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Climate Change and Weather-related Disasters: What Role for Insurance, Reinsurance and Financial Sectors?

*Alberto Monti**

ABSTRACT

The adverse impacts associated with extreme weather events have increased over the last few decades, and this appears to be due to several factors, including climate change and global warming, the growth of urban development and population density in exposed areas, and a higher concentration of assets and values at risk. The growing impact of the direct and indirect costs associated with weather-related disasters worldwide calls for an evaluation of possible strategies to reduce their large-scale damaging effects. The design and implementation of effective financial management strategies to deal with the increasing costs arising out of extreme weather events require a proactive role of governments in direct and continuous collaboration with the private sector. This paper discusses possible roles of insurance, reinsurance and financial sector participants from a public policy perspective, with a view to understanding how they can contribute to the achievement of designated policy goals.

1. Introduction

As evidenced by recent dramatic events, the frequency and severity of extreme weather phenomena, such as droughts, floods and associated landslides, storms, tropical cyclones, ocean and coastal surges, heat waves, forest fires and cold snaps, have increased over the last few decades. Escalating impacts associated with these events appear to be due to several factors, including climate change and global warming, the growth of urban development and population density in exposed areas, and a higher concentration of assets and values at risk.

While the ongoing effects of global warming on climate extremes is debated in the scientific community,¹ a few things seem relatively clear:

* Professor of Law, Bocconi University, School of Law, Italy.

1. See Intergovernmental Panel on Climate Change [IPCC], *A Report of Working Group I of the Intergovernmental Panel on Climate Change, Summary for Policymakers*, in CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS. (Susan Solomon et al. eds.,

rising sea levels increase the risk of storm surges thereby increasing the exposure and vulnerability of assets located in coastal areas; increasing land and air temperatures exacerbate the risk of wild fires and drought and pose serious health risks for the population; and changing patterns of precipitation aggravate the risk of winter storms and floods.²

The growing impact of the direct and indirect costs associated with weather-related disasters worldwide³ calls for an evaluation of possible strategies to reduce their large-scale damaging effects.⁴ In this respect, the design and implementation of effective financial management strategies to deal with the increasing costs arising out of extreme weather events require governments to take a proactive role in direct and continuous collaboration with the private financial sector.

This paper discusses possible roles of insurance, reinsurance and financial sector participants from a public policy perspective, with a view to understanding how they can contribute to the achievement of designated policy goals.

2. Financial Management of Weather-Related Disasters: A Public Policy Perspective

From a public policy viewpoint, the rising costs associated with extreme weather events pose serious challenges to governments worldwide. The main issues in this field have been recently identified and addressed by the Organisation for Economic Co-operation and Development (OECD).⁵ The

Cambridge University Press 2007) available at <http://www.ipcc.ch/>; see also HARTMUT GRABL ET AL., WEATHER CATASTROPHES AND CLIMATE CHANGE – IS THERE STILL HOPE FOR US? (Munich Re's Geo Risks Research 2005).

2. Lloyd's, 360 Risk Project, in CLIMATE CHANGE REPORT (Lloyd's 2006), available at http://www.lloyds.com/NewsCentre/360_risk_project/The_debate_onclimatechange/. See also U.N. Env'tl. Programme Fin. Initiative [UNEP FI], *Adaptation and Vulnerability to Climate Change: The Role of the Finance Sector* (Nov. 2006), available at <http://www.unepfi.org/>.

3. The increases in disaster losses due to natural catastrophes primarily result from weather related events, in particular windstorms events and floods. See, e.g., MUNICH RE, TOPICS GEO NATURAL CATASTROPHES 2007 (Munich Re 2008); SWISS RE, SIGMA NO. 1/2008, NATURAL CATASTROPHES AND MAN-MADE DISASTERS IN 2007 (Swiss Reinsurance Co. 2008). See also MUNICH RE, TOPICS GEO NATURAL CATASTROPHES 2006 (Munich Re 2007); SWISS RE, SIGMA NO. 2/2007, NATURAL CATASTROPHES AND MAN-MADE DISASTERS IN 2006 (Swiss Reinsurance Co. 2007).

4. See CLIMATE EXTREMES AND SOCIETY (Henry F. Diaz & Richard J. Murnane eds., Cambridge Univ. Press 2008).

5. Established in 1961, the OECD is an intergovernmental organization based in Paris. The OECD brings together the governments of countries committed to democracy and the market economy from around the world to: support sustainable

OECD, in the context of a broader project focusing on the financial management of large-scale catastrophes (natural and man-made), established the OECD International Network to promote the exchange of information and experiences among policymakers, industry, and academia in OECD and non-member countries, and provide state-of-the-art expertise and policy advice.⁶

Key public policy questions include: Are governments in developed and emerging countries adopting efficient strategies to manage the increasing financial burden of catastrophes? What are the roles and responsibilities of key stakeholders in the public and private sectors in the management of disaster risks and costs? How best to prepare for the unprecedented challenges posed by large-scale risks?

Under the auspices of this project, the OECD just completed a survey and comparative review of different policy strategies and approaches with respect to the prevention, mitigation, and financial compensation of large-scale catastrophes in selected OECD and non-member countries. The comparative review focuses, in particular, on the approaches adopted by governments regarding financial coverage against disaster risks, and the respective roles of the public and private sectors in providing compensation and incentives to reduce the risk of catastrophic losses.⁷

The public sector is directly concerned with this issue and these questions for several reasons. First, the increasing financial impact of weather-related disasters on individuals and businesses may be significant, which could lead to large welfare losses and have broad macroeconomic consequences. Second, public assets, including buildings and infrastructures, are exposed to extreme climate risk and whose destruction or impairment may have economic impacts. Finally, in the aftermath of a catastrophe, the public authority will likely be under strong political pressure – or sometimes even under a legal duty – to provide compensation to victims. In light of the above, the availability of financial compensation

economic growth; boost employment; raise living standards; maintain financial stability; assist other countries' economic development; and contribute to growth in world trade. The OECD also shares expertise and exchanges views with more than 100 other countries and economies, from Brazil, China, and Russia to the least developed countries in Africa, <http://www.oecd.org>.

6. See <http://www.oecd.org/daf/fin/catrisk/>; ALBERTO MONTI, *Financial Management of Large Scale Catastrophes*, CATASTROPHE RISK MANAGEMENT, 20 (September 2006); ALBERTO MONTI, *Managing and Financing Large Scale Risks in OECD Countries. Challenges and Institutional Solutions*, INS. REG. & DEV. AUTHORITY J., vol. V, n.5, 13 (April 2007).

7. See ALBERTO MONTI, *Policy Approaches to the Financial Management of Large-Scale Disasters*, FINANCIAL MANAGEMENT OF LARGE-SCALE CATASTROPHES', POL'Y ISSUES IN INS. n.12, 11-142 (OECD Publishing) (2008).

and risk transfer tools *ex ante* can enhance economic efficiency and performance.

Many OECD countries have developed policies focused on the financial management of large-scale disaster risks with common goals of reducing the negative impact of disaster losses on the population and economy and facilitating and improving relief, rehabilitation and reconstruction efforts. In several OECD countries, moreover, policy objectives in this area expressly include the enhancement of disaster risk prevention, reduction, mitigation, adaptation and response strategies, and the reduction of government exposure to catastrophe risk. The long term goals of these policies are to minimize the total cost of disasters (i.e., the sum of disaster losses, the cost of preventive/mitigation measures and transaction costs) and build disaster-resilient societies. To implement such policies and to achieve the stated objectives, governments have employed a wide array of different policy tools and pursued different strategies.

In the aftermath of a catastrophe, governments in all OECD countries regularly provide some degree of post-disaster assistance and aid to the population. Emergency rescue and relief efforts are generally acknowledged to be part of the responsibilities of a State to its citizens. Such efforts are aimed at saving lives and providing temporary assistance to the population hit by a disaster event, and the costs of such measures are usually financed through the payment of taxes. In certain countries, emergency relief costs and sometimes also government exposures to public assets and critical infrastructure disaster losses are funded by dedicated catastrophe reserve funds, occasionally supplemented by market-based risk transfer tools.⁸

In terms of reconstruction costs and compensation of property damages and economic losses suffered by those affected by a disaster, the situation differs across jurisdictions. In some states the government directly provides, to a greater or lesser extent, compensation to property owners *ex post* by means of either permanent structural arrangements (such as compensation funds) or *ad hoc* disbursement of public funds on a discretionary basis.⁹

In a number of countries, pursuant to the principle of solidarity – often recognized at the constitutional level – the mutualisation of losses arising out of a disaster event is perceived as a fundamental right of the citizens, and the role of the government in the compensation phase is, therefore, considered essential. This is the case, for instance, in Belgium, France, Italy and Spain.

8. This is the case, for instance, of Mexico.⁸ See ALBERTO MONTI, *Policy Approaches to the Financial Management of Large-Scale Disasters*, FIN. MGMT. OF LARGE-SCALE CATASTROPHES, POL'Y ISSUES IN INS. N.12, 11-143 (OECD Publishing) (2008).

9. See *Financial Compensation for Victims of Catastrophes. A Comparative Legal Approach*, TORT AND INS. LAW VOL. 14 (Michael Faure & Ton Hartlief eds., Springer 2006).

In other countries, the protection of private property against disaster risks is to a large extent left to the initiative of the owners (i.e., businesses and individuals), with a view to highlighting individual responsibilities, minimizing moral hazard, and providing incentives to invest in cost-effective risk prevention and mitigation measures. In this respect, private insurance often plays an important role in the coverage of property damages and economic losses caused by large-scale events,¹⁰ but the level of disaster insurance penetration, as well as the actual terms and conditions of coverage, vary significantly across domestic markets.

In response to the peculiar insurability problems posed by catastrophic risks – such as the geographical and inter-temporal risk spreading issues and the high cost of capital to cover low-probability/high consequence risks – and in the context of country-specific disaster risks and other possible national factors, some OECD governments have entered into partnerships with the private insurance sector with the policy objective of making disaster insurance available to the general public at affordable rates and/or ensuring that private assets exposed to risk are duly covered by insurance. To this end, special institutional arrangements aimed at the explicit coordination of public and private actions have been set up to deal with losses caused by different catastrophic perils, including extreme weather phenomena, other natural catastrophes (e.g., earthquakes), accidental manmade disasters (e.g., industrial and technological accidents), and terrorist attacks.

Public sector participation in these explicit coordination schemes has often entailed one or more of the following: (a) the introduction of a mandatory or quasi-mandatory disaster insurance regime – to provide sufficient risk pooling and reduce the potential impact of adverse selection – and the provision of the necessary supporting legal and regulatory framework; (b) the provision of reinsurance arrangements, dedicated lending facilities, or other form of State guarantee, to limit private sector exposure in case of catastrophic losses and reduce the cost of capital to cover low-probability/high-consequence events; and (c) the creation of the basic preconditions for the private insurance market to work properly (e.g., regulations and measures concerning preventive and mitigation measures, land use, mandatory building codes, and emergency planning).

Generally, coping with issues related to natural catastrophes has led to the development of different policy approaches and institutional models where preventive and mitigation measures are accompanied by the implementation of specific public or private insurance coverage systems and other instruments. The design and implementation of a sound strategy to

10. See COMITÉ EUROPÉEN DES ASSURANCES [CEA], REDUCING THE SOCIAL AND ECONOMIC IMPACT OF CLIMATE CHANGE AND NATURAL CATASTROPHES (CEA 2007) available at <http://www.cea.eu/>.

manage the increasing financial burden of large-scale disaster costs at a country or regional level require, in fact, a coordinated and integrated approach, entailing several steps and involving all relevant stakeholders.

In this respect, it is worth noting that a proper technical understanding of the underlying risks, including risk differentials across regions, is a prerequisite for establishing a sound technical basis for financial arrangements and making them sustainable in the long run. Uncertainties associated with climate change do not facilitate the accomplishment of this task, since historical data on past events and losses are not sufficient to properly assess future probabilities.

In any case, once the relevant hazards, risks, vulnerabilities and exposures have been assessed, the expected financial burden of future disasters can be alleviated by the adoption of cost-effective risk prevention, reduction, mitigation, and response measures.¹¹ Such measures, however, cannot completely eliminate the direct and indirect costs of weather-related calamities.

To cover the economic costs of natural disasters, some countries have devised a framework of contingency measures either by way of establishing special government disaster funds or by promoting catastrophe insurance coverage, whereas other countries have decided to deal with the issue of emergency assistance and compensation for disaster losses on a purely *ex post*, *ad hoc* basis, with a minimal or non-existent level of *ex ante* commitment of financial resources.

The level of *ad hoc*, *ex post* government intervention for the compensation of losses due to natural disasters varies significantly across OECD countries. Some countries rely almost exclusively on an *ex post* approach. In Italy, for instance, *ad hoc*, *ex post* compensation of disaster losses by the State is the rule, with limited or no involvement of the private insurance sector. Other countries use *ad hoc*, *ex post* compensation as a complement to other funding mechanisms, such as structural catastrophe funds or disaster insurance.

The opportunity to develop an *ex ante* strategy for the financial management of large-scale catastrophes is generally suggested by the observation that purely *ex post* approaches to the compensation of disaster losses may have several limitations. In many cases, *ex post*, *ad hoc* funding is cost-ineffective and untargeted. Delivery of compensation is often too slow and, if the hazard risk exposures are significant, the fiscal burden may be unsustainable for the public authorities in the long run. Moreover, *ex post* allocation of public funds to meet critical needs may divert resources from

11. See U.N. secretariat of the Int'l Strategy for Disaster Reduction [UN/ISDR], *Words Into Action: A Guide for Implementing the Hyogo Framework* (Apr. 30, 2007); UN/ISDR, *Indicators of Progress: Guidance on Measuring the Reduction of Disaster Risks and the Implementation of the Hyogo Framework for Action* (U.N. Jan. 2008).

other projects, and critical decisions have to be made under political pressure. Furthermore, *ad hoc* compensation likely entails inequalities in treatment and discontent. Finally, even if the matter is not straightforward, *ad hoc, ex post* compensation mechanisms may also entail moral hazard, reducing the incentive to take precautions *ex ante* and increasing the total cost of disasters.

Possible *ex ante* solutions include the establishment of dedicated catastrophe funds, market-based or state-sponsored disaster insurance and reinsurance programs, alternative risk transfer (ART) and alternative risk financing (ARF) tools – such as risk securitization and contingent capital arrangements – allowing broader risk spreading through capital markets. The establishment of dedicated catastrophe reserve funds, with special appropriations in the public budget or prior legislated spending authorities, requires some degree of *ex ante* financial planning and a commitment of public money to cover emergency relief costs and, sometimes, post-disaster reconstruction costs. Since rules on the use of such funds in case of a disaster are established *ex ante*, money can be disbursed promptly and a relatively consistent treatment of similar situations is ensured across time. Such rules may also limit moral hazard by limiting the scope of government compensation (e.g., strictly defining eligible damages and placing a cap on the level of public assistance).

In Hungary, for instance, the Fund for Flood and Inland Water Compensation (*Wesselényi Miklós*) regulates the compensation of flood damages. Individuals who own real property in risky regions of Hungary pay contributions to the Fund and, based on these contributions, are entitled to indemnification in the case of loss. The Fund is co-financed by government budgetary support if it lacks enough resources to fulfill its obligations. Along the same lines, in Austria, the Catastrophes Fund covers parts of the damages caused by natural disasters and further help is provided by special laws enacted on an *ad hoc* basis. Similarly, limited *ex post* compensation is available in Poland through various dedicated funds and budget allocations. In Mexico, the Natural Disasters' Fund (FONDEN), created by the federal government, provides support, in a complementary manner and within the limits of its resources, in case of emergency and natural disaster situations.

Public catastrophe reserve funds may not be economically or politically viable to finance the expected costs of low probability disaster events, such as events with a return period of 100 years or more, due to the extremely long time horizon. Moreover, if catastrophe funds are aimed at covering not only emergency relief costs and public infrastructure losses, but also damage to private property owned by businesses and individuals, moral hazard may arise, and the incentive to take precautions could become very low, particularly if the catastrophe funds are not well-designed or if the rules governing these funds are not perceived to be credible.

In many OECD member countries, there is some degree of coordination (sometimes explicit – for example, in the form of institutional

arrangements) among stakeholders for the prevention, mitigation, and coverage of future potential losses caused by large-scale disasters. In the context of such coordination schemes, particularly those institutional in character, insurance and reinsurance sector participants, capital markets, and public authorities have a defined role to play. These solutions are not necessarily public-private partnerships (PPP) arrangements *per se* (a PPP is a voluntary association of both public and private actors seeking to address common goals through shared resources and skills), but are nevertheless based on some level of mutual understanding of disaster risk exposures and broad assumptions regarding the respective roles played by the public and private sectors.

The aim of such coordination is mainly to orchestrate the efforts of the various stakeholders involved by setting up a clear framework for action. Coordination may take place spontaneously, when economic actors recognize that cooperative behavior serves the interests of all parties involved. Spontaneous coordination between the private and the public sectors generates an implicit partnership. In the United Kingdom, for instance, insurance coverage against flood damage has been a standard feature of household policies since the early 1960s and the British insurance industry was able to make this commitment to its customers on the understanding that the UK government would provide effective flood defenses.

With implicit partnerships, the coordination between public and private sectors (and other stakeholders for that matter) is subject to a degree of uncertainty and may lead to opportunistic behavior. Explicit partnerships – in the form of institutional arrangements where risks, duties and responsibilities are clearly allocated among the various participants – may facilitate more stable and reliable coordination efforts. With explicit arrangements, there is a basic understanding among all stakeholders regarding the allocation of responsibilities for the taking of precautions, as well as responsibilities for the assumption of risks and losses. It should be noted that this does not necessarily require the State to take charge of the compensation of disaster losses or provide a financial commitment in support of private insurance; what is important is that mutualization options for protecting against catastrophic losses are clearly understood and debated before a major disaster. Individuals, businesses, central and local authorities will then be aware of the expected roles played by different stakeholders in dealing with large-scale disasters and of their expected financial exposures.

3. The Role of Insurance, Reinsurance and Financial Sectors

In OECD countries, insurance coverage plays an important role in the financial management of large-scale natural disasters. In several countries, including Belgium, France, Norway, Spain, and Switzerland, for instance,

where inclusion of natural disaster risks in fire and/or other property insurance policies is mandated, most natural disaster losses incurred by households and businesses are covered *ex ante* by insurance companies. Likewise, flood risks in the United Kingdom are largely covered by the private insurance market.¹²

Climate change, however, poses serious threats for the insurance and reinsurance sectors worldwide. The increased frequency and severity of extreme climatic events entail a growing exposure of insurance and reinsurance companies across different lines of business including property, business interruption, life, health and liability. From an insurance viewpoint, the ongoing change in intensity and distribution of extreme weather events creates uncertainty and requires constant monitoring and adaptation of underwriting standards.

The threat of a mega-disaster striking a major inhabited area, for instance, has dramatically altered the insurance environment. Today many insurers and reinsurers indicate that they cannot continue to provide the same level of coverage against hurricanes and floods without incurring an excessive risk of insolvency or substantial losses of capital or surplus. These concerns stem from a balanced reassessment of the insurance industry's financial exposures following recent heavy losses.

The insurance market depends on the ability to pool homogeneous but uncorrelated risks faced by a large number of policyholders. When a large number of uncorrelated risks are pooled, insurance companies can predict with considerably greater certainty the average occurrence of a particular insured event, and thus can efficiently provide financial coverage based on the reduction of uncertainty. The ability of pooled risks to reduce uncertainty diminishes when the risks of policyholders are correlated, as in the case of disaster risks.¹³

A related problem with disaster insurance concerns the ability of the traditional insurance mechanism to properly manage low probability and high consequence (LPHC) events, such as major natural catastrophes. The insurance and reinsurance capacity for large-scale risks is ultimately limited

12. See ALBERTO MONTI, *Policy Approaches to the Financial Management of Large-Scale Disasters*, 12 POL'Y ISSUES IN INS., 11-142 (2008).

13. See, e.g., 8 POL'Y ISSUES IN INS. (2005) (in particular Part I *Insurability of Catastrophic Risks*). See also John R. Coomber, *Natural and Large Scale Catastrophes – Changing Risk Characteristics and Challenges to the Insurance Industry*, 31 THE GENEVA PAPERS ON RISK & INS. ISSUES 88-95 (2006); Dwight Jaffee & Thomas Russell, *Markets Under Stress: The Case of Extreme Event Insurance*, in *ECONOMICS FOR AN IMPERFECT WORLD: ESSAYS IN HONOR OF JOSEPH E. STIGLITZ* (Richard Arnott et al. eds., MIT Press 2003); Kenneth A. Froot, *The Market for Catastrophe Risk: A Clinical Examination*, 60 J. OF FIN. ECON. 529-71 (2001); M.G. Faure, *The Limits to Insurability from a Law and Economics Perspective*, THE GENEVA PAPERS ON RISK & INS. ISSUES 454-62 (1995).

and the financial management of such risks may be quite costly for the industry, mainly due to the sheer magnitude of potential insured losses (i.e., the size of aggregate claims in case of a disaster) and the inter-temporal mismatch between the size of annual premiums and the size of the annual expected losses.

The risks of losses from weather-related catastrophes can be correlated both temporally and spatially, and this creates the above mentioned geographical and inter-temporal risk spreading problems. The accumulation of risk can be quite high in the primary market, since the same catastrophic event can cause losses involving many different insured properties and infrastructures at the same time, giving rise to potentially immense claims burdens in a single policy period. International reinsurance and the possible bundling of different perils may address this issue.

A further problem concerns the lower level of predictability of certain catastrophic risks relative to other insurance risks. Until recent years, there has been a general lack of reliable data and objective information concerning the economic effects of natural disasters. Considerable uncertainty is associated with the estimation of the probability of disasters of different magnitudes occurring and the size of the resulting losses. Technology and computer modelling of natural perils have only recently reached the point where such risks can be clarified. Climate change poses new challenges assessing these weather-related risks.

Finally, on the demand side, it has been demonstrated that the bounded rationality of most individuals may lead them to underestimate or ignore LPHC risks. Even a reasonably priced catastrophe insurance coverage, therefore, may often be perceived by prospective policyholders as too costly.¹⁴

Notwithstanding the above, interesting business opportunities for the insurance and reinsurance industry are generated by a growing demand for coverage in a riskier environment.¹⁵ It is generally recognized, in fact, that the insurance and reinsurance industries are a lever of economic development and have developed substantial expertise in risk management. Therefore, they will play a critical role in addressing global challenges such as those posed by climate change and extreme weather events.

14. See, e.g., C.F. Camerer & H.C. Kunreuther, *Decision Processes for Low Probability Events: Policy Implications*, 8 J. OF POL'Y ANALYSIS & MGMT. 565-92 (1989).

15. Andrew Dlugolecki, *Climate Change and the Insurance Sector*, 33 THE GENEVA PAPERS ON RISK & INS. ISSUES 71-90 (2008); Arthur Charpentier, *Insurability of Climate Risks*, 33 THE GENEVA PAPERS ON RISK & INS. ISSUES 91-109 (2008); EVAN MILLS & EUGENE LECOMTE, FROM RISK TO OPPORTUNITY: HOW INSURERS CAN PROACTIVELY AND PROFITABLY MANAGE CLIMATE CHANGE (CERES 2006); ASS'N OF BRITISH INSURERS [ABI], FINANCIAL RISKS OF CLIMATE CHANGE (ABI 2005).

In the context of an implicit or explicit coordination scheme involving the public and private sectors, the insurance and reinsurance industry can contribute significant technical expertise, operational capabilities and financial capacity in various phases of the disaster risk management process. Examples of such expertise and capabilities include: risk assessment, risk spreading, investment, and management of assets covering technical provisions, claims handling, and loss adjustment.

The availability of accurate disaster risk models, and the ability of the insurance industry to process claims arising out of a catastrophic event in an expedited manner, often turn out to be crucial elements in the success of the coordination schemes. The efficiency of a system providing voluntary or compulsory insurance coverage against disasters, in fact, largely depends on the professional expertise of insurance companies both in the underwriting and in the claims-handling phases. In several OECD countries, the private insurance sector has developed the requisite technical expertise for providing proper risk assessment and risk allocation mechanisms, rapid loss adjustment services, and effective incentives to reduce risk exposure.

The compensation of disaster losses through risk-based insurance policies is self-funded from premiums received. This mechanism makes insurance a reliable financial tool for managing and funding risk, because the insurance industry specializes in reserving and investing collected funds for the purpose of claims payment. With respect to natural catastrophe risk, a private insurance-based mechanism is more likely to have funds to cover losses over time than an *ex post* governmental aid disaster program, which may have to compete for funding with other programs that are subject to changes in the political climate. The solid experience of the private insurance sector in assessing risks and adjusting losses, moreover, may offer great advantages. Efficient and expedited claims settlement practices may lead to socially beneficial results. Risk-based insurance may be able to provide additional precautionary incentives for policyholders, through the mechanism of private surrogate regulation.

Governments in OECD countries have sometimes encouraged the use of private-sector insurance capacity by adopting regulatory, accounting, and fiscal measures concerning, for instance: the introduction of a mandatory or quasi-mandatory disaster insurance regime; the fiscal treatment of disaster insurance premiums, with a view to providing incentives to purchase coverage, and the possibility for insurance companies to establish tax-deductible reserve funds for catastrophic risk. The aim of such policies is to stimulate both the demand and the supply side in order to facilitate the

financial coverage of catastrophic risks by financial institutions and other private-sector participants.¹⁶

In Belgium, Denmark, Finland, France, Iceland, Japan, New Zealand, Norway, Spain, Switzerland, and Turkey, for instance, the private insurance sector actively cooperates with the public sector in the context of explicit coordination schemes. In some OECD countries, the role of the private insurance sector in the financial coverage of losses due to natural catastrophes and extreme weather events is currently under scrutiny, to a greater or lesser extent.

In several countries, insurance companies, either individually or through their industry associations, have also launched various initiatives aimed at raising public awareness of natural disaster risks and how to prevent or mitigate loss. These measures range from the publication of reports, studies, newsletters and brochures, to educational programs in schools (Japan), to the development of publicly accessible risk zoning models (Austria), to the provision of early warning systems (Germany). In Canada, the insurance industry founded, in 1998, the Institute for Catastrophic Loss Reduction, an independent, not-for-profit centre for multidisciplinary disaster prevention research, and the P&C insurance industry association is also actively involved in promoting prevention and mitigation. In the United States, private insurers support the Institute for Business and Home Safety, which conducts a wide variety of research and communications on building-related safety issues, and the Insurance Information Institute, which provides safety messages to the public.

If the insurance industry is called upon to play a central role in the financial management of large-scale natural disasters, then it is very important to make sure that insurance and reinsurance companies are able to perform the assigned tasks effectively. In this respect, the following areas deserve special attention:

- *Solvency of insurance undertakings.* The setting and enforcement of appropriate solvency standards are crucial to avoiding a large number of insolvencies among insurance firms in case of a disaster event. Catastrophe insurance requires access to very large capital resources and a very high level of capital allocation. If the insurance sector capital base is not sufficient to support high catastrophe risk retentions, reinsurance or alternative risk transfer tools (ARTs) become necessary. Insurance regulators and supervisors, therefore,

16. Information in this and subsequent paragraphs is derived from data provided by several countries that responded to an OECD questionnaire survey. See Monti, *supra* note 7.

should carefully monitor insurers' catastrophe reinsurance and ART arrangements.

- *Business continuity and crisis management plans.* The providers of insurance services must be able to withstand a disaster event, not only financially, but also from an operational viewpoint. As a consequence, insurance supervisors should check disaster preparedness and crisis management plans of insurance companies, in order to assess their ability to promptly and efficiently perform all the necessary services (e.g., loss adjusting, claims management, claims payment) in the aftermath of a disaster event.
- *Claims management practices.* Insurance supervisors should closely monitor claims management practices to ensure that disaster insurance claims are processed in a timely, fair, and efficient manner.

In the context of explicit coordination schemes with the insurance industry, some OECD governments have also decided to offer special reinsurance arrangements, dedicated lending facilities or other forms of backstops or guarantees to limit private sector exposure in case of catastrophic losses.

Where OECD governments have elected to make a financial commitment, they have acted, directly or through a special purpose entity, as:

- *Primary insurer:* The government acts as an insurer by providing insurance and responding to claims either to the fullest or up to a certain limit. Sometimes the private insurance sector contributes to the scheme by providing some operational capabilities (such as marketing and premium collection).
- *Reinsurer of last resort:* The government protects the insurance sector by offering special reinsurance arrangements. Government-sponsored reinsurance programs may be mandatory or optional for primary carriers.
- *Backstop liquidity provider:* The government provides liquidity to the insurers incurring payout burdens or losses due to a catastrophic event by means of a pre-arranged contingent loan facility.

- *Guarantor*: The government guarantees that any special purpose entity, pool or fund created to cover catastrophic risks will meet all its obligations.

Special risk-sharing agreements between the private and public sectors, mixing the above features, have also been implemented in some countries.

The government's decision to play an active role in disaster risk transfer schemes by making an *ex ante* commitment of financial resources is often linked with the resolution to introduce a mandatory or quasi-mandatory catastrophe insurance regime. The mandatory nature of the disaster insurance scheme is often cited as a key component of several institutional arrangements implemented in OECD countries. However, one must clarify the meaning of "mandatory" under a scheme. Some countries have made the purchase of catastrophe insurance coverage mandatory. Others have simply required insurance companies to make catastrophe insurance available, by introducing a mandatory offer of coverage that can be declined by the policyholder. In a number of countries, moreover, fire or other first party insurance policies are marketed on a voluntary basis, but insurance companies are required by law to include coverage for catastrophic risks in such policies: This is the case, for instance, in Belgium, France, Norway, Spain, and Switzerland.¹⁷ In this respect, it is important to note that different levels of compulsion reflect different policy objectives and market conditions, and have different advantages and disadvantages.

The mandatory offer of catastrophe insurance is consistent with the goal of ensuring that disaster coverage is available on the market, so that businesses and individuals who are willing to purchase financial protection can do so. However, low risk awareness or cognitive biases that may affect the demand side could lead to sub-optimal take-up rates, since prospective policyholders, who are not obliged to purchase catastrophe coverage, would not be able to make rational decisions. As a result, there could be several individuals who realize too late that they made the "wrong" decision when they elected not to purchase coverage. Moreover, if the penetration rate remains very low, this may generate insufficient risk pooling.

The mandatory purchase of catastrophe insurance is consistent with the objective of making sure that all those exposed to disaster risks, willing or unwilling, are covered by insurance, at least up to a certain extent. While this option – assuming that an effective enforcement mechanism is in place – ensures widespread diffusion of catastrophic risk coverage, it may be unpopular. It is, in fact, paternalistic, in the sense that it limits private autonomy, forcing everyone to purchase coverage. Such a choice may be justified not only by the above mentioned constraints to rational decision

17. With the exception of the cantons of Schwyz, Uri, and Obwalden, where fire and natural perils coverage is mandatory.

making but also by the risk of negative externalities (i.e., situations when individual's actions impose costs on others which are not reflected in the private cost function of the agent) and/or opportunistic behaviors. It may be argued, for instance, that the individual decision not to purchase financial protection against catastrophes *ex ante* imposes costs on the society as a whole (i.e., social costs), in terms of required post-disaster aid and/or negative macroeconomic consequences. More generally, this policy choice becomes less unpopular if the government is able to explain how, when compared to other mechanisms to compensate for disaster losses, a mandatory disaster insurance scheme can save taxpayers' money. To facilitate public acceptance of this option, it could also be explained that risk-based disaster insurance – when correctly priced, affordable, and linked to actionable measures by policyholders – provides financial incentives to encourage investment in cost-effective mitigation measures to reduce vulnerability and, as a consequence, contributes to the reduction of the social costs of disasters.

The mandatory inclusion of catastrophe coverage in basic property insurance policies (e.g., fire, homeowners, motor) marketed on a voluntary basis can be effective if the penetration rate of such basic policies is relatively high, so that they are used as a "vehicle" to spread catastrophe insurance coverage among businesses and individuals. Compared to the mandatory purchase of catastrophe insurance, this option entails a lower extent of compulsion and may, therefore, be less unpopular. However, it may have negative effects on the market for the basic property policy to which the mandatory catastrophe extension applies. First, there is a risk that those who do not perceive the benefits of disaster insurance, or who are rationally unwilling to purchase it, may decide to drop the basic property coverage due to the increased cost of the "package." It should nevertheless be noted that in some countries the widespread diffusion of basic property policies is due to a requirement imposed by mortgage lenders, so that the decision to drop all insurance coverage would be inhibited by such private commitment. Second, tying different insurance products together (e.g., fire insurance and flood insurance) may distort competition, since policyholders would be forced to choose the same insurance company for the coverage of both risks. This, of course, becomes problematic only if the price, terms and conditions of the compulsory extension of coverage are not mandated by the law.

Concerning the different types of public sector *ex ante* financial commitments in disaster risk transfer, it should be noted that:

- The policy choice to provide primary insurance coverage against disaster risks may be dictated by the fact that the private insurance sector is unwilling and/or unable to provide any coverage. Private-sector operational capacity, if available and cost-convenient, may be used to perform such functions as marketing, premium collection and

claims handling. This option, however, may crowd out competition from the private sector and in the long run discourage adaptation in insurance markets or limit the attractiveness of insurance markets for new investment.

- The option to provide special reinsurance arrangements is aimed at limiting private sector exposure to peak risks. This solution may be justified if the primary insurance carriers are able to retain a portion of the risk, but there is not enough reinsurance capacity on the private market to provide the required stop loss arrangements. The provision of such a limitation to private-sector exposure may also be part of an institutional arrangement in which mandatory offer, purchase, or extension of disaster risk coverage is introduced by law. In this respect, this option may be aimed at protecting the insurers' solvency and, therefore, the effectiveness of the whole system. Depending on the extent of compulsion, pricing, terms, and conditions of the reinsurance arrangements provided by the government, this policy option may crowd out private-sector reinsurance capacity, limit the scope for innovation, and inhibit the development of alternative risk transfer (ART) solutions to cover peak risks.
- The choice to act as a backstop liquidity provider, for example by offering a pre-arranged contingent loan facility to insurance companies writing disaster risks, is aimed at helping insurers to smooth catastrophe losses over time. In other words, in this scenario private insurance and reinsurance companies retain the ultimate risk, but they benefit from a more convenient inter-temporal flow of funds. This allows private sector participants to gradually adjust the pricing of coverage over time and alleviates the financial problems associated with the inter-temporal mismatch between the size of annual premiums and the size of the annual expected losses. Depending on the pricing, terms, and conditions of the backstop liquidity arrangements provided by the government, this option may crowd out capital market solutions, limit the scope for innovation, and hinder the development of private-market alternative risk financing (ARF) tools.

The potential crowding out effects, inherent to each of the different options outlined above, may be avoided by periodic assessments of market conditions.

Individual insurance schemes and insurance markets adopt different approaches to the pricing of weather-related risks. While some coordination

schemes apply a risk-based pricing mechanism, others have opted for flat pricing, invoking the principle of solidarity. In any case, it is important to recognize the impact of risk differentials across the territory of a country or region and to incorporate such risk differentials in the pricing mechanism, with a view to providing proper incentives to those most exposed to risk, while keeping coverage affordable and pricing manageable.

Risk zoning is used for pricing purposes by private insurers in the Czech Republic, Germany, Japan, Mexico, Turkey, and the United States, and its use is now also considered in Austria, Belgium, and Poland. In the United States, moreover, premiums are heavily based on the prior claims experience of the insured, and discounts are available for installing specified equipment such as storm shutters, wind-resistant glass and fire suppression systems. Risk-based pricing is also adopted by British insurers to cover flood risks.

In France, on the other hand, pursuant to the applicable legislative provisions, pricing of insurance against natural catastrophes is based on a fixed percentage of the basic premium charged for the underlying property insurance policy, without specific risk differentials. As a result of a change in the Spanish scheme, the *Consortio's* surcharge for property and business interruption coverage (with the exception of property coverage for motor vehicles, whose price is set at a fixed amount per vehicle) is now calculated as percentage of the sum insured, instead of being a fixed percentage of the base premium.

Flat rates are easy to administer and, if coupled with mandatory insurance, may be an effective mechanism to cross-subsidise the cost of insurance across the insured pool, which is consistent with the principle of solidarity. However, this option entails moral hazard and reduces the incentives to adopt cost-effective risk prevention and mitigation measures. Deductibles and coinsurance may help cope with moral hazard, but may not be sufficient. Risk-based deductibles, nevertheless, may be a possible alternative to risk-based premiums, even if the incentive mechanism is different insofar as the reward for the adoption of risk-reduction measures (i.e., a lower deductible in case of future losses instead of a lower premium at renewal) may be perceived as too distant in time and/or uncertain by the policyholder.

Risk-based disaster insurance, if correctly priced and linked to actionable measures by policyholders, can not only provide coverage against damage – permitting more rapid economic and social recovery – but also alerts individuals to the hazards they face and creates financial incentives to encourage investment in cost-effective mitigation measures to reduce vulnerability. It should be noted, nevertheless, that approaches to pricing may need to be more pragmatic in disaster insurance schemes than would normally be the case if the schemes are to be effective and sustainable in the long run. Nevertheless, risk management incentives should be encouraged.

In recent years, the transfer of the higher layers of disaster risks (peak risks) to capital markets has also been considered by public and private sector participants in the context of an integrated catastrophe risk management strategy. Capital markets, in fact, may provide an additional source of funding and financial capacity to absorb catastrophic risks, including risks associated with climate change. The worldwide market for catastrophe bonds (cat bonds) and other insurance-linked securities (ILS) is relatively young, since it started in the late nineties, but it is constantly growing. According to available data,¹⁸ 2007 was another record year, with total new issues in the amount of US\$7 billion (US\$4.69 billion in 2006; US\$1.99 billion in 2005; US\$1.14 billion in 2004; US\$1.73 billion in 2003). A cat bond is a high-yield bond that contains a provision that may cause the principal or interest payments to be delayed or lost to the investors in the event of a specified triggering (catastrophic) event (e.g., a hurricane, a flood). The cat bond, issued by a special purpose vehicle (SPV) and sold to institutional investors, provides the sponsor with fully collateralized multi-year cover for well-defined risks on an excess of loss basis and serves as an alternative or complement to traditional reinsurance.

The emergence of new trigger types,¹⁹ new sponsors²⁰ – including sovereign sponsors – and an increased use of shelf offerings that allow more

18. “With USD7 billion in publicly disclosed issuances for the year, 2007 was by far the most active year in history of the catastrophe bond market. Record-setting years are becoming commonplace, as this is the third year in a row in which a new issuance record was established. Cat bond issuance volume for 2007 increased by 49 percent over the 2006 record of US\$4.7 billion and 251 percent over the 2005 record of US\$2 billion. The 27 transactions completed exceeded the 20 closed in 2006 and nearly tripled the 10 placed in 2005.” GUY CARPENTER, THE CATASTROPHE BOND MARKET AT YEAR-END 2007, 5 (MMC Sec. Corp. 2008). Concerning 2006, Guy Carpenter reported that: “(a)cross nearly all measurable dimensions, including the number of issuances, total risk capital issued, total risk capital outstanding, number of perils securitized, diversity of trigger type and offering structure, activity exceeded all previous annual records, generally by a large margin.” GUY CARPENTER, THE CATASTROPHE BOND MARKET AT YEAR-END 2006, 3 (MMC Sec. Corp. 2007).

19. The trigger on ILS and weather derivatives determines the conditions under which payments are made to the sponsor. The most important trigger types are: (a) indemnity (the payouts depend on the sponsors actual losses); (b) index (the payouts are triggered by the industry loss estimated by an agency that collates such information for CAT events); (c) parametric (the payouts are determined by well defined parameters of a CAT event); (d) model (the payouts are triggered by a model industry loss that is determined by running the actual event parameters through a modeling firm’s database of industry exposures); (e) hybrid (the payouts are determined by a combination of two or more existing trigger types).

20. Not only insurance/reinsurance companies, but also other corporate entities as well as governments now sponsor these transactions. During 2006 two

flexibility and lower costs, have been witnessed in recent years.²¹ A growing securitization activity in non-bond form, such as sidecars, Industry Loss Warranties (ILWs) and other vehicles was also recorded.²²

Since modern catastrophe risk securitization transactions inevitably entail some degree of basis risk (i.e., the risk associated with imperfect hedging of the underlying losses), it becomes crucial to determine the objectives pursued by the sponsor. In May 2006, for instance, the Mexican government issued a parametric catastrophe bond to cover certain financial consequences of catastrophic earthquake risks. The transaction provides catastrophe cover, up to US\$160 million, to the Mexican government for financing emergency costs if an earthquake of magnitude 7.5 or 8 hits regions near Mexico City or along the Pacific Coast. The cat bond was sold to institutional investors in the United States and in Europe and it was part of a larger transaction combining securitization and reinsurance instruments to the benefit of FONDEN.²³ The catastrophe bond issued on behalf the government of Mexico is mainly aimed at providing the necessary liquidity for emergency response measures, not at covering the losses caused by a severe earthquake. A similar objective is pursued by the Caribbean Catastrophe Risk Insurance Facility (CCRIF),²⁴ launched under the auspices of the World Bank, which allows Caribbean governments to purchase parametric insurance coverage that will provide them with an immediate cash payment after the occurrence of a major hazard event, thus enabling them to overcome the liquidity crunch that may follow a disaster and start recovery operations without delays.

In a number of emerging countries, innovative capital market solutions, including multi-country, multi-peril catastrophe bonds have been recently considered to cover the cost of emergency relief measures and damages to public infrastructures and lifelines due to a disaster. In most OECD countries, however, there has been, to date, little or no use of ARTs to cover disaster risks.

catastrophe bond transactions were sponsored by non-insurance entities, the first by FONDEN, a facility created by the government of Mexico (earthquake risk), the second by Dominion Resources Inc., a U.S.-based energy company.

21. A shelf offering is a structure that, after the initial offering, allows sponsors to issue additional notes of a similar risk profile with abbreviated offering documents, on an as-needed basis throughout a transaction risk period.

22. SWISS RE, SIGMA NO. 7/2006, NEW OPPORTUNITIES FOR INSURERS AND INVESTORS (Swiss Reinsurance Co. 2006).

23. See SWISS RE, DISASTER RISK FINANCING: REDUCING THE BURDEN ON PUBLIC BUDGETS (Swiss Reinsurance Co. 2008).

24. See <http://www.ccrif.org/>

In Europe, the Reinsurance Directive²⁵ recently enabled member state regulators to establish a softer regulatory regime for insurance special purpose vehicles (ISPVs). Domestic incorporated and unincorporated ISPVs should greatly simplify insurance securitization structures and provide an attractive legal framework for insurance risk securitizations. The transposition of this Directive in the domestic legislation of E.U. member countries is, therefore, expected to facilitate the development of the use of insurance-linked securities to transfer catastrophic risk exposures to capital markets,²⁶ also in anticipation of Solvency II.²⁷

4. Conclusion

In a changing risk scenario, insurance, reinsurance and financial sector participants can play an important role in the financial management of disaster risks associated with global warming, both in developed and developing countries.

25. Council Directive 2005/68/EC, 2005 O.J. (L 323) 1-50 (EU).

26. In Germany, for instance, the existing regulation on solvency margins (Kapitalausstattungsverordnung) has been amended to allow the commitments by regulated ISPVs to count against the reserves of an insurer in the same way as claims under a reinsurance would be counted.

27. Solvency II is the European Commission's planned reform of prudential regulation for European insurers. It will be a risk-based, forward-looking regulatory regime founded on a market-consistent approach. Companies will be encouraged and given incentives to run their business with an increased focus on risk, governance and further transparency through disclosure. The European Commission published its formal draft proposal for a Framework Directive on 10th July 2007 and the text is currently being discussed in Council and Parliament. Solvency II is based on a three pillar approach which is similar to the banking sector (Basle 2) but adapted for insurance. The first pillar contains the quantitative requirements. There are two capital requirements, the Solvency Capital Requirement (SCR) and the Minimum Capital Requirement (MCR), which represent different levels of supervisory intervention. The SCR is a risk-based requirement and the key solvency control level. Solvency II sets out two methods for the calculation of the SCR: the European Standard Formula or firms' own internal models. The SCR will cover all the quantifiable risks an insurer or reinsurer faces and takes into account of any risk mitigation techniques. The MCR is a lower requirement and its breach triggers the ultimate supervisory intervention: the withdrawal of authorisation. The second pillar contains qualitative requirements on undertakings such as risk management as well as supervisory activities. The third pillar covers supervisory reporting and disclosure. Firms will need to disclose certain information publicly, which will bring in market discipline and help to ensure the stability of insurers and reinsurers (disclosure). In addition, firms will be required to report greater amount of information to their supervisors (supervisory reporting).

In developed countries, there are great advantages to having an operational private insurance/reinsurance industry. First, the insurance and reinsurance markets may be able to absorb some catastrophe risk that would otherwise fall on the government. Second, even if there is no sufficient financial capacity in the market to provide meaningful protection, the administrative resources of the private insurance industry can provide a platform for establishing a government-funded and -directed program. In this respect, insurance companies can perform key services such as marketing of the policies, premium collection, loss adjustment and claim payment.²⁸

In emerging economies, the private insurance market is still very often underdeveloped. The cost of insurance in such economies can be an impediment to growth of the sector. In consideration of the above, alternative risk sharing, risk financing and risk transfer tools, such as micro-insurance solutions at community level, or parametric coverage purchased directly by the government to obtain the necessary liquidity for emergency response measures in case of a disaster, may be more appropriate and easier to implement. Micro-insurance is the protection of low-income people against specific perils in exchange for the payment of premiums proportionate to the likelihood and cost of the risk transferred. Generally speaking, micro-insurance is for persons ignored by the mainstream commercial and social insurance schemes and it can be delivered through community-based schemes, credit unions and other micro finance institutions, as well as major multinational insurance providers.²⁹ Index-based financial risk transfer mechanisms, such as index-based climate insurance, provide viable market-based solutions to the risks posed by extreme weather risks and can help climate change adaptation, especially for the poorer layers of society.

From a normative perspective, a clear and transparent allocation of risks and responsibilities among public authorities, firms and individuals emerges as a key component of effective coordination schemes, and a driver to the success of any catastrophe risk management program. Another critical element is the ability to link policy tools (i.e., the technical features of a coordination scheme) with the underlying policy objectives pursued by the government, such as providing adequate financial protection to all individuals and entities, or simply making coverage available. In any case, financial management strategies should primarily focus on promoting techniques of prevention, adaptation, and mitigation.

In those systems that rely on insurance solutions to compensate for property losses due to catastrophes, the level of disaster insurance

28. See POL'Y ISSUES IN INS. NO.8 (OECD Publishing 2005)

29. See PROTECTING THE POOR 12-13 (Craig Churchill ed., Int'l Labour Org. [ILO] in association with Munich Re Found. 2006).

penetration often remains a key concern. Even if disaster insurance coverage is made compulsory by operation of law, the enforcement of the regime may prove to be very difficult, especially if there is a lack of insurance culture among the population. Promoting disaster risk awareness and educating the population to the financial consequences of large-scale disasters becomes, therefore, extremely important.

In general, the challenge is to identify financial solutions that provide the right incentives to invest in cost-effective preventive measures with a view to reducing vulnerability and the total cost of disasters. The total cost of disasters is the sum of the cost of disaster losses (insured and uninsured), the cost of preventive measures to avoid or mitigate disaster losses, and transaction costs (i.e., the costs of implementing the scheme).³⁰ On the other hand, it is important to bear in mind that public and private investments in disaster risk reduction and mitigation measures, by limiting exposure and vulnerability to disaster risks, facilitate the development of new risk financing, risk sharing and risk transfer tools. In light of the above, it becomes clear that disaster risk reduction, mitigation and financing efforts are closely linked to one another, and should be carefully coordinated by policymakers.

30. See GUIDO CALABRESI, *THE COST OF ACCIDENTS: A LEGAL AND ECONOMIC ANALYSIS*, (Yale Univ. Press 1970).
