economists would argue that the variety of risks of mortality and morbidity that result from individuals' voluntary choices are of no welfare significance at all in the sense that the social and private values of these outcomes are identical. Indeed, any intervention in the economy, whether an environmental regulation or a revenue-raising tax policy, will change the incomes and actions of

potentially a large number of individuals. Incomes of some may rise and others' may fall, the mix of industrial production may change possibly toward more risky occupations or perhaps not. And all of these effects will cause changes, either positive or negative, in any of a variety of classes of outcomes referred to as "risks" of mortality, morbidity, or other consequences that might be considered either good or bad from an individual's perspective. But if these consequences are the result of voluntary choices, then there is no special reason to focus on them from a public policy point of view since the full costs and benefits of these outcomes are already summarized by changes in prices, wages, and incomes.

Still, something about the fact that a regulation can make people poorer and thus indirectly cause a decline their health status, or cause in increase in occupational mortality by rearranging the pattern of production activities, seems to demand one's attention. Indeed, it is true that the individuals who experience these risks are not indifferent to them, so it is not that the outcomes are of no importance at all. Those exposed to mortality risks in their occupations require compensation for bearing those risks. And those who are made poorer by a regulation and bear more mortality and morbidity risk as a result are not necessarily happy that they must accept these and other consequences of lower income and wealth. The same can be said for any of the voluntary risks targeted in risk-risk analysis. Hence, the consequences of changes in voluntary choices induced by a regulation may not be traditional externalities, but they are some of the many ways in which a regulation's impact is manifested. Surely they are not completely irrelevant.

Of course they are not, but this raises the interesting question of how policy makers should weigh them to determine the full consequences of an intervention. Indeed, thinking about these voluntary risks from a social perspective yields an interesting observation. Suppose a regulation seeks to reduce a traditional environmental externality, so that the explicit benefits are easy to classify and evaluate from a social perspective. Suppose further that the monetary costs of the regulation cause a host of changes in individuals' incomes and behavior that then ripple through the economy, but that the social and private values of all of these consequences are equal, so that no other true externalities are affected. In this case, one can imagine that many people's health status and risk profiles along many dimensions will change, for better or worse, depending on their circumstances. Of course, more than health and safety outcomes will be affected in this process as well, from ordinary consumption, educational attainment, and recreation, to other small and large choices in life.

Nevertheless, from a conceptual point of view, one can imagine valuing all of these different consequences for each individual. For example, person who is made poorer either by a regulation might experience reduced consumption, enjoy less leisure, and purchase less medical care. The total value of all of these impacts from this individual's perspective, however, would equal the original change in income. Conducting this hypothetical valuation exercise for each person directly or indirectly affected by the regulation, positively or negatively, and then summing these estimates would, in the end, yield simply the regulation's compliance costs.[3] This should make sense because income and, in general, consumer and producer welfare, do not simply vanish or materialize. Income may be shifted around, and a variety of consequences may result from different choices, but because all of these are the product

[3] Some might argue that if society views the costs and benefits of the various direct and indirect effects a regulation imposes differently from private individuals, this valuation and summation will yield something other than the original compliance costs. This is true, but it represents nothing more than the assertion that these effects do have an element of social concern different from their purely private value, and thus should be grouped with more conventional externalities. This possibility, however, has already been introduced and discussed.

of voluntary choices directly and indirectly spawned by the mandates and costs of the regulation, they will all sum up to the original compliance costs when all is said and done.

This illustrates a central issue in determining the policy relevance of risk-risk analyses that include voluntarily-chosen outcomes. At least in this example, risk-risk analysis would indeed seek a variety of possible risks and other effects that result directly and indirectly from the impact of a regulation. But the process of trying to trade off these risks against the direct externality-based benefits is problematic. Because the former are not the same risks as the latter, policy makers would then have to weigh the two sets of risks using some sort of comparison rules. Resorting to monetary valuations here will not work, however, unlike in the case of conventional externality risks, because these voluntary risks are simply a different ways to express costs of a regulation. If opponents of a regulation would be unsuccessful arguing against the policy in terms of dollar costs versus risk-reduction benefits, converting voluntary risks into monetary values will not help.

In these cases, two possibilities still might make searching for these risks and arraying them against the benefits of the target regulation a worthwhile pursuit. One is to assume that in fact the private and social values of various voluntarily-assumed risks are not the same, so that society and policy makers have an independent interest in these outcomes. It is easy to find plausible arguments along these lines, such as noting that individuals often do not pay the full social costs of health care, especially for serious maladies, or of long spells of unemployment. One could also argue that costly regulations that significantly reduce many people's incomes could negatively affect the development and advancement of their children, and possibly produce other socially undesirable results, such as crime. Even more sources of these second-best divergences of social and private valuations stem from the occupational mortality literature, such as the pain and suffering of families of workers killed or injured on the job. In any event, policy makers will then need to determine just how significant these social concerns are, situation-by-situation, to introduce them into the overall evaluation of the relevant regulation.

The other possibility is that the number and types of even voluntarily-assumed risks caused by a regulation may be large enough in comparison to the direct risk-reduction benefits that they are inherently compelling in a debate about the social merits of the intervention without any more formal or rigid methods for trading them off against one another. This is perfectly legitimate theoretically, since converting the high costs of a regulation into the numerous unfortunate outcomes individuals may suffer as a result simply uses a different language and richer images to describe monetary compliance costs whose magnitude appears not to sway proponents of the intervention.

Thus, for voluntarily-assumed risks, unless arguments are brought to bear on why the social and private costs of these outcomes actually are different, risk-risk analysis is really more a rhetorical device and polemical tool than it is a matter of rigorous and precise risk comparison. Proponents of risk-risk analysis may not find this conclusion unsettling, however, if their primary goal is to prevent the promulgation of regulations that fail conventional cost-benefit tests by wide margins.[4] But from an

[4] A example is the debate between OSHA and OMB concerning worker protection standards for a number of air contaminants. Many economists would argue that fully informed workers are compensated for bearing these risks, so OSHA regulations that mandate various additional exposure protection measures reduce welfare. This is because if the requirements were the socially least costly method for addressing these risks, the market would have already adopted them. Hence, the regulation reduces economic efficiency unless it merely codifies arrangements that market would have developed and instituted anyway. From this perspective, bringing risk-risk analysis to bear on such a regulation is a last

analytical perspective this is important. When risk-risk analysts generate heterogeneous risks that must be weighed against one another, they can no longer claim to be assessing regulations in terms of dominance.

Summary

Whether it is applied in its direct or indirect forms, and whether it focuses on conventional externalities, on other voluntarily-assumed risks, and even on a nearly infinite variety of possible outcomes of potential social concern, the value of risk-risk analysis in the overall health and safety policy making process depends in part on whether decision makers can use its results with some degree of confidence in the theoretical grounding of the approach.

This section has argued that pure apples-to-apples comparisons are quite compelling. When matters move to heterogeneous risks, incorporating additional traditional externalities essentially adds new sources of costs and benefits to the debate. Including voluntarily-assumed risks amounts to a restatement of the costs and impacts of a regulation in different, but perhaps polemically useful, terms.

At least on this score, consequently, risk-risk analysis broadly defined appears to have some promise as another method for informing policy debates on environmental and other regulation, assuming the information is reliable, feasible to obtain, and usually significant enough in quantitative to terms to warrant the attention of decision makers.

3. Practical Considerations and Risk-Risk Analysis

So far, the focus of this assessment has been on how policy makers might interpret and use the results of risk-risk analyses, given the several variants of this approach advanced by its proponents and the many different types of risks and other outcomes of concern potentially of importance. But the value and viability of risk-risk analysis in the environmental policy making process also depends on what one generally might expect to find using the approach regarding the risks regulations may induce, and at what levels of effort.

The main concern in this section, consequently, is with practical issues and considerations that may be critical factors in determining whether and how risk-risk researchers can arrive at results of sufficient accuracy and reliability to be used in policy deliberations. Examining closely the empirical realities that confront risk-risk analysis is suggested, at least in part, by the facts that it seems simple to hypothesize direct and indirect sources of risk that may change, either positively or negatively, when evaluating any particular regulation, and that the list of possible concerns to be included can become nearly open-ended. Indeed, creative analysts find it easy to make guesses about possible connections of a regulation's impact to any of a variety of items and outcomes of interest. But speculation does not establish fact. Hence, it is worth exploring what it might involve to obtain robust risk-risk results of value in policy making discussions.

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ditch effort, but one that in reality seems to have succeeded. The standard argument that the OSHA intervention is inefficient on the face it seems to fail, as do arguments based on high explicit monetary compliance costs and low benefits. If risk-risk analysis works here when all else has failed, one can hardly blame proponents for advocating an expansion of its use.

To begin with, it seems reasonable to hold risk-risk analysis to the same standard of proof as one normally does traditional empirical assessments of the benefits of environmental and other health and safety regulations. Of course, practical benefits analyses are conducted at all levels of comprehensiveness, disaggregation, and complexity, and perfection is rarely a realistic goal in light of everyday uncertainties and the costs of obtaining ever more accurate inputs and results. Nevertheless, it is incumbent upon those estimating the human health and other types of benefits of a regulation to satisfy certain basic requirements for empirical analyses and factual evidence. These include documenting causation, identifying populations and other resources at risk, and achieving levels of accuracy that reasonable people would consider to be adequate given the nature of the problem, the quality of available data, and the uncertainties inherent in real-world analysis.[5]

Such standards are normally applied to conventional regulatory benefits assessments. Since the goal is to weigh all of these other direct and indirect risks along with the explicit benefits to determine the net risk impact of the policy, the same requirements should apply to risk-risk efforts to identify and measure other risks that might be increased or decreased by a regulatory intervention. Hence, while this does not require anything approaching perfection in assessing induced risks, it does call for more than hypotheses about them.

Direct Risk-Risk Analysis

Of the several different variants of risk-risk analysis, clearly the direct form stands the best chance of satisfying everyday standards of proof. This is because direct risk-risk analyses typically focus on the individuals and situations explicitly targeted by an environmental regulation, so that the induced consequences the approach seeks to detect and measure are normally very closely related to the activities or choices already of critical importance in evaluating the policy. The seatbelts and driving speed case, the cancer risks of saccharine versus the risks of obesity, the risks of osteoporosis and heart attacks among post-menopausal women as compared to the breast cancer risks of estrogen therapy, and infant safety in airline as opposed to automobile travel, all seem amenable to careful analysis of individual choices and identifiable consequences with measurable probabilities. Even in traditional policy evaluations, the normal process of, for example, assessing the risks of alternatives that might be used by industries and individuals should a particular substance be banned or restricted, also seems a theoretically coherent and empirically feasible exercise.

In all cases, however, it is not sufficient to point to possible increases in risks that might be arrayed against the explicitly-measured benefits, for anything is conceivable. The relevant issue is whether those potential risks will in fact materialize. There are two ways for policy makers to gather evidence on the relative sizes and importance of these risks. One is illustrated by the saccharine case in which the affected individuals actually expressed their preferences about the alternative outcomes in a way that policy makers could not ignore. But these situations will normally be the exception, rather than the rule.

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[5] Some might argue that actual regulatory benefits assessments contain a number of biases and omissions, and that they often fail to satisfy rigorous standards for scientific inquiry. But debating the possible shortcomings of practical risk assessment misses the thrust of the argument, for the limitations such analyses face are inherent in conducting real-world evaluations based on available data and realistic funding constraints. The point here is that conventional benefits assessments are normally required to go far beyond casual assertions about risk reduction, to actually measuring or modeling them.

The more common way to obtain this information is to conduct direct risk-risk analyses at levels of detail sufficient to produce convincing conclusions regarding offsetting risks. In general, this will normally be a nontrivial task. In the case of airline versus automobile safety for infants, for instance, the first step would be to estimate how many people would actually elect to drive a long distance instead of flying, given the added cost of purchasing a seat for a small child. One might then try to directly compare accident and survival rates for the two modes of transportation. But critics would argue that the relevant automobile accident mortality rate is that for parents with young children on long trips at the times, in the ways, and in the vehicles they normally drive, not the average rate for all driving.

Thus, what appears to be a straightforward measurement issue can become a debate about the circumstances that apply to perhaps small subsets of the population. Still, this seems to be a worthwhile endeavor as long as the magnitude of the induced risks the task is likely to uncover is large enough to matter in policy decision making.

Having said that, however, at a deeper level the sense that the direct form of risk-risk analysis can normally satisfy conventional standards of proof, albeit at sometimes considerable research expense, actually flows from something far more basic. This is the tacit assumption underlying direct risk-risk analyses that what is important to measure is only those risks explicitly targeted in the analysis. In the case of seat belts, the focus is restricted to automobile driving-related mortality risks. Possible additional occupational deaths associated with making the seat belts and installing them, for example, and the potential indirect health consequences of higher automobile prices due to mandated safety equipment, are not investigated. It is therefore not just the causal proximity of the induced risks in direct risk-risk analysis that makes the approach appear to be feasible in practice. It is also the unstated, but implied, assumption that behavioral and other changes that will occur "elsewhere" as a result of the regulation are not of significance, so that they need not be included.

This is a central consideration in determining the ability of risk-risk researchers to provide accurate and robust results for policy makers at practical levels of effort. The issue can be thought of as a process of setting the "boundaries" for a risk-risk analysis, thereby defining the constellation of activities and situations that need to be explored to arrive at definitive net risk conclusions. While direct risk-risk analyses tend to set very tight boundaries either explicitly or implicitly, this is not generally the case with the other forms of this approach.

Indirect Risk-Risk Analysis

Indirect risk-risk analysis considers a host of possible outcomes of concern that could result from the wide the variety of changes in individual's actions that a regulation ultimately causes. Here, even if only a handful of specific risks are targeted, the empirical problem can rapidly escalate to a major modeling and data collection task. If these risks can result from changes in the behavior of many individuals and the levels of output of industrial facilities throughout the economy, presumably risk-risk researchers would have to trace from the initial impact of the regulation through to secondary effects and beyond to detect and measure the relevant harms.

In the occupational realm, input-output modeling provides some assistance in this endeavor, because this approach provides at least some notion of how a regulatory intervention might ripple through the economy and because occupational mortality statistics are available. One should be aware that results based on this type of modeling are national averages, so that any variations across specific

plants and areas actually affected indirectly by the regulation will not be detectable. Furthermore, there are occupational risks in the no-regulation baseline. Hence, increases in employment in certain risky occupations due to a regulation might simply have pulled workers from one set of risky pursuits to another. Thus, while the input-output modeling approach tries to identify occupational risks associated with a regulation's mandates, this is not itself a full tallying of the risk increases and decreases that might occur between the baseline and the regulated states of the world, since activities that would have occurred but do not because of the rule, are not explicitly identified and estimated. Therefore, it is not clear without considerable study that measuring risky jobs associated with a regulation's mandates tells the entire story.

Even harder to measure are the various other possible risks of social concern, such as non-occupational mortality and morbidity, non-human resource damages, and even equity issues related to the incomes and welfare of different subsets of the population. For example, a regulation might indirectly change energy production at various locations, causing increases and decreases in environmental damages across the country, and it might increase the level of employment in some risky occupations and decrease it for others. It might even alter people's choices about risk-reduction measures such as modes of travel and medical expenditures. Thus, a single intervention could alter a host of choices and circumstances leading to changes in risks of all types in almost any economic sector.

And in many instances, it is not only the nature of the risk and the activity that gives rise to it that matters, but also the location and other specifics surrounding the risk that determine its social cost. This is especially true for traditional environmental externalities where the emission of a given quantity of a pollutant may cause different damages depending on where it occurs. Similarly, another subtle complication is that economic linkages and individual's choices and circumstances change over time. This means that the connections from the point of direct impact of a regulation will have to be updated repeatedly to maintain accuracy.

The problem is that there is little guidance for deciding how far removed a specific change in a choice or production activity must be from the point of initial impact of a regulation for any of the associated consequences to be of no concern. This is hard enough when only one type of risk is deemed to be relevant for the analysis, say human mortality, and it becomes far more difficult from a practical standpoint as more and more risks and outcomes are added to the exercise. Risk-risk researchers appear eager to include all of these indirect effects, but seem to be singularly unaware of the practical difficulties of doing so. A case in point is Keeney's (1994) suggestions for other candidates to include in risk-risk analyses, ranging from health and safety consequences, jobs created or lost, and technologies spawned, to comfort, convenience, and the pursuit of happiness. Keeney goes on to note the many mechanisms and linkages through which even one of these effects of concern -- human mortality -- can be affected by regulatory costs, such as lower wages, lost jobs, nutrition and education, smoking incidence among lower income workers, and even mortality risks associated with the failure to purchase new tires for a car or a smoke alarm for a dwelling.

The essence of the matter is that it is easy to nominate hypothetical sources of indirect risks. And it is just as straightforward to describe the process of locating and measuring them in words or in algebra and symbols. Indeed, added complications simply expand the size and dimensions of the various matrices that mathematically represent measuring these indirect effects. But the reality is that every new dimension incorporated into such a description translates into significant practical modeling and data collection efforts, which can become overwhelming in fairly short order.

From this is should be clear that indirect risk-risk analysis is inherently in danger of becoming hopelessly open-ended and impractical, if not also less and less coherent from a policy perspective. But this tendency is exacerbated by the political climate in which the approach is supposed to be of particular help. Opponents of costly health and safety regulations who locate increased risks that result from an intervention have really only fired the opening salvo of what can amount to an endless battling of competing studies of indirect risks. Proponents of the rule will not only quibble with the accuracy of opponent's induced risk estimates, but will also set about the task of locating other indirect risks that are reduced by the ripple effects of a regulation. And both sides have an incentive to extend the list of outcomes of social concern in an attempt to gather yet more evidence for or against the proposed rule and to expand the boundaries of the analysis to capture more sources of them. Compromising and agreeing on boundaries appears not to be in the interests of anyone involved.

In light of all of this, it should not be surprising that few, if any, true indirect risk-risk analyses have been conducted. The reality is that it is much easier to hypothesize that various possible sources of health and safety risks might be affected by a regulation, but proving that these claims are true and of sufficient quantitative significance poses a formidable challenge. At least so far, as a result, indirect risk-risk analysis has really been more described and lauded as a useful tool for policy making than practiced with any seriousness and commitment.

That is not to say that indirect risk-risk arguments are not common in policy debates. Indeed, in the area of environmental, health, and safety regulation, assertions based on the indirect risk-risk concept are frequently encountered, for they are easy to concoct. Considering the merits of canceling a pesticide's registration for use on certain agricultural commodities, for example, the direct benefits consist of reduced cancer or other health risks associated with the chemical's use. Opponents of the cancellation might claim, however, that the resulting higher food prices will indirectly harm the health of poorer consumers, perhaps by more than the direct benefits of the policy. These sorts of hypotheses are not typically buttressed by careful technical analyses and robust empirical findings. Indeed, in this case, casual analysis suggests that it would take very high compliance costs and very small benefits for this induced risk increase to be true. But this is precisely the point. Such proposals are normally just possibilities raised in heated policy debates. As such, they are quite powerful rhetorical weapons because of their inherent plausibility, as well as the difficulty opponents encounter in trying to refute assertions.

Of course, this in no way means that specific indirect risk-risk propositions could not actually be investigated quantitatively, because the complexity and detail required for accuracy in such studies do not make them epistemologically impossible. Rather, it simply means that most indirect risk-risk analyses are prohibitively expensive to pursue with sufficient rigor to produce results that all parties would agree are comprehensive, robust, and accurate.

Once again, proponents of risk-risk analysis will not necessarily find this observation very damaging. From a more political perspective, one strong motivation for conducting risk-risk analysis stems from the lack of success in the policy debates of conventional arguments that compare high monetary costs with small risk-reduction benefits. Objections to proposed regulations based on indirect risk-risk possibilities thus are often advanced in the process of policy deliberations in which the proponents of the interventions have been encouraged, if not required, to devote serious attention to these assertions. In this context, the ability to hypothesize sources of indirect risks becomes the power to prevent the promulgation of regulations. Hence, if indirect risk-risk assertions do prevent what are

considered by its proponents to be grossly undesirable regulations, then they might judge the approach to be a success.

But this is a fairly restricted definition of success; one that is predicated less on truth than on political expediency. Of course, many observers of environmental policy making over the past decade may be in great sympathy with those who attempted to hold health and safety regulation to at least some modicum of balance between costs and benefits. Nevertheless, this assessment of risk-risk analysis seeks to determine its ultimate value to decision makers of all persuasions based on economic principles and traditional standards of public policy evaluation.

Health-Health Analysis

It is perhaps partially in response to the inherent difficulties of conducting accurate indirect risk-risk analyses that attention has centered recently on the health-health approach. As described earlier, this version of risk-risk analysis appears to offer an easy method for converting regulatory costs into indirect mortality and other human health effects by using statistically-estimated relationships between these risk outcomes and income or wealth. Unfortunately, health-health analysis also faces many difficult empirical hurdles when applied in practice.

First of all, it is widely acknowledged in the health-health literature that moving from the intuitively appealing observation that richer people tend to be healthier to definitive predictions of the impact on individuals' health status of regulation-induced changes in their income or wealth is no simple matter. Even casual consideration of the issue confirms that many characteristics, experiences, and behavior affect people's mortality risk, not just income. As reviewed in Lutter and Morrall (1994), numerous studies have explored this relationship. These analyses have used a variety of data sets and attempted to control for a number of different factors that also influence mortality risk, such as educational attainment, and have resulted in a wide range of estimates of the income-mortality risk relationship.

Recent research efforts focusing on the health risk impacts of changes in wealth and income, however, have revealed even more basic problems with measuring these effects accurately. For example, Smith, Epp, and Schwabe (1994) argue that empirical attempts to estimate the income-health relationship based on cross-country evidence are flawed. They suggest that differences in mortality across countries are not due to differences in self-protection efforts brought about by income variations, but are attributable instead to economic growth, the traditional source of improved public health as development occurs. Hence, the cross-country evidence is produced by a very different set of events than the changes in individual risk-avoidance and health-related expenditures embodied in the health-health framework.

Along different lines, Chapman and Harihan (1994) note that the income-health relationship is subject to reverse causality. While it may be the case that higher income leads to enhanced health status through improved medical care, better nutrition, and other risk reduction activities, it may also be the case that healthier people are able to earn more than less healthy people. A related issue investigated by Graham, Hung-Chang, and Evans (1992) concerns the influence on health status of changes in transitory as opposed to permanent income. This is quite important in the context of health-health analysis of regulatory costs because it is not at all clear that income changes caused by regulatory effects are permanent.

Thus, the evolving literature seeking to refine quantitative estimates of the relationship between income and health status reveals more than anything else the inherent complexity of the issue. It also drives home a basic truth that is easy to forget in the quest for tractable methods to estimate risk-risk regulatory tradeoffs, which is that a single estimate of this relationship will not suffice. Whatever impact regulation-induced changes in income and wealth may have on mortality risk, this will in general depend on the initial incomes, health status, and many other characteristics and circumstances of those who are affected. Indeed, as Keeney (1994) argues, in addition to estimates based on gender and income, it would be useful to account for race, education levels, initial health status, and age. Thus, rather than confirming that health-health analysis is a simple way to convert regulatory costs into implied mortality risks, this literature instead suggests a need for a large matrix of quantitative estimates of the effects of changes in income of different amounts, for many groups of different people, and for a variety of mortality and morbidity outcomes.

At least on this score, researchers in this branch of risk-risk analysis appear to be aware of at least some of the challenges inherent in evaluating human health risk tradeoffs using health-health analysis. But they appear to appreciate far less a more basic source of complexity and empirical difficulty in obtaining accurate predictions of regulation-induced health impacts in the real world of policy evaluation. A second set of practical issues, implicit in the acknowledgement of the literature that a single "answer" to the income-health relationship is not sufficient, revolves around the incidence of regulatory costs and other changes in individuals' incomes that might occur as a result of the intervention.

Once said, the importance for the entire health-health approach of estimating the exactly whose income or wealth changes by how much seems obvious. Indeed, even extremely fine detail and disaggregation of the impact of changes in income and wealth on health status does no good if one does not know who gains and who loses due to the specific regulation under review. For example, a regulatory compliance cost of, say, $1 million per year is likely to have no health consequences at all if it is spread across 1 million consumers of a regulated product or activity. But the same costs borne by 1,000 workers may indeed alter their and their families' health status for the worse. On the other hand, if these costs are shouldered by even a modest number of shareholders of a corporation, the regulatory burden may have no impact at all on health outcomes, if they are sufficiently wealthy to begin with.

Of course, all will agree that estimating the incidence of regulatory costs is an appropriate and necessary first step in applying health-health analysis in the real world. But the difficulties in doing so should not be underestimated, for determining how costs are borne can require a considerable amount of study. Moreover, cost incidence can change over time as the short run evolves into the long run, and, especially in the context of estimating long-run health impacts of regulatory interventions, it is probably the longer run incidence that counts, rather than the immediate incidence of a regulation's costs. And to make matters more complex, presumably the levels and distribution of income, wealth, and other determinants of health for the affected populations must be gathered, since the change in mortality or morbidity will depend on those factor as well.

Finally, strictly speaking, health-health analysis should go beyond the incidence of regulatory costs per se to examine other changes in income and wealth that can result. This is of more than passing importance, according to the literature, because it is possible that a regulation might impose a minuscule cost on a large number of consumers, but also increase the employment and income of a relatively small number of poorer workers. In this case, the indirect health impact of the regulation might be positive, not negative.

But tracing these possible changes in income and wealth from the initial point of an intervention's impact can be exceedingly difficult and data intensive. And, as a general matter, there are no easy ways to set tight boundaries on just how far from the activities immediately affected by a regulation any of these changes in income can be, negative or positive, to confidently exclude them from the analysis. Policy interventions can cause a wide variety of repercussions in many markets, most of which are not normally considered necessary to detect and measure in conventional quantitative cost-benefit evaluations. But for health-health analysis, by hypothesis, changes in even distant markets and unrelated activities might harbor induced changes in health effects of importance. Thus, as with indirect risk-risk analysis, the health-health approach faces the constant threat of escalating into an ever more complex and detail-dependent empirical analysis, with no apparent rational means for confining the inquiry to practical levels of effort.

In light of these realities, it should be no surprise that the few applications of health-health analysis conducted to date have focused on raising the possibility that health impacts may be caused by regulatory costs, rather than performing rigorous assessments of the incidence of those costs, estimating other changes in incomes that might result, and then meshing those findings with accurate parameters that translate changes in income into implied health effects. Furthermore, from a practical perspective, many regulations' costs are distributed widely, especially in the long run. Hence, the expected impact on individuals' incomes and their health status are likely to be miniscule. Hence, as with the indirect risk-risk approach, so far health-health analysis has been used more as a weapon in policy debates than as a research technique intended to locate and measure the actual financially-induced health impacts of regulatory costs and impacts.

Once again, if the issue is one of forestalling what are thought to be seriously deficient regulations from a social perspective, then success for health-health analysis might be measured in those terms. But if the question is whether this form of analysis really can provide policy makers with accurate and reliable information about the indirect income-to-health consequences of regulations at reasonable levels of effort, matters are not so clear.

Summary

Based on these practical considerations, it is reasonably clear that it is feasible to conduct traditional direct risk-risk analyses and reach robust results at reasonable levels of effort. This is primarily because the scope of these inquiries is restricted to actions and consequences that, for the most part, flow from or accrue to those explicitly targeted by, or closely associated with, the regulation in the first place. Developing accurate quantitative estimates of these risks is feasible in practice, although it will still require considerable analysis and data. Hence, this analysis should be undertaken only when the expectation is that the induced risks will be significant enough to play a role in policy making.

The "boundaries" for the indirect and health-health variants of risk-risk analysis, however, are hard to define narrowly. For these approaches, the empirical analysis tends to expand to encompass numerous activities and conditions quite remote from the point of direct impact of an intervention, rendering the task generally infeasible in practice. From this perspective, it is questionable whether these forms of the risk-risk approach can yield reliable information to policy makers on risk tradeoffs given realistic constraints on practical empirical analyses.

4. Implications for Risk-Risk Analysis

Of the two basic themes that have been pursued in this assessment of risk-risk analysis, the concerns about the practical feasibility of conducting these studies play a more important role in deciding the policy relevance of the approach than do the issues and considerations involved in defining the significance of these risks from a social perspective. This should make sense because if it was actually very easy and inexpensive to obtain accurate quantitative estimates of the many different risks typically of interest in risk-risk analyses, then they probably should be measured and any ambiguities concerning their meaning for policy makers could either be addressed along the way, or they could simply be discarded.

But the fact is that conducting any form of risk-risk analysis in general will be costly, and some more so than others. Indeed, applications of the indirect and the health-health versions of the approach can easily escalate into major data collection and modeling tasks, with each side of the debate always pushing for wider boundaries and more end points of concern to turn the results to their advantage. Hence, it seems safe to advise confining risk-risk analysis to the traditional direct form of the approach.

Under direct risk-risk analysis, conscious decisions not to expand the boundaries of the analysis to numerous outcomes in remote locations are often based on very strong suspicions that a specific reaction to a regulation will occur, normally caused by behavioral changes on the parts of the entities directly affected by the intervention. Even here, of course, documenting and measuring these offsetting risks is not necessarily straightforward, and may require some considerable data collection and analysis. And there is also absolutely no guarantee that these increased risks will be anywhere close in magnitude to the risk-reduction benefits of the regulation. Nevertheless, the traditional direct risk-risk analysis does avoid the major pitfall of endlessly expanding boundaries and details, as well as lengthening the list of outcomes of concern, that constantly threaten the practical feasibility of the more expansive forms of the approach.

At a deeper level, however, support for direct risk-risk analysis flows from the more fundamental point that often the same individuals who would enjoy the explicit benefits of a regulation also suffer the induced risk increases. Thus, the moral force behind direct risk-risk analysis is at its peak when one can argue that well-intentioned regulators might cause more harm than good to precisely those individuals they mean to help. When this is the case, expanding the analysis to distant effects that might or might not materialize, that would affect people otherwise unconnected to the regulation, and that are hard to locate and quantify, seems counter-productive and almost silly. But even when parties other than those who stand to benefit from the regulation are included, the actions and consequences that produce the induced risks targeted in direct risk-risk analysis are at least very closely connected in a causal sense to the point of initial impact of the regulation. It is thus likely that in practice, careful studies of this type may well provide policy makers with useful and accurate information at a reasonable cost, as long as the pressure to expand the boundaries of the analysis is resisted.

By implication, the prospects for indirect risk-risk analysis are not so sanguine. Because of its very nature -- risks anywhere and everywhere may be affected, either positively or negatively, by a regulation and its inevitable ripple effects throughout the economy -- this approach will never really become a rigorous part of the policy review process. Incentives to expand the boundaries of the analysis

and to lengthen the list of risk outcomes to be investigated will always be strong, and the costs of tracing economic linkages to even remote activities to detect and measure them will generally be prohibitive.[6]

Hence, while some forays into occupational mortality risks will no doubt be attempted using input-output modeling, even these will be subject to questions concerning both their policy relevance and accuracy, the hope of making the indirect risk-risk approach operational in an empirically and theoretically defensible way, and on a routine basis, is not likely to be satisfied. It will remain, perhaps rightly, largely a "framework" that has a great deal of plausibility and hence emotional appeal, but no real future as a theoretical and quantitative tool to be used in the everyday policy evaluation of environmental and other regulations.

As for the health-health variant of risk-risk analysis, matters are much the same. The fact that the income and wealth of a wide variety of people possibly far removed from the initial impact of a regulation may be affected means that a substantial amount of resources could, and perhaps should, be devoted to an exhaustive tracing of the incidence of the direct costs imposed by a regulation, as well as the indirect effects of the intervention on incomes throughout the economy.

This approach must also grapple with a fairly stringent standard of proof regarding the health impacts of regulation-induced changes in income or wealth. As outlined earlier, it is one thing to quote statistical evidence from a variety of sources on the income-health relationship, but it is quite another to make definitive and defensible quantitative statements about the impact of a specific regulation on particular subsets of the population. What would be needed is believable estimates of cost incidence and other transitory and permanent changes in income and wealth attributable to a particular regulation, and causal health-income relationships that are sensitive to the variety of factors that influence health status. The level of effort necessary to obtain robust results is likely to be substantial and probably beyond the value of the information to policy makers.

While the technical feasibility of conducting risk-risk analysis is an important consideration, it is only part of the answer to the broader question of the value of this approach in regulatory evaluation. The other major component has to do with the ultimate nature and meaning to policy makers of the risk end points typically of concern in risk-risk analysis. This assessment has reached several conclusions that bear on this issue.

First, the point of departure of the risk-risk literature is normally characterized as a search for apples-to-apples risk tradeoffs, so that the comparability of risks is immediate and obvious. Of course, proponents of the approach would be quick to point out that risk-risk analysis need not target only identical risks. Nevertheless, the implicit appeal of the approach, emphasized repeatedly in this literature, is that policy makers will find it easier to make socially more beneficial decisions about

[6] The need to trace all of the complex interconnections in the economy in the search for risks and other effects of concern is the primary reason why these analyses are infeasible in practice. This is precisely the same problem that makes environmental life cycle assessment impossible to conduct accurately in practice. Indeed, an indirect risk-risk analysis targeting traditional environmental externalities is essentially a life cycle assessment. Note that here, as with life cycle assessment in general, it is not just the nature of the externality that matters, but also its location, since often the actual social damages an externality causes depend on the specific circumstances and conditions where it occurs. For a more detailed discussion and critique of environmental life cycle assessment, see Arnold (1995), Chapter 10.

proposed environmental and other health and safety regulations, especially avoiding those with costs far in excess of benefits, if the consequences are all stated in purely risk terms.

This assessment suggests that this promise is only partially true. Certainly for situations in which nearly identical risks are identified and measured, policy makers will indeed find it relatively easy to weigh risk increases and decreases against one another. In another class of instances, even when the regulation-induced risks are quite different from the explicit benefits of an intervention, if the same individuals would experience both, and they can voice their opinion on the choice sufficiently clearly, then policy makers might avoid the need to compare heterogenous risks by following the expressed preferences of the affected parties.

But these two cases will be the exception rather than the rule if the more expansive versions of risk-risk analysis are pursued, where many types of risks and outcomes of social concern are sought in even activities and situations remote from the point of impact of a regulation. Here, policy makers would potentially confront a wide variety of different kinds of risks, from human mortality and morbidity (voluntarily- or involuntarily-assumed), and non-human resource damages and conservation concerns, to equity issues, employment, education, innovation, and so on. In these more general circumstances, it is not at all obvious that risk-risk analysis makes a policy maker's decision about a given regulation more clear cut since the risk tradeoffs will normally be anything but apples-to-apples.

As argued here, one way to establish the policy relevance of these risks is to assume that they are of social concern because their private and social valuations are not equal, such as with classical externalities, in which case risk-risk analysis results would have direct bearing on the net social benefits of an intervention -- extra costs and benefits previously unexplored. Assuming these are identified and measured accurately, policy makers would still face the task of trading the externalities off against one another using defensible methods of comparison.

Risks that are voluntarily assumed, however, are not normally of special significance to policy makers beyond the explicit compliance costs that give rise to them. Here, policy makers may elect to search for reasons why these sorts of risks might still be of independent importance to them, arguing that many of these consequences do have social impacts not felt by the individuals subject to them, thus partially placing them in the externalities category. Here as well, assuming these are located and quantified, policy makers must still define clearly their social significance to include them in decision making.

On the other hand, if these effects are instead left as purely voluntary risks and outcomes, their policy relevance is really no more and no less than the significance of the original regulatory costs that start the analysis in the first place. In these cases, the ultimate benefit to policy makers, if any, of expressing regulatory burdens in different terms is the possibly enhanced political persuasiveness of describing monetary compliance costs in terms of their multitude of consequences. Of course, measuring the many impacts a regulation's costs might produce is a difficult task in practice, so the fact that these risks are really compliance costs in different clothing should be carefully considered by regulators in deciding the value of pursuing this information. This may only be worth the investment in a few particularly egregious cases where costs vastly exceed benefits, and thus where converting costs into practical consequences for debating purposes might meaningfully improve social welfare.

In the end, it appears that conducting any sort of formal risk-risk analysis should probably only be contemplated when the expectation is that enough induced risks might be found and accurately

documented to conceivably make a difference in policy makers decisions. And in contemplating whether to conduct traditional direct risk-risk analysis, or even a few tightly focused and caution extensions into indirect risk-risk and health-health analysis, common sense should prevail, for the issue is not whether policy makers would want the information if it were available. Instead, it is whether it is worth devoting the resources necessary to obtain accurate information on this type given its frequently uncertain policy interpretation and often modest expected impact on policy decisions. Thus, far from installing this approach as a standard hurdle in the regulatory evaluation process, this calls for only a very limited role for risk-risk analysis in highly selective applications. Otherwise, far too many resources will be spent chasing hypothetical induced risks, without any appreciable benefit to policy makers.

It is probably no coincidence that this assessment has concluded that risk-risk analysis should continue to occupy mostly the same position in the policy making process that it has historically. This being primarily selective application of direct risk-risk analysis to situations in which suspicions are strong that induced risks closely related in a causal sense to an intervention might be substantial and worth investigating carefully, and where weighing induced risks and direct benefits will be convincing. Policy makers for many years have applied this commonsense notion of risk-risk analysis in their deliberations.

For example, the proposed ban on asbestos automobile brakes for the replacement market was slated to occur a number of years after the initial promulgation of the regulation because of safety concerns associated with using non-asbestos components in systems designed for asbestos parts. Similarly, direct risk-risk analysis has commonly been employed in arguing against policies that seek to reduce voluntarily-assumed risks, especially when the probabilities are high that induced risks may be greater than the direct benefits. The case of airline child safety seats is a case in point, where mandating the costly purchase of a seat for a small child might place the child at greater risk through automobile travel.

Thus, direct and important induced risks have not traditionally been ignored in regulatory evaluations. Indeed, direct risk-risk analysis seems to be the natural public policy counterpart to the way most individuals weigh different actions in their daily lives, accounting for positive and negative results of alternative options in making a decision. It should not be surprising, therefore, that policy makers have pursued the commonsense strategy of considering clear and palpable risks potentially increased by regulations along with monetary compliance costs, just as private individuals would take similar consequences into account in making choices.

What has never been a part of this process is the extension of policy concern and, hence, regulatory evaluation to all of the indirect sources of risks which advocates of risk-risk analysis suggest ought to be included to obtain a more complete tabulation of the net changes in risks caused by an intervention. Perhaps only subconsciously, policy makers may be aware that the more general forms of risk-risk analysis lead ultimately to an "anything goes" pursuit of a wide variety of heterogeneous risks and other social concerns without reasonable boundaries and with no obvious prospects for generating robust results of coherent and unambiguous decision making value.

These extended forms of risk-risk analysis also have no counterpart in individual choices for precisely the same reason. No individual would seriously contemplate all of the endless empirical modeling and data collection necessary to identify and quantify numerous presumed-to-be-relevant sources of indirect risks. Policy makers should not either, for they have no magic wand that will

somehow simplify this vast, complex, changing, and interconnected world enough to make the necessary measurements practically feasible.

To be sure, plausible assertions rooted in the indirect risk-risk and health-health approaches will continue to be seen in policy making circles. But they will generally be possibilities and hypotheses rather than the product of careful empirical analyses. As such, they may well serve political purposes in often heated policy discussions, but this does not make the general approach a useful and feasible analytical tool for evaluating regulations on a routine basis.

One final point is in order. There is some evidence that risk-risk researchers are at least partially aware of some of the problems with the approach discussed here. That the list of risks and outcomes of concern can become very long, that it is not obvious in most instances whether the approach will really uncover enough induced risks to matter much to policy makers, and that the income-health relationship is a very complex one requiring considerable disaggregation and detail, are observations noted here and there. But they are nearly universally regarded as manageable empirical challenges, not inherently different from other quantitative economic undertakings.

But the conclusion of this assessment, to the contrary, is that examining these and other issues and complications more carefully suggests that applying the approach is generally infeasible in practice. Indeed, all but the most focused and circumscribed versions of risk-risk analysis confront the insurmountable task of endless tracing of market and non-market linkages in search of risks and other outcomes of concern. This finding is similar in spirit to the observation in Smith, Epp, and Schwabe (1994) that Wildavski's original "richer-is-safer" argument was one couched more as "... crude ways of incorporating the positive effects of growth, not measures of the individual tradeoffs people are hypothesized to make in deciding the resources they will allocate to averting behavior to either improve their health or avoid deteriorations in it."(p.73) Thus, the problem is not so much what is contemplated theoretically in risk-risk analysis as it is the task of actually acquiring the information necessary to make it a viable practical tool for policy makers.

At this point, it should be clear to those who follow environmental policy formulation closely that the central argument of this assessment applies in a much broader context. Indeed, "indirect" analysis has become ubiquitous in policy circles in recent years. The general form this approach takes is to begin with a possible policy intervention and then search for environmental outcomes that might indirectly result. Examples of this abound. Life cycle assessment of alternative products, such as paper and plastic grocery sacks, seeks to measure all of the direct and indirect environmental concerns associated with typical consumer or producer choices. Advocates of mandating enhanced recycling of municipal solid waste assert that environmental benefits will flow from reduced virgin materials use and potential energy savings. Opponents of using the organic fuel additive ETBE point to possible increased pesticide and erosion problems if more corn or other crops are planted. Those seeking to reduce the federal budget deficit argue that many provisions of the corporate tax code lead to increased environmental damages.

All of these manifestations of this indirect form of thinking share the same empirical problems. It is difficult in general to actually identify and measure the indirect effects of interest and to connect them causally to the policy intervention in question in a way that convincingly demonstrates that changing a choice or a policy will actually reduce some possibly far-removed environmental harm. Moreover, in most instances the boundaries defining what effects are to be considered and included are arbitrary. The solid waste recycling mandate, for example, could well actually increase total

environmental damages if recycling activities are more polluting than processes using virgin-source inputs. Thus, justifying a requirement that more waste be recycled by asserting that virgin materials might be saved is incomplete and therefore suspect. Similarly, using ETBE may increase some agriculture-related risks related to corn and other feedstocks, but this might displace other even more risky agricultural practices. And arguing that the tax code is associated with sectors and actions that cause environmental harm is not the same as proving that without these tax provisions, the harm would not occur.

Of course, this is not to say that such claims are never valid and that interventions based on these lines of reasoning are never good social policy. But whenever proponents of a regulation or mandate seek to justify it on the basis of indirect benefits, caution should be observed. As a general matter, economic teaches that the best remedies for environmental and other externality problems are those that target the sources of the harms directly using any of the various regulatory and non-regulatory tools at the disposal of policy makers. Once this is done, there is no need to tinker with any of the numerous economic activities conceivably connected with the original externality, and the need to define and measure them as risks related indirectly to any of a number of policy interventions vanishes.

On a fundamental level, therefore, even if risk-risk and other forms of indirect analysis could be performed comprehensively and accurately, trying to adjust and evaluate regulatory programs based on their results is a poor substitute for well-focused efforts to correct actual environmental problems when and where they occur.

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