A Perspective on Valuing Changes in Health Risk

by
Ann Fisher

Food Marketing Policy Center
Research Report No. 9

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1. Introduction

Once we have some estimates from safety inspections, however good or bad we think they may be, the question becomes what to do with this information. This includes making a policy decision about whether to take action to reduce those contaminants, and whether they are microbial or toxic chemicals. Taking that next step means that we need to be reasonably confident about whether a policy action is worthwhile, or what its value would be. There are two categories of health effects that need to be thought of in terms of valuation. The first category is the risk fatal effects that we typically assumed from cancer and sometimes from other sorts of poisons. Compared with the second category, those are easier to deal with because death is a relatively clearly defined endpoint. The second category is risk of non-fatal morbidity effects. These are more difficult to deal with because there is a difference between being sick overnight with flu symptoms versus being sick for two weeks with flu symptoms versus being sick for two years with flu symptoms versus being sick overnight with something that you think is a serious heart attack, etc. There is no single identifiable endpoint when you are talking about morbidity, which complicates matters substantially.

In this paper I will concentrate primarily on valuing changes of the risk of death and concentrate less on the valuing of morbidity effects, which reflects our degree of understanding rather than the relative importance of the two. I shall emphasize what I perceive as the best approach, although whether it is the right approach will have to be determined by the test of time. Much of this information is available in the *Journal of Policy Analysis and Management* article that I have written with Lauraine Chestnut and Dan Violette (1989).

2. Valuing Changes in Mortality Risk

Think about what happens in a regulatory procedure that might increase food safety through food safety inspections. To keep the matter simple, assume an initial risk of fatality of three in a hundred thousand. By increasing the number of food safety inspections suppose that risk of fatality is reduced to one in a hundred thousand. If a hundred thousand people eat that food item each year, then on the average the increased inspections would save two statistical lives per year. This is not saving two people per year in the usual sense. Instead, the increased inspections reduce the risk to each of those hundred thousand people who eat that food item so that their individual risk goes from three per hundred thousand to one per hundred thousand per year. We cannot identify which two people are saved. All we can say is that because these food safety inspections remove some contaminated food from the market, and with the same hundred thousand people eating the now safer food item, on the average we would save two statistical lives per year.

This illustrates the basic of valuation issue for policymakers. What a life is worth is not couched in terms of an identifiable life. Instead, policies reduce small risks by small amounts for each of many people. When those small reductions in risk are aggregated across many people, then they add up to the number of statistical lives saved. It is important to keep in mind that in most instances we never will be able to identify who the people are who were saved because of that particular policy action.

The valuation can be applied to results of the type of risk analysis described by Mauskopf (1989). The risk assessment yields an estimate of statistical lives saved per year for each policy option that is available. Now suppose we have gone through that process and we look again at each of those one hundred thousand people who are eating this particular commodity. Suppose we know that to each of them it would be worth $10 per year to reduce that risk from three in a hundred thousand to one in a hundred thousand. Then all of them together are willing to spend a million dollars. Because the policy would save two statistical lives, the value of one statistical life is $500,000 for the group eating this food item.

I have glossed over some problems by assuming that we know how many people are eating this food, that we have an estimate of what they are willing to pay on an individual basis, and that they are all willing to pay the same amount. Why this willingness-to-pay concept? As a measure of welfare, economists typically are more comfortable with this notion of willingness-to-pay on an individual basis. There are some complications because of the individual's willingness-to-pay to reduce his own risk of death versus his or her concern about the pain and suffering that is caused to loved ones and the altruistic feelings about generalized others and their risk of death. Now suppose that we want to come up with an estimate of the willingness-to-pay for reducing the risk of death. We do not ordinarily buy and sell risk in the market like we do ice cream cones or most other goods and services, so we have to come up with another way of estimating the willingness-to-pay for reducing the small risks by small amounts for each of many people. Federal agencies have grappled with this problem. Table 1 shows the value per statistical life (VSL) used by several agencies. You will see that not all of them use a willingness-to-pay (WTP) approach. Some rely on a human capital (HC) framework, which emphasizes the individual's contribution to society, rather than society's expressed values for reducing fatal risks.

Basically there are three approaches that economists feel more or less comfortable with. Two of them look at actual behavior. One of these is based primarily on looking at what happens in labor markets where some workers have higher risks of accidental deaths on the job and may get a wage premium for bearing that job risk. Another approach looks at some of the safety decisions that people make, such as purchasing smoke alarms, using seat belts, or deciding not to smoke. The third approach is to be a little more direct and simply ask people what they would be willing to pay for a reduction in risk, usually in the form of what are called contingent valuation studies. I shall describe these three approaches, the techniques that are used, the advantages and disadvantages of those techniques, what kinds of results they give us, and what sorts of conclusions we might draw from them.

Consider the wage risk studies first. Suppose two jobs are alike except that in job A the annual risk of death is a one in ten thousand higher than in job B and the workers in job A on the average get $500 a year more pay. If ten thousand workers are willing to forego that $500 a year and work in job B—which otherwise is like job A—then we can calculate the value for statistical life (VSL) as the $500 per year times the one statistical life that would be saved per ten thousand workers times the ten thousand workers that are willing to forego that $500 a year, or five million dollars per year [VSL = ($500/workers/year)(1 life/10,000 workers)(10,000/workers) = $5 million]. This deliberately is a different figure than the one before to emphasize the need to look at empirical evidence to see what those amounts are; we have no theoretical expectations of what the amount should be.

Table I. VSL Estimates Used by Various Federal Agencies to Evaluate the Mortality Benefits of Their Regulatory Proposals (Millions of 1986 dollars)

Agency	Value	Methodology	Application
Occupational Safety & Health Administration	$3.84	WTP—risk premium estimate based on hedonic labor market study (Viscusi, 1981).	Use in benefit-cost analyses of safety standards, but not health standards.
Consumer Product Safety Commission	$1.5 for Adults $2.0 for Children	WTP—based on a literature review by Miller (1986).	Use in most economic analyses of regulations affecting human life.
Department of Transportation	$1.0 minimum	WTP—based on review of several studies.	A 1986 memo to individual DOT administrations sets this as the minimum value to be used when a value of life is considered in regulatory analyses.
Federal Aviation Administration	$0.7 before 1986	WTP plus externalities—risk premium estimate based on hedonic labor market study (Thaler and Rosen, 1975).	The $0.7 estimate was regularly used in benefit-cost analyses of FAA rule making prior to the 1986 DOT memorandum (see above). Now the $1 million value is routinely applied.
	$1.0 minimum now	Based on DOT memorandum.	
Federal Highway Administration	$0.39-0.98 before 1986	Lower bound based on HC, upper bound based on WTP plus externalities—risk premium estimate based on consumer market study of life insurance use (Landefeld and Seskin, 1982).	Infrequently need to use VSL estimates in regulatory analyses. The agency expects to issue definitive guidelines for use of a VSL estimate based on WTP sometime in 1988.
	$1.0 minimum now	Based on DOT memorandum.	
National Highway Traffic Safety Administration	$0.35 before 1986	HC plus externalities.	Do not use in benefit-cost analyses of rule makings. Use to examine the economic costs of accidents and sometimes included in appendices to regulatory analyses in response to public comment.
	$1.0 minimum now		
Environmental Protection Agency	$0.45-8.0	WTP—based on risk premium estimates from various hedonic labor market studies.	Regularly used in benefit-cost analyses of regulatory proposals.

These wage risk studies (or wage hedonic studies, as they sometimes are called) rely on regression analysis to control for the characteristics of the jobs that differ aside from risk and to determine how much of the difference in wages can be attributed to the difference in risk itself. This approach relies on a number of important assumptions. For example, it assumes that workers are aware of the differences in risks across jobs, but many people have argued that workers do not know what their risk level is, especially when they take a job. Fortunately, there has been some research on this question by Viscusi and O'Connor (1984). They found that chemical workers, who have some of the highest accident risks in the labor force, have risk perceptions very close to objective measures of the risk for job categories. So the criticism that workers may not know what their risks are probably is not true across the board. Certainly there will be some workers who are not aware, but they do have the capability to learn about the risk on the job, and the evidence suggests that they indeed do learn about their own risks.

A second assumption that is important in the wage hedonic studies is that workers are able to move freely between jobs. This certainly is not perfectly true. Rigidities in the labor market prevent workers from moving as freely between jobs as they might like. The real test is whether there are differential wage premiums for workers in equally risky jobs but where some of them are in union jobs and others are in non-union jobs, with the presumption being it is hard to move from a non-union job to a union job because they have to be a union member. Unfortunately, there is conflicting evidence on whether wage premiums are higher for union workers than for non-union workers, and so the jury is still out on that particular assumption and what kinds of problems that creates for us.

Another criticism of the wage risk studies is that it may be difficult for the regression analysis to control for all of the other relevant job characteristics. If other unpleasant job characteristics are not part of the regression equation, then the risk premium estimate can reflect some of these other characteristics. Some, but not all, of the wage risk studies have done a pretty good job of controlling for other job characteristics.

Still another criticism is that we need to control separately for non-fatal job accident risks. This criticism is not as well founded as some of the others because Workman's Compensation typically takes care of the non-fatal risks. Workman's Compensation does not cover the pain and suffering component, but does cover the out-of-pocket costs that would be associated with getting a broken arm set, does cover the repairing of a mashed finger, etc.

There are two more criticisms of wage-risk studies in general. One is that the studies typically have focused on the wages paid rather than on the total compensation package. That would include things like the Workman's Compensation plus other insurance premiums, day care, and other benefits. However, so long as the relationship between wages and total compensation remains constant as you look across job categories and what we are interested in is the differential between the risky jobs and the non-risky jobs, then the non-wage compensation will wash out when we do the analysis anyway. If we are more interested in the absolute size of the differential, then the estimated risk premium gives an underestimate because we have not looked at the total compensation package. This may be offset partly by the final criticism, which is that wage-risk studies typically do not account for taxes and thus take-home pay is less than the stated wage rate. On the other hand, so long as all the workers are in about the same tax bracket, that effect probably also washes out. Given these criticisms, what conclusions can be drawn from the wage-risk studies?

Table 2 (taken from Fisher, Chestnut, and Violet, 1989) summarizes the results for wage-risk studies as well as other approaches to valuing changes in the risk of fatality. Is risk compensation the same across all jobs? Probably not, but if it is close to being the same for the job categories in a wage-risk study, then its effect will be neutral. Whether it really is the same for all these job categories has not been investigated to my knowledge, but for the kinds of jobs included, I suspect that the assumption is realistic. (The Gegax, Gerking, and Shultze study has some contingent valuation estimates for white collar workers that suggest they may require higher risk premiums—if they did face the same risk—see below.) Some evidence that deals with this issue is discussed below. Table 2 shows fifteen wage risk studies that provide some evidence that might be helpful in deciding what the wage risk studies can tell us. The early wage risk studies, which are the first nine on the table, basically fall into two categories. One category uses actuarial risk data. These data are from very broad occupational groups where the

Table II. Estimates of the Marginal Willingness to Pay for Reductions in Risk

Study	Mean Risk Level for the Sample[a]	(Millions of 1986 dollars) Range of Estimates	Judgmental Best Estimate
EARLY LOW-RANGE WAGE-RISK ESTIMATES			
1. Thaler and Rosen (1975)[b]	11.0	0.44-0.84	0.64
2. Arnould and Nichols (1983)[b]	11.0	0.72	0.72
3. Dillingham (1979)	1.7	0.38-1.2	0.45
EARLY HIGH-RANGE WAGE-RISK ESTIMATES (all based on BLS industry accident rates)			
4. R. Smith (1974)	1.0 to 1.5	8.5-14.9	8.50
5. R. Smith (1976)	1.0 & 1.5	3.6-3.9	3.70
6. Viscusi (1978)	1.2	4.1-5.2	4.30
7. Olson (1981)	1.0	8.0	8.00
8. Viscusi (1981)			
a. w/o risk interaction terms	1.04	5.4-7.0	7.00
b. with risk interaction terms	1.04	4.7-13.4	
9. V. K. Smith (1976)[c]	3.0	1.9-5.8	3.90
NEW WAGE-RISK STUDIES			
10. Dillingham (1985)	1.4-8.3	2.1-5.8	2.50
11. Marin & Psacharopoulos (1982)[d]			
a. manual workers	2.0	2.7-3.1	2.90
b. nonmanual workers	2.0	9.0	
12. Low and McPheters (1983)[e]	3.6	0.9	0.90
13. Leigh and Folsom (1984)	1.3-1.4	4.3-10.2	6.80
14. Gegax, Gerking, & Schulze (1985)			
a. all union workers	8.2	1.9	
b. union blue-collar workers	10.1	1.6	1.60
15. Moore and Viscusi (1988)	0.79[f]	5.2-6.6	5.4
	0.52[g]	1.9-2.1	
NEW CONTINGENT VALUATION STUDIES			
16. Jones-Lee *et al.* (1985)	0.8-1.0	1.6-4.4	3.00
17. Gegax, Gerking, & Schulze (1985)	4.2-10.0	2.4-3.3	2.80
CONSUMER MARKET STUDIES			
18. Ghosh, Lees, & Seal (1975)	not reported	0.56	0.56
19. Blomquist (1979)	3.0	0.38-1.4	0.61
20. Dardis (1980)	0.9	0.36-0.56	0.46
21. Ippolito & Ippolito (1984)	varied	0.24-1.26	0.52

a. Approximate annual deaths per 10,000 people.
b. Based on actuarial risk data.
c. Assuming 0.4 % of all injuries are fatal, as reported by Viscusi (1978) for the BLS injury statistics, and that the risk premium for fatal injuries is 33-100 % of the premium for all risks.
d. Their age-adjusted normalized risk variable is not directly comparable to the risk levels used in other studies. However, the average risk of death for the entire sample was 2 in 10,000.
e. Four years of risk data were used. The overall mean was not reported, but the mean for one year was 3.6 deaths out of 10,000 workers across all cities in the sample.
f. This row is based on NIOSH National Traumatic Occupational Fatality data by one digit SIC code for each state.
g. This row is based on BLS accident rates by two-digit SIC code.

expected age-adjusted deaths for the overall population are subtracted from the death rate for each occupation and the remainder is assumed to represent the deaths associated with the occupation. When you look at actuarial data you get some very strange results, as illustrated by Table 3 (Fisher, Chestnut, and Violette, 1989). For example, bartenders have a risk factor of 176 and firemen have a risk factor of only 44. For policemen it is 78 and for elevator operators it is 188. The actuarial data suggest it more dangerous to be a bartender or an elevator operator than it is to be a policeman or a fireman in terms of the risk on the job! The reason this does not make much sense is that personal characteristics may lead people who are at high risk of death to choose jobs like elevator operator or bartender compared with people who probably are healthier to begin with and decide to be policemen and firemen. Those personal characteristics are not included in the actuarial information.

Because of these concerns, we were very skeptical about the results of the first two studies in Table 2, the Thayler and Rosen study, and the Arnold and Nichols study. The studies numbered four through nine yielded estimates approximately at the same time as the first two, but were based on better data. They used the Bureau of Labor Statistics (BLS) accident rate by industry. These studies still need to account for the fact that job risks are not likely to be uniform across all occupations within the same industry. For example, a secretary working for a steel company is categorized in the same industry as the bessemer furnace operator. They probably have different job risks, so most of the studies based on the BLS data also have some kind of indicator to let you know one of them was a secretary and the other one was a worker out in the more dangerous part of the plant.

There seems to be more credence for the studies based on the BLS data. However, there is still the problem that the first two studies and studies four through nine all are based on only two data sets. The ones that are based on the actuarial data give low estimates of the value for a statistical life, in the neighborhood of $640,000 to $720,000. The studies based on the BLS data give much higher estimates per statistical life, from about $4 million to over $8 million per statistical life. Allan Dillingham looked at a different data set based on Workman's Compensation data gathered by the state of New York. He used what seemed to be a much better risk variable and his value-per-statistical-life estimate of about $450,000 was down there in the low range.

Table III. THALER AND ROSEN (1975) RISK DATA ON EXTRA DEATHS BY OCCUPATION

Occupation	Risk*	Occupation	Risk*
Fishermen	19	Truck drivers	98
Foresters	22	Bartenders	176
Teamsters	114	Cooks	132
Lumbermen	256	Firemen	44
Mine operators	176	Guards, watchmen, & doorkeepers	267
Metal filers, grinders, & polishers	41	Marshalls, constables, sheriffs, & bailiffs	181
Boilermakers	230	Police & detectives	78
Cranemen & derrickmen	147	Lonfshoremen & stevedores	101
Factory painters	81	Actors	73
Other painters	46	Railroad conductors	203
Electricians	93	Ships' officers	156
Railroad brakemen	88	Hucksters & peddlers	76
Structural iron workers	204	Linemen & servicemen	2
Locomotive firemen	186	Road machine operators	103
Power plant operatives	6	Elevator operators	188
Sailors & deckhands	163	Laundry operatives	126
Sawyers	133	Waiters	134
Switchmen	152	Taxicab drivers	182

Source: Society of Actuaries
* Units of measure are extra deaths per 100,000 policy years. To convert to the probability of an extra death per year on each job, multiply by 0.00001.

Thus, despite the concerns about the shortcomings of basing estimates on actuarial data, EPA felt in 1982-83 that the low estimates could not be discarded. And so the original recommendation for EPA in its regulatory impact analysis guidelines had a value-per-statistical-life range of $400,000 to $7 million (1982 dollars) for the agency to use when valuing mortality effects.

That was several years ago, when EPA was first trying to do regulatory impact analyses in response to Executive Order 12291. We also looked at the few contingent valuation studies that were available then. In these early contingent valuation attempts, economists had not taken advantage of what they could learn from psychologists, market researchers, and statisticians. EPA did not place any credence in these primitive contingent valuation results, and they are not reported in Table 2. The consumer market studies that were available at that time (numbers eighteen, nineteen and twenty) were consistent with the low range from the wage-risk studies and gave another reason for not discarding those low wage-risk estimates.

Several new studies have become available since EPA's designation of the $400,000-$7 million range for valuing statistical lives. Most of them use different data sets and are more sophisticated than the earlier wage risk studies, especially in terms of characteristics of the jobs and risk measures.

The Dillingham study for 1985 is important because basically he looked at his earlier study and basically said, "oops, I goofed." He reported his revised results in *Economic Inquiry*. He had used a risk measure that was quite flawed in his earlier study. When he corrected that risk measure, his estimate went from about $450,000 to $2.5 million. That substantial difference gave another reason to discount the first two studies (in addition to the problems already pointed out about the actuarial data).

Another study I would like to talk about in this category, the Low and McPheters study, has a low estimate. They looked at the death rates for policemen and came up with a wage risk estimate of about $900,000. There are perhaps several basic problems with their study. One problem is that they used starting salaries rather than average salaries for policemen. It may be that policeman start at low salaries, but when they get some notion of what the risk really is they either leave or they get higher wages. Low and McPheters did not investigate this and I do not have any data on it, but I would guess that either there is a disproportionate share of starting policemen on most policemen forces or the senior ones get much higher wages than the junior ones. Another problem is that while all of the wage risk studies have been criticized because they probably cover workers or people in our society who are more risk prone or less risk adverse than average, policemen are probably even more so. There is an image associated with being a policeman that probably is important to many people who choose to go into that line of work. There may be some glamour associated with being a policeman that compensates for a lower wage. A more important flaw in the Low and McPheters study is that they really could not look at the right risk measure. Their data showed only twenty-three deaths out of 64,000 policemen. That was too small a measure to give them a very good indicator of

risk, so the statistical technique they used may only showing that you have to pay higher wages to get more policemen rather than showing a value for statistical life.

The new contingent valuation studies are much better than the earlier ones. For example, the researchers used pretesting to be reasonably sure that people understood what they were asking. The Jones-Lee study is for Great Britain and covers both blue collar workers and non-blue collar workers. Gegax, Gerking, and Schulze used a mail survey to get data for both hedonic wage analysis and contingent valuation analysis for the same workers. Their study is attractive from the wage-risk perspective because they had the workers' perception of their own on-the-job risks, which the other studies did not have. They did not get the same estimates in their wage-risk results and contingent valuation results for these workers who have the same perceived risks. They have a best estimate of $1.6 million from the wage-risk results, but $2.8 million is their best estimate for the contingent valuation results. But it is important here to go back and address the question of blue collar workers versus non-blue collar workers. Gegax, Gerking, and Schulze did not get significant wage-risk results for the white collar workers and so their $1.6 million estimate is primarily for blue collar workers. They did get significant results for the white collar workers in the contingent valuation portion. They hypothesized that the reason they and others have not been able to get significant results in the wage-risk studies for white collar workers is because there simply is not much variation in risk across white collar jobs. (There is significant variation across blue collar jobs.) The fact that they get something that is larger, but still in the same ballpark as the contingent valuation results leads them to believe that 1) white collar workers probably are a little bit more risk adverse, 2) they probably do have a higher value for reducing their own risk by small amounts, and 3) there is no real reason to exclude consideration of white collar workers; the results from the blue collar workers could be viewed as a lower bound because of white collar workers' higher risk aversion.

One more study should be discussed before drawing some conclusions. That is the Ippilito and Ippilito consumer market study. They looked at how smoking changed in response to new information about smoking (such as the Surgeon General's report). Assuming that the people believed that the Surgeon General's report implied that smoking a pack of cigarettes per day would shorten a life on the average by three and a half years, they estimate a value for statistical life of about $500,000 in 1986 values. That is much lower than all of these other numbers that have come out of new studies. However, my concern is that smoking may not be a particularly helpful consumer product to look at because smoking is habituating, if not addictive. Smokers see clear benefits from smoking, and there are some real costs associated with stopping because of the withdrawal symptoms that are hard to account for in an analysis like this. If we were to do the same kind of a study about the revealed health effects of some other consumer product that was not habit-forming, I suspect that the value-per-statistical-life estimate would be much larger.

What does that mean in terms of the overall conclusions that I would draw from this set of data? If we knock out the first three studies for the reasons I have described, knock out the Low and McPheters Study (number twelve), knock out Moore and Viscusi (which is irrelevant because of the size of the estimate), and knock out the Ippilito and Ippilito study, and we recognize that the other three consumer market studies are likely to give us underestimates of the risk for reasons described, that leaves about 15 studies with risk estimates varying between about $1.6 million and $8.5 million per statistical life saved. I have recommended that EPA update the old range from $400,000 to $7 million in 1982 dollars to this new range of $1.6 to $8.5 million in 1986 dollars. This reflects more than the inflationary effect because of the dropping of studies at the low end of the range.

The range of $1.6 to $8.5 million per statistical life saved is wide. What about a best estimate? My response is that there is no best estimate within that range because these studies were done for workers, primarily, looking at job risks. If we wanted to translate the results just to job risks, then I might be willing to choose a best estimate. However, USDA and EPA are not talking about on-the-job risks, but about risks from food and environmental contaminants. There is a lot of evidence (not described here) indicating that people have values for components of the risk aside from the probability of death. One of these components is whether they view risk as voluntary versus involuntary. For example, if you eat raw oysters even though you know they come from a contaminated area, that is very different than feeding your child some presumably safe applesauce that turns out to have a pesticide in it. Or perhaps your doctor has prescribed apples, but it turns out that all of the apples you can buy have been sprayed with this pesticide. These are involuntary

risks compared to the voluntary choice to eat those oysters that could be contaminated. There may be higher values placed on avoiding some of these involuntary risks than are placed on voluntary risks. Worker risk can be viewed as a voluntary risk. People have argued that workers do not have any choice. In reality, they do not have to work in a particular risky environment. They can work at the Seven Eleven, which is going to be safer. It also is going to pay less. They are making conscious decisions to have the higher pay that accompanies the riskier job. There may be some individuals who really do not feel that they have any viable choice, but most people have a choice; it is just a choice they choose not to exercise.

3. Valuing Changes in Morbidity Risk

Morbidity valuation, as indicated above is a tougher problem because there is no single endpoint. In addition to knowing how many people are affected, you need to know how badly they are affected, how sick they are going to be for how long, and what kind of illness or what kind of disability they are going to suffer as a result of that particular contamination. The cost-of-illness approach has been the primary approach used in the past to look at how to value changes in morbidity. The cost-of-illness approach typically looks at the out-of-pocket medical costs associated with treating an illness. More sophisticated versions include the wages that are lost, especially when people do not have sick leave as part of their job compensation package.

Still more sophisticated versions of the cost-of-illness approach look at other kinds of averting behavior in which people may engage in order to reduce the frequency or severity of particular illnesses. For example, the mother who is concerned about the applesauce being contaminated if she buys it at the store may purchase a food processor and apples, peel the apples, and process them herself. It may cost substantially more to take that averting behavior than it would just to pull a few of those jars of applesauce off the shelf in the grocery store. Some averting behaviors involve a joint product problem. For example, it may be that the mother bought the food processor not just to prepare the baby's food, but also because she wanted to have more uniform carrot slices in her homemade soups. For some kinds of morbidity valuation it gets to be substantially more complicated. For example, one of the averting behaviors for air pollution is to use air conditioning, which filters some of the exterior and the interior air pollutants out of your ambient environment in the home. But how do you separate the portion of your decision to purchase the air conditioner so that you would have cleaner air in the home from the portion of the decision to purchase the air conditioner because you want to be cooler when it is hot outside? That is a tough call to make. Another example might be a food-borne illness that causes people just to have less energy, such as with a chronic illness. They may hire someone to come in and clean, or to do yard work, or whatever. But their hiring of services may be partly because they do not like to do that job anyway. It is not always clear just how to parcel out that aspect of the averted behavior. A good cost-of-illness study would try to account for all three of these: medical costs, the wages that are lost, and other averting behavior that takes place. The medical cost estimates also can be a problem because of medical insurance. What individuals spend to get over an illness or to reduce its severity may be much different from the cost of providing that care because much of it may have been covered by medical insurance. But from society's perspective the full cost should be included, which would mean looking at the insurance component as well. Which way to look at it depends upon whether you are looking at the cost-of-illness measure from the perspective of society's cost of having that illness occur or reducing that amount of illness, or whether you are trying to use the cost-of-illness measures as a proxy for the willingness-to-pay—which is appropriate for a policymaking perspective. If you are looking at it from the willingness-to-pay perspective, then if that person has to give up wages because he or she was sick, then this is a component of willingness-to-pay. (It is also a component of the productivity loss from the societal perspective of what it cost society to have that illness.)

The cost-of-illness measure has been used frequently. Unfortunately it has not been used very carefully. Often it does not include lost wages and does not correct for the insurance component. (But again, for aggregate willingness-to-pay, all together we do pay for medical insurance, and so probably that does need to be accounted for in either what society is willing to pay for reducing illness or in measures of illness's cost to society.) However, the cost of illness has been shown both theoretically and empirically to be an underestimate of willingness-to-pay because it does not account for pain and suffering. It does not account (by and large) for the discomfort that is associated with friends and relatives being unhappy because you are sick or having to help you because they need to take you to the doctor when you cannot drive yourself or having to provide care for you when you are at home. This is all part of the willingness-to-pay to avoid or reduce the amounts of illness. Contingent valuation is one approach that can account for pain and suffering. Edna Loehman has done some of the early work on contingent valuation of symptom days or restricted activity days. Her work was very early and there have been some improvements in technique since then. However, they are still far from perfect, and we do not have good answers yet for how to value symptom days or restricted activity days. Another problem is that symptom days or restricted activity days do not match very well what the risk assessors estimate when they at look at morbidity. In air pollution studies, for example, the risk assessors look at things like restricted forced expiratory volume (FEV), and it is not clear how that is related to something that you and I would think of when we get a respiratory illness. We think about things like sneezing, runny noses, tightness of the chest, and maybe burning eyes. These symptoms may not track what the epidemiologist and toxicologist see as the outcomes that are of interest.

4. Conclusions

In summary, it is important to recognize that health and safety policy decisions implicitly assign values to reductions in morbidity and mortality risks. The prudent policymaker will be aware of those implicit assignments and compare them against available estimates of society's willingness-to-pay for reducing these risks. Although available estimates have many shortcomings, they still can provide useful benchmarks. This statement is truer for mortality risks, where the endpoint is clearly defined relative to morbidity endpoints.

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