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ENVIRONMENTAL RISKS AND INSURANCE

A COMPARATIVE ANALYSIS OF THE ROLE OF INSURANCE
IN THE MANAGEMENT OF ENVIRONMENT-RELATED RISKS

by

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Introduction

In the recent times, the complex relationship between human activities and the environment has become a major public concern, raising issues of legal, political and economic relevance.

The adverse impact of industrial activities on natural resources and biodiversity, as well as the need for sustainable development, stimulated a debate on appropriate policies and techniques aimed at improving the current level of environmental protection and preservation. Conversely, a growing concern has developed over the effects of such extreme natural events as hurricanes, typhoons, floods and earthquakes which pose a serious threat to human life and property, being able to disrupt local communities and to affect the economic stability and growth of entire nations.

From the increasing incidence of environmental pollution and soil contamination, to natural disasters occurring on seasonal to inter-annual time scales, the risks posed by the constant interaction between human activities and the environment are diverse, manifold and often catastrophic in their consequences. Therefore, the elaboration of effective risk-management plans, aimed at formulating viable response strategies, requires the pro-active contribution of all the economic actors involved: governments, public officials, international organizations, financial institutions and private parties are all called upon to take part in this endeavor.

Against this backdrop, this report focuses upon the role of insurance and reinsurance companies in the management of environmental risks. In particular, according to the proposed research plan, the analysis concentrates on issues related to two different kinds of environment-related risks:

1. the **environmental liability risk** (i.e. the financial risk associated with environmental pollution and contamination) and
2. the **natural catastrophe risk** (i.e. the risk of major damages in connection with the occurrence of natural disasters, such as earthquakes, floods or other extreme environmental conditions).

Both these environment-related risks, as mentioned, are characterized by the potential for catastrophic consequences. However, even if they may share some common features, they are structurally different from the standpoint of the insurer and, therefore, they deserve to be treated separately in this report.

After a brief overview (Part I) of the traditional functioning of the insurance and reinsurance mechanisms and an introduction to the general problems affecting the insurability of certain risks, Part II of this study deals with the risk of liability for environmental pollution, taking into account both **factual and legal variables that may**

affect risk insurability. Environmental liability risk, in fact, is highly influenced by the underlying legal and regulatory framework. In this perspective, a **theoretical discussion** of the most relevant features of an environmental liability regime is followed by a **comparative analysis** of the policy choices already implemented in various legal systems belonging to both the civil law and the common law traditions, as well as by the **evaluation of the most recent developments** that are taking place at the European Community level.

To this purpose, particular attention is devoted to the recent proposal for a **“Directive of the European Parliament and of the Council on environmental liability with regard to the prevention and remedying of environmental damage”** presented by the Commission of the European Communities on January 23, 2002 [COM(2002) 17 final]. The proposal aims to establish a framework whereby environmental damage would be prevented or remedied; the main benefits expected include improved enforcement of environmental protection standards, in line with the “polluter pays” principle, and efficient levels of prevention. According to the text of the proposal (article 16), EU Member States should encourage:

- **the use** by operators of any appropriate insurance or other forms of financial guarantee in order to provide effective cover for obligations under the Directive and
- **the development** of appropriate insurance or other financial security instruments and markets by the appropriate economic and financial operators, including the financial services industry.

In response to the above, the insurance industry has developed new strategies and techniques to tackle the peculiar insurability problems posed by ecological damage phenomena and made strong commitments at an international level ⁽¹⁾. This report presents an **overview of the different environmental insurance products** currently available on the international market and suggests that modern ecological insurance may serve **different purposes**: in addition to contributing in the solution of the **“judgment proof”** (or “insolvency”) problem, in fact, it guarantees the ***ex ante* internalization of pollution costs** posed by the industry and it might also be able to work as a **surrogate regulation mechanism** ⁽²⁾, providing appropriate incentives for increased prevention and precaution.

With a view to throwing some brighter light on the role that the insurance sector is expected to play in the near future, the interaction among regulation, liability, funds and insurance is discussed with reference to both the comparative analysis of different legal regimes and a proposed institutional model.

⁽¹⁾ See, especially, the UNITED NATIONS ENVIRONMENTAL PROGRAMME - UNEP Statement of Environmental Commitment by the Insurance Industry, signed in Geneva, on 23 November, 1995.

⁽²⁾ See: K. S. ABRAHAM, Environmental Liability and the limits of insurance, 88 Columbia L. Rev. 946 ff.

Part III of this report, in turn, is devoted to the analysis of the **role of insurance in the management of natural catastrophe risk**, i.e. the risk posed by the potential occurrence of extreme natural events such as hurricanes, floods and earthquakes.

Starting from the observation that natural disaster risks pose severe problems to the traditional functioning of insurance and reinsurance – mainly because the risks that arise from these events are not independent and because of the **magnitude of their economic consequences** –, this part of the study discusses alternative risk management solutions already tested in different institutional contexts.

Since the law of large numbers does not apply – at least at the primary market level ⁽³⁾ –, aggregating risks is unproductive and the natural comparative advantage of insurance may be lost when dealing with natural catastrophes ⁽⁴⁾. This factor, together with the size of expected losses, explains why the **partnership between governments and the private sector** is crucial in developing effective natural catastrophe risk management strategies.

This part of the study, therefore, describes and analyzes several governmental disaster schemes and other institutional arrangements that have been designed and tested around the world in order to supplement or replace traditional reinsurance.

Moreover, since capital markets have developed new **financial instruments** such as **catastrophe bonds**, **weather derivatives** and other complex **risk securitization** devices aimed at providing funding and economic protection against large losses from natural disasters, the present analysis will also take into account the current role of such financial techniques.

As a conclusion, this report suggests that, while insurance cannot be considered as a ready-to-use solution to the complex problems posed by the “environmental liability risk” and by the “natural catastrophe risk”, it should be regarded by governments and policy makers as a precious and valuable instrument in the available array of risk management tools.

⁽³⁾ With respect to the international reinsurance market, some risk carriers affirm that natural catastrophe risks can be relatively well diversified on a global scale, since natural disasters are independent from each other, provided sufficiently broad terms of reference are defined. See: Swiss Reinsurance Company (2002), Natural Catastrophes and man-made disasters in 2001, Swiss Re SIGMA series 1/2002. Zurich, Swiss Reinsurance Company, p.11.

⁽⁴⁾ PRIEST, G.L. (1996), "The Government, the Market, and the Problem of Catastrophic Loss." Journal of Risk and Uncertainty 12 (Number 2/3): 219-237

PART I RISK, INFORMATION AND INSURANCE

1. Different attitudes towards risk and the traditional functioning of insurance and reinsurance mechanisms

Economic actors have different attitudes towards risks. It depends on several factors, including the nature of the risk, the probability of loss, the potential magnitude of the loss and the ability to absorb its economic consequences. Assuming rationality and perfect information, economic actors are able to calculate the actual value of a given risk by discounting the magnitude of the loss by the probability of its occurrence ($P \times L$).

Once the risk is properly identified and evaluated, however, risk management decisions still need to be taken. In this perspective, economic actors may be:

- **risk averse**: if they are willing to pay even more than the actual value of the risk in order to transfer its harmful consequences to someone else;
- **risk preferring**: if they prefer to retain the risk of loss, rather than transferring it by paying upfront an amount equal to its actual value.
- **risk neutral**: if they are indifferent with respect to the alternative between (a) retaining the risk and (b) transferring it to someone else by paying upfront an amount equal to its actual value.

Risk aversion, therefore, generates demand for insurance. Insurance companies, in turn, are willing to undertake the risk in exchange for an amount of money relatively close to its actual value (the premium), because the law of large numbers makes them able to manage such risks effectively, by making predictable, with reasonable accuracy, the claims they will pay from year to year. According to this mathematical law, the larger the number of exposures considered, the more closely the losses reported will match the underlying probability of loss. This means that insurance companies need to pool together a rather **large number of homogeneous but independent risks** in order to become risk neutral.

The traditional insurance mechanism can be divided into four phases:

- **risk assessment** (the evaluation of risk, which is usually performed through statistical and probabilistic analyses)
- **risk transfer** (the shifting of its harmful consequences by way of the insurance contract)
- **risk pooling** (the placement of the risk in a pool of homogeneous but independent risks allows the insurer to spread the risk and to benefit from the law of large numbers)
- **risk allocation** (the pricing of the risk through premium setting)

As the magnitude of expected losses increases, **the insurers' financial ability to absorb them can be severely jeopardized**. In other words, over and above certain levels of financial exposure, insurers themselves tend to be **risk averse**. In this context, coinsurance and reinsurance are viable options for primary carriers who are willing to cede

part of the risk they undertook, in exchange for the payment of a fraction of the premiums they collected.

Traditional reinsurance agreements may be of different types, among which:

- **quota share (proportional) treaties** (by which the reinsurer undertakes a quota of the risk transferred to the primary carrier)
- **excess of loss (stop loss) treaties** (by which the reinsurer undertakes the upper layer of the risk, after a certain attachment point).

2. Risk predictability, generalized uncertainty and informational asymmetries

Insurance is able to perform its functions correctly under specific conditions of risk and uncertainty. All agree that, in order to be insurable, the risk must be predictable, at least by means of past experience and statistical calculations.

Severe problems are posed by:

- **Generalized uncertainty** – which may undermine the insurer's ability to properly evaluate and assess the risk *ex ante*
- **Informational asymmetries** – in favor of the prospective insured, generating distortions and agency problems:
 - Adverse selection
 - Moral Hazard

This report shows, *inter alia*, how **traditional** insurance and reinsurance mechanisms can face difficulties in covering:

1. the **environmental liability risk** (Part II) and
2. the **natural catastrophe risk** (Part III).

Environmental liability risk is tightly connected with the **underlying legal and regulatory framework**, whose **features may generate uncertainty, or otherwise limit risk insurability**. **Factual** uncertainty concerning the nature of the risk and its consequences are also problematic. Finally, obstacles are posed by relevant **information asymmetries**.

The traditional insurance mechanism may also not be appropriate to cope with natural catastrophe risk, since **risk predictability**, the ability to **spread the risk spatially** and the **financial capacity** of the market are severely limited.

In both cases, furthermore, the **magnitude of expected losses** and the **information problems** affecting risk predictability and assessment require **joint efforts** by several insurers and reinsurers. It is worth noting that the highlighted need for **information sharing practices** and **market concentration** – in order to increase capacity – suggests a careful approach to **antitrust regulations** and **competition policies** in this area.

PART II ENVIRONMENTAL LIABILITY RISK AND INSURANCE

1. Environmental pollution as a negative externality

The use, impairment and endangerment of natural resources - such as air, water, land, flora and fauna - are commonly considered in the law and economics literature as external costs of production generated by the industry. The environment is a public good and, therefore, pollution can be conceived as a **negative externality** which affects the society as a whole; if the costs of production are not fully internalized, an industrial activity may receive incentives even if it has inefficient outcomes, given the fact that part of its costs are socially borne. Nowadays, environmental protection is a worldwide growing concern: natural resources are becoming really scarce on our planet and - in this perspective - all the nations are affected by inefficient uses of them ⁽⁵⁾.

2. Different legal approaches to the externality problem: regulation v. liability

The goal of imposing full **internalization** of pollution externalities is, therefore, very important and, theoretically, it can be **achieved through different legal devices**. A way of dealing with this problem is characterized by the strict centralized enforcement of a sophisticated net of **regulation**; those command-control rules, setting standards and sanctions, operate *ex ante* and reflect the results of a costs-benefits analysis already performed by the authorities. A second possible solution is the *ex post* imposition of the external costs on the actors through a mechanism of **liability rules**, enforced by courts; in this perspective, the polluter can pursue his own activity but he is forced to pay for the damages that he causes to the environment, thereby internalizing the cost of pollution.

Of course, both these alternative approaches have already been widely analyzed and criticized: the former mainly because of its own intrinsic rigidity and the latter in light of the relevance of litigation costs and of the so-called 'judgment proof' problem. It has been said that possibly a combination of the two is the most efficient solution.

This report tries to go a step forward, by focusing upon **the impact of modern environmental insurance on both the liability system and the regulatory framework**. In particular, the advantages and the limits of the *ex post* mechanism of environmental liability and the role of professional ecological insurance in preventing the most common failures of this device are considered and discussed.

⁽⁵⁾ The relevance of this problem has been clearly depicted by the inspired words of the *Declaration of the Sacred Earth Gathering of Spiritual Leaders* at the UNCED Conference, Rio de Janeiro (Brazil), 1992 (*The planet Earth is in peril as never before (...) The World Community must act speedily with vision and resolution to preserve the Earth, Nature and Humanity from disaster. Time to act is now. Now or never.*) and, less dramatically, addressed by the Principles of International Environmental Law as reflected in *The Rio Declaration on Environment and Development* of June 1992 (Principles of Sustainable Development, Polluter Pays Principle, Principle of Prevention, Principle of Good Neighbourliness and International Cooperation, Precautionary Principle, Principle of Good governance, Principle of Common but Differentiated Responsibility, Principle of Sovereignty over Natural Resources and the Responsibility not to cause Environmental Damage).

3. Environmental liability: compensation and deterrence

It is often said that environmental liability regimes should be aimed at achieving efficient levels of **compensation** and **deterrence**. In other words, applying economic theory to environmental policies, the introduction of a civil liability regime in response to the ecological emergency can be explained as an attempt to pursue two important and interrelated policy goals:

- **compensation for environmental harm** (or restoration of the impaired resources) and
- **deterrence of inefficient activities** (thereby preventing pollution that is not cost justified).

a) *The choice between negligence and strict liability*

In determining the features of a liability rule, the first choice is between strict liability and a negligence standard. Negligence is of course an effective mechanism of risk spreading, but it has been shown that strict liability is more efficient in circumstances where the potential tortfeasor is in a better position to evaluate the costs and benefits of a particular *level of activity* than either the potential victims or the court (finder of fact) ⁽⁶⁾. The negligence standard, in fact, provides incentives to the parties only with respect to:

- **the level of care** (the diligence in performing a given activity)
but not with respect to
- **the level of activity** (the intensity and frequency of a given behavior or activity).

Both these variables, however, affect the probability of an accident ⁽⁷⁾.

When the injured party has substantially no control over the risk of materialization of the loss (*unilateral accidents*), there is no need to give her incentives to invest in precautions and it is sufficient to take into account the behavior of the potential tortfeasor. A strict liability standard, imposing a full internalization of the negative externalities, forces the potential tortfeasor to consider both the level of care and the level of activity and, therefore, it generates incentives to behave efficiently ⁽⁸⁾. Environmental pollution events, in the vast majority of cases, are **unilateral accidents**. Hence, to protect the environment through an efficient level of deterrence, strict liability proves to be more appropriate from a law and economics point of view.

As regards the compensation perspective, strict liability has many advantages compared to a negligence standard, at least in the industrial pollution setting. In the typical pollution case, the proof of negligence can be perceived by the injured parties as a *probatio diabolica* - an obstacle often too difficult to overcome - given the difficulties in accessing

⁽⁶⁾ S. SHAVELL, "Strict Liability Versus Negligence", 9 *Journal of Legal Studies* 1980, 1.

⁽⁷⁾ ID., *Economic Analysis of Accident Law*, Harvard University Press, 1987.

⁽⁸⁾ "The failing of the negligence rule that is under discussion can be regarded as resulting from an implicit assumption that the standard of behavior used to determine negligence is defined only in terms of care. Were the standard defined also in terms of the activity level, injurers would make sure not to engage in their activity to an excessive extent" IBID., at 25.

relevant information and the technical character of the notions involved. A strict liability rule, instead, is conceivable as a form of insurance whose beneficiaries are the injured parties. Moreover, deprived of any punitive character, this form of liability is more easily transferable on the commercial insurance marketplace. In this sense, environmental insurance would work as a form of reinsurance.

b) Direct v. indirect protection of the environment

A second set of options, which characterizes the process of introducing an environmental liability rule, has been pointed out by scholars engaged in the comparative study of environmental laws⁽⁹⁾.

On one hand, we have the possibility to conceive a general notion of environment (or natural resources) and to grant it **direct protection** as a good itself. In case of a polluting event, the legal system will therefore hold the tortfeasor liable for compensation of any kind of damage caused to natural resources, in addition to and apart from any property damage, bodily injury or economic loss indirectly suffered by individuals as a consequence of pollution. A public authority (generally, the State) will then be entitled to receive compensation on behalf of the citizens. This peculiar choice has been made in the United States, in Italy, in Switzerland and in Portugal.

On the other hand, nevertheless, stands the option to introduce tougher liability rules for the violation of other fundamental rights, such as health or property, whenever those violations take place in occasion of a polluting event; in doing so, the environment receives **indirect protection**, because the polluting activity works as a signal of endangerment of natural resources. This view is embodied in the German *Umwelthaftungsgesetz* of 1991. Under sec. 1 of the German Act, for example, operators of facilities listed in a specific appendix to the law are strictly liable to injured persons for bodily injury and property damage due to an environmental impact that issued from said facilities, and causation is presumed, pursuant to sec. 6.

Imposing the **obligation to compensate for natural resources damages and cleanup costs** - compared to the indirect protection scheme - has the clear advantage to force the tortfeasor to **fully internalize the negative externalities** of her activity, but introduces new problems, the most important of which is related to the **evaluation and quantification of the harm**, still unresolved. In particular, the issue of damages is extremely controversial with respect to the **value of natural resources** that cannot be fully restored or replaced after the polluting event. In order to overcome this problem, it could be better to hold responsible parties liable for the **cost of clean up of impaired resources**, once clean up standards have been determined by the authority with a sufficient level of predictability.

With respect to this last issue, it is extremely important to point out that in several legal systems, instead of civil liability, there are other **administrative and/or criminal rules imposing obligations to cleanup contaminated sites**. In case of pollution, the owner and/or operator of the site or facility, in other words, is forced by the public

⁽⁹⁾ See: B. POZZO, "The liability problem in modern environmental statutes", 4. *ERPL* 1996, 111-144.

authority to adopt immediately security and preventive measures and then to decontaminate the site, under the threat of fines, or even imprisonment⁽¹⁰⁾.

In any event, from an insurability perspective, it is very important to **distinguish** between **liability** (being it civil, administrative or criminal) **for cleanup of soil or water pollution** and **the obligation to pay natural resources damages (NRDs)**.

c) Allocation and apportionment of concurrent liabilities

Another dilemma arises in the very usual situation in which more polluters are involved in the same environmental accident: should the liability be imposed on an **individual basis** or should all the polluters be held **joint and severally liable** for the clean-up costs? If the compensation profile is considered alone, joint and several liability clearly offers great advantages to the injured parties. The deterrence goal, however, requires that each polluter pays for the consequences of her own activity: if liability is not individual, the mechanism of incentives will not work, given the difficulties for the potential polluter to perform a costs-benefits analysis. Moreover, if insurability issues are taken into consideration, a strict joint and several standard should be avoided, because it impairs the ability of risk-carriers to evaluate and assess the risks posed by prospective customers.

d) Defenses: pro and contra

- Force majeure
- Regulatory compliance
- Development risk
- Contributory negligence

e) A Brief Summary

A first set of conclusion can now be drawn. The introduction of a liability rule to protect the environment should aim at two interrelated goals: **compensation** and **deterrence**. In light of this goals, the most appropriate choice could perhaps be a strict, proportionate environmental liability regime for cleanup costs of the impaired resources, imposed on dangerous activities. Limited defenses could be admitted. Of course, both the compensation and the deterrence functions are *de facto* undermined by the so-called ‘judgment proof’ problem: if the polluter, after the accident has no assets to repay the damage caused, the whole system of environmental liability could collapse and the result would just be an additional waste of the resources invested in litigation.

It has been said⁽¹¹⁾ that relying on insurance could be unsuited to the goals of tort law, because the traditional standardized system, lacking the ability to highlight the characteristic features of each different customer⁽¹²⁾, does not provide any additional incentive. It is true that the traditional mechanism of insurance could fail in this peculiar

⁽¹⁰⁾ As for Italian Law, see: Ministerial Decree n° 471 of October 25, 1999 and Legislative Decree n°22 of February 5, 1997 (Ronchi Decree).

⁽¹¹⁾ See U. MATTEI, *Comparative Law and Economics*, Ann Arbor, Michigan University Press, 1997.

⁽¹²⁾ On the relevance of risk differentiation in insurance: G. PRIEST, “The Current Insurance Crisis and Modern Tort Law”, *Yale Law Journal* 1987, 1521-1590.

context, but it has to be noted that **modern environmental insurance** works in a quite different way. If the amount of the insurance premium and the conditions of coverage **accurately reflect the level of risk created by the insured**, then the insurance relationship, while giving effect to the **compensation** function, will **add incentives to the liability system**, working as a **private surrogate regulation** mechanism ⁽¹³⁾, with the flexibility of a case by case determination of applicable standards.

4. Environmental liability risk and insurance: factual uncertainty

Environmental risk, however, presents many difficulties to the insurance industry, specially when the focus is on the so-called **gradual pollution** phenomena, which are characterized by:

- **factual uncertainty** and
- **long terms effects** (long tail liabilities).

As mentioned in Part I of this report, insurance is able to perform its functions correctly under specific conditions of uncertainty. Environmental risk is a peculiar one, given that it includes components of both **factual and legal uncertainty**. This is true particularly when we consider the so called gradual pollution, that kind of pollution which develops slowly and secretly over a long period of time and whose damaging effects show only in the long run. In this context, there are problems of **asymmetrical information** as well as of **generalized uncertainty**. Given the complexity of modern production technologies, problems of **adverse selection** ⁽¹⁴⁾ could be widely present in environmental insurance settings, whenever the classification of every specific risk undertaken is not accurately performed by the insurer. **Moral hazard** phenomena ⁽¹⁵⁾ are also seriously involved in this context: it is easy to understand how the industry could erroneously perceive the insurance coverage and the insurance premium as a license to pollute. To tackle these further problems, risk-carriers have to introduce **monitoring and bonding devices**.

Gradual pollution events, moreover, present relevant aspects of **generalized factual uncertainty**: in most cases it is very difficult to determine when pollution began and how long it lasted; synergetic pollution is a quite common phenomenon and it is far from easy to identify single contributions; long terms effects of pollution raise problems related to the adequacy of traditional **trigger-of-coverage** clauses ⁽¹⁶⁾ as well as of **policy limits**.

The **factual uncertainty** regards also the potentially damaging effects of new technologies and substances; in other words, the relevance of the so called **development risk** plays a great role in this context. These peculiar features of environmental risk are

⁽¹³⁾ See: K. S. ABRAHAM, Environmental Liability and the limits of insurance, cit.

⁽¹⁴⁾ On the implications of this peculiar information asymmetry, see the study by Nobel Prize GEORGE A. AKERLOF, "The Market for 'Lemons': Qualitative Uncertainty and the Market Mechanism", 84 Quarterly Journal of Economics, 1970, 488-500.

⁽¹⁵⁾ S. SHAVELL, "On Moral Hazard an Insurance", 93 Quarterly Journal of Economics, 1979, 541-562.

⁽¹⁶⁾ Such as *occurrence* or *accident* triggers.

common to every legal system and they can explain why, at present, this risk is almost everywhere excluded from general liability insurance and gradual pollution coverage is provided only under very specific policies.

5. Environmental liability risk and insurance: legal uncertainty

What differentiates the situation is the **level of legal uncertainty**. This variable represents the level of generalized uncertainty introduced by the legal system itself and basically depends on:

- a) the way in which legal rules (i.e. the environmental liability regime) are designed and shaped by the authority;
- b) the way in which those legal rules and propositions are interpreted and applied by legal actors (agencies, judges, scholars etc.) in a given institutional framework.

Environmental risk is, for the insurance industry, a risk of liability and the **choices made by law and policy makers greatly affect risk insurability**. The domain of risk insurability is limited. If generalized uncertainty - being it factual, or legal, or both - become excessive, then insurance will become a mere gamble: the unpredictability of losses, in fact, will prevent the prospective risk-carrier from performing effectively her statistical calculus of probabilities. In such a situation, insurers may change their attitude towards risk, moving from risk neutrality to risk aversion. This, of course, would undermine the very basis of the whole insurance mechanism.

As mentioned, the **level of legal uncertainty** may be detected from two different perspectives: *a)* on one hand we have to consider specific features of the environmental liability regime adopted in a given legal system and *b)* on the other we have to test the intrinsic coherence of each legal formant as well as the coherence among different formative parts of that system ⁽¹⁷⁾.

a) Features of the liability regime

As regards the first component of the **level of legal uncertainty**, the choice of a strict liability standard – made by a legal system in light of its efficient outcomes – would not constitute a problem in terms of insurability; to the contrary, more problems would be caused by a negligence standard which involves a punitive profile that is not easily reconcilable with the transfer of liability to the insurer. In the allocation of liability phase, a joint and several standard creates excessive uncertainty for the insurer because she would have to compute not only the risk created by the prospective insured, but also the risks generated by all the other actors whose conduct may eventually combine with the one of the insured in the causation a polluting event. The insurer, moreover, would bear the risk of insolvency of these other subjects, without being able to monitor or control them. Such problem would notably increase the cost of insurance. Hence, an individual standard seems

⁽¹⁷⁾ The notion of legal formant refers to every legal proposition that concurs in the solution of a given legal issue. Court decisions are legal formants as well as scholarly writings, constitutional norms, regulatory standards, statutory provisions et cetera. Legal formants, therefore, are sources of law in a practical sense. See R. SACCO, “Legal Formants: A Dynamic Approach to Comparative Law”, 39 *Am. J. Comp. Law* 1991, 1 ff., 349 ff.; see also, U. MATTEI, *Comparative Law and Economics*, cit., 104 ff.

much better once insurability issues are taken into consideration. If a direct protection scheme is chosen, legal uncertainty is negatively affected by the controversial and sometimes obscure criteria used by the courts in order to evaluate natural resource damages. The value of impaired resources is very difficult to determine and there is no agreement on the subject. The only damage measure that at present seems to be reasonable and predictable is the **cost of cleaning up impaired amenities**. In the process of implementation of an environmental liability regime, the outlined concerns should be taken into account. As long as the damages awarded in pollution cases are almost completely unpredictable *ex ante*, in fact, the insurance industry will not be able to assess environmental risks properly and, therefore, will not be willing to offer reasonably priced coverage.

b) On legal formants and incoherence: a complex analysis

To detect the second variable which affects the **level of legal uncertainty**, it is necessary to look at the way in which a given legal system actually works. The above mentioned notion of legal formants is fundamental to this layered analysis ⁽¹⁸⁾. In every legal system, what is written in a statute may sometimes differ remarkably from the judgments of the courts on the same legal issue. The rule formally announced by the court in its opinion may turn out to be incompatible with the actual outcome of the case ⁽¹⁹⁾. In Italy, for example, a negligence standard is officially adopted by legislation, but courts tend to enforce a strict liability regime. Retroactive liability is not imposed by Law 349/86 (the Italian statute on environmental liability), but again, some recent decisions of the Italian Corte di cassazione impose civil liability for environmental harm retroactively. The only decision on the issue of quantification ⁽²⁰⁾ does not provide any guidance for the implementation of those criteria set forth in art. 18 comma VI of Law 349/86. In the United States, the provision of CERCLA regarding damages to natural resources ⁽²¹⁾ has been seldom enforced by courts. Case law on environmental liability insurance issues, moreover, is quite confused and contradictory ⁽²²⁾. Those evidences of incoherence among legal formants greatly affect the **level of legal uncertainty**, introducing elements of destabilization that eventually undermine the effectiveness of any insurance mechanism.

⁽¹⁸⁾ See: MATTEI, U. and MONTI, A. (2001), Comparative Law and Economics. Borrowing and Resistance, Global Jurist Frontiers, Vol. 1: No. 2, Article 5, 2001, <http://www.bepress.com/gj/frontiers/vol1/iss2/art5>.

⁽¹⁹⁾ For a sharp distinction between *definitions* and *operative rules* enforced by courts see: SACCO, cit.

⁽²⁰⁾ Pretore di Milano - sez. distaccata di Rho, June 29, 1989, in *Foro it.*, 1990, II, 526; notes and comments on this decision are available in English in 6 *AIDA Pollution Bulletin*, July 1991, 7.

⁽²¹⁾ See CERCLA. § 107 (1-4) (C).

⁽²²⁾ Scholars have written extensively on the subject, see: K.S. ABRAHAM, *Environmental Liability Insurance Law - an analysis of toxic torts and hazardous waste insurance coverage issues*, 1991 Prentice Hall Law & Business; I. SULLIVAN, T. G. REYNOLDS, W. J. Jr. WRIGHT, "Hazardous waste litigation: Comprehensive General Liability Insurance coverage issues", 494 *Practising Law Institute / Lit.* 1994, 267, and the Symposium issue of the 28. *Gonzaga Law Review*, 1992-1993.

6. Modern environmental liability insurance approaches

a) *Integrated risk management approach through differentiation*

In response to the outlined problematic factual features of environmental risk, the insurance industry has developed new techniques to cope with this peculiar phenomenon. As mentioned, the traditional insurance mechanism works on a four phases basis (risk assessment, risk transferring, risk pooling, risk allocation) and the insurer remains basically external to the situation assessed in the first step, merely accepting or refusing to undertake a given risk. In modern environmental insurance, instead, professional risk-carriers have the knowledge and technical abilities needed to actively intervene on the risk features during a new phase (**risk remodeling**), which takes place before the transfer of risk.

Pollution coverage is currently provided only on an **site-specific** basis; in fact, the modern philosophy of ecological insurance requires an extremely **careful evaluation and classification** of the risk to be transferred. As for this, a comprehensive inspection of the industrial installation is performed *in limine* by a team of qualified engineers belonging to the insurance company. As soon as the risk is properly assessed - if the minimal insurability (safety) requirements are met - the risk carrier will cooperate (in a new phase) with the prospective insured in order to reduce the risk and to **enhance loss prevention strategies**. Such feature plays a very important role: **prevention of environmental harm should be a primary goal of every ecological policy** ⁽²³⁾. Even if insurance coverage gives effect to the compensation function of environmental liabilities, it could easily be the case that impaired natural resources are unique and not replaceable or repairable; loss prevention, therefore, acquires great importance.

After this 'remodeling' phase, in which cooperation between insurer and insured is fundamental, **pollution coverage is tailored** on the insured needs and it is provided by the risk carrier on a **long term basis**. A long term commitment is needed by both parties; pollution coverage is provided to the insured with the peculiar time limitations of:

- **claims made** ⁽²⁴⁾ or
- **manifestation/discovery** ⁽²⁵⁾

formulas and a stable relationship is essential to justify the reciprocal investments in cooperation. In this way, the insurer will participate with her **expertise and technical knowledge** in the development of each customer's risk-management strategy. During the entire period in which the contractual relationship is in force, the risk carrier will closely monitor the insured, generating additional incentives; investments in precautions and in safety devices will be rewarded by the insurer with a reduction in the annual premium and/or with a broader coverage, thereby enacting and implementing a flexible mechanism of **surrogate regulation** ⁽²⁶⁾. The point just made, therefore, lines up with the broader

⁽²³⁾ The *Principle of Prevention*, together with the *Polluter-Pays Principle*, for example, is at the very foundations of the environmental policy announced by the European Commission.

⁽²⁴⁾ Under a claims made formula, the coverage is triggered by the filing of a claim against the insured.

⁽²⁵⁾ Coverage is triggered by the discovery of pollution conditions.

⁽²⁶⁾ See K. S. ABRAHAM, *Environmental Liability and the limits of insurance*, cit. See also: CLIFFORD G. HOLDERNESS, "Liability Insurers as Corporate Monitors", 10 *Int. Rev. of Law and Econ.* 1990, 115-129.

perspective that considers the opportunity to conceive liability insurers, in various instances, as efficient regulators of the practice of their customers ⁽²⁷⁾. Furthermore, in addition to loss prevention strategies and financial coverage, the insurers started recently to offer integrated services, the most important of which is **crisis management**.

b) Different products for different needs

From an insurance point of view, a correct approach to the pollution risk entails the need for a few technical distinctions:

- **First party v. Third party coverage**
- **Known v. Unknown pollution**
- **On site v. Off site contamination**

Insurers are moving away from using traditional policies and conventional tools for assessing environmental exposures because they may provide inadequate cover. In the recent years, the international environmental insurance sector has developed **several types of new products** aimed at meeting different needs, taking into account that often businesses must assume **the costs of cleaning up their own polluted sites**, as well as others that may have been contaminated by their activities. The most important are:

- **Environmental liability policy (EIL)** (third party coverage)
- **Coverage for on site cleanup liability** (first party coverage)
- **Cleanup cost cap (brownfield site)** (this type of policy covers excess remediation costs due to unknown or undiscovered contamination, poor remedial technology performance, regulatory changes and natural disasters. It is generally designed to address the risk and uncertainty associated with beginning or continuing an environmental remediation project)
- **Contractors pollution legal liability**
- **Transportation coverage**
- **Environmental coverage for landfills** (integrated insurance/financial products)

Moreover, some carriers offer the possibility to combine different coverages in a single tailor made insurance policy.

c) Increased market capacity through pollution insurance pools

In some European countries insurance companies have created Pools to deal with the peculiar problems posed by environmental liability risk:

- **Italy:** Pool RC Inquinamento
- **France:** Assurpol

⁽²⁷⁾ See, for example: ANTHONY E. DAVIS, "Professional Liability Insurance as Regulators of Law Practice", *LXV Fordham Law Review* 1996, 209.

- **The Netherlands:** Nederlandse Milieupool
- **Spain:** Pool Español de Riesgos Medioambientales

d) *Alternative risk transfer (ART) / Alternative risk financing (ARF) methods*

An alternative to insurance is offered by:

- **Captive insurance companies**
- **Finite risk products**
- **Loss portfolio transfers (buyouts)**

e) *Statement of Environmental Commitment of the Insurance Industry*

It is worth noting that participants in the insurance sector began to play an eminent proactive role in the environmental arena, voicing their concerns and interests in public and committing themselves to the Principles of Sustainable Development affirmed in the *1992 Rio Declaration on Environment and Development*. Under the auspices of the United Nations Environmental Programme ⁽²⁸⁾, a *Statement of Environmental Commitment* was signed in a ceremony at the UN offices in Geneva by 17 leading insurance companies on November 23, 1995. At present, 88 insurance companies (+ 5 associated members) from 27 countries joined the initiative by signing the *Statement* and the number of participants is constantly increasing. In this significant document the general principles of sustainable development are fully recognized and translated into a commitment towards environmental protection by means of insurance practice, risk management strategies and loss prevention.

7. Environmental risk and insurance: a problem of incentives

In light of this modern and innovative attitude adopted by the industry, insurance seems to be an appropriate legal and economic tool available to correct most of the failures of both the decentralized liability mechanism and the regulatory approach to the ecological emergency. Modern environmental insurance would in fact solve (at least partially) the judgment proof problem that affects the liability approach and it would also introduce and enforce a full set of technical safety standards characterized by a sufficient level of precision and flexibility. It may also contribute in lowering transaction costs.

At present, however, it can be empirically observed that environmental insurance is not widespread at all. Gradual pollution coverage is still perceived as too costly by the industry and most firms do not decide to insure against these environmental risks spontaneously. The cost of environmental insurance policies is affected by the complexity of the new techniques outlined, by the factual features of the risk itself ⁽²⁹⁾ and by the level

⁽²⁸⁾ UNEP has been working with the banking and insurance industry to try to promote greater awareness of environmental issues in the business sector to encourage sound environmental management. UNEP is dedicated to promoting sustainable development, which aims to achieve a balance between trade, development and environment.

⁽²⁹⁾ See B. BERLINER and J. SPÜHLER, "Insurability issues associated with managing existing hazardous waste sites", in *Integrating Insurance & Risk Management for Hazardous Waste*, edited by HOWARD KUNREUTHER and RAJEEV GOWDA, Kluwer Academic Publishers 1990.

of legal uncertainty. An explanation of the difficulties experienced by most insurers in marketing Environmental liability policies (EIL) and other environmental coverages can be found in the fact that gradual pollution risk is a so-called **low probability/high consequences risk** and, generally, such risks are not rationally faced by economic actors: they can be easily **underestimated or even ignored** ⁽³⁰⁾.

Moreover, even from a pure rational choice theory point of view, the **limited liability structure of corporations** introduces significant distortions in the picture, altering the correct incentives mechanism ⁽³¹⁾. Given the magnitude of losses in the environmental field, in fact, it will often be the case that the amount of potential ecological damage is much greater than the measure of potential liability of the polluter.

Another phenomenon that widely occurs is the following: after the plant has passed the severe insurability inspection performed by the risk-carrier's engineers, the prospective insured refuses to purchase coverage because she feels that her activity is safe enough. Of course, the fact that a plant is insurable does not mean that it is completely safe and that an accident will never occur. The satisfactory results of the inspection, instead, indicate only that the risk created by that particular plant has all those characteristics of predictability that allow a professional risk carrier to undertake it. In any event, many firms have clearly stated that they will not buy pollution coverage unless they are obliged to do so.

8. Compulsory environmental liability insurance?

In light of these considerations, a system of **mandatory pollution insurance** - at least for those activities that are particularly dangerous for the environment - would seem a desirable solution. Even this conclusion, nevertheless, turns out to be **rather problematic**. A system of compulsory insurance can be bilateral or unilateral. In the former case, the firm has the obligation to buy coverage in order to be allowed to operate and the insurance industry has the obligation to provide coverage at pre-determined conditions to each and every applicant. Bilateral mandatory pollution insurance, however, is incompatible with the very nature of modern environmental insurance techniques. As mentioned, environmental policies are tailor-made and site-specific and not every plant necessarily has all those characteristics that make it insurable. Standard conditions set by legislature and applicable to every insured, moreover, would drag pollution insurance back to the traditional insurance scheme, which has proved to be highly inappropriate in this context. As long as unilateral mandatory insurance is concerned, purchase of pollution coverage is still a condition to operate for the firms, but insurers do not have any obligation and they may, therefore, refuse coverage to anyone at their own discretion. In this latter case, the incentive mechanism embedded in modern environmental insurance would be able to work properly, but the insurance industry would be placed in the uncomfortable and inappropriate position of **environmental policeman**. In fact, the insurer would be entrusted

⁽³⁰⁾ See KUNREUTHER & SLOVIC, "Economics, Psychology Protective Behavior", 68 *American Economic Ass'n Proceedings* 1978, 64; KUNREUTHER, "Limited Knowledge and Insurance Protection", 24 *Public Policy* 1976, 227; CAMERER & KUNREUTHER, "Decision Processes for Low Probability events: Policy Implications", 8 *Journal of Policy Analysis and Management* 1989, 565-592.

⁽³¹⁾ See HANSMANN & KRAAKMAN, "Towards Unlimited Shareholder Liability for Corporate Torts", 100 *Yale L. J.* 1879.

with the power to decide which firms can continue their activity and which should instead withdraw from the market. This is a policy choice that the authority has to make.

9. Financial security: possible alternatives to liability insurance

- Self insurance through tax deductible reserves
- First party insurance
- *Ex ante* deposits
- Guarantee provided by financial institutions
- Risk sharing agreements:
 - P&I Clubs (Protection & Indemnity Mutual) / Oil Pollution Funds
- Compensation funds
 - *Limitation fund*
 - *Advancement fund*
 - *Guarantee fund*
 - *Restoration fund*

10. Financing past pollution: the issue of retroactive liability and the limits of liability

Retroactive liability and insurance are, in principle, incompatible. Limited applications: cleanup cost cap coverage (brownfield sites).

Limits of liability:

- Past pollution
- Chronic pollution
- Diffuse pollution

Suitable alternative ⇒ **Restoration fund.**

11. A proposed institutional model

In summary, in an efficient institutional model the authority would introduce an environmental liability mechanism for clean up costs or restoration of impaired resources enforced on a strict, individual and non retroactive basis. It would also regulate dangerous activities, setting standards of operation at the minimum level of insurability and requiring proof of adequate financial guarantee. Hence, having encouraged the operators of dangerous activities to seek pollution coverage, the legal system could rely on the new techniques developed by modern environmental risk-carriers and on the incentives created by long term insurance relationships. Several types of environmental damages will be excluded from the liability regime (diffuse and chronic pollution, past pollution, etc.). As

for the residual environmental damages, the efficient institutional system could rely on a complementary method of compensation based on a no-fault Compensation Fund.

12. A comparative analysis of different legal and regulatory frameworks

In this section, the report discusses some real world experiences. The purpose of this part is not to explore the details of the selected systems, rather to outline their most relevant provisions with respect to environmental liability and insurance, in order to compare them with the proposed institutional model.

- a) *The U.S. System*
- b) *The German System*
- c) *The Italian System*
- d) *The proposal for a “Directive of the European Parliament and of the Council on environmental liability with regard to the prevention and remedying of environmental damage” presented by the Commission of the European Communities on January 23, 2002 [COM(2002) 17 final]*

13. Comparative remarks and policy conclusions

The comparative analysis shows how different legal framework affect environmental risk insurability. Modern environmental insurance may well provide the tools to bridge the gap between liability and regulation:

- ecological insurance, in fact, gives effect to the **compensation** function of the environmental liability regime, providing the victims with a reliable source of funds when the accident occurs;
- moreover, with a view to reducing the risk of a polluting event, the insurer may act as a **surrogate regulator**, trying align the interests of the insured with environmental safety concerns;
- furthermore, by imposing the *ex ante* **internalization of environmental costs**, ecological insurance gives appropriate incentives to prevent the persistence of inefficient activities.

In order to encourage the growth of a pollution insurance market, law and policy makers should put their best efforts in circumscribing, limiting and defining with a sufficient level of predictability the risk of environmental liabilities.

This reports suggests an institutional model of interaction among regulation, liability, funds and insurance that conveys the results of a comparative law and economics analysis.

PART III

NATURAL CATASTROPHE RISK AND INSURANCE

1. The problem

Large losses created, among others, by hurricane Andrew in Florida in 1992, the Northridge earthquake in California in 1994, the Kobe earthquake in Japan in 1995, the Kocaeli earthquake in Turkey in 1999, windstorms Lothar and Martin in Europe in 1999, the Bhuj, Gujarat earthquake in India on January 26, 2001 and tropical storm Allison in the USA in 2001 put large strains on the capacities of the reinsurance markets and, consequently, the availability of catastrophe insurance coverages has decreased substantially.

2. Market failures in natural catastrophe insurance

Natural catastrophe risk is a low probability and high consequences risk. This poses several problems to the traditional functioning of insurance:

- Bounded rationality of individuals
- Low level of risk predictability
- Geographical risk spreading problem (cumulative risk in the primary market)
- Limited market capacity:
 - magnitude of losses (aggregate claims)
 - inter-temporal spreading problem (mismatch between size of annual premiums and size of the expected loss)
- Adverse selection

The outlined problems and failures of the private market for catastrophe insurance call for an evaluation of alternative risk management solutions.

3. The importance of public-private partnership for disaster management

Since the private insurance sector encounters several difficulties in handling catastrophe risks which do not fully meet the prerequisites of insurability, some sort of intervention of the public sector is advisable. Besides, the trend worldwide is generally towards co-operation between governments and the private sector in the management of disaster risks.

The public authority can play a fundamental role by:

- providing the requisite legal framework
- subsidizing the cost of administering the disaster management scheme
- subsidizing the cost of insurance to the beneficiaries
- being a reinsurer of last resort

The private insurance sector, in turn, has the requisite expertise for:

- expedite loss assessment
- effective surrogate regulation

The creation of government-subsidized insurance schemes is the most common example of partnership.

4. A comparative analysis of different legal and regulatory frameworks

Complex governmental risk management strategies have been implemented in several legal systems. Some of the most relevant institutional arrangements involving a public-private partnership are discussed in this section:

- **FRANCE: National Disaster Compensation Scheme CAT NAT / Caisse Centrale de Réassurance CNR** (In France, a disaster compensation scheme has been established by law in 1982. It provides for a compulsory disaster extension on all property damage policies. Coverage under the catastrophe extension is triggered when the state of natural disaster is declared by inter-ministerial decree. The Caisse Centrale de Réassurance (CCR), a state-owned company, entered into an agreement with the Authorities that allows it to offer reinsurance cover with a Government guarantee in the field of natural disasters. This state-run cover does not, however, give CCR a monopoly in natural disaster reinsurance. In fact any insurer may seek cover for itself from the reinsurer of its choice, and may even take the risk of not underwriting reinsurance. Nevertheless, CCR remains the only company within its sector of activity which offers a whole range of reinsurance solutions with unlimited cover. This is an advantage for insurers, since it gives them absolute security in the event of a major loss, be it a large-scale event such as a flood occurring every hundred years or a geological problem such as subsidence, which causes all kinds of damage. CCR thus provides a guarantee of solvency and security for insureds within the natural disaster compensation scheme.)
- **SPAIN: Consorcio de Compensación de Seguros** (The Consorcio is a state-owned company, which is included in the category of public business entity, and it is a separate legal entity that has full powers to act. The Consorcio has its own assets and liabilities, separate from those of the State, and its activity is governed by private law. This means that the new company, when doing insurance business, apart from being governed by the terms of its own Legal Statute, is subject, like any other private insurance company, to the legal rules laid down in the Private Insurance Ordering and Supervision Act and its enacting regulations, and to the Insurance Contract Act.)
- **USA: National Flood Insurance Program (NFIP)** (In 1968, the US Congress created the National Flood Insurance Program in response to the rising cost of taxpayer funded disaster relief for flood victims and the increasing amount of damage caused by floods. The NFIP makes federally-backed flood insurance

available in communities that agree to adopt and enforce floodplain management ordinances to reduce future flood damage)

- **CALIFORNIA: California Earthquake Authority (CEA)** (Established in 1996 to relieve pressure on private insurers, the California Earthquake Authority is a privately financed, state-run insurance program that sells a “mini-policy” with a larger deductible and more limited coverage of external structures than conventional earthquake insurance policies. There State offers no guarantee: therefore, if losses from an earthquake drain the established fund, the CEA may run out of business and claims will be paid out on a pro-rated basis.)
- **FLORIDA: Florida Hurricane Catastrophe Fund (FHCF)** (In 1993, the State of Florida established the Florida hurricane catastrophe fund to allow insurers to transfer a portion of their catastrophic risk. The Fund reimburses a fraction of insurers’ losses caused by sever hurricanes and it is funded by premiums paid by insurers that write policies on personal and commercial residential properties. An important provision limits the Fund’s obligation to pay losses to the sum of its assets and borrowing capacity.)
- **HAWAII: Hawaii Hurricane Relief Fund (HHRF)** (In 1993, Hawaii created a voluntary homeowner’s catastrophe fund in order to provide hurricane insurance for customers of insurers which would no longer voluntary offer such coverage. The Fund discontinued its operation by the end of 2000, in light of improved private market conditions.)
- **NEW ZEALAND: Earthquake Commission (EQC)** (The Earthquake Commission is a Crown Entity, wholly owned by the government of New Zealand and controlled by a board of commissioners. Crown Entities are not Government departments or state-owned enterprises but nevertheless belong to the Government and are subject to public sector finance and reporting rules. EQC administers the Natural Disaster Fund. The Government guarantees that this fund will meet all its obligations.)
- **JAPAN: Japanese Earthquake Reinsurance (JER)** (In accordance with the promulgation of the law concerning earthquake insurance and following the launch of sales of dwelling earthquake insurance to be written in conjunction with dwelling and shop-owners comprehensive insurance policies, Japan Earthquake Reinsurance (JER) was established by the 20 domestic non-life insurance companies in 1966. The law stipulates that the government underlies the funds of the company. Thus, there is no problem with the company's solvency.)
- **TURKEY: Turkish Catastrophe Insurance Pool (TCIP)**. (Following 1999 earthquake disasters occurred in the Marmara Region and Duzce, earthquake insurance has been made compulsory primarily for dwellings, through a Earthquake Insurance Program. Earthquake insurance premiums are ceded to the Turkish Catastrophe Insurance Pool, which is managed by the Natural Disasters Insurance Council, DASK in the Turkish abbreviation.)

5. Risk sharing through capital markets

With a view to increasing market capacity and to lower reinsurance costs, the landscape of risk transfer alternatives has evolved significantly in recent years. Governments, primary carriers as well as global reinsurers now have the option of turning to the capital markets for supplemental catastrophe protection. Catastrophe securities are a recent development in investing: by floating such bonds for specific risks over limited time periods in defined geographic regions, insurers and reinsurers reduce risk by transferring it to investors. Investors, in turn, have viewed the introduction of the insurance-linked security as an opportunity for the development of a new market, with the added attraction that so-called **cat bonds** are largely uncorrelated with other financial instruments. Investors (usually hedge funds or other major institutional financiers) get a high rate of return, in exchange for the possibility of losing much of their principal or interest, or both, in the event of disasters. Cat bonds have the potential to greatly increase the amount of capital available for catastrophic risk, as well as alter the pricing of risk.

- Physical trigger vs. loss trigger

Catastrophe bonds entail almost **no credit risk**, since the money are in escrow or in a trust fund, invested in liquid securities and, therefore, readily available. However, the use of physical trigger cat bonds entails a different risk, named **basis risk**. In contrast to traditional reinsurance, in fact, **this kind of coverage may not be a perfect hedge** for the insured portfolio. It is necessary to compare the reinsurance credit risk with the indexed cat bonds basis risk.

6. Hedging versus financing instruments in the management of disaster risks

In developing countries the insurance market might be less attractive to international reinsurers, due to rather low profitability. Since some developing countries are catastrophe prone areas, it is important to discuss the alternative to catastrophe reinsurance in the management of disaster related costs.

- Risk hedging instruments (pre disaster)

- Cat bonds versus traditional reinsurance:
 - Basis risk v. credit risk
 - Immediate payoffs from cat bonds v. delayed payment from reinsurance indemnity
 - Cost of implementing each measure
 - Cost of each instrument

- Risk financing instruments (pre/post disaster)

- Catastrophe Reserve Fund (pre)
- Catastrophe Tax (post)
- Government Debt instruments (post)

- International Loans (post)
- Budget Diversion (post)

Disaster risk spreading through governmental programs can be negatively affected by:

- Ineffective tax collection system
- Inefficiencies and corruption in the governmental agencies

7. Regulation and catastrophe insurance

Regulatory policies greatly affect the development of markets for disaster risk coverages and, consequently, the availability of effective catastrophe insurance. This section of the report discusses the effects of:

- Regulatory constraints
- Market entry/exit rules
- Rules on the admissibility of ART
- Financial and fiscal issues
- Regulation of claims practices
- Antitrust and competition policies

8. Integrated risk management strategies: catastrophe bonds and insurance can be coupled with incentives and other regulatory mechanisms to reduce disaster losses.

An effective disaster risk management strategy requires the proactive involvement of all the stakeholders:

- **Key Stakeholders:**
 - Homeowners and businesses at risk
 - Government
 - Insurers / Reinsurers
 - Investors in Cat Bonds
- **Principles of Catastrophe Risks Management:**
 - Integrated approach
 - Scientific risk estimates
 - Risk predictability
 - Expected loss estimates
 - Structural mitigation and vulnerability reduction
 - Incentives to minimize adverse selection / moral hazard
 - Expedite settlements

Well-enforced regulatory measures, such as building codes, can complement insurance and other financial instruments by forcing the adoption of **cost-effective risk mitigation measures** (RMMs). Incentives are needed since property owners often underestimate the risks from disasters (low frequency/high severity risks).

In addition, effective mitigation measures may produce **positive externalities** by reducing other costs arising out of a disaster.

9. Conclusions.

This section of the report presents several economic and institutional alternatives to the traditional insurance and reinsurance mechanisms in the **management of natural catastrophe risk** and discusses the implications of an **integrated approach to disaster management** based on insurance, prevention, mitigation, compensation and a close partnership between the public and the private sectors.

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