

Global Change, Natural Disasters and Loss-sharing: Issues of Efficiency and Equity

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Global change in the form of climate warming, demographic developments, land use and capital movements to vulnerable regions will likely contribute to the already increasing human and economic losses from natural disasters. As countries in both the developing and developed world contemplate increasing losses from natural disasters, and as the victims relate these losses to human culpability, questions of burden-sharing for preventing and absorbing human and financial losses are becoming increasingly topical. This paper provides an overview of two forms of state and market burden-sharing at the local and global levels: collective loss-sharing after a major disaster by the state or the international community and the pre-disaster transfer of risk through insurance and other hedging instruments. With the recent attention given to the role of the private sector for apportioning and preventing disaster losses, we examine the efficiency and equity arguments for both collective loss-sharing and private risk transfer. We give special attention to the potential for governments of poor countries to transfer their natural disaster risks to the insurance and reinsurance markets, and to the international capital markets with newly developing hedging instruments, such as catastrophe bonds. We suggest that, under certain conditions, subsidized risk transfer can be an efficient and equitable way for industrialized countries to assume partial responsibility for the increasing disaster losses in poor countries, in addition to their role in aiding the economies of these countries.

1. Introduction

The human suffering and economic losses from natural disasters are high and increasing. According to figures published by Munich Re (1998) in the decade 1988–1997, major natural catastrophes cost the world's economies around US\$ 700 billion. Although figures on natural disaster losses must be treated with caution given the lack of reliable reporting, a trend towards higher losses appears certain. Munich Re (1999) estimates that in this decade the number of natural catastrophes has been five times as great, and eight times as costly, as in the 1960s. These losses seriously affect both the developing and developed world. Yet, according to the World Bank, the per capita cost of natural disasters *in relation to GDP* is at least 20 times higher in the developing than in the developed world (as reported in Freeman, 1999). Moreover, up to 95 per cent of recent disaster deaths have occurred in poor countries (Mitchell and Ericksen, 1997).

Despite the cautious interpretation by the Intergovernmental Panel on Climate Change, many scientists suggest that increasing extremes of weather are a likely consequence of global warming, although it is not possible to predict their magnitude and timing (MacDonald, 1998;

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Changnon *et al.*, 1997). Another phenomenon of global change, however, appears to be more directly and seriously implicated in increasing disaster losses. Changing patterns of land use, especially deforestation, and the increasing concentration of people and capital in vulnerable areas (for example, in the coastal regions exposed to windstorms, in the fertile river basins exposed to floods, and in urban areas exposed to earthquakes) are primary contributors to increasing disaster losses.

As the public in both the developing and developed world contemplate the potential of huge future losses from natural disasters, and as the victims relate these losses to human culpability, questions of accountability and liability for preventing and absorbing the financial losses are becoming pre-eminent. Paradoxically, the citizens of many countries view their governments as implicated in private losses from natural disasters at a time when their public officials are attempting to place more responsibility on those directly at risk. At the global level, developing countries in the “South” are increasingly holding the “North” accountable for their weather-related disaster losses as a result of the North’s historical emissions of greenhouse gases.

These three levels of social responsibility – the global, the state (or community) and the individual – are importantly linked. In most countries and to varying degrees, the state takes on responsibility for post-disaster emergency relief and compensating the victims of catastrophic events, as well as for pre-disaster measures for mitigating losses from these events. We refer to this route for redistributing the burdens as *collective loss-sharing* at the state level. Similarly, there is collective burden-sharing at the global level. International disaster aid, either direct or in the form of subsidized loans, transfers losses out of the country to the international community, and economic aid before a disaster can be targeted to mitigation measures. In addition to voluntary international aid, some developing countries are calling for a fund on the part of the developed world as a way of institutionalizing liability and collective loss-sharing at the global level. Moreover, losses are shared domestically and internationally through financial lending institutions since natural disasters cause defaults on residential and commercial loans and diversions from government budgets. During the past decade, for example, up to 35 per cent of the World Bank’s lending for infrastructure projects in Mexico has been diverted to finance disaster relief (Freeman, 1999).

Collective loss-sharing is a way of redistributing the burdens of natural disasters after a disaster has occurred. To pay for relief and reconstruction, governments generally make use of *financing instruments* by setting aside funds prior to a disaster or tapping their own funding sources – borrowing, taxes or budget diversions – after the event occurs. Since estimates show that natural disaster losses are a relatively small fraction of the GDP of the nations affected as a whole (Swiss Re, 1997b), large, developed countries should have little problem in absorbing the losses of needy victims and repairing infrastructure damage. This is not the case, however, for governments of developing countries, which may face severe difficulties in financing the losses of large disasters, as well as in financing pre-disaster mitigation measures.

The market also plays an important role in distributing and preventing losses. Insurance, reinsurance and capital market-based securities, such as catastrophe bonds, transfer losses from the immediate victims to a wide and increasingly global web of premium payers and investors. This type of loss-sharing, which we refer to as *risk transfer*, is a way of sharing risks *ex ante*, or before a disaster occurs. Risk transfer on the part of individuals or governments requires the use of *hedging instruments*, which are pre-disaster arrangements in which the purchaser incurs a relatively small cost in return for the right to receive a much larger amount of money after a disaster occurs. The important distinction between risk transfer and collective loss-sharing is that the former is purchased by the persons or community at risk,

whereas the latter is provided by the state and thus (usually) funded by current and future taxpayers. Risk-transfer instruments, however, can also serve as important redistributive instruments if the premiums for insurance or the interest for capital market securities are subsidized by those outside the victim community.

The many different possibilities and combinations of loss-sharing and risk-transfer instruments offer opportunities for defining or redefining rights and responsibilities, and thus enabling the sharing of the burdens of natural disasters across citizens of a country and worldwide. The use of these instruments for sharing burdens, however, raises difficult issues of efficiency and equity. It is well known that collective loss-sharing lowers incentives for households and businesses to invest in loss-reducing activities or to locate out of harm's way. Similarly, international disaster aid may lower incentives for state governments to invest in loss-mitigation measures. As a recent case in point, experts are attributing the large death toll in Turkey's earthquake to a failure on the part of the public authorities to implement the building code in the affected communities. According to the U.N. Secretariat for the International Decade of Natural Disasters, worldwide, only one dollar is spent on prevention for every \$100 spent on rescue efforts (Geitner, 1999). This raises difficult issues of efficiency and social equity in the management of catastrophic risks.

We begin our discussion with an overview of collective loss-sharing and risk transfer for spreading the burdens of disasters on the global level. From available statistics, we tentatively conclude that the victims and their governments bear the major share of the losses from natural disasters, that is, there is little global sharing of natural disaster losses. With the recent attention given to increasing the role of the private sector for apportioning losses, in section 4 we examine the efficiency and equity arguments for both collective loss-sharing and private risk transfer. In section 5, we discuss the potential of sovereign risk transfer, specifically the possibilities for governments of poor countries to transfer their natural disaster risks to the insurance and reinsurance markets, and also to the international capital markets with newly developing hedging instruments, such as catastrophe bonds. A novel idea discussed in this paper is that the wealthy countries provide aid to poorer governments in purchasing risk-transfer instruments, and that they link this aid to preventive measures. We suggest that, under certain conditions, subsidized risk transfer might be an efficient and fair way for the industrialized countries to assume partial responsibility for the increasing disaster losses in the poor countries.

2. An overview of global loss-sharing and risk transfer

Most reported disaster losses can be attributed to floods, windstorms and earthquakes, which appear to be approximately evenly divided with respect to their global economic losses (Munich Re, 1998). Yet the global pattern of these financial losses is uneven. As shown in Table 1, the overwhelmingly largest proportion of disasters and disaster victims reported by Swiss Re from 1995 to 1998 occurred in Asia, followed by North America, Europe and Africa. Excluding Japan, the Asian losses are largely from flood damages (Munich Re, 1998). Windstorm damage, alternatively, appears to disproportionately affect the developed world, and earthquake damage during the past few decades appears to be more evenly split between the developed and the developing countries (Freeman, 1999). Droughts, which impose the largest human suffering on the very poor countries of Asia and Africa, are generally underreported (International Federation of Red Cross and Red Crescent Societies, 1998).

Table 1:
Catastrophes and insured losses 1995–1998

Region	Number of catastrophes	Insured losses in US million	Per cent insured losses
Europe	173	8,926	17
North America (U.S.)	330 (170)	33,220 (29664)	65 (58)
Asia (Japan)	643 (20)	6,470 (2,975)	13 (6)
Africa	139	370	1
Others (inc. space)	37	2,172	4
World total	1,322	51,158	100%

The numbers represent aggregate Swiss Re data over the years 1995–1998 (Swiss Re, *Sigma* No. 2/1996, No. 3/1997, No. 3/1998 and No. 1/1999).

Risk transfer via private insurance

Private insurance is an important market institution for transferring the risks of large losses to a third party. Of course, privately financed insurance is not a redistributive instrument in the sense that expected losses are transferred away from the community at risk. Rather, the temporal and spatial distribution of these losses are altered such that the geographically dispersed premium-holders choose to incur small losses over the long term in order to avoid the risk of a large loss. As primary and reinsurance markets become more international – attracting capital from investors throughout the world – insurance becomes an institution for transferring disaster risks over the globe.

Not surprisingly, private insurance cover is unevenly distributed. Referring to Table 1, Asia has the highest percent of the disasters (and victims), but only around 13 per cent of worldwide insured catastrophic losses. In contrast, North America has only about half the number of disasters and 65 per cent of worldwide insured losses, and Europe lies in between. According to Swiss Re (1998), industrialized countries, which have only 20 per cent of the world's population, account for 90 per cent of the worldwide premium volume from all types of insurance.

Given the costs of insurance and lack of an insurance infrastructure, it is not surprising that individuals and businesses in poor and emerging-economy countries carry less insurance for catastrophic risk in relation to their losses than rich countries. Taking account of the income of the developing countries, however, the picture is somewhat surprising. The insured losses in relation to per capita GDP of the developing countries are actually higher than in the industrialized world (Swiss Re, 1997b). Given income constraints on purchasing insurance, it appears that the developed world has a relatively strong preference for insuring its catastrophic risks. However, the high level of catastrophic cover in relation to income may be accounted for by the insurance purchases of international firms operating in these countries.

Although considerably higher than in the developing world, the extent of insured losses in the industrialized countries is also quite low, particularly for earthquakes and floods, for which cover usually ranges from 5 to 20 per cent. Alternatively, storm damage is considerably

better insured, usually in the range of 60–95 per cent (Swiss Re, 1997b). U.S. corporations carry little insurance on large losses, especially for losses of between \$10 million and \$500 million, and insurance is virtually non-existent above \$500million (Froot and O'Connell, 1997).

In examining the global incidence of natural disaster losses, the question arises as to who ultimately pays the *insured* losses. In principle, and in the absence of government involvement, the premium-payers bear the costs of insured risks in the long run. To the extent that insurers and reinsurers diversify their risks geographically, the risks are spread across the international community of premium-payers. However, a unique feature of catastrophic risk insurance is that risk-sharing is not possible only through shared premiums among those at risk. The problem is the timing, since a rare catastrophic event can occur before enough premium income has accumulated to cover the claims. To be viable, the private insurance market must match a smooth flow of annual premiums to non-smooth, stochastic annual loss payments (Jaffe and Russell, 1997). Therefore, insurance companies rely on both reinsurance and capital reserves to meet very large, dependent claims.

A great deal of recent attention has been given to the question whether the capital reserves of insurance and reinsurance companies are sufficient to cover large losses. In the U.S., the insurance industry has calculated scenarios for natural catastrophes ranging from US\$21 to 101 billion of insured losses. With insurance reserves of over US\$250 billion and access to reinsurance markets, it appears that the U.S. insurance industry can cover even the large mega-catastrophes. However, the uneven spread of these reserves may render the insurance industry vulnerable to large defaults and insolvencies in the case of a mega-disaster (Cummins and Doherty, 1997). Moreover, studies by both Froot (1997) and Swiss Re (1997b) show that the overwhelming proportion of large events in the U.S. and worldwide is not covered by reinsurance.¹ In the case of bankruptcies, the losses could be passed on to present and future policy-holders (through “pay back” arrangements), other insurance companies and their premium-payers and, in some cases, the government and taxpayers.

To overcome the finite nature of insurance capital, recent attention has been given to novel risk-transfer or hedging instruments, including catastrophe bonds (Smith *et al.*, 1997). A catastrophe bond is an instrument offered by the insurer or industry at risk, whereby the investor receives an above-market return when catastrophes do not occur, but shares the insurer's losses by sacrificing interest or principal when catastrophes do occur. With these bonds or other capital market instruments, insurers can pay to transfer catastrophe risk to investors and, therefore, directly to the global capital markets.

To date, there have been only 16 offerings of such bonds and only by the private sector, amounting to about US\$2 billion (Swiss Re, 1999). While experience is new, the potential of this risk transfer mechanism is enormous. The size of the U.S. capital market alone is in the order of US\$ 26 trillion, which could easily absorb the average annual global losses from natural disasters of around US\$70 billion.

Collective loss-sharing and risk transfer via governments

National and local governments are heavily involved in insuring, redistributing and absorbing the costs of catastrophic events (Challis, 1997). Governments can act, either

¹ In 1997, CatXL of US\$52.9 billion were purchased, the biggest shares bought by U.S. insurers (35%), the UK (11%) and Japan (9%).

separately or in combination, as primary insurers, as reinsurers, e.g. by running a state pool for insurers, or as a reinsurer of last resort. These are different forms of government-facilitated risk transfer. If the government subsidizes premiums, then it combines its insurance capacity with a distributive one. Governments also redistribute risks – or facilitate collective loss-sharing – by providing emergency aid and post-disaster relief, which generally draws on taxpayers. Finally, governments directly absorb losses to public infrastructure resulting from natural disasters.

Government as insurer

A well-known example of a government acting as a primary insurer is the U.S. National Flood Insurance Program (NFIP), which seeks to provide insurance at actuarially fair premiums combined with incentives on communities and homeowners to take appropriate loss-reducing measures (Pasterick, 1998). Given the size of the U.S. and the large number of persons living in flood plains, the program is sufficiently diversified to cover most regional losses with premium payments. In contrast to the NFIP, many government insurance schemes operating in Europe, for instance the French national insurance programme, cross-subsidize claims (Gilber and Gouy, 1998).

The government could also administer a mutual insurance programme, such as that existing in Europe to cover the risks of nuclear power plants. The great advantage of this type of scheme is that insurance can be offered without actuarial estimates of the risks (Skogh, 1999). Skogh (1998, 1999) suggests that the difficulty in assigning probabilities to unforeseen or unpredictable events is one explanation of why the state covers risks collectively.

Government as aid provider

The government can also act simply in a distributive capacity independent of private or public insurance by transferring disaster losses from the victims to the tax-paying public. This collective loss-sharing mechanism is substantial throughout the world. In the U.S., during the 1977–1993 period, the average annual expenditure by the federal government for disaster assistance was more than \$7 billion in 1993 dollars. This is significantly greater than the average annual loss borne by reinsurers on U.S. catastrophe coverage (Froot, 1997). In Europe, there is a more established tradition of collective loss-sharing or solidarity for natural disaster losses. In Poland, for example, the central government responded to the 1997 flood with more than a half billion U.S. dollars in flood relief covering about 16 per cent of the estimated, direct losses. This aid was financed with a loan from the Polish National Bank and from diverting funds from other items on the national budget. Counting in the international loans, more than a third of the direct losses were absorbed by the Polish Government, and therefore by present and future taxpayers (Kunreuther and Linnerooth-Bayer, 1999).

In addition to rescue operations and victim compensation, governments can also finance pre-disaster mitigation measures. Mitigation measures can be either public, for example, building flood barriers, or private, for example, flood-proofing homes.

Government as victim

Another way that governments and their taxpayers absorb losses from natural disasters is by paying the bill for public infrastructure damage. These bills can be significant. For example, in 1997, Poland suffered public infrastructure damage amounting to 41 per cent of the reported direct flood losses, and in eastern Germany the infrastructure damage (mainly

dikes) amounted to 85 per cent of the total. Alternatively, in the less densely populated area damaged by the 1993 U.S. mid-West flood, public infrastructure damage was only 6 per cent of the total (Interagency Floodplain Management Review Committee, 1994).

Throughout the world, public infrastructure is seldom insured, and generally the costs of repairing infrastructure are absorbed by the taxpayers. This is not a financial problem (although it may raise issues of equity) in large countries, such as the U.S., where the federal government absorbs up to 90 per cent of state and local government infrastructure losses from major disasters, thus spreading these losses across the entire U.S. population. However, in small countries, governments may have difficulties raising the funds to repair infrastructure and pay other disaster-response bills. In Poland, the infrastructure losses from the 1997 floods amounted to over 2 per cent of Poland's GDP (Kunreuther and Linnerooth-Bayer, 1999), and it was estimated that due to lack of funds it would be several years before all the roads and bridges were repaired (Swiss Re, 1997c).

The idea that governments, in addition to private insurers, might benefit from transferring their risks has recently been proposed by Freeman (1999). Governments can hedge their risk of incurring large capital expenditures for post-disaster response and rehabilitation by purchasing traditional insurance and also by transferring their risks directly to the capital market through catastrophe bonds or derivative transactions. To date, catastrophe bonds have only been marketed by the private sector, although the California Earthquake Authority proposed, but never implemented, a large catastrophe bond (US\$ 1.5 billion) to cover state expenses in the aftermath of a major earthquake. Since the triggers for these bonds need not be losses, but can be a physical phenomenon such as flood waters reaching a certain stage, they can improve the insurability of disaster losses

Freeman (1999), among others, has pointed out other advantages of sovereign risk transfer for large and infrequent losses to public infrastructure. He compares governments with private companies. For managers of firms or primary insurance companies, a major motivation to purchase insurance or reinsurance (or to issue catastrophe bonds) is to decrease the variance of their cash flows and thus decrease their risk of insolvency. Insurance raises the firm's value by raising expectations about future cash flows, leading, for example, to increased customer and investor confidence (Doherty, 1997). Governments also carry a large and highly dependent portfolio of infrastructure assets, and for the same reason as firms, they may wish to reduce the variance of these losses by diversifying with insurance and other risk-transfer instruments (Freeman and Pflug, 1999). Especially for unstable economies, insurance can increase investor confidence in the country, as well as improve credit relations with lending organizations. Institutions like the World Bank are concerned about the large budget diversions that occur after a natural catastrophe and that jeopardize repayment of their loans.

A country is similar to a private firm, and also importantly different. Governments generally do not go bankrupt, but they pass their budget losses on to taxpayers, the same persons whom ultimately finance insurance or alternative risk-transfer instruments. Since governments generally have less expensive options for financing infrastructure damage *ex post* to a disaster by issuing bonds, accepting international (and often subsidized) loans, or raising taxes, the advantages of (possibly) more expensive risk-transfer instruments are not so clear. According to a representative of the Austrian Finance Ministry, raising post-disaster funds by issuing highly rated Austrian bonds is less expensive than purchasing *ex ante* risk-transfer instruments (Eder, 1999).

The situation can be quite different for poor or emerging-economy governments. The higher risk of defaulting on their debt, or constraints due to fiscal austerity, may make it difficult for poor or emerging-economy countries to issue debt instruments. This is especially

the case after a major or “mega” disaster that severely depletes capital and results in major economic disruptions (see MacKellar *et al.*, 1999). Other *ex post* financing instruments, such as catastrophe taxes or budget diversions, may also be difficult or very costly to implement. Moreover, if the funds are diverted from internationally financed projects, they can diminish investor confidence in the country.

Whether these costs of *ex post* financing measures, however, outweigh the considerable costs of *ex ante* risk transfer would need careful consideration. What is clear is that those countries that could potentially benefit from risk transfer are precisely those that can least afford it. This predicament may provide an opportunity for subsidization of developing country risk transfer by the industrialized countries, which we will discuss in section 5.

Collective loss-sharing through international disaster aid

The notion of subsidizing *ex ante* risk transfer takes on added importance considering the current levels of *ex post* international disaster aid. Despite the comparatively large burdens imposed by natural disasters on developing and emerging-economy countries, direct donations from the developed world are small. Looking again at Poland, the country suffered flood losses in 1997 totaling about US\$3 billion or 2.7 per cent of its GDP (Polish Statistical Bureau, 1998). Only about 1 per cent of these losses was covered with international aid, which was donated mainly by Germany (Kunreuther and Linnerooth-Bayer, 1999). Poland is not an exception in receiving only a small amount of internationally donated aid.

Most official bilateral aid is given by the 21 members of the Organization of Economic Development (OECD) through its Development Aid Committee (DAC). Since reported figures for DAC spending on humanitarian aid include donations that cover losses from military conflict as well as natural disasters, figures reporting only disaster aid are unavailable. In 1996, the total amount of humanitarian aid reported by DAC was around US\$ 2.9 billion or about 4 per cent of reported natural disaster losses of that year. Keeping in mind that aid to conflict-ridden areas is a large proportion of this figure, the amount of bilateral international disaster aid from the developed world appears small relative to the magnitude of the losses from natural catastrophes (International Federation of Red Cross and Red Crescent Societies, 1998). Of course, it is higher if unofficial donations are included.

International disaster aid also comes in the form of subsidized loans from international lending organizations. After the Polish floods, low-interest loans from the European Investment Bank, the World Bank and the European Bank for Reconstruction and Development amounted to about 20 per cent of the total direct losses (Kunreuther and Linnerooth-Bayer, 1999). The World Bank estimates that it has loaned US\$14 billion to developing countries over the last two decades for disaster relief and recovery (Gilbert and Kreimer, 1999), and the Asian Development Bank also reports large loans for this purpose (Arriens and Benson, 1999). Of course, only the subsidies of these loans count as disaster aid; the rest will be paid back by present and future taxpayers in the countries receiving the loans.

In sum, in most countries the state plays the most important role in absorbing the financial losses from the victims of natural disasters. Collective loss-sharing by the state is usually financed from *ex post* financing instruments, such as public borrowing or from international lending organizations, budget diversions, and, ultimately, taxes. There is little international disaster aid and thus little loss-sharing at the global level. Although it varies among countries and type of disaster losses, insurance and reinsurance coverage are also limited as market mechanisms for transferring private and public disaster risks. Finally,

governments experience large infrastructure losses from natural disasters. These losses are seldom insured, but are usually financed from *ex post* financing instruments.

3. State loss-sharing and private risk transfer: efficiency and equity

The socially desired roles of the state and the market in sharing losses and transferring risks from natural disasters have been subject to a great deal of debate. Priest (1996) reflects an extreme view in arguing that “if the societal goal is to optimize risk reduction, there are strong reasons to terminate government disaster assistance in its entirety” (p. 235). The main (but not the only) argument underlying this position is the failure of *ex post* public disaster aid or collective loss-sharing to provide incentives for the socially optimal reduction of the damages from natural disasters. This is an *efficiency* argument, where the goal is to optimize the overall social risk level given the costs of its reduction.

However, the relative efficiency of the market versus the state for sharing the burdens of disastrous events is inconclusive. Placing the responsibility for damages on those facing them, and offering lowered premiums to encourage loss mitigation, has had a lot of success especially in Europe (Crichton, 1999). However, the market does not adjust perfectly. In the U.S., empirical evidence suggests that incentives offered by private insurers are often ineffective in promoting mitigation (Kleindorfer and Kunreuther, 1998); however, a more proactive role of insurers, for example, in enforcing building codes, might have potential for reducing the social costs of disasters (Freeman and Kunreuther, 1997). While private insurance should be more efficient at providing risk-transfer services than governments, the practice rests on the assumption of well-functioning, competitive insurance markets and premiums. Will insurers provide a service at the market clearing price and quantity, such that incentives are in place for cost-efficient risk mitigation?

The cost of insurance (catastrophe bonds) is the premium (interest paid) less expected losses. In a competitive market, the costs of insurance should primarily reflect the brokerage fees and risk-management services provided by the insurer. This appears to be the case for high-frequency events, in which case the variance of the actuarial estimates is small. But an additional factor enters into the competitive pricing of very rare and high-severity events, since there is inherently more uncertainty and ambiguity of the actuarial estimates. Kunreuther *et al.* (1995) show that ambiguity in the probability estimates increases the disutility of risk-bearing.

Froot (1997) demonstrated empirically that in 1997, the premium for U.S. catastrophe cover was more expensive than what would be expected in competitive markets, that is, higher than actuarial values plus brokerage and risk-management fees. He had several explanations for this, including the scarcity of capital (see also Jaffee and Russell, 1997), inefficient underwriting practices, adverse selection, moral hazard, and government regulation. However, the lack of major insurance losses from natural disasters in the past few years has increased the availability of capital and lowered premiums (Swiss Re, 1999). Moreover, the market is becoming more competitive with the entrance of the Bermuda reinsurance companies and with the potential of catastrophe bonds and other alternative hedging instruments. Indeed, insurers appear to be exploring these innovative hedging instruments in anticipation of the next disasters with large insured losses or in anticipation of a downturn in financial markets. Still, premiums may remain above actuarially fair values, if, as Skogh (1999) argues, ambiguity in the actuarial information leads to the systematic increase of premiums.

The hesitancy of insurers to provide cover for natural disasters raises the question

whether these risks are insurable. Kunreuther (1998) argues that, in theory, insurers can offer protection against any risk that they can identify, and for which they can obtain information to estimate the frequency and magnitude of potential losses, as long as they have the freedom to set premiums at any level. Due to problems of ambiguity in estimating very low probability events, adverse selection, moral hazard, and highly correlated losses, insurers may want to charge premiums that considerably exceed the expected loss. These premiums may be so high as to make insurance ill affordable. In fact, after hurricane Andrew and the Northridge earthquake, insurers in these states wanted to significantly decrease their disaster risk exposure and increase their prices.

In sum, collective loss-sharing in the form of *ex post* disaster aid is inefficient if it discourages private investment in loss-preventing measures. By placing responsibility on those at risk, and adjusting premiums to account for their measures to reduce risk, risk transfer (in the absence of moral hazard) can promote socially desired levels of protection. However, this is only the case if insurance premiums reflect competitive market conditions.

Equity

Are efficient policies considered fair? It is well known that if the initial wealth distribution is not considered just or desirable, then efficient policies may exacerbate the inequalities. Consider, for example, a poor community whose residents have chosen not to purchase insurance or to invest in disaster mitigation measures, and a wealthy community that has invested in insurance and mitigation. If both communities fall victim to a catastrophic event, the relative position of the poor community worsens in comparison to the wealthy community. This is a Pareto efficient outcome since each community made an informed choice for or against protection (and had there been no disaster, the relative position of the poor community would have improved). This raises the question: should residents of poor communities receive *ex post* compensation from the government in the form of disaster aid and subsidized mitigation programmes? Kunreuther (1998) raises this question in the context of a “natural disaster syndrome”, where residents in California cannot afford the increased premiums for earthquake insurance and, instead of selling their homes at reduced prices, prefer to rely on the government for disaster relief should an earthquake occur. We will examine this question from three different equity standpoints or views of fairness: the utilitarian, the libertarian, and the egalitarian.

The utilitarian would argue for *ex post* compensation to the poor or relatively poor community if this aid enhanced overall welfare in society. Generally, redistributive policies that transfer wealth from the wealthy to the poor (assuming decreasing marginal utility of income) raise overall welfare, unless these policies lead to incentives for welfare-reducing behaviour. The utilitarian would *not* advocate *ex post* disaster aid if it lowered overall welfare by misplacing incentives for cost-efficient, individual or community mitigation measures.

The utilitarian is not concerned with the *distribution* of welfare *per se*, but with the total welfare in society. Consider an example from India, where the very poor settle in highly flood-prone areas in full awareness that they are exposed to high risks. This strategy has allowed very marginal persons to survive; in fact, these settlers have adapted to the flooding as a way of increasing their fish catch (Barthakur, 1999). It would seem that mitigation and compensation measures would benefit the poor in these areas. However, another outcome is possible, that these measures raise the value of this land so that the very poor can no longer afford to live there, leading to their further marginalization and extreme poverty. The utilitarian would

accept this outcome if those settling in the higher valued area gain more than those who are economically forced to leave.

While the utilitarian values collective loss-sharing provided overall welfare is enhanced (if it does not discourage loss mitigation measures), the libertarian would oppose this compensation. Government-backed aid to the poor community would violate the rights of those coerced into giving this aid. The libertarian accepts the initial rich-poor endowment and rejects policies that violate individual rights. If the California homeowners and the Indian settlers are responsible for their own fate, they should receive no involuntary financial aid. Likewise, the libertarian would oppose any efforts by the government to require households and businesses at risk to purchase insurance.

The egalitarian also rejects the utilitarian view of a fair disaster response policy. Egalitarians do not necessarily value measures that promote all-around improvements in welfare, for example cost-effective mitigation strategies, if they serve to increase inequality. MacLean (1993) has put this succinctly. If the initial endowment between a rich community and a poor one is, say, (100, 30), the egalitarian may prefer a move to (110, 40) over a move to (195, 45). In other words, egalitarians might advocate less for everybody if it is distributed more uniformly. Thus, the (relatively) poor inhabitants of earthquake-prone communities in California as well as the Indian settlers should receive compensation. In the latter case, egalitarians would reject market outcomes that forced the very poor Indian settlers off their land. In contrast to utilitarian consequentialism, egalitarian and other distributive justice theories concern themselves with the perceived fairness of the distribution *per se*.

This claim for promoting more social equality even at the expense of efficiency would argue for collective loss-sharing programmes that benefit the underprivileged, even if these programmes reduce incentives for mitigation or moving out of harm's way. But how much do disaster response and recovery programmes actually improve the welfare of the very needy? Dunfee and Strudler (1999) argue that U.S. disaster aid programmes arose in part in response to pressure from middle- and upper-income persons. In this case, it would be hard to find support for collective loss-sharing within the libertarian or egalitarian communities. A claim might be made by utilitarians that a sudden and unanticipated drop in the property of an otherwise well-off person imposes a large decline in his or her psychological wellbeing, and this qualifies this person for support. This is the principle behind some pension systems, for example, in Austria, which guarantee the retiree an income commensurate with his or her past lifestyle, even at the expense of less well-off tax payers (Linnerooth-Bayer and Ney, 1999).

Fairness and responsibility

To this point, we have assumed little attribution of blame or responsibility outside of the victims of natural disasters (who can take mitigative measures), but the concept of loss reduction through community or state programmes changes the discourse and the ethics rather fundamentally. As a recent example, the large human and economic losses from the earthquake in Turkey have been partly attributed to the failure of the local authorities to enforce building codes (Hotz, 1999). The state can also be held responsible for inadequate zoning regulations or for permitting the conditions that force people to settle in high-risk areas. In Honduras, poverty, population growth and land rights have forced poor people into vulnerable areas such as steep hillsides and unprotected riverbanks (Abromovitz, 1999). In Europe, populations are also concentrating in many vulnerable areas. For example, population and commercial activities have located around Mount Vesuvius to such an extent that projected economic damages from a volcanic explosive eruption may be an unprece-

dented amount of the Italian GNP (Amendola, 1998). With increasing population, it is inevitable that more people are exposed to disaster risks. There are now 40 cities of over a million inhabitants located within 100 kilometers of a major earthquake fault (Hotz, 1999).

Throughout much of Europe, where traditionally governments have assumed responsibility for catastrophic losses, natural disasters are increasingly framed as policy disasters, that is, failures of effective public policies for prevention (Rosenthal *et al.*, 1998). After the 1997 floods, the Polish public viewed the central government as largely responsible for the damage, mainly through its neglect in maintaining the system of dikes and preventing excessive exploitation of the forests (International Federation of Red Cross and Red Crescent Societies, 1998). Indeed, the Prime Minister made a public statement that uninsured victims had only themselves to blame for their financial losses and should not expect government help. The public outcry from this remark forced the Prime Minister to apologize (Stripple, 1998).

While different ethical positions converge on the importance of responsibility, they do so for different reasons. Egalitarians view responsibility as inherent in their plea for equality. Responsibility factors strongly, for instance, into Rawls' original position. The moral reciprocity in the veil of ignorance forces individuals to treat others as they would want to be treated themselves, making responsibility to fellow humans – irrespective of political borders – an intricate functional property of Rawls' justice scheme (Kymlicka, 1990, p. 278, as discussed in Van Well, 1997, p. 7). In contrast, libertarian theories hold rights to be supreme, and responsibility takes the form of protecting and honoring these rights (Kymlicka, 1990, p. 275). Thus, Young (1994) argues against any obligation of the North *vis-à-vis* the South to redress damage from CO₂ emissions, an argument that he recognizes depends on the lack of legal rights for retribution on the part of those who may suffer from climate change. Aristotle's "equity principle" is perhaps the strongest statement of responsibility. It holds that social goods (and bads) should be allocated in strict proportion to each claimant's contribution to the good, or responsibility for the bad (Young, 1994).

Unlike efficiency, notions of what is fair are socially contingent. The different ethical views may be related to contending notions of social organization, including procedures for allocating responsibility, for self-justification, or for calling others to account (Douglas, 1985; Thompson *et al.*, 1990). Liberal philosophy justifies individualistic forms of organization that place emphasis on the private sector and on preferences, rights, liabilities (responsibilities) and incentives. Alternatively, hierarchical organization, for which utilitarianism often serves as justification, is characterized by positional authority, procedural rationality and a paternalistic view of the state that decides and acts in the best interests of its citizens. There is a legitimate role of the state in actively mitigating against the damages of natural hazards, as well as redistributing the burdens. Egalitarian organization emphasizes social equality and moral rightness, and generally takes a more holistic approach to policy issues. According to this ethic, it is the moral imperative of the collective to compensate the victims of natural disasters, but only if they are the underprivileged.

Priest's argument of terminating government disaster assistance in its entirety is, therefore, rightly qualified by its contingency on the societal goal of optimizing risk reduction. If efficiency is not the sole goal of a catastrophic risk management strategy, then collective loss-sharing – even at the cost of efficiency – may be socially sanctioned. A neighbour's help in time of need, at least within social limits, is a cherished community value, and the utilitarian, egalitarian, and even libertarian (if this help is voluntary) would argue that it should not be discouraged because of the displaced incentives on loss mitigation. Different views of fairness stemming from different forms of social organization suggest that neither

the market nor the government will be acceptable as the sole mechanism for disaster burden-sharing.

4. Global risk transfer and loss-sharing

Attribution of blame, or responsibility, figures strongly in the recent attention given to global risk transfer and loss-sharing. There are already calls on the part of a consortium of small island states for a fund to be financed by the wealthy countries to compensate them in the future for increased storm activity and sea level rise if they should occur (Tol, 1998).² The climate change policy debate thus raises issues of efficiency and equity, accountability and responsibility, for natural disaster risks on a global level (Pearce *et al.*, 1996; Rayner and Malone, 1998; Linnerooth-Bayer, 1999).

From the discussion in the previous section, a claim for compensation on the part of the South might be based on the North's historical contribution to climate warming. Alternatively, absent any liability on the part of the North, arguments might be put forth based on global solidarity in helping poor victims recover from natural disasters. Again, we would expect different claims based on different principles of fairness. Absent strong disincentives for taking preventive measures, the utilitarian would be obliged to support global distributive aid or global loss-sharing irrespective of the North's responsibility, and the egalitarian would claim it as a moral imperative. Yet there is very little international aid from the wealthy to the poor countries following major disasters. Indeed, the historical record suggests that willingness to pay on the part of states for international commitments of *all* sorts is for the most part devoid of humanitarian and moral commitments to global redistribution (Victor, 1999). However, demands for global redistributive actions are moving more to the forefront as global democratization forces societies to open their political systems, thus empowering egalitarian and other groups that are morally committed to global loss-sharing (Linnerooth-Bayer, 1999).

A novel idea for global loss-sharing is that the wealthy countries subsidize or fully finance global risk transfer on the part of very poor and emerging economy countries, and especially those facing "mega" disasters that swamp their *ex post* financing alternatives. Organizations that provide loans to developing countries, such as the World Bank and the Asian Development Bank, may be able to play an important role here. These banks could subsidize or fully finance alternative risk-transfer instruments. In the case of catastrophe bonds, the banks could serve as brokers by purchasing the bonds from developing countries at a low interest rate and then issuing them to private investors (Kunreuther and Linnerooth-Bayer, 1999). In fact, a similar plan was recently proposed by the World Bank to create an international intermediary that would increase access to commodity price risk insurance in developing countries (Chote, 1999). The proposed intermediary would link developing country entities with providers of price insurance, or it would offer the price insurance itself and hedge its position through existing options and other risk-management markets.

This type of arrangement could complement *ex post* disaster aid by providing subsidized disaster assistance from the developed to the developing and emerging-economy countries. However, in light of the costs of risk transfer in comparison to collective loss-sharing (recall

² In addition to a compensatory fund, climate change insurance has become topical among economists addressing the imbalance of the global burdens imposed by a warming climate (Chichilnisky and Heal, 1993; Nordhaus, 1994).

that the purchaser pays brokerage fees and compensates for the ambiguity in the risk estimates), this arrangement would need careful examination with regard to its efficiency and equity. Risk-transfer instruments, including catastrophe bonds, are not exempt from the danger of principle-agent problems that plague reinsurance transactions. Difficulties may arise from asymmetric information and adverse selection, if the public authority possesses information of local conditions that are not readily available to the purchasers. Another important consideration is that of moral hazard if the purchase of insurance or the issuance of catastrophe bonds diminish the incentives of the public authorities for careful risk analysis or cost-effective mitigation measures. On the other hand, if the premiums or interest on these instruments are linked with mitigation measures, they can actually lead to cost-effective reduction of losses (Kunreuther and Linnerooth-Bayer, 1999).

Finally, it is important to consider the implications of this arrangement for social equity. Egalitarian (and libertarian) groups would oppose any imposition on poor countries to purchase risk-transfer instruments on the market – thus paying brokerage and other fees to the private insurers or paying interest to international investors. However, subsidies on these purchases, to make them affordable and attractive (from a benefit–cost perspective) to poor countries, may change these ethical reservations. Still, there might be concerns that these market mechanisms are introduced as a distributive, loss-sharing policy, and later the subsidies are withdrawn. Another concern might be that these policies “crowd out” or result in less humanitarian aid after a disaster (the weight of this argument, however, is diminished by the actual extent of these contributions). It would be hoped that humanitarian aid, as direct aid or subsidized loans, would then contribute to covering those losses that are uninsured or not otherwise covered by alternative risk-transfer instruments.

5. Conclusions

As countries in both the developing and developed world contemplate increasing losses from natural disasters, and as victims relate these losses to policy failures and human culpability, attention is being given to the accountability of and liability for preventing and absorbing the financial losses. To date, social solidarity in the form of government aid financed by taxpayers plays the most important role in absorbing the financial losses from the victims of natural disasters. Although countries differ, there is comparatively little risk transfer in the form of insurance, and far less loss-sharing with international disaster aid.

The comparative advantages of risk-transfer policies versus traditional financing policies will depend critically on the relative costs of the two options, their effects on mitigation, institutional constraints, as well as on considerations of equity. Different views of fairness stemming from different forms of social organization suggest that neither the market nor the government will be acceptable as the sole mechanism for disaster burden-sharing. Thus, some form of a public–private partnership may be appropriate (Kunreuther and Roth, 1998).

Given the far greater relative burden of natural disasters on developing and emerging-economy countries, and the possible implication of the developed world in this burden, the idea of greater global loss-sharing is emerging. As a way of augmenting traditional disaster aid, we have suggested that aid before the disaster in the form of risk-transfer mechanisms be given consideration. At least for poor countries facing mega disasters, in which case *ex post* financing alternatives may be limited, competitively priced risk transfer linked to mitigation measures might be advantageous. However, the costs of risk transfer will likely be prohibitively high for poor countries. On grounds of both efficiency and equity, there may

be an opportunity for wealthy countries, possibly through international lending organizations, to share the disaster losses of the poor countries by helping them finance risk-transfer policies.

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