



Original paper

Insurance against Losses from Natural Disasters in Developing Countries. Evidence, Gaps and the Way Forward

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Abstract This paper examines recent experience with insurance and other risk-financing instruments in developing countries, informed by experience in developed countries, to provide insights on the effectiveness of insurance for reducing economic insecurity. Insurance and other risk financing strategies are viewed in the overall context of risk management, including the prevention of losses as well as financing the recovery process through risk pooling and transfer strategies. Specific examples of public-private insurance programs for households/businesses, farms and governments are described, including their limitations, especially in light of recent post-Katrina experience in the US. By examining the costs, benefits and risks of public-private risk-financing programs, insights are provided on the effectiveness of insurance as a mechanism for providing economic security to vulnerable communities and governments.

Key words Insurance; Risk financing; Developing countries

1. INTRODUCTION

The impacts of natural hazards - weather variability, climate extremes and geophysical events - on economic well-being and human suffering have increased alarmingly (Munich Re 2010; CRED 2010). Furthermore, more than three-quarters of recent losses can be attributed to windstorms, floods, droughts and other climate-related hazards (UNISDR 2007). The rising trend can be largely attributed to changes in land use and increasing concentration of people and capital in vulnerable areas, for example, in coastal regions exposed to windstorms, in fertile river basins exposed to floods, and in urban areas exposed to earthquakes (Mileti 1999; Swiss Re 2010). Climate change also appears to be playing a role (Schönwiese *et. al* 2003; Emanuel 2005). For example, the Intergovernmental Panel on Climate Change (IPCC 2007) has predicted that climate change will increase weather variability as well as the intensity and frequency of climate-related extremes.

Low- and middle-income countries, and especially the vulnerable within these countries, suffer the

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most. During the quarter century (1980-2004) over 95% of natural disaster deaths occurred in developing countries, and direct economic losses averaged US\$54 billion per annum (Munich Re 2005). As illustrated in Figure 1, a sample of large natural disasters over this period showed that fatalities per event were higher by orders of magnitude in low- and middle-income countries compared with high-income countries; and losses as a percentage of gross national income (GNI) were also highly negatively correlated with per capita income.

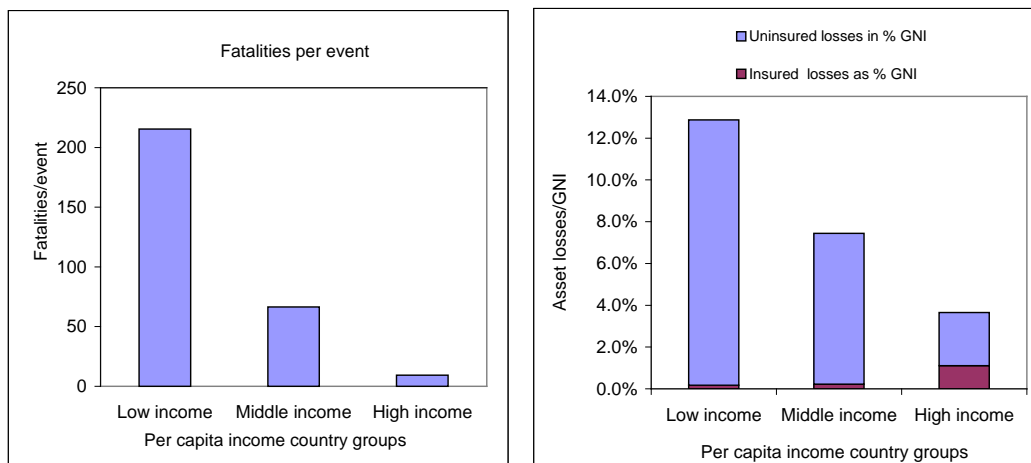


Figure 1. Differential burden of natural disasters: (i) fatalities per event and (ii) insured and uninsured losses according to country income groups² (Source: Munich Re 2005).

Not only are there considerable differences in developed and developing countries in the human and economic burden, but also in insurance cover. In the richest countries about 30% of losses in this period (totaling about 3.7% of GNP) were insured; in low-income countries, only about 1% of losses (amounting to 12.9% of GNP) were insured.³ It should be kept in mind that these disaster statistics do not (for the most part) reflect long-term indirect losses, which can be very significant particularly in countries with little capacity to cope (Mechler 2004; World Bank 2008; Hochrainer 2009). Due to the lack of insurance, combined with exhausted tax bases, high levels of indebtedness and limited donor assistance, many highly exposed developing countries cannot raise sufficient capital to replace or repair damaged assets and restore livelihoods following major disasters, exacerbating the impacts of disaster shocks on poverty and development (Gurenko 2004).

The seriousness of the post-disaster capital gap, as well as the emergence of novel insurance instruments for pricing and transferring catastrophe risks to the global financial markets, has motivated developing country governments, as well as development institutions, NGOs and other donor organizations, to consider pre-disaster financial instruments as a component of disaster risk management (Linnerooth-Bayer *et al.* 2005). Donor-supported pilot insurance programs, such as in Mongolia (Mahul and Skees 2006), Turkey (Smyth *et al.* 2004) or the Caribbean Island States (World Bank 2007), are already demonstrating their potential to pool economic losses and smooth incomes of the poor facing

² Note: Country income groups according to World Bank classification using GNI per capita. Low income: less than 760 US\$/year, middle: 760-9360 US\$/year, high larger than 9360 US\$/year in 2005.

³ These losses are mostly *direct* losses of productive assets and property (*stocks*). Only to a minor extent are *indirect* losses of value added (*flows*), such as business interruption losses, accounted for and insured.

weather variability, climate extremes and geophysical disasters. However, many of these recent insurance programs are still in the pilot stage, and none have experienced a major and widespread catastrophic event. Therefore, it is too early to fully assess their effectiveness in reducing economic insecurity. Yet, the need for careful examination of their effectiveness and sustainability, even if based on a short operating history, is underscored by recent experience with disaster insurance systems in developed countries, especially the widespread inefficiencies of agricultural insurance systems (Skees 2001) and the insurance controversies following Hurricane Katrina's devastation to poor communities in New Orleans (Masozera *et al.* 2007). The question arises whether developing countries should follow the path of the developed world in forming public-private partnerships to insure against catastrophic events, and which insurance instruments and modifications may be appropriate for better tackling the developmental dimensions of natural disasters?

The intent of this paper is to examine recent experience with insurance and other risk-financing instruments in developing countries, informed by that of developed countries, to provide insights on the effectiveness of insurance for reducing economic insecurity. Insurance and other risk-financing strategies should be viewed in the overall context of risk management, including the prevention of losses as well as financing the recovery process through risk pooling and transfer strategies. These issues are discussed in section 2. We then turn to examining insurance and other risk-sharing mechanisms in developing countries: household/business insurance instruments in Section 3; agricultural insurance instruments in Section 4; and government risk pooling and transfer in Section 5. Throughout we discuss relevant experience in industrialized countries. In Section 6 we discuss the effectiveness of insurance for providing economic security to vulnerable communities by examining their costs, benefits and risks, and the appropriate role for donors. Finally, we conclude with general observations about the future role of insurance instruments in developing countries.

2. DISASTER RISK FINANCING AS PART OF DISASTER RISK MANAGEMENT

Insurance instruments are only one of many activities in managing risks of natural hazards. A first priority in risk management is to invest in preventing or mitigating human and economic losses. Disaster prevention can take many forms: reducing exposure to risks, (e.g., land-use planning); reducing vulnerability (e.g., retrofitting high-risk buildings); or creating institutions for better response (e.g., emergency planning). The residual risk can then be managed with insurance and other risk-financing strategies for the purpose of providing timely relief and assuring an effective recovery.

2.1 Elements of Disaster risk financing

Risk financing through insurance and other hedging instruments spreads and pools risks, thus lessening the *variability* of losses, but not directly reducing them.⁴ By providing indemnification in exchange for a premium payment, insured victims benefit from the contributions of the many others that are not affected, and thus in the case of a disaster they receive a contribution greater than their premium payment. However, over the long run, insured persons or governments can expect to pay significantly more than their (expected) losses. This is due to the costs of insurance transactions and the capital

⁴ Insurance and other risk financing mechanisms are based on the *Law of large numbers*, which states that with an increasing number of observations the probability distribution can be estimated more precisely and the variance around the mean decreases.

reserved by insurance companies for potential losses (or reinsurance), as well as the financial return required for absorbing the risks. The “load” can be significant, or as much as 500% of the pure risk (expected losses) (Froot 2001; Mechler 2004). Still, people buy insurance, and justifiably so, because of their aversion to (large) losses, i.e., their concern about the volatility of the possible outcomes. Insurance and other risk-transfer instruments are thus justified by the concept of risk aversion. It is because of aversion to large losses that people are willing to pay for insurance.

Globally, insurance penetration for disaster risks is varied. As shown on Figure 2, in the US, parts of Europe and Australia, the average person pays over USD 500 annually in premium for non-life disaster cover compared to Africa and parts of Asia with less than USD 5 in per capita premium. The averages, however, hide large differences in these regions. In Africa, for instance, there is virtually no coverage at all in a number of countries compared with a per capita premium in South Africa of 160 USD (Munich Re 2003; Swiss Re 2007).

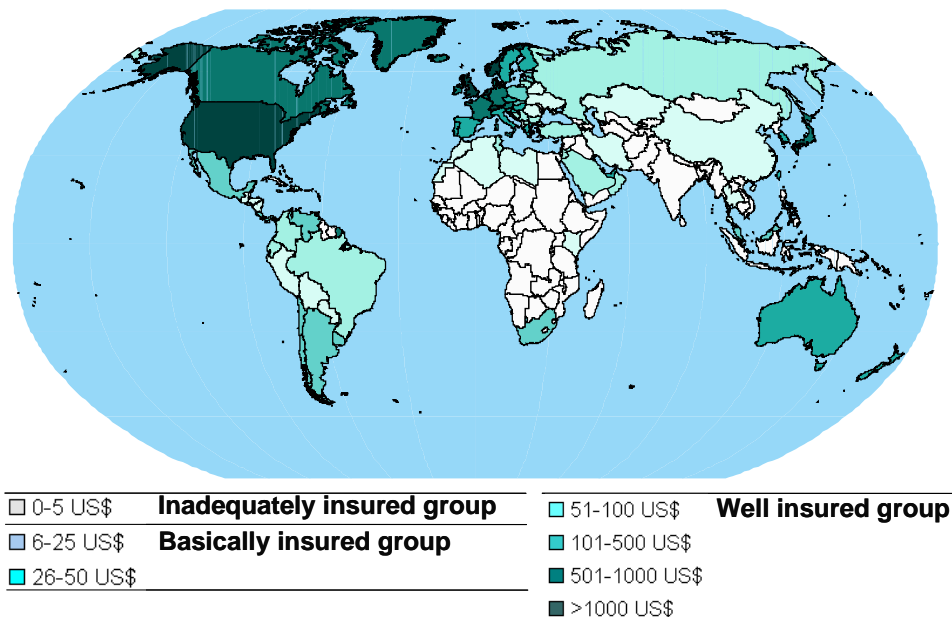


Figure 2. Global distribution of non-life insurance premiums per capita (Source: Munich Re 2003)

The insured share of economic losses has risen from approximately 10% in the 70s to about 25% in 2004; yet the overall penetration for many hazards remains relatively low (see Figure 3). Globally, storm risk (since it is often bundled with property insurance) has the greatest penetration with about 50% of losses currently absorbed by insurance, followed distantly by flood cover at less than 10%. Other hazards, such as earthquake, wildfire, lighting etc., have even less cover.

As recent major disasters show, even in high-income countries, households and businesses rely extensively on public assistance (see Figure 4). After the 1995 Kobe earthquake, where only about 4% of damaged or destroyed homes were insured despite a national public-private seismic insurance system, the government provided extensive assistance. Taking another example, in the US about 30% of total direct private and public losses from the 1994 Northridge earthquake were absorbed by private insurance companies, and the federal government provided extensive assistance to private victims, as well as to state governments for repairing public infrastructure. In stark contrast, in the UK, which claims 75% flood

insurance penetration, the government gave practically no assistance to the private victims after the 1998 Easter floods.

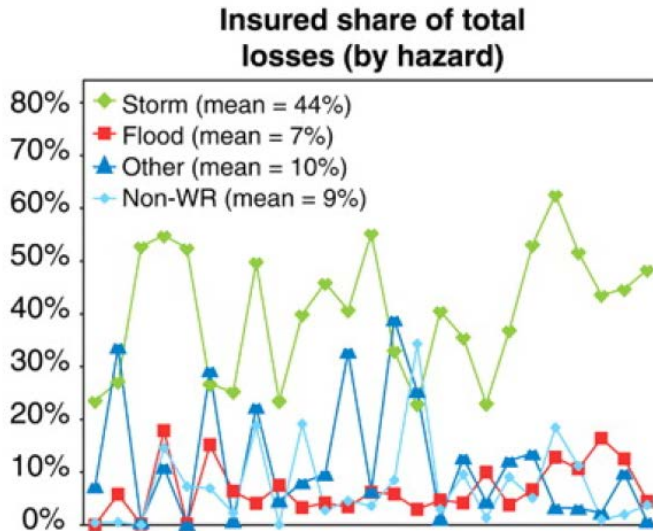


Figure 3. Global disaster insurance density for different hazards (Source: Mills 2005).

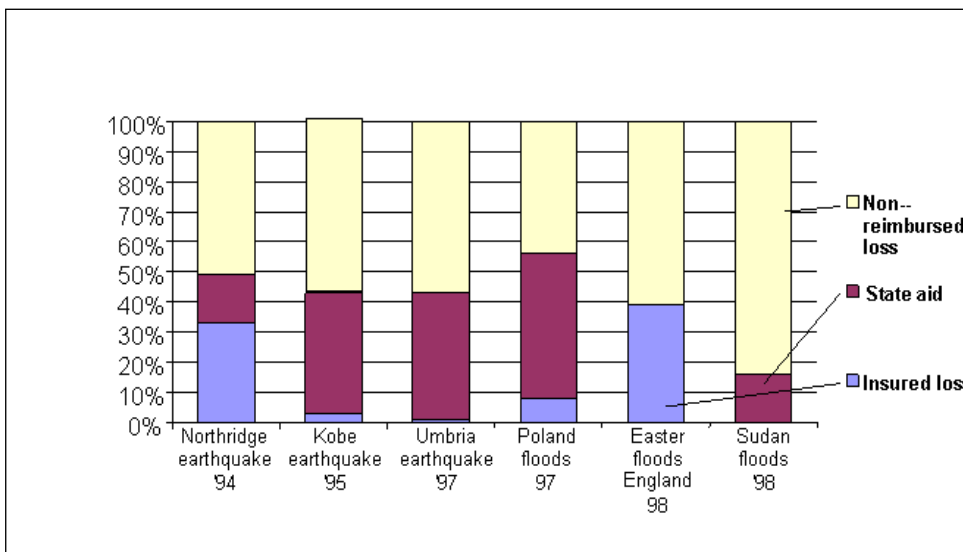


Figure 4. Insurance and government assistance for selected disasters as a percentage of direct losses (Source: Linnerooth-Bayer and Mechler 2007).

Insurance is practically non-existent in least developed countries, like Sudan, where the victims, themselves, absorbed over 80% of the losses from the severe flooding in 1998, and the state covered the rest with outside assistance (Linnerooth-Bayer and Mechler 2007). Outside donor aid and financial assistance are volatile, and with the exception of highly publicized disasters (e.g., the 2004 Indian Ocean Tsunami), aid is usually only a small fraction of what is needed. Humanitarian assistance reported by the

Organisation for Economic Cooperation and Development (OECD) Development Aid Committee in the 1990's was less than 10% of disaster losses in recipient countries (Freeman *et al.* 2002). Post-disaster arrangements are not only often insufficient for meeting needs for relief and reconstruction, but they tend to be ad hoc and inefficient (Cardenas *et al.* 2007).

In the absence of government assistance and international aid, poor victims rely on an array of (often innovative) pre- and post-disaster arrangements for financing their recovery. As shown on Table 1, insurance is only one of many different modalities for this purpose. The most usual financial course is to raise needed capital after a disaster strikes: Individuals take out emergency loans from family, micro-credit institutions or money lenders; sell or mortgage assets and land; or rely on public and international aid. Likewise, governments raise post-disaster capital by diverting funds from other budgeted programs, borrowing money domestically, or taking loans from international financial institutions.

Table 1. Examples of pre- and post-disaster risk financing arrangements

	Security for loss of assets (households/businesses)	Food security for crops/livestock loss (farms)	Security for relief and reconstruction (governments)
<i>Post-disaster (ex post)</i>	emergency loans; money lenders; public assistance	sale of productive assets, food aid	diversions; loans from World Bank and other IFIs
<i>Pre-disaster (ex ante)</i>			
Non-market	kinship arrangements	voluntary mutual arrangements	international aid
Inter-temporal	micro-savings	food storage	catastrophe reserve funds, regional pools, contingent credit
Market-based risk transfer	property and life insurance	crop and livestock insurance (also index based)	Insurance or catastrophe bonds (also index based)

While many locally based funding sources, for example, borrowing from neighbours or family, appear to work reasonably well for small localized events (Cohen and Sebstad 2003), they are problematic for catastrophes that affect large regions or many persons at the same time (so-called co-variant or systemic risks). To hedge against co-variant risks, households may purposely locate family members outside of harms way or diversify their livelihoods. They may also arrange contingent savings or food supplies, activities that spread risks temporally. Alternatively, households/businesses and farms can purchase property or crop insurance, which spreads risk both temporally and spatially. Insurance can be provided by micro-insurance programs, which are distinguished from other types of insurance by their provision of affordable cover to low-income clients. Like individuals, governments can also spread risks temporally and spatially by setting up reserve funds or regional pools and by purchasing insurance or hedging instruments (e.g., catastrophe bonds or contingent credit), respectively.

2.2 Innovative Solutions

Many of these risk financing modalities are conventional; yet, some, most notably index insurance and catastrophe bonds, are rather novel and have been made possible by new developments in modelling risks

and financial transactions. Whereas conventional insurance is written against actual losses, index-based (parametric) insurance is written against physical or economic triggers. Index-based insurance is against *events* that cause loss, not against the *loss* itself. For example, crop insurance may be based on measures of insufficient rainfall at key points in the growing season or a loss index determined by the correlation between historical weather events and crop yields in a region. The insurer will pay out if rainfall measured by a rain gauge falls below a specified level regardless of crop damage. The major advantage, of index-based insurance is the substantial decrease in transaction costs, which, particularly for developing countries, have impeded the development of insurance mechanisms. The major disadvantage is *basis risk*, which is the lack of correlation of the trigger with the loss incurred. If the rainfall measured at the weather station is sufficient, but for isolated farmers insufficient, they will not receive compensation for crop losses.

As another novel insurance mechanism, a catastrophe bond is an instrument whereby disaster risks are packaged (*securitized*) in the financial markets (they can be parametric or indemnity-based). The investor receives an above-market return when a specific catastrophe does not occur in a specified time but sacrifices interest or part of the principal following the event. Disaster risk is thus transferred to international financial markets that have many times the capacity of the reinsurance market. Another advantage accrues to investors. By adding catastrophic risk to their investment portfolios, needed diversification is increased since natural catastrophes are not correlated with stocks and other investments tied to economic performance. There are also risks to this and other novel financial instruments, especially if they are not subject to national or international regulation and oversight (the benefits and risks of insurance instruments are discussed in greater length in Section 6).

In what follows we discuss the effectiveness of insurance and other *ex ante* risk-financing schemes that offer security to low-income households and businesses, farms, and governments.

3. INSURANCE FOR HOUSEHOLDS AND BUSINESSES

3.1 Microinsurance schemes

Households and businesses in poor countries cannot easily afford commercial insurance to cover their risks, even in the unlikely case that providers exist. Without an insurance culture, or support from family or the government, disasters can lead to a worsening of poverty as victims take out high-interest loans (or default on existing loans), sell assets and livestock, or engage in low-risk, low-yield farming to lessen exposure to extreme events (Varangis *et al.* 2002).

The intent of microinsurance is to service low-income markets by offering limited cover and greatly reducing transaction costs (Mechler *et al.* 2006). Until recently natural hazards have not been explicitly considered as a niche for microinsurance because they impact large regions with multiple and simultaneous losses, and thus are both more uncertain and have higher potential losses than other types of insurance. The co-variant or systemic nature of the risks – and the large capital reserves necessary to avoid insolvency – distinguishes catastrophe cover from health, accident and other forms of microinsurance. Given the challenges for providing microinsurance for natural disasters, it is notable that programs are recently emerging with the support of governments, NGOs and international donors.

The diversification needs (due to insurers limited capital reserves) can add significantly to the costs of providing micro-insurance, which raises the challenge of assuring the financial sustainability of microinsurance providers and at the same time providing affordable premiums to poor, high-risk communities. Many support subsidies (in the broadest sense) to meet this challenge and caution against shifting full responsibility to the poor, while others warn against the negative incentives promoted by

subsidies and favour limiting support. It is notable that some programs (like the *Afat Vimo* program in Gujarat, see Vaux 2007) does not adjust premiums to award risk-reducing behaviour, which introduces moral hazard in the sense that clients may not take cost-effective preventive measures. Despite the advantages of donor-supported public private partnerships in providing sustainable and affordable insurance, there are thus concerns that excessive public and international support will distort market prices and greatly jeopardize the incentive effects of insurance.

3.2 National insurance programs

Microinsurance programs usually serve only very few clients. Scaling up across regions with uncorrelated risks adds valuable diversification to these schemes (the scaled-up Proshika scheme in Bangladesh appears to include co-variant risks, see ILO 2005), but at the same time diminishes the institutional familiarity and trust that contributes both to their success and expense. This raises the question of how insurance can effectively serve large regions or countries exposed to high systemic risks.

Even in industrialized countries, private insurers have been reluctant to offer region- or nation-wide policies covering flood and other hazards because of the systemic nature of the risks, as well as problems of moral hazard and adverse selection (Kunreuther 1998). Moral hazard occurs when the insured change behaviour after the purchase of the insurance, making them more risky. Adverse selection occurs when those facing higher risks purchase insurance, and those less at risk do not. Especially for large-scale systems, purchasers often have information that is not known to insurers, or costly to obtain. This asymmetric knowledge jeopardizes the insurance pool.

Furthermore, even well capitalized and diversified insurers face insolvency for repeated high-loss events, and demonstrates the importance of public or private arrangements that protect clients against insurer insolvency (Insurance Journal 2005; US Government Accounting Office 2005; StormingMad.com 2006).

In an attempt to exploit the advantages of a national pool for disaster risks, and to avoid the problems that plague systems in high-income countries, the World Bank and Turkish experts designed the Turkish Catastrophe Insurance Pool (TCIP). The purposes of this pool were to reduce the government's fiscal exposure (large post-disaster liabilities) by gradually building up capital in an insurance pool funded by affordable private contributions, and to create incentives for retrofitting apartment buildings and reducing risk. The TCIP would not have been possible without recent advances in catastrophe modelling. In the absence of large sets of historical data, advanced risk modelling simulation techniques have increased the confidence insurers place in risk estimates and greatly enhanced the insurability of catastrophic risks (Kozlowski and Mathewson 1997; Bier *et al.* 1999; Clark 2002; Boyle 2002). Although risk assessments can be very resource intensive, by drawing attention to risk and prevention measures they can be useful beyond the pricing of insurance contracts. This is the case in Turkey, where local universities have worked together with government in assessing risks and drawing up a blueprint for prevention.

4. INSURANCE FOR FARMERS AND HERDERS

In 2001, global annual agricultural and forestry insurance premiums amounted to some US\$6.5 billion compared with the estimated total value of agricultural production of US\$1,400 billion, or 0.5% global cover. This cover is concentrated in developed countries, with only a minor percentage of global premiums paid in the developing world (Roberts 2005). Still, programs exist throughout Asia (e.g., in India, Malaysia and the Philippines), Latin America (e.g., in Argentina and Brazil) and Africa (e.g.

Mauritius). For the most part, they are heavily subsidized, such as the crop insurance program in the Philippines, where farmers are at high risk to cyclones, droughts and pests (Reyes and Domingo 2009).

There is a great deal of controversy surrounding subsidized agricultural insurance. Subsidized programs in North America and Europe are viewed by many economists as failed policy. Commenting on the US farm insurance program, Jerry Skees (2001) has this to say:

What was once a good idea — using crop insurance to share risk in agriculture — has become bad public policy in America. What was touted as a “market-based solution” is now very costly, inefficient, and inequitable...

The system is highly subsidized, from 40 to 60% of premium, which not only keeps farmers in high-risk production but also gives greater financial advantages to those with higher premium, meaning higher risk, practices. Distorting market prices has led to vast inefficiencies and high costs to the government. The authors query whether post-disaster aid – itself very inefficient - would not be preferred to the current market-based insurance solution. Subsidies are a concern for agricultural insurance programs in developing countries, not only because of inefficiencies caused by market distortions, but also because governments cannot afford to facilitate income transfers given the large segments of the population often engaged in farming. Whether these concerns should be transposed to international donors querying their role in supporting pro-poor insurance programs is a subject of debate, which will be taken up in Section 6.4.

4.1 Index-based crop insurance

Traditionally, insurers have paid claims based on actual losses (indemnity-based insurance), which requires extensive networks of claims adjusters who assess individual losses following an event. It also means investing in marketing to individual farms and controlling moral hazard. Moreover, insurers in low-income countries have far less access to global crop reinsurance markets than do those in developed countries. The low volume of business and large fixed transactions costs means that reinsurers can service these markets only at high cost. Traditional indemnity-based crop insurance programs are thus costly, which is a reason why many such programs have failed in developing countries (World Bank 2005).

To avoid the high transaction costs of indemnity-based insurance systems, index-based or parametric schemes make payouts contingent on a physical trigger, such as rainfall measured at a regional weather station, thus circumventing expensive claims settling. In the case of weather derivatives, farmers collect an insurance payment if the index reaches a certain measure or “trigger” regardless of actual losses. These schemes may offer a less costly and thus more viable alternative to traditional indemnity-based crop insurance.

Because of the physical trigger, there is no moral hazard; to the contrary, farmers will have an incentive to reduce potential losses, for instance, by diversifying their crops. Because they can access higher yield and higher risk crops, the insurance will promote cost effective higher-risk activities (in contrast to moral hazard). In the words of one of the designers of the Malawi program:

We want farmers to adopt high return technologies that allow them finally to make the leap and accumulate earnings over time. Systemic risk is THE factor impeding this and so far banks cannot handle the risk and the high transaction costs in rural areas. This Malawi transaction shows that there is a sustainable way to take the big rocks out of the way - drought risk – and clear the path to development! (Hess 2005)

Although direct premium subsidies are not necessary, the program received assistance from the World Bank for starting up operations. It should be kept in mind, however, that the Malawi program provides only very limited coverage. By reducing loan repayments in the case of drought, the insurance only

indirectly protects farmers from loss of livelihood and food insecurity. Providing higher coverage to reduce food insecurity would likely render the system unaffordable to the subsistence farmers.

This is not the case with a similar pilot scheme, BASIX, launched by a rural microfinance organization in the Indian state of Andhra Pradesh, which provides cash payouts – albeit to middle-income farmers - who insure their cash crops (Hess and Syroka 2005; Mechler *et al.* 2006).

Comparing the two schemes in Malawi and India, neither of which has public assistance from taxpayers, the question arises whether more extensive outside assistance for microinsurance schemes of this type is necessary. Can the private market fulfil the insurance needs of the poor? The answer, of course, depends on the ability of clients to afford the requisite cover. Middle-income farmers in Andhra Pradesh can afford the premiums for insurance that significantly reduces their insecurity; this would not be the case for very low-income farmers in Malawi, who cannot afford such extensive coverage. Unless supported by technical assistance, national subsidies or international donors, these schemes are out of reach for very low-income smallholder farmers facing high risks.

This explains why international insurers have been reluctant to commit significant capital and underwriting expertise to developing market based micro-insurance programs. Support from international donors can change this. As a recent case in point, Swiss Re has insured about 150,000 smallholder farmers in Kenya, Mali and Ethiopia against drought through a parametric product. The insurance is purchased by the internationally backed NGO, and other partners are being solicited to provide further financial support.

4.2 Index-based livestock insurance⁵

In Mongolia, where domestic animals provide subsistence income, and wealth to protect nearly half the residents, a harsh winter (dzud) can have devastating effects even for experienced herders. To protect herders against livelihood losses from extreme weather, an innovative livestock insurance program has recently been developed by the World Bank. It stands in contrast to Mongolia's traditional indemnity-based livestock insurance, which was ineffective for several reasons: the high costs of settling claims across vast areas, the disincentives to reduce losses and the incentives to falsely report animal deaths. The goal of the new public-private system according to its founders (see Mahul and Skees 2006) is to (i) offer insurance coverage that is attractive to herders, (ii) involve the domestic insurance market while protecting it against catastrophic losses, and (iii) limit the fiscal exposure of the government.

As with other index-based systems, the Mongolian scheme minimizes moral hazard, but since the claim payment is triggered by the event (the dzud) rather than individual losses, basis risk is a concern. Insurance claims depend on overall mortality, which means the index-based livestock insurance (IBLI) provides strong incentives to individual herders to manage their herds so as to minimize the impact of major dzud events. But, the imperfect match between index payouts and individual livestock losses can be a significant issue for extreme winters with large losses, in which case the designers hope that other informal risk sharing measures will be enhanced.

Like in Malawi (Suarez *et al.* 2007), lack of understanding of the index system may present a problem, and focus groups with herders have already been conducted to help shape educational material. Finally, the potential for fraud in the distribution of the product, and elsewhere in the system, is not negligible despite certification of sales persons, the use of unique identification numbers and redundant accounting systems.

⁵This section is based on Mahul and Skees 2006.

5. INSURANCE FOR GOVERNMENTS

Governments usually have responsibility for a large portfolio of public infrastructure assets that are at risk to natural disasters. Moreover, most governments are obligated to provide post-disaster emergency relief and assistance to vulnerable households and businesses. Governments of developing countries typically finance their post-disaster expenses by diverting from their budgets or from already disbursed development loans, as well as by relying on new loans and donations from the international community. In the past, these post-disaster sources of finance have often proven woefully inadequate to assure timely relief and reconstruction in developing countries. For example, two years following the 2001 earthquake in Gujarat, India, assistance from a government reserve fund and international sources had reached only 20% of original commitments (World Bank 2003). Post-disaster assistance is not only often inadequate, but it can discourage governments and individuals from taking advantage of the high returns of preventive actions.

5.1 Insuring governments

In wealthy countries government insurance hardly exists at the national level, although states in the US, Canada and Australia often carry cover for their public assets. In theory, there is little rationale for insuring public infrastructure risks in large developed countries. It was noted in Section 2.2 that people buy insurance because of their aversion to large losses. In contrast to individuals, governments are not, in theory, risk averse, and thus in most circumstances should not purchase insurance (in Sweden insurance for public assets is illegal). This is the result of a well-known theorem by Arrow and Lind (1970), who give two reasons for the risk neutrality of the public sector: if the government spreads its risk over its citizens (most usually by means of taxation), the expected and actual loss to each individual taxpayer is minimal due to the sheer size of the population. Moreover, a government's relative losses from disasters in comparison with its assets may be small if the government possesses a large and diversified portfolio of independent assets.

Neither of these reasons apply to small, low-income and highly exposed countries that have overstretched tax bases and highly correlated infrastructure risks (Linnerooth-Bayer and Mechler 2004; Hochrainer and Pflug 2009). Realizing the shortcomings of after-the-event approaches for coping with disaster losses, sovereign insurance may become an important cornerstone for tackling the substantial and increasing effects of natural disasters (Gurenko 2004). This message became clear to the Mexican authorities after experiencing the 1985 earthquake in Mexico City. Colossal expenses on rehabilitation and reconstruction resulted in an increase in the fiscal deficit of \$1.9 billion over the next four years (Cardenas *et al.* 2007). In 1996 the authorities created a financial risk management program (FONDEN) including a catastrophe reserve fund. In 2005, after the severe hurricane season, the FONDEN fund was exhausted, leading the Finance Ministry to consider hedging against natural disaster shocks. As a result, the authorities recently engaged in an international risk-transfer transaction to provide financial protection to the fund. Mexico has thus become the first transition country to transfer its public sector catastrophe risk to the international reinsurance and capital markets (see Cardenas *et al.* 2007).

5.2 Insuring donors that insure governments

Like governments, donor organizations provide assistance, sometimes in the form of cash payments, for post-disaster relief. In the case of large-scale droughts and other disasters, donor organizations and the institutions they support can be strapped for cash. In this case, the organizations, themselves, might consider insurance.

This was the reasoning behind an innovative idea by the World Food Programme in Ethiopia. One of the objectives was that those in need of assistance should be helped before they have depleted their productive assets. In that way the long-term costs of supporting households can be significantly reduced. According to Wiseman and Hess (2007), the potential for combining index-based approaches and safety net tools is substantial. Well-established safety net programs, such as the PSNP (Productive Safety Net Programme) in Ethiopia, can be scaled-up relatively quickly to ensure that resources can reach beneficiaries before negative coping strategies are employed. A recent survey showed that beneficiary households have lower levels of asset depletion after disasters than non-beneficiary households. There are also spin-off benefits. Most importantly, the predictability of the system and the monitoring/evaluation systems can lead to more comprehensive contingency planning.

However, like in other index-based systems, a limitation of the Ethiopian insurance approach is basis risk, which has to be carefully managed both in terms of designing the index and explaining the product limitations to the user. A more problematic limitation of this system is its integration with other donor-supported programs targeted to those chronically short of food, and especially nomadic herders, who are difficult to include in the PSNP. Mainly for this reason, the system is recently being modified.

5.3 Pooling small states' sovereign risks

As discussed earlier, larger countries can generally absorb the impact of adverse natural events since the affected region can be subsidized by revenues from unaffected regions. This type of geographic distribution of risk is not possible for many small states, and for this reason they can benefit from pooling arrangements stretching beyond their borders. Only few such vulnerable developing countries, however, have insurance. Exceptions include Colombia, Madagascar, Honduras and Barbados. A limitation facing small states intent upon transferring their risk is that they pay international prices subject to wide fluctuations. For example, Barbados experienced a ten-fold increase in insurance premiums after Hurricane Andrew in 1992 despite the fact that the island does not lie in a major hurricane path.

Partly to avoid this limitation, the Caribbean Catastrophe Risk Insurance Facility (CCRIF) was recently established to provide the Caribbean Community (CARICOM) governments with limited, but immediate, liquidity in the event of a major hurricane or earthquake at a significantly lower cost than if they were to purchase insurance separately in the financial markets. Early cash claim payment received after an event will help to overcome the typical post-disaster liquidity crunch (Ghesquiere *et al.* 2006). The facility appears well protected against insolvency with reinsurance and pro-rated contracts. Once again, a major concern about the long-term acceptance and viability of the pool is basis risk. For instance, Hurricane Dean (2007) imposed damages on Jamaica, but not sufficient to trigger compensation from the pool.

6. EFFECTIVENESS OF CURRENT PROGRAMS

How effective are insurance mechanisms and programs for providing developing country households, businesses, farms and governments security against natural perils? This discussion has described many innovative and promising recent programs, but experience is too short to fully assess their current and prospective role in genuinely reducing the financial burdens of disaster shocks. With an eye to the role of insurance in high-income countries, it is possible, even with their short operating experience, to glean some insights on the effectiveness of insurance mechanisms. Effectiveness is multi-dimensional, and depends ultimately on the benefits, costs and risks of insurance systems compared to other types of risk-management activities. We will focus mostly on (at least in principle) quantifiable dimensions here.

Indicators and criteria's used to assess programs and potential schemes include risk aversion of the relevant risk bearers, affordability of fair insurance premiums, intervention needs (due to inefficiencies or possible marked distortions due to outside support), solvency and sustainability issues of programs, moral hazard and adverse selection problems, basis risk, institutional stability as well as trust, and pricing issues under dynamic conditions (such as climate change). It should be noted that not all indicators can be assessed rigorously here and in some cases a focus on specific indicators is given as these are necessary conditions before others can come into focus. However, we tried to incorporate different dimensions in our discussion to emphasize the multi-dimensional aspects to adequately assess effectiveness of such programs.

6.1 Benefits of insurance in developing countries

Insurance is generally considered to have a fundamental role for the operations of modern society and a necessary precondition for economic development (Brainard 2008). By sharing losses geographically or temporally, it allows risk-averse individuals and businesses to limit their losses in case of an event. By transforming uncertain large losses into a certain annual premium individuals and businesses are able to seek higher-risk, higher profit activities (Liedtke 2007). Not only does insurance provide a context for higher profit activities, but by providing low-income households, farmers and businesses with the right to post-disaster liquidity, it lessens the burdens from disasters by securing livelihoods and expediting the recovery process. For many, an insurance contract is more dignified and reliable than dependency on the *ad hoc* generosity of donors.

Insurance instruments can also have large payoffs to governments. Due to limited tax bases, high indebtedness and low uptake of insurance, many highly exposed developing countries cannot fully recover by simply relying on limited external donor aid (Mechler 2004). By providing ex post liquidity that enables governments to provide relief to the most vulnerable and to invest in reconstruction and recovery – and quickly get back on their feet - insurance reduces long-term losses and the significant development setbacks from disasters (Cardenas *et al.* 2007). Just like investments in prevention, insurance can therefore save lives and livelihoods. With internationally backed risk-transfer programs, developing country governments will rely less on debt financing and international donations, and assured funds for repairing critical infrastructure will attract foreign investment.

Insurance instruments can also provide incentives to reduce risk, but only if they do not themselves encourage negligent behavior. For example, in Mauritius, for each crop season farmers are placed on a 100-point scale, which determines the level of premium to be paid as well as the indemnity level they will receive in the event of a claim. As farmers improve or worsen their claims record, they are moved on the scale (Roberts 2005). Index-based insurance provides these incentives more indirectly. The already mentioned livestock-insurance scheme for Mongolian farmers, for instance, can only gain by taking measures to protect their herds against adverse winter weather since insurance claims are based on average livestock loss in designated regions.

6.2 Costs of insurance in developing countries

The benefits of insurance make it a potentially integral part of an overall disaster risk management strategy. However, as documented throughout this discussion, these benefits come at a cost. In contrast to other types of insurance (e.g., for health or funeral expenses) insurers offering cover for co-variant risks face large, stochastic losses and thus must hold expensive capital reserves, diversify or purchase reinsurance, all of which “load” or add to its cost. Moreover, providing insurance at a small scale involves high transaction costs for reaching clients, estimating risks and handling claims. For example, enlisting new clients in the *Afat Vimo* microinsurance scheme in India costs about the same as the premium, and

the cost of processing claims about three times the premiums. Transaction costs are also proving high for alternative sovereign insurance instruments such as the catastrophe bond in Mexico (Cardenas *et al.* 2007).

Because of the transaction and capitalization costs, catastrophe insurance premiums are often substantially higher than the long-term actuarially fair risk premium. This means that governments and individuals can pay significantly more for disaster insurance than their expected losses over the long term. For example, in the Caribbean region, insurance premiums (paid mostly by businesses) were estimated to represent about 1.5% of GDP during the period 1970–1999, while average losses per annum (insured and uninsured) accounted for only about 0.5% of GDP (Auffret 2003).

With these high costs, it is pertinent to ask how insurance mechanisms can serve low-income clients facing high risk? As current programs demonstrate, insurance premiums are made affordable by targeting higher income clients, limiting coverage, providing outside support and forming partnerships. The TCIP and BASIX systems target middle-income property owners and farmers, respectively. The *Proshika* scheme limits claims to twice the amount in the savings account; in Malawi, the insurance covers only the cost of the seed: in the case of the Caribbean pool, insurance amounts to only about 20% of estimated losses to public infrastructure. Voluntary support from NGOs and international assistance support also adds significantly to the affordability of insurance. Arguably, the Afat Vimo and Malawi programs, and also Swiss Re's recent initiatives in Africa, would not be possible without the significant support they receive from NGOs. The reinsurance and catastrophe bonds that transfer risks from Mexico and Ethiopia to the international capital markets were made possible by outside technical support from IFIs and other types of start-up assistance. The World Bank not only pays the often significant costs of starting up systems, but has also helped capitalize the insurance pools in Turkey and Mongolia. The Indian pro-poor regulations explain the predominance of microinsurance in India, which is made affordable through extensive cross subsidies. Direct taxpayer and donor subsidies are also significant for the Afat Vimo system, Mongolia, and the Caribbean pool.

6.3 Risks of insurance in developing countries

The compelling benefits of pre-disaster financing strategies, if tailored to the needs of developing countries, and the prohibitive costs of these strategies for low-income individuals and fiscally strapped governments, makes a strong case for donor-supported public-private insurance systems to serve the poor. Yet, as recent and past experience in developing and developed countries shows, there are risks to an insurance strategy. Broadly, these risks can be categorized as resulting from:

- the solvency and sustainability of insurance systems;
- inefficiencies and market distortions arising from outside support;
- moral hazard, adverse selection and basis risk;
- institutional stability; public confidence and trust;
- modelling and pricing uncertainties;
- climate change.

The solvency and sustainability of insurance systems

Keeping in mind that recent insurance systems and initiatives offering cover for natural perils in developing countries are, for the most part, still in pilot stages, and none have experienced a major and widespread catastrophic event, it is important to examine their viability and sustainability in the longer run. This issue is all the more pressing given recent experience of insurance serving high-income clients,

especially the flood insurance program in the US, which despite a largely diversified system and public involvement is facing strong pressures from Hurricane Katrina and other recent catastrophes. Moreover, the withdrawal of private insurers from high-risk markets in the US and insurer insolvencies after the 2005 hurricane season also raise warning signals for insurance in high-risk developing countries.

Inefficiencies and market distortions arising from outside support

Despite compelling arguments for internationally supported partnerships between insurers, NGOs and governments, there are concerns that excessive support will distort market prices and greatly jeopardize the incentive effects of insurance, crowd out private initiatives, and create unstable systems due to the inability of donor institutions to make long-term commitments. Critics rightly point out that subsidized premiums in the US farm insurance program have weakened incentives to plant more robust crop varieties, or to move away from farming in high drought or flood risk areas. If the intent is to provide transfers to the poor, it is argued, it is far better to compensate them directly rather than subsidize insurance systems.

Tempering this argument is the fact that even donor-supported insurance has a greater incentive effect than the current practice of free public assistance to disaster victims. While there is a great deal of concern about distorting prices and thus giving the wrong signals for risk reduction, it is also important to keep in mind that risk markets may not be operating optimally and thus prices may already have distortions. Donors can compensate for price distortions by linking their support with vulnerability reducing measures. The challenge is thus to design incentive compatible public/private programs, such as those in Mauritius and Mongolia.

Moral hazard, adverse selection and basis risk

Moral hazard and adverse selection have contributed to the reluctance of private insurers to enter many catastrophe markets, most notably flood coverage, and motivated governments to form public-private insurance systems. As noted above, moral hazard can be countered with measures, like in Mauritius, that provide incentives for insurance clients to take protective measures. Besides setting premiums to reflect individual risks, insurers can set high deductibles and otherwise fashion contracts that share responsibility (e.g., co-insurance). Even in developed countries, however, insurers are understandably reluctant to invest heavily in monitoring risk behaviour, preferring to rely on the government to regulate risk-reduction measures. This is the explicit strategy of the French national insurance system, although incentives have been added to the insurance system. Claimants receive less and less payments for repetitive damages.

Risks of adverse selection and moral hazard facing conventional insurance systems are absent in the case of index-based programs, for example, in Malawi, Mongolia, Ethiopia and the Caribbean. Yet, basis risk may be one of the most difficult challenges facing these programs. Will farmers in Malawi or governments in the Caribbean continue supporting a system if a major loss occurs for which they are not compensated, especially (as in Malawi) if clients are not well informed about basis risks? This question has been raised in the Caribbean, where Hurricane Dean swept across Jamaica but did not trigger payment from the pool. The non-payment became an issue in the Jamaican elections that followed closely after the hurricane. Although the government continues to support the pool, the controversy highlighted problems in designing an appropriate index. Not only are there concerns about the hurricane index in the Caribbean, but also in Mongolia, where a fraudulent animal census could greatly prejudice the insurance outcome.

Institutional stability, public confidence and trust

The Mongolian case raises a more general issue. Are implementing institutions and governance systems stable and trustworthy, a condition essential for the sustainable operation of insurance systems? Without competent regulatory bodies that assure conditions for both insurers and clients, the market cannot provide sustainable insurance contracts. Among other reasons, there will be no protection for clients if insurers renege on claims, and well capitalized firms will be undercut by those with insufficient capital.

Responses to the Malawi survey showed widespread mistrust in the implementing institutions and insurance mechanisms, notably in the administering NGO, the private insurer and the weather station data. Even more worrying is the apparent lack of understanding of the insurance contract. Many farmers in Malawi did not fully understand the index-based system. In India, there are concerns that farmers' enthusiasm for the BASIX system is based on generous payouts in recent years. Will farmers continue to pay premiums after several "good" years with no payout? Misunderstandings and misinformation are a serious problem even in industrialized countries, which became apparent after the acute disappointment of Hurricane Katrina victims with respect to the extent of their flood and wind insurance coverage.

Fraud can also plague insurance systems. The risk of census fraud in Mongolia is not an isolated concern. In Mexico, purchasers of the catastrophe bond are protected by international controls, but there is no guarantee that post-disaster payments to FONDEN will be appropriately allocated to help the most vulnerable. It should be kept in mind, however, that fraud is a major issue with the alternative of free post-disaster donor assistance.

Modelling and pricing uncertainties

Data quality and availability are crucial factors determining the feasibility and viability of insurance schemes. Increasingly, methodologies are available to calculate risks now and in the future, yet a history of observations is necessary. Data availability was good in Malawi and the Caribbean; however, for example in Madagascar there is a need for collecting data and keeping time series of weather and extreme event observations (World Bank 2008). In terms of modelling, in all instances state-of the art methods were utilized involving catastrophe or weather simulation. Catastrophe models typically generate probabilistic losses by simulating stochastic events based on the geophysical characteristics of the hazard and combining the hazard data with analyses of exposure in terms of values at risk and vulnerability of assets. In addition, there has been important progress in the mathematics of extreme value theory, and in the convergence of the theories of finance and insurance, rendering possible the pricing of more exotic risk-transfer instruments, such as weather derivatives and catastrophe bonds (Embrechts *et al.* 1997). Such advances in modelling have generally made feasible the implementation, analysis and donor support of risk-transfer programs in developing countries and made it possible to better estimate and price low-probability extreme event risks, even if there are limited historical data available.

Climate change

Finally, climate change will likely impose additional stress and risks on weather insurance. Weather-related disasters are increasingly viewed as intensified by the emissions of greenhouse gases on the part of northern-hemisphere countries, in addition to land-use and other local practices. The Intergovernmental Panel on Climate Change (IPCC) has predicted that climate change will increase weather variability as well as the intensity and frequency of climate-related extremes and there is some evidence of a current "climate signal" with the IPCC (2007) reporting observations of long-term and widespread changes in

wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones.

There is growing acknowledgement on the part of insurers that the impact of climate change on future weather losses may be profound. The chairman of Lloyd's of London deemed climate change to be its number-one issue, and Europe's largest insurer, Allianz, stated that "climate change stands to increase insured losses from extreme events in an average year by 37 percent within just a decade while losses in a bad year could top US\$400 billion" (quoted in Mills 2007). After its members suffered US\$7 billion in projected insured flooding losses during the summer of 2007 (130,000 claims), the Association of British Insurers is currently calling on the government to step up its investment in flood defences as a necessary condition for maintaining insurability (ABI 2007).

However, modelling of climate change impacts for weather related extremes within insurance models are still in its infancy. The output of Global Circulation models (GCMs) or regional downscaling models are not useful here as they calculate changes in averages, such as mean rainfall or mean temperature changes, but not changes in the variability which would be actually needed here. One way to overcome this problem is to re-run the models very often and using the variability of the results as an indication of the variability of the future weather. Especially for index-based insurance arrangements, at least from the supply side perspective, such an approach seems fruitful as the changing weather patterns, such as rainfall over a given time period, can be directly linked to the claim payments, which in turn enables the insurer to calculate its ruin probabilities and therefore also the premiums (see for example Hochrainer, Mechler and Pflug 2009). For loss based insurance types there is the additional challenge of estimate future exposure and vulnerability levels of their asset portfolio. It seems clear that with such large uncertainties high loading factors for extremes within the premium calculation are used (see Froot 2001). This will make insurance unaffordable for most people, especially the poor. One way to overcome this problem is to establish public-private partnerships where for the extreme risk the government acts as a reinsurer.

6.4 Role of donors, NGOs and other international organizations

There are compelling reasons for the donor community to follow the examples of financial institutions like the World Bank and the World Food Programme and invest in risk-transfer programs. By sharing responsibility with individuals and the state, donors leverage their limited budgets and substitute a calculable annual commitment to a financial risk transfer system for the unpredictable granting of post-disaster aid. Viewed as an alternative to post-disaster assistance, support of insurance programs has the added advantage of requiring detailed assessments of risk and thus directing early attention, not only to insurance, but to prevention. What makes donor-assisted risk-transfer programs attractive are thus the mutual benefits to developing countries and the donor community in reducing the long-term need for assistance.

Despite these benefits, the appropriate role of donors, NGOs and other international organizations with respect to their support of insurance in the developing world is controversial. This role was debated by experts at a meeting on *Insurance Instruments for Adaptation to Climate Risks* in Laxenburg, Austria (Linnerooth-Bayer *et al.* 2007). The arguments can be roughly characterized as follows:

- *Against outside assistance:* Financial and other types of donor support for enabling insurance, especially if in the form of direct subsidies, will lower premiums and therefore lessen incentives for reducing vulnerability. As a case in point, the highly subsidized US crop insurance program has led to inefficiencies caused by farmers planting in very high risk areas. If the intent is to provide transfers to the poor, it is argued, it is far better to provide direct cash transfers directly rather than subsidize insurance systems. Not only is excessive outside support for public-private systems inefficient, but it risks crowding out private capital necessary for fledgling insurance

markets. While partnerships, like the TCIP, actually create an opportunity for the private market to carry out business, there is danger that by offering deep premium subsidies ill-conceived public-private partnerships may prevent private companies from entering the market. Finally, donor institutions seldom make long-term commitments, thus jeopardizing the sustainability of insurance programs dependent on their support. For all these reasons, donors should restrict their assistance to correcting market failures, e.g., information deficits and the private provision of public goods.

- *Pro outside assistance:* The disaster insurance market is not fully efficient even without subsidies, nor can it be expected to provide insurance to vulnerable individuals and governments unable to pay the (full) price. Moreover, direct cash transfers sufficient to build an insurance market for these risks are unlikely, given current levels of support from DFID (Department for International Development, UK) and others. The alternative to supporting insurance systems is *not* reducing poverty to the extent that all citizens of the developing world will be well insured (even developed countries have not achieved this), but the alternative is, rather, continuing to aid victims after disasters strike. Post-disaster aid is characterized by even greater inefficiencies than subsidized insurance programs, as well as being ad hoc and undignified. Moreover, insurance as opposed to post-disaster aid can create a favourable environment for investment. For these reasons, donor-supported insurance systems are a legitimate route for addressing poverty, especially if they keep market distortions as low as feasible. It was precisely this motivation that resulted in the social insurance systems that contributed so greatly to the equitable development of Europe and other industrialized countries. The case is stronger given the responsibility of industrialized countries for the damage inflicted by greenhouse gas emissions on vulnerable and low-emitting countries. Since the global market is already massively distorted by the failure of the developed world to internalize these costs, support for adaptation measures, such as insurance, is not only justified, but a moral imperative.

Experts at the Laxenburg meeting explored a middle way between these two views. Most participants agreed that, if at all, donors should contribute only to sustainable, incentive-compatible insurance programs that serve clients who cannot be served by the commercial market. It is important thus to reduce the cost of insurance for those who cannot afford it through minimally distorting interventions. Donor support might thus take the following forms:

- Providing improved information (e.g., assistance in conducting risk assessments), market institutions (e.g., insurance regulations) and market infrastructure (e.g., weather stations);
- Assisting in the delivery and administration of insurance contracts;
- Reducing the price of high layers of risk (the low-probability, very high impact events) but maintaining the “pure risk price” on lower levels (e.g., by providing low-cost reinsurance or directly absorbing these risks);
- Pooling insurance programs that have uncorrelated or negatively correlated risks, e.g., the spatially differential effects of El Niño events in Africa;
- Brokering reinsurance deals, e.g., the case of the Caribbean pool.

In sum, there are many issues both pro and con donor support for insurance. A middle way forward would avoid excessive support that distorts market prices and crowds out private capital, but would enable highly exposed poor communities and governments to access insurance.

7. CONCLUDING REMARKS

The question motivating this discussion was whether developing countries should follow the path of the developed world in building public-private partnerships to insure against catastrophic events, and

which insurance instruments and modifications may be appropriate for better tackling the developmental dimensions of natural disasters?

While most would agree that private and social insurance systems have provided security against old age and disability, unemployment, and other risks in the developed world, the record of insurance for providing security against floods, earthquakes and other hazards is more tenuous. Due to the specific nature of covariant risks, insurance penetration is weaker and uneven. Private insurers have been reluctant to commit capital to many types of hazards; adverse selection and moral hazard continue to plague indemnity-based systems; subsidies have proven disruptive to markets; private and national programs alike are often under-capitalized; and climate change appears to be contributing to increased insurance losses and, in some cases, insurability. These are problems that will limit the effectiveness of insurance in developing countries, as well.

At the same time, recent and innovative insurance programs in developing countries may potentially offer a preferred alternative to reliance on post-disaster donor aid. With this in mind, it is important to closely examine the development of nascent insurance systems throughout Asia, Africa and Latin America. As summarized below, this brief review has highlighted opportunities and challenges of many pioneering efforts that aim to provide security to low-income households, businesses, farms and governments:

- Micro-insurance systems are providing low-cost cover for disasters to low-income households and businesses, with an apparent large potential for scaling up. A challenge is to create public-private systems – backed by international expertise and capital –that can sustain major events and at the same time provide cover to those who cannot afford risk-based premiums. To serve developing country clients, who can afford sufficient cover, the challenge is to create favourable market conditions by putting into place the requisite regulatory bodies, such that private insurers can operate in non-subsidized markets;
- Early experience with index-based crop and livestock insurance suggests that it can be a cost-effective alternative to indemnity-based agricultural insurance, and avoids moral hazard and adverse selection. The challenge is to design systems that can operate in countries with weak financial and regulatory institutions, that minimize moral hazard and that promote public trust;
- Insurance and alternative insurance instruments are already providing security to vulnerable governments. There is significant potential for these instruments to supplement international assistance in assuring sufficient and timely capital for the recovery process. In light of the significant costs of these instruments, the challenge is to identify the appropriate layers of risk to transfer and the lowest cost/risk solutions;
- By spreading risk across hazards and regions, regional, national and (potentially) global pools for public- and private-sector risks can greatly reduce the cost of risk bearing. A challenge is to develop unified risk estimation procedures and a common “risk culture” for the regions and countries involved.

In sum, there is large potential for insurance in the developing world: for changing the way development organizations provide disaster assistance, engaging the private sector in vast markets, providing reliable and dignified post-disaster relief, supporting adaptation to climate change and, not least, spurring economic development. There are also many challenges: assuring sustainability and affordability in light of co-variate risks and adverse selection; defining an appropriate role of donors in light of the inefficiencies of subsidies; and assuring that systems avoid moral hazard and contribute to “good” investments. Pilot programs are offering a testing ground that should be carefully monitored and built upon by governments, international development organizations, NGOs, private insurers, and the climate-adaptation community.

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