Public Expenditures and Risk Reduction

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Abstract

Governments in developing countries spend money on goods and services that have an impact on people's exposure to risk. This paper presents a simple approach to valuing such expenditures from the perspective of risk reduction. There are two types of expenditures: public provision of insurance, such as for health care or crop yields; and policies aimed at other objectives that change peoples' risk profile, such as transfer programs, tax and subsidy policies, and infrastructure investments. Several examples of each type show that incorpo-

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rating the risk-reducing perspective significantly alters the value of public expenditures, which indicates that these considerations should be included in standard public expenditure analysis.

That public spending rises with a country's per capita income is well known. In the United States, for example, public spending was 7.5 percent of gross domestic product (GDP) in 1913 and is 33 percent today. Governments in present-day developed countries spend about twice as much as developing countries. Less well known is that government spending on goods and services is the same in developed and developing countries; the difference is almost entirely the result of transfer payments, which are about 22 percent of GDP in the industrial world (Tanzi and Schuknecht 1997). Many of these transfer payments—unemployment insurance, pensions, health insurance, and guaranteed loans—have the characteristic that they are aimed at mitigating risk in the private economy.

    In this paper, we explore how the existing framework for evaluating government spending on goods and services, welfare economics (Samuelson 1954; Musgrave 1959), can be extended to incorporate the government's various risk-reducing activities. Because governments do not typically classify their expenditures by their risk-altering characteristics, our approach will be more conceptual than empirical. We illustrate our points with some simple examples and models designed to capture the risk-reducing properties of various public expenditures. We show that adopting a risk-reducing perspective has implications for the costs and benefits of certain public expenditures and taxes that are different from the standard analysis, which indicates directions of change in the composition of public spending that are welfare-enhancing.

    In the first section of the paper, Analytical Framework, we present an approach to evaluating the welfare consequences of policies that influence the size and distribution of risks that people face. We also show how the approach can provide insight into the positive question of *why* governments of developed countries spend more on risk-related expenditures than governments of developing countries. In the next section, Applying the Framework, we apply the framework to the normative question of evaluating the benefits and costs of common programs associated, directly or indirectly, with the reduction of risk, including crop insurance, medical care, income support, flood control, education, and loans. The last section offers some concluding remarks.

Analytical Framework

The framework for evaluating public expenditures aimed at reducing risk begins with the metric for valuing the reduction of risk to the individual, which is the familiar von Neumann-Morgenstern framework. Risk aversion is modeled in this framework by a utility of income function that rises at a decreasing rate. As a result, people will generally prefer a certain outcome to a risky one with the same expected value. A job at $20,000 per year is better than taking a 50 percent chance on getting one at $40,000 with a 50 percent chance of no income at all. How much that is worth depends on how much greater the difference in utility is between $20,000 and zero than the difference between $20,000 and $40,000. There is an amount of money that one is willing to pay to assure an income of $20,000 (minus that payment) as opposed to taking the risk. This is called the risk premium and the amount of income left over after paying the premium is called the certainty equivalent income to the risky situation.

Formally, this can be expressed as $U(W - V) = EU(W + \Sigma e_i)$ where $U(\cdot)$ is the utility function of income (strictly speaking, wealth) denoted W, and V is the maximum amount one would pay to have a certain income relative to the variable one. The expectations operator E takes the average of utility when wealth is risky, and Σe_i is the sum of all risky components of wealth, each normalized to have zero mean. This expression says that there is a value V that makes the individual indifferent between the situation with a certain income, $W - V$, and the situation in which that person faces all risks. The risky component is written as a sum of potentially many different "shocks" to income in which only their sum—their net impact on income—is of ultimate concern to the individual.

Even if we can "explain" the higher government expenditure in developed countries by showing the value of reducing risks (box 1), it does not follow that all those expenditures are justified. Public expenditures in general are justified only when market failures or distributional concerns exist, and this is true for risk-reducing public expenditures, too. After briefly sketching out the foundations of this approach to the analysis of public expenditures, we turn therefore to an examination of potential failures in risk markets, and proceed to explore the implications for public policy in some special cases.

The framework for evaluating government spending on goods and services is based on the rationale for public intervention in the economy, which in turn is derived from the fundamental theorems of wel-

BOX 1: WHY DO RICH COUNTRIES SPEND MORE ON REDUCING RISK THAN POOR COUNTRIES?

At first glance, the fact that public spending on risk reduction rises with income seems counterintuitive, because a common assumption is that people's aversion to risk declines with income, such that the risk premium (and therefore the benefits from government spending to reduce risk) would be higher in poorer countries. The countervailing effect is that the magnitude of the shocks to income is much greater in rich countries. Many of the risks that public programs mitigate are related to income. If someone earning $100,000 loses a job, the absolute value of the loss is considerably greater than if the initial income was $20,000. Can this feature explain the large variation in public spending on risk reduction across countries and over time? With constant relative risk aversion, if losses are strictly proportional to income, then so will be the premium, in which case this feature alone cannot explain the variation in public spending. If, however, the losses are more than proportional to income, the premium (as a percentage of income) rises quite dramatically with income (figure 1). If, for example, the level of income that one is left with after a typical shock to income rises with income, but only with an elasticity of 0.8, we observe that the risk premium rises from zero to nearly 18 percent of income at levels of around $6,000. That this gap of 18 percent also happens to be close to the difference in public spending on transfers between developed and developing countries suggests that such reasoning may be an explanation for the difference.

FIGURE 1. RISK PREMIUM AS A SHARE OF INCOME —
ILLUSTRATIVE PARAMETERS

Premium (in percent of income)

Risk-reducing expenditures and income
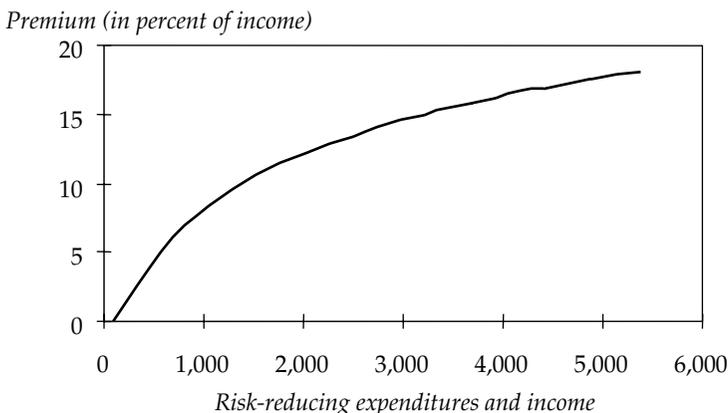
fare economics. If the conditions of the first welfare theorem were to hold, there would be no need for a government, because the unfettered market would reach a Pareto-efficient allocation. If there is a concern for equity, the second welfare theorem shows how, with a suitable redistribution of initial endowments, the desired Pareto-efficient allocation can be achieved by the private market. Hence, the rationale for public intervention must be associated with one or more of the conditions of the welfare theorems not being met. The most common ones are the existence of externalities, public goods, non-competitive markets, and various elements of imperfect information (often collectively referred to as "market failure") on the one hand, and the inability to redistribute endowments to achieve equity objectives on the other. This simple point alone can be a powerful tool in scrutinizing public expenditures. The largest item in the Indian government's agriculture budget, for example, is a fertilizer subsidy. Forty years ago, the subsidy was justified on the grounds that it was a new technology so unknown and inherently risky that individual farmers might not have an incentive to adopt it. Today, the market-failure rationale for the subsidy has all but disappeared (Pradhan and Pillai-Essex 1994).

The existence of a market failure only indicates a rationale for government intervention; it does not necessarily imply a need for public expenditure. The textbook case of an externality is the polluting factory, which emits toxic chemicals into a stream and inflicts a cost to downstream users of that stream. Although the competitive equilibrium in this case will not be Pareto optimal, the solution is typically to levy a pollution tax on the factory, rather than to initiate a public expenditure program.

Finally, for cases where there is some market failure, and where public expenditure is the most appropriate instrument, there remains the issue of how important the market failure is. Because governments have limited resources, we need to have a sense of the quantitative benefits and costs of these different expenditure programs to allocate public resources rationally. The quantitative assessment is made up of two components: (a) the difference between social and private benefits (in the price dimension), and (b) the net addition of service (in the quantity dimension). In evaluating these benefits and costs, we need to keep in mind that most cases of market failure are ones where a private market exists, but does not provide the socially optimal level of output. For example, many believe that education carries with it a positive externality, insofar as society attaches a value to having a literate

and numerate population, beyond the benefit increasing the wage the individual receives from education.[2] Yet education is a private good, so the benefit of public provision of education (assuming that provision is the best instrument), then, is only the external effect of the additional educational attainment over and above what the private sector would have achieved in the absence of public intervention. Because education and many other public services are nontraded goods, the calculation of net benefits should take into account the extent to which public provision crowds out the private sector. If the government was providing education, but the private sector could still provide more (with perfectly elastic supply), the public education would completely crowd out private education, which would make the net benefit of this public program zero (Devarajan, Squire, and Suthiwart-Narueput 1997; Hammer 1997).

Although quantitative analyses of the benefits of public expenditure programs (in the welfare-theoretical sense developed here) are hard to come by, some suggestive evidence exists. Hammer, Nabi, and Cercone (1995) evaluate the impact on infant mortality of the Malaysian government's expenditures on public medical personnel and immunization. They find that government spending on doctors at the margin has no significant effect on infant mortality, whereas spending on services such as immunization, which have clear external effects, is highly significant. Spending on public medical personnel was simply crowding out private medical personnel, which left the net effect not significantly different from zero. Similar results for health care have been found by Alderman and Lavy (1996), for income transfers by Cox and Jimenez (1995), and for secondary education by Jimenez and Lockheed (1995).

Finally, the theory of the second best is often invoked in justifying and evaluating public expenditures. If there is a distortion in the economy, government intervention, and possibly government expenditure in some other (undistorted) market, may be warranted because it can affect welfare in the distorted market. For example, if a failure in the

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2. Some claim education to be a "public good" on these grounds, but this does not accord with standard definitions. A public good is nonexcludable, meaning that you cannot charge for it even in principle, because nonpayers cannot be excluded from benefiting. A public good is also nonrivalrous, meaning that one person's use of the good does not reduce the amount available for others. Although underutilized classrooms may fall into this category, usually teachers' time and classroom seats are limited.

credit market prevents young people from obtaining student loans, public support to education may be justified. Note, however, that two conditions have to be met. First, the market in which intervention is being considered must be linked to a truly distorted market. Second, removing the original distortion must be more difficult or costly than this "second-best" approach. As to the first, the mere fact that government policies change conditions in related markets is not in itself a justification. Such effects could be in the form of a "pecuniary externality" where the impact of a policy is solely through the workings of competitive markets. There may be distributional consequences; for example, universal primary education supported by government could well raise the wages of teachers (or all people who are potential teachers), but if the supply of such factors is competitive, the existence of such effects poses no difficulties or particular issues for policy analysis. If markets are incomplete, even pecuniary externalities with competitive markets could have effects on efficiency (Greenwald and Stiglitz 1986, de Meza and Gould 1992).

Of course, when serious market failures are associated with these affected activities, the activities need to be taken into account. For example, a project, such as a road that indirectly increases steel output, would not have to take into account the changes in steel or of the coal or labor used in its production if they were all competitive markets. If, however, steel production caused pollution, the value of the reduction of pollution would be a further cost of the project that would have to be valued. This example also illustrates the second condition. Appropriate pollution control policies applied directly to the steel industry would obviate the need for the road project to worry about steel production. Only when such policies are unavailable—for example, for technical or political reasons—is this interconnectedness important (Sen 1972).

As the discussion on evaluating public expenditures makes clear, the fact that governments affect the risk profile, and hence welfare, of private agents is not sufficient justification for the existence of a public expenditure program to mitigate risk. Many markets associated with the bearing of risk, however, are characterized by market failures. In some cases, the markets may simply not exist. In others, private agents will supply a suboptimal level of risk reduction. Consequently, there is a role for government, both in attempting to correct these market failures directly, and—where that may not be feasible—in addressing risk-market failures through intervention in other markets.

Applying the Framework

Several important failures in risk and risk-related markets can be discussed with reference to the framework outlined in the previous section. The most common one in the literature is the frequent absence of insurance markets. The simple model of individual decisionmaking under risk specified above implies that there will be a demand for insurance—a willingness to pay the quantity V above and beyond the actual expected cost of assuring wealth W. A firm that can pool all risks and ensure a payment to all customers to make their income $W - V$ can collect V as profit. Competition should drive this profit down to the actual cost of providing the insurance itself, so that people will end up paying this cost, which is less than V, and gaining consumer surplus from the difference.

Many reasons explain why such a market will fail to emerge or will supply insurance in far less than optimal amounts. They fall under the general categories of adverse selection and moral hazard (Rothschild and Stiglitz 1976). Adverse selection occurs when there is asymmetric information between buyers and sellers of insurance. For example, an individual may know if he is a bad health risk, but an insurance company may not be able to detect this. Consequently, insurance companies offer health insurance reflecting the average risk of the population. At this price, however, assuming no quantity constraints, only those with a higher-than-average risk will purchase insurance. As a result, the lower-than-average risk population leaves the market, saddling the insurance company with a riskier population than they expected. If the company raises its premium, even more people leave the market, and eventually the market dries up.

Rothschild and Stiglitz (1976) show that, for a market to exist, insurance companies will have to offer price-quantity packages, thereby limiting the amount of insurance at a given price that an individual can buy. This kind of quantity rationing, however, as they show, can be Pareto inefficient.

Moral hazard is a situation where an individual, having purchased insurance, may have an incentive to undertake suboptimal levels of risk-reducing activity. For instance, purchasers of theft insurance may not lock their doors, even though society would be better off if they did. Perhaps the most graphic example is that of arson—when people burn down their own houses to collect on fire insurance.

The existence of moral hazard and adverse selection can prevent the insurance market from appearing at all. The complete absence of the

market imposes costs on people of the full amount of V, although this fact alone does not justify government intervention—let alone government expenditure—in risk markets. The first question to ask is whether, by intervening, the government can do better.

That someone, such as an insurance company, has the ability to pool or otherwise bear the risks that at least some individuals would prefer not to is a basic insight into the value that government can bring to the market. Efficient markets will result in those who either do not care as much (are less risk averse) or who have such risk-reducing options as diversification opportunities available to them actually having more risk shifted onto them from the more risk-averse, less protected consumers. In exchange for absorbing more risk, they are paid some of the risk premium, V, that the risk-averse individuals gain in the bargain. Government may be in the position to bear this risk itself better than some individuals. The government would then do the pooling. It is not clear, however, how publicly provided insurance gets around the problem of moral hazard. Mandatory, publicly provided insurance can get around the problem of adverse selection. Alternatively, the government may choose to regulate insurance markets to correct some of the existing failures. In all these cases, the main thrust of the policy would be to shift risks, and the value of doing so would be V per affected person.

Explicit insurance is not the only way that people deal with exposure to risk. In many circumstances, people have opportunities to reduce their own exposure through diversification of various sorts. The classic example forms the basis of the contemporary theory of finance. The value of any security is not simply its expected return, but is related to the degree to which it is correlated with the rest of the market and therefore serves to reduce the risk of holding portfolios. In our notation, a premium is to be paid to any one asset e_i if it can reduce the variation of the sum of all returns—the investor's net variance.

People have other means to help deal with risk. In traditional societies, the extended family provides an insurance policy of sorts. Hard times may result in intrafamily transfers with either explicit or implicit repayment arrangements; that is, they may be gifts or loans. The credit market itself may serve as an insurance mechanism if people use it to borrow or draw down savings in bad years and pay back or build up savings in good. However, as will be seen shortly, credit markets themselves are often faulty for reasons similar to insurance markets, especially for consumption loans. The degree to which they are faulty will determine the value of policies that reduce the risk that one would borrow against.

In sum, the valuation of mitigating risk needs to be in comparison to the net exposure $\sum e_i$ after diversification or other protective activities are undertaken. Savings on any real costs associated with the protection, however, would be another benefit from the program. For example, agricultural households are sometimes noted to have more livestock or other, relatively liquid, productive assets than would be justified by considerations of profitability alone. The increase in farm profits from shedding such unprofitable activities, caused by having to handle less risk or having more efficient means of handling those risks, would be a benefit of an insurance program for, say, crops or health, or even unemployment. Other costs associated with protection include delayed schooling of children (Alderman and Paxson 1992), inefficient (in terms of expected income) crop mixes (Morduch 1994), mobility-reducing insurance arrangements (Bannerjee and Newman 1993), and nepotism in labor markets (Hoff and Sen 2001).

The actual calculation of certainty equivalent incomes, or the risk premium that could be obtained from people, requires specifying an explicit functional form for utility. This introduces a highly subjective element into the calculation because this is not a directly observable function. Further, there is no reason to believe it is common across people, nor even that the degree of risk aversion on the margin is equal, unless markets are working so well as to allow the equalization of marginal risk across people. If such markets did exist, however, there would be no particular justification of government intervention at all. The most careful calculation would try to approximate the willingness to pay for a particular degree of risk reduction for different types of people and add up across types (differing by income, risk aversion, and degree of wealth at risk).

Finally, in addition to providing insurance, governments use a variety of other instruments to address problems of risk. For instance, governments may attempt to mitigate the risk of price fluctuations facing farmers by agreeing to buy farm output at a fixed price, even when the world price is varying. In what follows, therefore, we examine two forms of public expenditures associated with risk reduction: (a) public provision of insurance and (b) other public expenditures that alter the risk profile facing individuals.

Government Provision of Insurance

Government policies can affect various different components that go into the calculation of the risk premium. Sometimes governments

attempt to provide insurance directly when the market does not. Two common areas where this occurs are in health and crop insurance.

Health Insurance. Although direct provision of services is more common in the developing world, many countries have instituted explicit health insurance as a means to help people deal with the financial consequences of medical care. The issue of health insurance is a complicated one to be sure—witness the recent debates in the United States and most other Organisation for Economic Co-operation and Development (OECD) countries. Here we only want to highlight the issue of valuation of the benefits of health insurance. From the perspective of correcting market failures, the benefit that the public can obtain over and above the laissez-faire equilibrium can be substantial. As mentioned, insurance markets for medical services are likely to be seriously distorted. In the early part of this century, the insurance industry in the United States considered medical care an uninsurable service because of the severe problems of adverse selection in voluntary markets and in the potential for abuse in terms of moral hazard (Arrow 1985). In the developing world, this situation still holds with very little private insurance existing even where medical care itself is largely private (Lewis and Chollet 1997).

To a large extent, evaluations of health insurance have focused on the benefits of medical services rather than on the benefits of insurance per se. By ignoring risk-reducing aspects, many discussions of health insurance and the relative merits of services to be covered by public schemes have been seriously flawed. The benefits of publicly provided health insurance should be the willingness to pay for insurance services that are not available because of the market failure reasons stated above. As a result, the value of public coverage depends at least as much on the probability of illness and the size of the expenses avoided by the policy as on the medical benefits of the treatments covered.

For example, if there is no insurance, what happens when a person falls ill with a condition that is treatable? The person could either choose to take the treatment or decide that it is too expensive and suffer with the condition. If he chooses to take the treatment, the value of public coverage of that condition is no longer related to the medical value of the treatment because the person is treated with or without public support. The value that public policy brings to this case is purely financial and is the willingness to pay, ex ante, for insurance against that disease condition. If the standard (constant relative risk aversion) utility function is used to analyze this situation, the value of

insurance will be: $V = Y - U^{-1}(pU(Y - C) + (1 - p)U(Y))$ where Y is income, p is the probability of illness, and C is the cost of the treatment. Note that health effects of the treatment do not appear in the valuation. This value must be higher than the administrative cost associated with processing the insurance. Otherwise there is no gain to be had from insuring the service at all, and it would be better to have people pay out of pocket when they need it.

If the person would *not* purchase the treatment out of pocket because it was too expensive, we might still ask if the person would have purchased actuarially fair insurance for the treatment if it had been available. The answer to this question is no longer independent of the health benefits that the treatment provides. A person would be indifferent between buying insurance and not buying it if the following equality holds:

$$pU(H_1, Y - pC) + (1 - p)U(H_0, Y - pC) = pU(H_2, Y) + (1 - p)U(H_0, Y) \quad (1)$$

where H_0 is health status when not sick at all, H_1 is health status after treatment when sick, and H_2 is health status when sick and left untreated. The left-hand side is expected utility if a person is insured and getting treatment that improves his or her health status from H_2 to H_1, and the right-hand side is the expected utility of refusing to insure and taking the risk of suffering with health status H_2 if the person gets ill. All this is contingent on $U(H_1, Y - C) < U(H_2, Y)$ because we have assumed that this treatment would not have been purchased out of pocket. The value of providing insurance in this case is the difference between the left- and right-hand sides of the above inequality.

Figure 2 shows the above relations graphed in the space of cost of treatment and health benefits of treatment. For the case of treatments that would be purchased out of pocket, curve OA is drawn with a health status of H_1 when illness occurs because it is assumed that treatment will be taken. The line segment *DE* is the combination of H_1 and C that solves equation (1). The vertical line at $C = B$ is the level of treatment costs such that the administrative costs of insurance exceed the value of the insurance itself. The figure is thus divided (by solid lines) into four areas. In area I, treatment would be paid for out of pocket, but people would prefer to insure against it. In area II, people would pay for treatment out of pocket, but would not bother to buy insurance because such treatments are too cheap to cover the administrative costs of insurance (aspirin for headaches is a good example).[3] In area III, people would neither buy the treatment out of

FIGURE 2. THE DEMAND FOR MEDICAL CARE AND INSURANCE

Health benefits

Cost of treatment
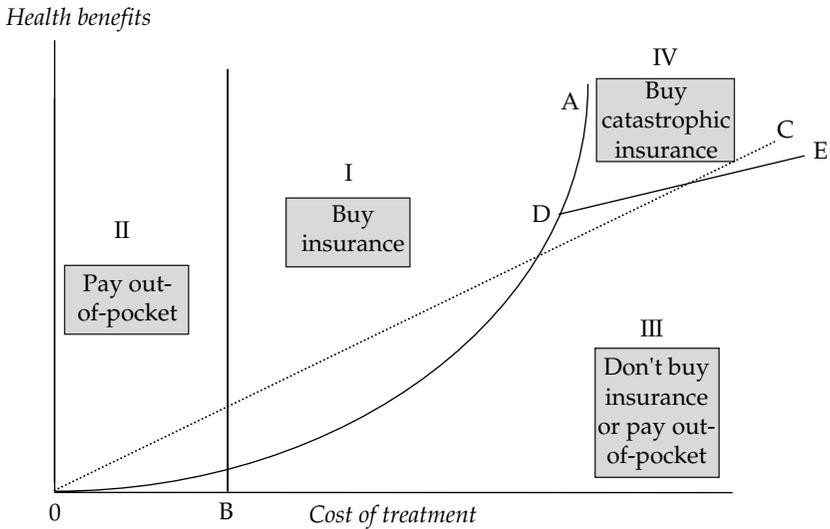
pocket nor demand actuarially fair insurance for it. In area IV, people would not buy the treatment out of pocket, but would pay for insurance for it. This represents a catastrophic loss for direct purchase, but is rare enough to have a sufficiently low expected cost to be worth the insurance value.

For comparison, the ray OC has been superimposed on the graph. These points share a common "cost-effectiveness ratio," or a constant health benefit per dollar spent on a medical treatment. This has been proposed as a criterion for public intervention in health care (Jamison and others 1993) and as a criterion for inclusion in an insurance package, public or private (Gold and others 1996). As illustrated here, treatments sharing a common cost-effectiveness ratio fall into all four areas. Thus, cost-effectiveness ratios provide no information whatsoever concerning the value of provision when insurance markets are absent—the market failure that justifies public coverage of the private benefits of health care.[4] Further, within areas I and IV, where insurance

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3. The actuarially fair costs of insurance should, strictly speaking, have included the administrative costs, A, and be equal to $Y - pC - A$.

4. The external benefits would be evaluated separately.

would be demanded if available, the loss imposed by the absence of insurance *rises* with the cost of treatment. The cost effectiveness ratio, on the other hand, worsens with higher costs and thus moves in the opposite direction from the true valuation of public provision.

Crop Insurance. Crop insurance is another area in which governments have sometimes provided a direct insurance instrument that private insurers would not. The reasons why such insurance policies would not be written by the private sector are again the potentially large problems of adverse selection and moral hazard. Moral hazard is a particular problem because there are many actions that a farmer could take that are not easily (that is, without very high cost) observable to the insurer, and that determine crop output along with truly random events, such as rainfall and other farm-specific risks. Effort and pur-chased inputs are two examples. A cotton insurance program in India ran into difficulty in part because some farmers would stop applying inputs (late in the production cycle) when it appeared that output would not be much higher than insured-for levels. Detailed character-istics that determine land quality would lead to adverse selection by those who know their land to be poor. There might also be an interac-tion of the two problems if those who knew themselves to be the type who would exploit the moral hazard problem would also dispropor-tionately sign up for the program.

   For all the reasons that private markets would not support crop insurance markets, the public sector has had a similarly bleak history of providing the service. Hazell, Pomereda, and Valdes (1986) cite numerous problems that have plagued public crop insurance pro-grams. Often, a goal of such programs is to be financially sustainable. The reasoning is that the service provided is genuinely valuable and can be covered with cesses on agricultural output. That these pro-grams typically cannot be sustained without continual subsidies illus-trates a problem that should be balanced with the identification of a market failure in the private sector. In many cases of seeming failure in risk and information-related markets, there may be no advantage that governments can bring to the problem to improve matters. Although the maximum potential of providing insurance can be calculated from the reduction of risks that people might like to avoid, it is not always the case that governments can improve upon the allocation of the market. If there is nothing that the government could know that a pri-vate insurer could not, the free market allocation may be "constrained Pareto-optimal."

That a market is constrained-Pareto-optimal means that the government cannot do any better than the private sector by intervention in the market with the information failure. As a result of the theory of the second best, however, it is still possible that there are other instruments directed at complementary or substitute markets that can improve welfare, a topic to which we now turn (Greenwald and Stiglitz 1986).

Other Public Expenditures

Other than providing insurance directly, governments intervene in less direct ways. Some policies are intended to reduce risk by changing particular elements of a risky component of income. In this section, we examine the impact of price stabilization schemes, transfer programs, government guarantees, and public expenditures on investments and consumption.

Price Stabilization. One common form of this is through commodity price stabilization schemes (Newbery and Stiglitz 1981). Countries often try to protect producers or consumers from wide fluctuations in the prices of basic commodities. Although they are often simply a transfer program in disguise, these stabilization schemes are publicly advocated as a way of reducing risk. The value of the stabilization plan to a producer depends on how the price variations translate into income. In turn, this will depend on the degree of diversification of farm production (monocultural areas being at greatest exposure to price risk) or of farm family income (farm families often have members in nonagricultural activities, sometimes as migrants to cities, as a hedge against low farm incomes), access to credit, and the nature of the market for farm output. As to the last consideration, if the commodity whose price is being stabilized is not traded internationally, as may be the case for basic staples, prices would ordinarily rise in times of low production and fall in times of good production. For a wide range of demand elasticities, this market mechanism provides substantial smoothing of farm revenues. Indeed, it is possible (Newbery and Stiglitz 1981) for stabilization of prices to destabilize incomes by removing the negative correlation of price and sales. To the extent that price stabilization leads to income stabilization, the value of the scheme can be approximated by the formula: $V = -\alpha \times \Delta\sigma^2/2$ where α is the coefficient of relative risk aversion and $\Delta\sigma^2$ is the change in the variance of income.

Transfer Programs. Another type of government policy that has significant implications for risk reductions is transfer programs for income support. Usually they are introduced for reasons completely different from risk reduction per se with the exception of unemployment insurance. Unemployment insurance is one area where it is clear that private markets are likely to be limited because of the extreme problem of moral hazard and adverse selection inherent in a voluntary program. There are many reasons for an individual to know his or her own probability of getting fired better than an insurance company would. Indeed, when combined with the moral hazard problem—people may choose to be unemployed if insured at high rates—people are certain to know more about their own inclinations to abuse the policy in this way than would the company. So, except for unusual, job-specific assets that might be covered by a specialty insurance contract (such as Lloyds of London's insuring a pianist against broken fingers), unemployment is not a good candidate for private insurance. Its benefit, though, may be estimated by combining the concerns for risk using the method above with models of incentive effects of labor supply.

Again it is important to evaluate the benefits of programs relative to private adjustments to the problem. Although private markets for unemployment insurance are likely to have serious problems, many arrangements in labor markets are clearly motivated by concerns over risk-sharing. Lifetime employment guarantees (explicit or implicit), as well as different quantity and wage adjustments as appear in macroeconomic models, are examples. The calculation of benefits is unlikely to be particularly persuasive in advocating (or contesting) the introduction of unemployment insurance because this is particularly a politically charged area. In the design of different elements of the program, however, length of time covered, job search requirements, and so forth may have quite different risk-reduction characteristics and may be evaluated one against the other differently.

Other transfer programs have risk-reducing characteristics even if that is not their main justification. In the framework above, safety net provisions, progressive income taxes, and other redistributive policies can induce a negative correlation of government transfers with random shocks to income. We might think of the policy as one that makes the net-of-tax-and-transfer income a function of the random shocks that make up income as in $W(\Sigma e_i)$ where $W' < 0$. The transfer program will have its main benefit in the promotion of equity and its main costs associated with incentive effects for work. However, there could be a

further benefit on efficiency grounds because of the risk-reducing nature of the policy. As an example: a linear income tax system (with a lump sum transfer component) would make after-tax income a linear function of pretax income with slope $b = (1 - t) < 1$, where t is the tax rate. The variance of income for any one individual is reduced to b^2 times the original variance. From the above formula, the value of this reduction in variance is $\alpha \times (1 - b^2)\sigma^2/2$. Depending on the distributions of risk aversion and the risky element of income across people, σ, this can be a substantial sum. For a tax rate of 30 percent, a typical level of α of 2 and the risky component of income having a variance of 10 percent of income, this comes to about 5 percent of income as a welfare gain. As this example shows, even nonprogressive (linear) income taxes can have this welfare-increasing property. The main distinction is between lump sum taxes and taxes, such as agricultural output taxes, that vary with income (Hoff 1991).

Public Investment. Governments often justify public investment—even in private goods, such as steel plants or textile factories—on the grounds that the returns on these investments are risky and governments are better able to take such risks. We now evaluate this argument in light of the framework developed above.

The notion that governments are better able to take risks stems from the proposition of Arrow and Lind (1970). They argued that, because the government is able to spread the risk of a public project across a large number of individuals (namely, taxpayers), the amount each individual bears is minuscule. The government then should behave as if it were risk-neutral, even if the individuals in society were risk-averse. The corollary is that the government should undertake risky projects (with a positive expected value) that private firms, being risk-averse, would not.

For several reasons, the Arrow-Lind theorem may not apply to developing countries. First, the risks associated with some public projects may not be easily spread across the population. Large irrigation projects, such as the Aswan Dam in Egypt or the Mahaweli Scheme in Sri Lanka, could have an impact on the fortunes of the whole country. To the extent that public projects are producing public goods, a case can be made that *by definition* the returns on the project are not independent of other risks faced by individuals. If the project's output is nonexcludable and nonrival, then the risks associated with the project are also nonexcludable and nonrival. When a dam bursts, the costs cannot be easily proportioned across the affected population (Fisher 1973).

Second, although governments in richer countries with wide tax bases are in a position to diversify their risk, smaller countries with narrower tax bases may not be. Meanwhile, the private sector may be represented by a multinational corporation with access to many more risk-diversifying instruments. This is especially true if the investment is in a private good, where the justification for government involvement is weak to begin with.

Third, the risk associated with a project may not be some exogenous factor, such as an earthquake or flood, but political risk. Especially for large infrastructure projects with high up-front investment costs, the major risk facing a private investor is that the government may nationalize the enterprise, or impose foreign exchange restrictions on multinationals' expatriating their profits. In this case, the most appropriate response of government would be to provide a guarantee against these events (because it is the government that controls them). Of course, a government's unilateral provision of a guarantee may not be credible, so a neutral third party, such as the World Bank, could provide the guarantee and monitor it. The increasingly widespread use of these guarantee instruments in developing countries is testimony to the importance of political risk in infrastructure investment decisions. This is an example of governments' addressing the appropriate market failure, namely, that of political risk insurance. Technological progress has turned many kinds of infrastructure into private goods, so there is no longer a compelling case for public provision of intercity roads, power, and telecommunication. Yet there remains the problem of political risk, which hinders private investment in this sector. The solution is not for governments to undertake the infrastructure investment, but to address the risk market failure by entering into contracts with guarantees against political risk.

Public Consumption. As mentioned above, in poor countries, public health insurance schemes are less common than direct public provision of health care. The reasons for this pattern are complex. They are likely to include the relative monitoring and regulation requirements of an arm's length insurance program versus management of services. In any case, whether insurance is publicly provided, the fear of catastrophic loss is a fact of life everywhere, and the ability to pay out of pocket for expensive medical treatment may be quite limited even when actuarially fair insurance would be affordable.

Much of the health care budgets of developing countries are devoted to hospital care. This has generally been criticized by donor

countries as being "inefficient" and inequitable in comparison to providing lower-level primary health care. However, given that people may be willing (and therefore able) to pay for relatively cheap services, but unable to pay for the catastrophic financial burden of hospital services, there is likely to be an efficiency argument for subsidy to expensive medical care. Here, the benefit of public expenditure in health should take into account the improvement in welfare from risk reduction, as well as any direct benefit of the services. This will be important for the higher-end services.

This observation does set up a potential conflict between efficiency and equity objectives. It is true, as the donor community points out, that hospital services tend to be disproportionately used by higher-income people and that the political power of urban elites has distorted investment priorities toward hospital services as a result. Although some reconciliation of the two goals is possible (such as fees for outpatient service for everyone and strict controls on referrals for inpatient services, which would limit free access to those with medical need rather than social influence), a residual conflict will still exist between the subsidy for high-end services and using health expenditures for redistribution goals.

As an application of this approach, we consider a recent project in Indonesia (see figure 3). Among other things, the project provides emergency referral and transportation for pregnant women with complications during delivery. The cost of such services is quite high, but the probability of surviving the delivery is greatly enhanced.

Because several of the variables in the calculation are either subjective or difficult to determine, a sensitivity analysis was performed on the calculation of risk premiums with regard to probability of need, risk aversion, and cost of the service. A complete evaluation would depend on the joint distribution of these parameters, and would require the summation of each family's willingness to pay to get at the overall insurance value. Nevertheless, the calculation for a single household with typical parameter values is revealing. It shows that for services that could potentially cost a substantial fraction of the family's wealth, the value of risk reduction per se can be in the neighborhood of 40 percent of the expected cost of the service. Evaluations that neglect this effect can, therefore, be far off.

Government Guarantees. As mentioned above, credit markets are often operating suboptimally because of information problems, which leaves open the possibility of government improvement. One kind of invest-

FIGURE 3. WILLINGNESS TO PAY FOR RISK REDUCTION:
WOMEN'S HEALTH IN INDONESIA
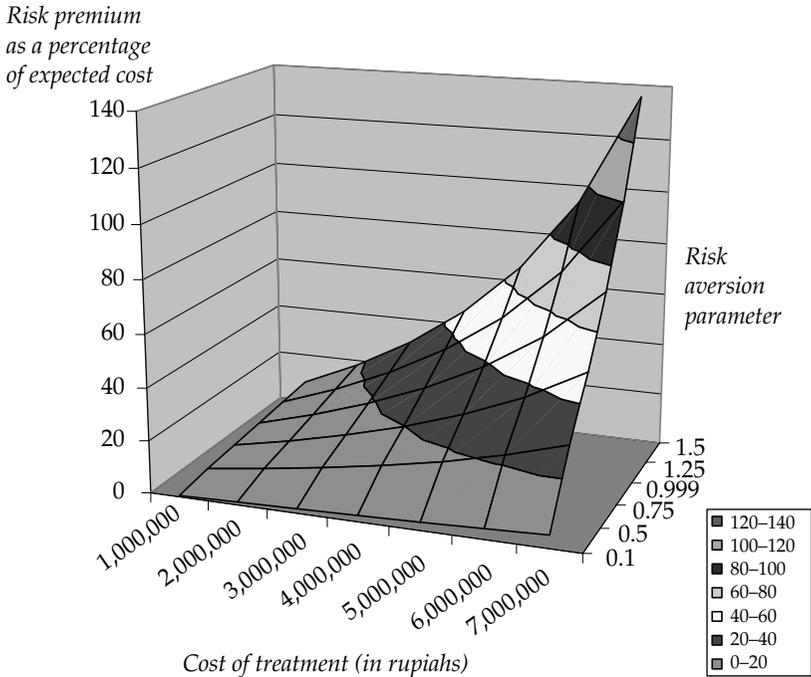
ment that is particularly prone to such problems is in human capital, or "education" to the layman. Two features of the market for loans to finance education make it particularly subject to distortion from uncertainty. First, as in consumption loans to smooth fluctuations in earnings, loans for education are generally unsecured. In the absence of slavery, lenders usually have no feasible way to impose collateral requirements—people are particularly mobile. This makes the market for loans for education (especially higher education because it is more expensive both in fees and in financing consumption over the period) especially risky from the lender's perspective, thus reducing loans for that purpose. On the borrower's side, there is another consideration. For the same reason—that you cannot put yourself up as collateral— you also cannot sell shares in yourself. As a result, the decision to enter a particular, specialized field represents a decision to "plunge" into a market. Diversifying your human capital investments is not possible as it is for financial investments. This can have two possible consequences.

First, it may simply result in people's bearing considerably more risk than they would prefer, which would lead to a direct loss in welfare. Second, to the extent that this effect is stronger in some fields—those with strong specialization and those that are subject to large swings in net demand (engineering, perhaps, because it is often mentioned as a "cobweb" market)—this may lead to people shying away from these subjects toward more generalist professions (law, perhaps). In developed countries, especially, a large part of the assets that people hold are in the form of education, skills, and experience.[5]

Policy implications for these market failures are not always easy to define. The absence of a functioning credit market holds open the possibility of student loan programs as a means of substituting for the market. It does not argue particularly well for a tuition subsidy as is common for developing countries, though it may provide a third or fourth best solution. Even a loan program, however, does not solve the diversification problem. For this, there may be some benefit in a risk-sharing arrangement with government—perhaps a surcharge on income taxes for those who attend university in lieu of standard repayment schedules.

Concluding Remarks

In this paper, we have argued that there is a case for incorporating the value of risk reduction when evaluating government expenditure, provided that the expenditure meets the standard welfare-economics criteria for government intervention in the economy. Using a series of examples, we showed areas where government spending on risk reduction could improve welfare, either by alleviating a risk market failure, or by reducing uncertainty in otherwise distorted markets. We also gave a few illustrative calculations of the risk reduction benefits of public expenditures and pointed to cases where their neglect could lead to serious underestimation.

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5. Interestingly, another large part is in the form of real estate, a house being one's largest asset. This, too, is difficult if not impossible to diversify and is subject to very variable returns which depend on regional markets. To the extent that returns to skills are also associated with a dominant regional market, these two large parts of a portfolio are covariate; witness the fate of steel or automobile workers in the "rust belt" of the United States who lost both jobs and equity in their homes as industry declined. See also Shiller (1993).

Lest our points be interpreted as a blanket call for increased government spending in these areas, we mention two important caveats. First, the design of optimal policies to correct information-based distortions has to be approached with care—it may stretch the institutional capabilities of the government. For instance, the sophisticated bidding scheme at the U.S. Federal Communications Commission, designed by some eminent game theorists to maximize welfare, was still seen to be prone to collusion among bidders. Similarly, our off-the-cuff proposal to tax university graduates still has the effect of subsidizing the consumption value of education—for which there is no particular public interest.

The second problem raises a deep, fundamental issue of incentives. Although there is demand for reducing exposed risk, especially for the poor, getting rid of *all* risk leads to no reason to do anything at all; this is the essence of the moral hazard problem in the first place. Hence, when taken to the limit, a fundamental tradeoff may exist between avoiding risk and fostering economic efficiency.

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