Environmental Assets & Liabilities

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Abstract: We review the extent to which the Federal Government faces liabilities arising from its management of environmental risks, and argue that the degradation of natural capital can lead to social risks which ultimately will end up to some degree as the responsibility of the Federal Government. We then look in detail at the Price-Anderson Nuclear Industries Indemnity Act and try to assess the nature of the liability assumed by the Federal Government under this Act. This is clearly very large indeed, and we argue that this risk is not well-managed by current institutions and policies and suggest ways of improving the management of nuclear risks.

Introduction

In this paper we are aiming to review some of the possible environmental liabilities of the Federal Government, with particular focus on its liabilities under the Price-Anderson Nuclear Industries Indemnity Act of 1957, which exempts the owners of nuclear power stations from certain liabilities. We begin with a general review of the nature of environmental assets and liabilities, as these are categories that are not widely known. We talk about natural capital as an asset of the nation, its significance, and some of the problems associated with valuing it. This leads naturally to a general review of potential liabilities at the Federal level. We then focus on the Price-Anderson Act and the alternatives to this Act. We argue that the P-A Act imposes significant liabilities on the Federal Government, and ask whether this is appropriate and necessary. To gain insights into this, we review the programs by which catastrophic risks are managed in other areas by a combination of private sector and Federal insurance programs.

Natural Capital as an Asset

A nation's environmental assets are diverse and important. Environmental economists talk about natural capital, on a par with physical capital, human capital, intellectual capital and other forms of capital.[3] Environmental assets, like any other assets, provide a flow of services over time. Often they provide these services over very long periods of time, periods that are orders of magnitude greater than those relevant for most other forms of capital.

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[3] For a discussion see Barbier and Heal, Valuing Ecosystem Services, The Economists' Voice, Berkeley Electronic Press, January 2006 , www.bepress.com/ev and the references there.

A good example is the New York City watershed, a collection of naturally-occurring ecosystems in the Catskills that cleanse and stabilize the flow of water to New York. This has provided these services since the earliest days of New York and if not disturbed can continue to do so for centuries more. Recently the City spent over $1 billion restoring the ecological integrity of this watershed, in order to restore the City's water to earlier levels of purity. We can see this as an investment in natural capital, with the benefit the flow of clean water and the avoidance of a complex and expensive filtration plant costing over $8 billion.[4] Although the Catskills watershed is an asset to New York City, and the City has invested extensively in it, the City does not own it. The watershed consists of land in the Catskills, most of which is privately owned either as farms or as homes.

Forests are another topical example of natural capital. Forest can of course be cut for lumber, and have great value in that role. And their growth gives a natural rate of return. In addition forests provide services such as carbon sequestration: in a world where greenhouse gases are threatening climate change and many companies are operating under carbon constraints, the ability to absorb carbon from the atmosphere is clearly valuable, even though it generally does not currently have a market value. But that is changing: the Clean Development Mechanism of the Kyoto Protocol provides a mechanism for monetizing the carbon services of forests, and the proposal of the Coalition for Rainforest Nations to generate avoided deforestation credits will take this further.[5] Forests are sometimes public property and sometimes private, and the carbon sequestration services that they provide are public goods. They provide other services as well – biodiversity support, for example, and recreational services – but carbon sequestration and lumber are their main sources of value. And at the carbon prices that have ruled in the European Union's Emission Trading Scheme, the present value of the carbon services of a forest often exceeds its lumber and agricultural values.

Natural resources such as oil, gas, coal and various other mineral deposits are also a form of natural capital, and the values of these are often reflected in the valuations of their owners, usually corporations. It is generally recognized that one of the main determinants of the stock market value of an oil company is the value of its oil reserves.[6] An interesting point is that if a corporation depletes its oil reserves, then under U.S. GAAP[7] and most equivalents, it must record this as depletion of assets in its financial statements. If however a nation depletes its reserves of oil or any other mineral resource, then the United Nations System of National Accounts does not require that it record a depletion

[4] For more details see Geoffrey Heal, Nature and the Marketplace, Island Press, 2000 and National Research Council, Valuing Ecosystem Services: Toward Better Environmental Decision-Making, National Academies Press, 2004, available at http://www.nap.edu/books/030909318X/html/ For a detailed study of all aspects, economic and scientific, see also the National Research Council's book Watershed Management for Potable Water Supply: Assessing the NYC Strategy, National Academy Press, 2000.
[5] See www.rainforestcoalition.org for more information. Also relevant is "A Solution to Climate Change in the World's Rainforests," Geoffrey Heal and Kevin Conrad, Financial Times, November 5 2005, http://www2.gsb.columbia.edu/faculty/gheal/FT_Nov05.pdf
[6] See for example Upton and Miller XXXX
[7] Generally Accepted Accounting Principles

charge against its income. If the national accounts of oil-producing countries were to record depletion charges, then their incomes would drop very significantly indeed.[8]

Soils are also important natural capital: a region with rich soils is agriculturally productive, and this is reflected in the value of land. Soils are complex ecosystems that evolve over time and can be damaged by overuse or by chemical pollution.

At a more abstract, but perhaps also more important, level, the climate system is an asset. The Floridian climate goes a long way to explaining why people want to live there, and some of the economic value that it generates is reflected in land values. The same is true of the climate of the Caribbean, or of skiing resorts in the Rocky Mountains. Climate also plays an important role in determining agricultural productivity. The climate system is more than the temperature, though that is a central part of it: the humidity, precipitation and wind patterns all play an important role in determining the value of a climate system. The world's climate system is currently changing in a way that will make it less valuable to many. Florida also illustrates this point.

The population of Florida has increased significantly over the past 50 years: 2.8 million inhabitants in 1950, 6.8 million in 1970, 13 million in 1990, and a projected 19.3 million population in 2010 (almost a 700% increase since 1950)[9]. The increase in the value exposed to natural hazards amplifies the potential for severe economic and insured losses. If Hurricane Andrew had occurred in 2002 rather than 1992, it would have inflicted twice the economic losses, due principally to increasing coastal development and rising asset values in Miami/Dade County and adjoining coastal areas in Florida affected by the storm.[10] Compounding this increase in exposure is the fact that there appears to be a trend for tropical storms to become stronger over time, presumably associated with climate change.[11]

Although all of these natural capital assets are important and in some general sense valuable, they are often hard to value precisely. Valuing natural capital and the services that it produces has in fact been an active area of environmental research in the last decade.[12] Sometimes a part of the value of natural capital is captured by markets, as for example the value of a forest as lumber. The owners of forested land in the Catskills watershed have traditionally valued it for the lumber that it produces. And more recently they have added to this the value of payments that they might receive from the City of

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[8] See Heal Accounting and the Resource Curse, in Escaping the Resource Curse, edited by Macartan Humphries, Jeffrey Sachs and Joseph Stiglitz, 2007 and references therein.

[9] Kunrether , H. and Michel-Kerjan (in press) ".Climate Change, Insurability of Large-scale Disasters and the Emerging Liability Challenge" *University of Pennsylvania Law Review*

[10] Andrew Dlugolecki, *Thoughts about the Impact of climate change on insurance claims*, in P. Höppe and R. Pielke (eds.), *Report of the Workshop on Climate Change and Disaster Losses, May 25-26*, (2006).

[11] See Emanuel, K. 2006. Hurricanes: Tempests in a greenhouse. Physics Today 59:74-75

[12] This literature is reviewed in National Research Council, Valuing Ecosystem Services: Toward Better Environmental Decision-Making, National Academies Press, 2004, available at http://www.nap.edu/books/030909318X/html/

New York for management of the land in a way conducive to the proper functioning of the watershed. But they get no payments for the carbon sequestered by their growing trees, and in this service they are providing a global public good without recompense.

The World Bank has recently published the results of a major study of the values countries' environmental assets, along with the values of their other forms of capital. Their methodology is set out in full in their publication "Where is the Wealth of Nations?" available at
http://siteresources.worldbank.org/INTEEI/214578-1110886258964/20748034/All.pdf.
Not all values are estimated directly: some are calculated as residuals.

Table 1 shows some of the conclusions that emerge from the Bank's studies. For low income countries, natural capital is an important and often the most important form of capital asset. It becomes a smaller part of the total picture as the level of development rises, falling from 29% of assets for low income countries to as little as 2% for high

Table 1 from Where is the Wealth of Nations page xxiv

— $ per capita and percentage shares —

Income group	Natural capital	Produced capital	Intangible capital	Total wealth	Natural capital share	Produced capital share	Intangible capital share
Low-income countries	1,925	1,174	4,434	7,532	26%	16%	59%
Middle-income countries	3,496	5,347	18,773	27,616	13%	19%	68%
High-income OECD countries	9,531	76,193	353,339	439,063	2%	17%	80%
World	4,011	16,850	74,998	95,860	4%	18%	78%

Source: Authors.
Notes: All dollars at nominal exchange rates. Oil states are excluded. OECD: Organisation for Economic Co-operation and Development

income countries. Note that even 2% is a large number absolutely for these countries, and that many forms of natural capital are omitted from the calculations because of data limitations. It is also interesting to note that for high income countries the role of physical capital or produced capital, the traditional stereotype of a capital asset, is limited at 17% of the total, with the most important category being intangible capital. This includes some environmental assets – climate for example – and also includes human and intellectual capital.

Environmental liabilities

What does this tell us about environmental liabilities? Certain categories of environmental liabilities are widely recognized, for example those generated by the Superfund legislation, and other liabilities associated with past pollution activities. Even with such well-studied liabilities as Superfund there are open questions as to who is liable because of the complexities of joint and several liability. But in general these are not the liabilities of the federal government. The Federal Government does have some easily-recognized liabilities associated with the pollution of Department of Defense sites, whose clean-up costs have been estimated at over $30 billion.[13]

A more interesting source of liabilities of the Federal Government could arise from changes in the state of natural capital that lead to its ceasing to provide the valuable services that it has provided in the past. A timely example is the gradual destruction of the barrier islands in the Gulf of Mexico offshore from New Orleans. Historically these islands protected New Orleans from storm surges, and their gradual disappearance contributed to the severity of the impact of Hurricane Katrina on that city.[14] This in turn created liabilities for the Federal Government through the designation of the area as a disaster area and the intervention of the Federal Emergency Management Agency (FEMA). Estimates suggest that Federal Government may spend as much as $150 billion in response to Hurricane Katrina,[15] and we can regard a part of this as an environmental liability as it is a liability that arose in part as a predictable consequence of the degradation of natural capital. Legally the Federal Government is probably not liable for damages of this sort, but politically it surely is: the public expects the Federal Government to step in and offer restitution is situations such as Katrina.

Hurricane Katrina is illustrative of a class of situations where the Federal Government may incur liabilities as a result of its failure to manage environmental issues adequately. In this case a part of the cause was undoubtedly the changes in the topography of the area around New Orleans as a result of dredging and canalization, and the removal of barrier islands, all of which can be considered degradation of natural capital or of environmental assets. The U.S. Army Corps of Engineers, a Federal Agency, was responsible for much of this. In addition some argue that climate change made a contribution to the severity of Katrina, and argue that the Federal Government by failing to act on this issue further contributed to the severity of the problem. The general point here is that to the extent that degradation of natural capital leads to increased severity and frequency of natural disasters, there is an increase in Federal liability, though this is hard to quantify. The natural disasters associated with the mismanagement of natural capital could include storms, wildfires, floods and droughts, all of which can generate liabilities in the billions.

Nuclear Liabilities

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[13] See the CBO report at http://www.cbo.gov/showdoc.cfm?index=4764&sequence=0

[14] See Joel K. Bourse Jr. "Gone with the Water," National Geographic, http://magma.nationalgeographic.com/ngm/0410/feature5/

[15] See the Christina Science Monitor at http://www.cbo.gov/showdoc.cfm?index=4764&sequence=0, September 14, 2005.

Nuclear power has a rather unique environmental profile. If a nuclear power station operates correctly, over its operating lifetime it has little if any environmental impact. It emits no gases, and indeed no pollutants of any kind. There is however a small chance of a very serious breakdown, a core meltdown, that can lead to vastly damaging pollution, as happened most spectacularly in the case of the reactor at Chernobyl in the Ukraine in 1986. In this case, clouds of radioactive waste floated over much of the Ukraine, Belarus, Eastern and Western Europe and Scandinavia. Death estimates are controversial, with international agencies estimating about 9,000 deaths as a direct result. Core meltdowns have also occurred twice in the U.S., once at the Enrico Fermi reactor in Newport, Michigan, in 1966 and again at Three Mile Island in Middletown, Pennsylvania in 1974. In it generally believed that little or no radiation was released in either of these cases.[16]

In addition to the risk of melt-down, nuclear power stations pose problems associated with the disposal of their radioactive wastes. Over its operating life a nuclear power station will produce many tons of highly radioactive long-lived waste, which poses a health hazard for many centuries and since 9/11/2001 has been recognized as a possible ingredient for a dirty bomb used in a terrorist attack. The selection of a policy for disposing of radioactive wastes from nuclear power stations is still controversial, and no country has yet implemented a coherent long-term policy in this respect. In the U.S., the current policy is that waste be buried at the Yucca Mountain Repository in Nevada, but this policy has not yet been implemented. In the meantime many hundreds of tons of highly radioactive waste sit in containment tanks at the sites of commercial nuclear power stations, often poorly guarded. Were some of this to fall into the wrong hands, the costs could be immense and would clearly fall substantially on the Federal Government: there is a Federal liability here.

A core meltdown is generally agreed to be the most serious accident that can occur to a nuclear power station. What is the risk of this event, and what are the possible consequences?

In the U.S., 104 commercial reactors have been built and operated, and as noted two – Enrico Fermi and Three Mile Island – have experienced meltdowns. In addition, according to data from the Nuclear Regulatory Commission (NRC), four have been closed for in excess of one year for serious failures that if not corrected could have caused core meltdowns.[17] This means that 6 in 104 reactors have experienced meltdowns or near-meltdowns. Normally this data is not presented as X meltdowns or near-meltdowns in Y reactors: it is presented per reactor year. By now most reactors have been operating over 25 years, so the risk appears smaller when presented this way. Both ways or presenting the data appear to have some merit.

An important point is that all the meltdowns and most of the near-meltdowns occurred in the 1960s and 1970s. There have been none since 1980. This suggests that the risks are

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[16] See "Walking an Nuclear Tightrope: Unlearned Lessons of Year-Plus Reactor Outages," David Lochbaum, Union of Concerned Scientists, available at http://www.ucsusa.org/clean_energy/nuclear_safety/walking-a-nuclear-tightrope.html

[17] Data from the U.S. Nuclear Regulatory Commission, available in Walking a Nuclear Tightrope," op. cit.

highest early in the life cycle of a reactor design. This would be reasonable, and consistent with the idea of a learning curve associated with the management of something as complex as a nuclear power station. There are both reassuring and disturbing aspects of this observation. It is reassuring as far as the safety of existing reactors is concerned, but disturbing when one recognizes that the currently-proposed expansion of nuclear power would be through new and as-yet untried reactor designs, designs specifically focused on reducing the (very substantial) capital costs of nuclear power stations. A new generation of reactors could take us back to the top of the learning curve and into an era of risk not experienced since the 1960s and 1970s.

What would be the costs of a core melt-down in which, as in the Chernobyl case, radiation was released from the containment vessel? There is no general theory for such a discussion, so we shall focus on a specific case, the case of Indian Point, a nuclear power station owned by Entergy Corporation and situated on the Hudson River 24 miles north of New York City. The huge population densities in the region make an accident here particularly threatening. Nuclear fallout from the plant could reach populated areas including New York City, northern New Jersey, and Fairfield County, Connecticut. A 1982 study by Sandia National Laboratories found that a core meltdown and radiological release at one of the two operating Indian Point reactors could cause 50,000 near-term deaths from acute radiation syndrome and 14,000 long-term deaths from cancer.[18] In addition to these horrifying health impacts, the release of a cloud of radioactivity over New York City could close the city down for business for a considerable period of time.

The financial costs of such an event are clearly stunning. 64,000 deaths valued at $6 million per person alone gives a cost of $384 billion. Cut this to one tenth and the number is still huge. In the case of the 9/11/2001 attacks, insured business losses and business interruptions were valued at in the region of $35 billion. A disaster at Indian Point could possibly close more of New York than the 9/11/2001 attacks, and for longer. So business losses in the region of $50-100 billion are possible, in addition to the costs associated with loss of life and damage to health. It is therefore not unreasonable to think that the direct and indirect costs of a nuclear accident could be in the hundreds of billions. Indeed a worst-case scenario could lead to the closure of New York City for years,[19] leading to almost unthinkable costs, most likely over $1 trillion.

The Price-Anderson Act and Nuclear Accident Insurance[20]

The Price-Anderson Act, originally enacted by Congress in 1957, limits the liability of the nuclear industry in the event of a nuclear accident in the United States. The Act was passed in order to encourage the construction of nuclear power plants in the United States. At the same time, P-A provides a ready source of funds to compensate potential accident victims that would not ordinarily be available in the absence of this legislation. The Act covers large power reactors, small research and test reactors, fuel reprocessing

[18] For more details see http://www.ucsusa.org/news/press_release/new-study-predicts-up-to-44000-prompt-fatalities-and-518000-longterm-deaths-from-indian-point-terror-attack.html
[19] The city of Chernobyl is still closed after the meltdown of 1986.
[20] For more details on nuclear accident insurance see Nuclear Energy Institute "Price-Anderson Act Provides Effective Nuclear Insurance at No Cost to the Public", February 2005.

plants and enrichment facilities for incidents that occur through plant operation as well as transportation and storage of nuclear fuel and radioactive wastes. The Act is seen as central to the commercial viability of nuclear power: according to Vice President Dick Cheney, without renewal of the Price-Anderson Act, “nobody’s going to invest in nuclear power.”

P-A sets up two tiers of insurance. Each utility is required to maintain the maximum amount of coverage available from the private insurance industry - currently $300 million per site. In the U.S., this coverage is written by the American Nuclear Insurers, a joint underwriting association or “pool” of insurance companies. If claims following an accident exceed that primary layer of insurance, all nuclear operators are obligated to pay up to $100.59 million for each reactor they operate payable at the rate of $10 million per reactor, per year. As of February 2005, the U.S. public currently has more than $10 billion of insurance protection in the event of a nuclear reactor incident. More than $200 million has been paid in claims and costs of litigation since the Price-Anderson Act went into effect, all of it by the insurance pools. Of this amount, approximately $71 million has been paid in claims and costs of litigation related to the 1979 accident at Three Mile Island.

As part of the Energy Policy Act of 2005, signed into law by President Bush on August 8, 2005, Price Anderson was reauthorized for the next 20 years. This is the fifth time that Congress has reauthorized the Act since P-A was first passed in 1957 but it is the longest extension ever granted. High prices and dwindling supplies of fossil fuels have increased interest in nuclear energy and the long extension of P-A may increase the feasibility of investment in nuclear power plants. One should note, however, that since the Three Mile Island accident in 1978 not a single nuclear power plant has been built in the United States.

Are Nuclear Power Plant Accidents an Insurable Risk?

A principal reason for the passage of the P-A Act was to protect the utilities against the possibility of a catastrophic loss from a nuclear power plant accident. Private insurers were reluctant to provide this coverage because they were uncertain as the likelihood of a severe accident (e.g. a core meltdown) and the consequences of such a disaster. In other words, it was believed at the time that protection against nuclear accidents did not satisfy the conditions for insurability of a risk by the private sector. Is this in fact correct – is it really necessary that the government should assume the liabilities associated with the P-A act, or could we in fact rely on the private sector to play this role?

The conditions for insurability in the context of environmental risks have been examined by Freeman and Kunreuther (1997). Cummins (2006) and Litan (2006) have recently examined this issue in the context of catastrophic risks. The discussion that follows uses concepts from these papers by focusing on a hypothetical insurer, Environa, which is deciding whether or not to provide coverage against damage from an environmental risk

Law of large numbers

Environa and other insurers are likely to be concerned about the variability of profits from the risks they insure. The ideal risk is one where the potential loss from each insured is relatively small and independent of the losses from other policyholders. As the insurer increases the number of policies it issues in a year, the variance in its annual losses decreases. In other words, the law of large numbers makes it highly unlikely that the insurer will suffer an extremely large loss relative to the premiums collected.

Insurance against underground storage tank (UST) leaks is an example of an environmental risk that satisfies the law of large numbers since losses are normally independent of one another. To illustrate the application of this law, suppose that an insurer wants to determine the estimated loss for a group of identical USTs each of which has a 1/100 annual chance of leaking and causing damage of $100,000. The expected annual loss for each UST would be $1000 (i.e. 1/100 x $100,000). As the number of UST policies *n* increases, then the variance of the expected annual loss decreases in proportion to *n*. Cummins (2006) considers the case where the insurer is willing to accept a low probability of insolvency ε arising out of a catastrophic loss when insuring a book of business. He shows that for risks which are independent and whose losses are characterized by the normal distribution so that the central limit theorem applies, the equity capital per policy approaches zero as the number of insured policies becomes very large.

Conditions for Insurability

The application of the law of large numbers is predicated on the ability of Environa or other insurers to estimate the likelihood and consequences of a risk and for the risks to be independent of each other. The risks associated with large-scale natural disasters are unlikely to satisfy the law of large numbers. The following three conditions can then determine the degree to which such a risk is insurable:

Condition 1 is the ability to identify and quantify the chances of the event occurring and the resulting losses under different levels of insurance coverage.

Condition 2 is the ability to set premiums for each potential customer or class of customers that reflect the risk.

Condition 3 is the ability to make a positive expected profit by providing coverage against the risk

We now examine each condition and raise some questions related to the ability of private insurers to provide coverage.

Condition 1: Identifying the Risk

To satisfy this condition, estimates must be made of the frequency at which specific events occur and the magnitude of the loss. The risk of a leaky UST is one with which the insurance industry is relatively comfortable because there is past data and scientific information that enables them to determine both the likelihood and consequences of such an event. Due to the infrequency of nuclear power plant accidents, it is much more difficult to estimate these parameters for insurance against this risk.

Condition 2: Setting Premiums that Reflect the Risk

Once the risk has been identified, Environa and other insurers need to determine a premium that reflects the risk while posing an unacceptably high chance of insolvency or severe loss of surplus due to a catastrophic loss. There are several factors that determine what premiums insurers would like to charge

Ambiguity of Risk A risk is ambiguous if we cannot assign a probability to it. Insurers, and indeed decision-makers in general, dislike ambiguity. The greater the ambiguity of a specific loss the higher the premium will be. In a mail survey of professional actuaries conducted by the Casualty Actuarial Society, 463 respondents indicated how much they would charge to cover losses against a defective product in two cases, one where the probabilities of a loss was well specified at p=.001 and one where they experienced considerable uncertainty about the likelihood of a loss with the same mean likelihood. The median premium values were five times higher for the uncertain risk than for the well-specified probability when the losses from each insurance policy were independent. This ratio increased to ten times when the losses were perfectly correlated. (Hogarth and Kunreuther 1989).

In another study a questionnaire was mailed to 190 randomly chosen insurance companies of different sizes asking underwriters to specify the prices which they would like to charge to insure a factory against property damage from a severe earthquake, to insure an underground storage tank and to provide coverage for a neutral situation (i.e. a risk without any context). Probabilities and losses were varied. The probability of loss and the size of the claim were either well-specified or there was ambiguity regarding the likelihood of the loss and/or the claim size. The underwriters wanted to charge considerably more for the same amount of coverage when either the probability was ambiguous and/or the claim size was uncertain. (Kunreuther et al. 1993).

Adverse Selection If the insurer sets a premium based on the average probability of a loss, using the entire population as a basis for this estimate, those at the highest risk for a certain hazard will be the most likely to purchase coverage for that hazard. In an extreme case, the poor risks will be the only purchasers of coverage, and the insurer will lose money on each policy sold. This situation, referred to as adverse selection, occurs when the insurer cannot distinguish between the probabilities of a loss for good- and poor-risk categories, but the insured can.

Moral Hazard Moral hazard refers to an increase in the probability of loss caused by the behavior of the policyholder. For example, providing insurance protection to a nuclear power plant may lead the utility to behave more carelessly than if it did not have coverage. One way to avoid the problem of moral hazard is to introduce deductibles and coinsurance as part of the insurance contract. A sufficiently large deductible can act as an incentive for the insureds to continue to behave carefully after purchasing coverage because they will be forced to cover a significant portion of their loss themselves. With coinsurance the insurer and the insured share the loss together. As with a deductible, this type of risk-sharing arrangement encourages safer behavior because those insured want to avoid having to pay for some of the losses.

Catastrophic Losses A nuclear power plant accident can produce catastrophic losses. Insurers who cover the risks from such disasters may have to pay potentially large claims to policyholders before they are able to collect sufficient premiums to cover their costs. This timing risk is an important element associated with catastrophic losses. [Litan (2006)]. Rating agencies may also play a role in influencing how many policies an insurer will want to write on risks with respect to catastrophic losses. A recent report by AM Best focuses on the importance of the ratio of annual insured catastrophic losses as percentage of policyholder surplus (PHS). In general, the report notes that the higher the level of loss relative to surplus, the greater has been the financial damage to the insurance industry (Williams and King 2006).

Condition 3 Earning a positive expected profit by marketing coverage

In theory insurers can offer protection against any risk that they can identify and for which they can obtain information to estimate the frequency and magnitude of potential losses as long as they have the freedom to set premiums at any level. However, due to problems of ambiguity, adverse selection, moral hazard, and highly correlated losses, they may want to charge premiums that considerably exceed the expected loss. For some risks the desired premium may be so high that there would be very little demand for coverage at that rate. In such cases, even though an insurer determines that a particular risk meets the two insurability conditions discussed above, it will not invest the time and money to develop the product.

More specifically, the insurer must be convinced that there is sufficient demand to cover the development and marketing costs of the coverage through future premiums received. If there are regulatory restrictions that limit the price insurers can charge for certain types of coverage, then companies will not want to provide protection against these risks. In addition, if an insurer's portfolio leaves them vulnerable to the possibility of extremely large losses from a given disaster due to adverse selection, moral hazard, and/or high correlation of risks, then the insurer will want to reduce the number of policies in force for these hazards.

Making USTs Safer Through Insurance [21]

[21] This subsection is based on Yin, H., Kunreuther, H. and White, M. (2007) "Risk-Based Pricing And Risk Reduction: Does The Private Insurance Market Help Reduce Underground Storage Tank Releases?

The availability and cost of private UST insurance is closely tied to specific risk reduction measures. When buying an insurance policy, the tank owner/operator needs to provide very detailed information. For example, the Tank Pollution Insurance Underwriting Rules of Zurich in North America (Zurich hereafter), one of the leading insurance companies in environmental insurance, requires that all risks should be submitted and agents cannot bind risks without prior approval. More specifically, tank owners/operators are required to make reports on the tank construction material, tank construction methods (single/double wall), leak detection systems, installation year, and tank contents (Zurich Storage Tank System Liability Application Form). Insurance premiums are structured on these factors to encourage risk reduction efforts.

With Zurich the premium is set on a per tank basis. Primary tank factors that impact insurance premiums include age of tank system, tank system construction, leak detection systems, contents, and capacity of tank system (Zurich Tank Pollution Insurance Underwriting Rules). Table 1 and Table 2 show how insurance premiums vary as a function of the type of tanks. Table 3 reveals how Zurich determines the premiums based on various tank characteristics, tank management procedures and previous tank release history. For example, the premium for a 5-year old double wall tank is only about $200, compared to $1,700 for a 30-year old single wall tank. And the absence of corrosion protection will cause the premium to increase by 10%. So do the absence of leak detection and overfill detection (Michigan Office of Financial and Insurance Services). Because the availability and cost of private insurance are closely tied to tank owner/operator's risk reduction behaviors, the use of private insurance motivates UST owners/operators to invest more to reduce risks.

Table 1: Tank Quality and Insurance Premium in 1995 (per Tank)

Type of Tank		**Premium**
Single-walled		
Tank Age	6-10 years	$700 - $1450
	11-15 years	$1500
	16-30 years	$2500- $4000
Double-walled		
Tank Age	6-10 years	$350-$725
	11-15 years	$400-$725

Source: Public Sector Consultants, Inc., 1995.

Table 2: Typical Insurance Policy (1997)

UST System (3 tanks per site)	**Premium** Insurer A	Insurer B	Insurer C
Fiberglass reinforced tank; double wall piping suction pump system; automated monitor & inventory	$1,350 ($5,000 deductible)	$825 ($5,000 deductible)	$1,320 ($10,000 deductible)
STI-P3 steel tank (installed 1991); cathodic protection; single wall piping; suction pump system; automated monitor & inventory	$1,500 ($5,000 deductible)	$1,250 ($5,000 deductible)	$1,320 ($10,000 deductible)

Single wall steel tank (installed 1985); cathodic protection; single wall piping; pressurized system; statistical inventory reconciliation; no overfill or spill prevention	$3,500 ($10,000 deductible)	$1,500 ($5,000 deductible)	$2,563 ($10,000 deductible)
Single wall steel tank (installed 1975); no cathodic protection; single wall piping; pressurized system; stat. inventory reconciliation; no overfill or spill prevention	Decline Coverage	$3,800 ($5,000 deductible)	$5,610 ($10,000 deductible)

Source: EPA, 1997.

Table 3: Part of Rate Factors at Zurich (2004)

Impacts of Tank Quality on Private Insurance Premiums:

Age	0-5	6-10	11-15	16-20	21-25	26-30	31-35	>35
Single Wall	$284-$339	$350-$470	$500-$700	$760-$1030	$1100-$1380	$1450-$1690	$1750	$1850
Double Wall	$185-$221	$228-$302	$320-$356	$365-$426	$441-$509	$441-$509	$526-$582	$620

Deductibles and Credits:

Deductibles	$5000	$10,000	$25,000	$50,000	$100,000
Credits	0%	12%	25%	41%	56%

Impacts of Preventive and Detective Measures on Private Insurance Premiums

	Yes	No	Unknown
Leak Detection	0%	+10%	+10%
Overfill Detection	0%	+10%	+10%
Corrosion Protection	0%	+10%	+10%

Impacts of Prior Releases on Private Insurance Premiums:

	Yes, Claim Closed	Yes, Claim Open	No
Location Prior Release	10%	20%	0%

Sources: Michigan Office of Financial and Insurance Services (OFIS)

Conclusions on Insurability

The catastrophic risks associated with a meltdown of a reactor in a populated area, together with the release of radioactivity, are unlikely to be readily insurable. The risks are unique and massive, and not well understood. Problems of moral hazard and adverse selection may also be serious, In the light of the fact that the private sector is unlikely to step in here, how well does the P-A act meet society's needs?

Evaluating Price-Anderson as an Insurance Program

Price-Anderson may provide $10 billion of insurance cover. This is perhaps 10% of the likely cost of a meltdown associated with the release of radioactivity. The Act is therefore inadequate in terms of its ability to provide insurance cover for the consequences of a bad nuclear accident. The gap between what is available under the Act and what would be needed would almost certainly be filled by the Federal Government, and so we can say that there is a potential liability of $100 billion or possibly much more under the Price-Anderson Act. The probability that this liability will be incurred is small, so the expected value of the liability is perhaps in the region of billions rather than tens of billions.

Regulatory Capture

An important issue is that the risk that the government faces with respect to nuclear accidents is not entirely outside of its control. The government, after all, has to license nuclear power stations, and through the NRC sets safety standards and manages their safety. A well-run and aggressive NRC could cut the government's risk significantly. There is a lot of evidence that the NRC suffers from regulatory capture and has performed poorly in its role of safety overseer.[22] The Federal Government can also influence the risks associated with nuclear power by influencing the location of nuclear power points. Locations near major population centers are clearly associated with larger liabilities than more remote locations.

Subsidies Associated with Price Anderson

As Heyes[23] points out utilities are subsidized under the P-A Act because they are only responsible for damage up to about $10 billion. Canada has a similar cap on damages specified in the 1970 Nuclear Liability Act and the courts were forced to address the decreased incentive that this limited liability provides for investing in safety measures. In fact, Ralph Winter in a commentary on Ontario Hydro's behavior pointed out that the utility is looking for alternatives to investing in safety measures because of the high costs associated with them.

Another disincentive for utilities to invest in safety measures stems from the fact that insurance premiums do not reflect the performance of the nuclear power plant. Should there be an outage by a plant the premiums are not adjusted upward to reflect the higher risk. By not having experience-rated premiums there is a type of interdependence that can be deleterious to all utilities in the industry. The financial vulnerability of one nuclear power plant depends not only on its own choice of security investments, but also on the actions of other agents. Inadequate investment elsewhere can raise a plant's premiums. This concept of *interdependent security* implies that outage in one plant could have financial impacts on all the other utilities operating nuclear power plants. As a result there may be suboptimal investment in the individual components (Kunreuther and Heal,

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[22] "Walking a Nuclear Tightrope: Unlearned Lessons of Year-plus Reactor Outages." UCS, David Lochbaum.

[23] Anthony Heyes, The Price of Price-Anderson, Regul;ation, Winter 2002-2003. Available at http://www.cato.org/pubs/regulation/regv25n4/v25n4-8.pdf

2003; Heal and Kunreuther, 2005)[24]. The existence of such interdependencies provides another challenge in determining the design of a nuclear power plant insurance program.

Modifying Price-Anderson

Learning from Other Federal and State Catastrophe Programs[25]

We now review the important role that the federal and state governments in the United States play in supplementing or replacing private insurance with respect to natural disasters and other catastrophic losses. In many respects the problems faced in these areas are similar to those associated with nuclear accidents: they are all associated with low probability high cost risks for which the probabilities are not well understood. It may be that there are lessons to be learned from these other areas. We shall also talk about terrorist insurance, which post 9/11/2001 has been a controversial issue and is covered by the "Terrorist Risk Reinsurance Act", TRIA. Terrorism, like nuclear accidents, poses the risk of a low-probability high cost event, in a situation where the probabilities are again to some degree under the government's control via its anti-terrorist policies.

Flood Insurance

Insurers have experimented over the years with providing protection against water damage from floods, hurricanes and other storms. After the severe Mississippi Floods of 1927, they concluded that the risk was too great and refused to provide private insurance again. As a result, Congress created the National Flood Insurance Program (NFIP) in 1968, whereby homeowners and businesses could purchase coverage for water damage. Private insurers market flood policies, and the premiums are deposited in a federally operated Flood Insurance Fund, which is then responsible for paying claims. The stipulation for this financial protection is that the local community makes a commitment to regulate the location and design of future floodplain construction to increase safety from flood hazards. The federal government established a series of building and development standards for floodplain construction to serve as minimum requirements for participation in the program. The creation of the Community Rating System in 1990 has linked mitigation measures with the price of insurance in a systematic way (Pasterick, 1998)[26].

Hurricane Insurance

The need for hurricane insurance is most pronounced in the state of Florida. Following Hurricane Andrew in 1992, nine property-casualty insurance companies

[24] Kunreuther, H. and Heal, G. (2003), "Interdependent Security", *Journal of Risk and Uncertainty*. 26: 2/3, pp. 231-249; Heal, G. and Kunreuther, H. (2005), "IDS Models for Airline Security", *Journal of Conflict Resolution,* 49: 2, pp 201-217.

[25] The material in this subsection appears in Wharton Risk Center (2005) Chapter 2 in *TRIA and Beyond: Terrorism Risk Financing in the U.S.* August.

[26] Pasterick, E. (1998), "The National Flood Insurance Program," Chapter 6 in Kunreuther, H.and Roth, R., Sr. (eds.), *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States.* Washington, D.C: J. Henry Press.

became insolvent, forcing other insurers to cover these losses under Florida's State Guaranty Fund. Property insurance became more difficult to obtain as many insurers reduced their concentrations of insured property in coastal areas. During a special session of the Florida State Legislature in 1993 the Florida Hurricane Catastrophe Fund (FHCF) was created to relieve pressure on insurers to reduce their exposures to hurricane losses. The FHCF, a tax-exempt trust fund administered by the State of Florida, is financed by premiums paid by insurers that write policies on personal and commercial residential properties. The fund reimburses a portion of insurers' losses following major hurricanes (above the insurer's retention level) and enables insurers to remain solvent (Lecomte and Gahagan, 1998)[27]. The four hurricanes that hit Florida in the fall of 2004 (Charley, Frances, Ivan and Jeanne) caused an estimated $23 billion in insured losses, with only about $2.6 billion paid out by the Fund. Each hurricane was considered a distinct event, so that retention levels were applied to each storm before insurers could turn to the FHCF.

Earthquake Insurance

The history of earthquake activity in California convinced legislators that this risk was too great to be left in the hands of private insurers alone. In 1985, a California law required insurers writing homeowners coverage on one to four unit residential buildings to also offer earthquake coverage. Since rates were regulated by the state, insurers felt they were forced to offer coverage against older structures in poor condition, with rates not necessarily reflecting the risk. Following the 1994 Northridge earthquake, huge insured property losses created a surge in demand for coverage. Insurers were concerned that if they satisfied the entire demand, as they were required to do by the 1985 law, they would face an unacceptable level of risk and become insolvent following the next major earthquake. Hence, many firms decided to stop offering coverage or restricted the sale of homeowners' policies in California.

In order to keep earthquake insurance alive in California, in 1996 the State legislature authorized the formation of the California Earthquake Authority (CEA), a state-run insurance company that provides earthquake coverage to homeowners. The innovative feature of this financing plan is the ability to pay for a large earthquake while committing relatively few dollars up front. There is an initial assessment of insurers of $1 billion to start the program and then contingent assessments to the insurance industry and reinsurers following a severe earthquake. Policyholders absorb the first portion of an earthquake through a 15 percent deductible on their policies (Roth, 1998)[28]. However, eight years after the creation of the CEA, the take-up rate for homeowners is about 15 percent, down from 30 percent when the California State Legislature created the CEA

[27] Lecomte, E. and Gahagan, K. (1998), "Hurricane Insurance Protection in Florida" Chapter 5 in Kunreuther, H. and Roth, R., Sr. (eds.), *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States.* Washington, D.C: J. Henry Press.

[28] Roth, R., Jr. (1998), "Earthquake Insurance Protection in California", Chapter 4 in Kunreuther, H. and Roth, R., Sr. (eds.), *Paying the Price: The Status and Role of Insurance Against Natural Disasters in the United States.* Washington, D.C: J. Henry Press. .

(Risk Management Solutions, 2004)[29]. It is questionable how effective this program will be in covering losses should a major earthquake occur in California.

Federal Aviation Administration 3rd Party Liability Insurance Program

Since the terrorist attacks of September 11, 2001, the U.S. commercial aviation industry can purchase insurance for third party liability arising out of aviation terrorism. The current mechanism operates as a pure government program, with premiums paid by airlines into the Aviation Insurance Revolving Fund managed by the Federal Aviation Administration (FAA).

As the program carries a liability limit of only $100 million, losses paid by government sources in the event of an attack will almost surely exceed those available through the current insurance regime. In that case, either the government would need to appropriate additional disaster assistance funds as it did in the aftermath of September 11th, or victims would be forced to rely on traditional sources of assistance (Strauss, 2005)[30].

Terrorism Insurance

Insuring the risks from terrorist attacks has some similarity to insuring nuclear accidents – indeed one worst-case terrorist scenario involves terrorists causing a nuclear accident. In both cases the probability distribution over possible losses is largely a matter of guesswork, with no historical record to provide a benchmark. And in both cases, government policies can influence the risks. So it is worth spending some time reviewing the extensive recent discussion of how to manage terrorist risks. Prior to September 11, 2001 terrorism exclusions in commercial property and casualty policies in the U.S. insurance market were extremely rare (outside of ocean marine) because losses from terrorism had historically been small and, to a large degree, uncorrelated. Attacks of a domestic origin were isolated, carried out by groups or individuals with disparate agendas. Thus the country did not face a concerted domestic terrorism threat, as did countries such as France, Israel, Spain and the UK.

In fact, insurance losses from terrorism were viewed as so improbable that the risk was not explicitly mentioned nor priced in any standard policy and it was never excluded from so-called "all-risk" policies with the exception of some marine cargo, aviation and political risk policies. Even the first attack on the World Trade Center (WTC) in 1993[31] and the Oklahoma City bombing of 1995[32] were not seen as being threatening enough for

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[29] Risk Management Solutions (2004), "The Northridge, California Earthquake. A 10-Year Retrospective", May.

[30] Andrew Strauss (2005), "Terrorism Third Party Liability Insurance for Commercial Aviation, Federal Intervention in the Wake of September 11", The Wharton School, Center for Risk Management and Decision Processes, June, Philadelphia.

[31] The 1993 bombing of the WTC killed 6 people and caused $725 million in insured damages. See Swiss Re (2002), *Focus Report: Terrorism—dealing with the new spectre.* Zurich: Swiss Re, February.

[32] Prior to Sept. 11th, the Oklahoma City bombing of 1995, which killed 168 people, had been the most damaging terrorist attack on domestic soil, but the largest losses were to federal property and employees and were covered by the government.

insurers to consider revising their view of terrorism as a peril worth considering when pricing a commercial insurance policy. Since insurers and reinsurers felt that the likelihood of a major terrorist loss was below their threshold level of concern, they did not pay close attention to their potential losses from terrorism in the United States (Kunreuther and Pauly, 2005)[33].

To more fully understand the losses from 9/11 from an insurability perspective, it is important to compare this event with other types of extreme events that have affected the (re)insurance industry. Table 3.2 presents the 15 largest worldwide insurance losses due to natural catastrophes and man-made disasters from 1970 to 2004. Prior to 9/11 losses, the largest loss experienced by the insurance industry was Hurricane Andrew, which devastated the coasts of Florida in August 1992 and inflicted $21.5 billion in claims payments (indexed to 2004) (Swiss Re, 2005)[34]. When one adds the $6-7 billion in payments by U.S. Federal Victim Compensation Fund to victims of 9/11 and their families, the claims from the 9/11 terrorist attacks are almost twice those from Hurricane Andrew (Congressional Budget Office, 2005)[35]. Claims from a major nuclear accident could be very much larger even that those associated with 9/11/2001.

Taking an even broader perspective, Figure 3.2 depicts the trend in worldwide insurance losses due to major natural catastrophes and man-made disasters from 1970 to the end of 2004 showing how insured losses have increased in recent years. Of the 40 most costly events over this period of time, over half occurred in the past 10 years and 80 percent of them occurred between 1990 and 2004 (in constant prices). In particular, the insured losses from Hurricane Andrew in 1992 and the Northridge earthquake in 1994 led insurers and reinsurers to pay much more attention to the catastrophic potential of natural disasters.

Table 3.2 The 15 Most Costly Insurance Losses, 1970-2004

U.S.$ Billion *(indexed to 2002)*	***Event***	***Victims*** *(Dead and missing)*	***Year***	***Country***
32.4[36]	9/11 Attacks	3,025	2001	USA
21.50	Hurricane Andrew	43	1992	USA, Bahamas
17.80	Northridge Earthquake	61	1994	USA

[33] Kunreuther, H. and Pauly, M. "Terrorism Losses and All-perils Insurance", *Journal of Insurance Regulation* (in press).

[34] Swiss Re (2005), "Natural catastrophes and man-made disaster in 2004: more than 300 000 fatalities, record insured losses", *Sigma* no 1/2005.

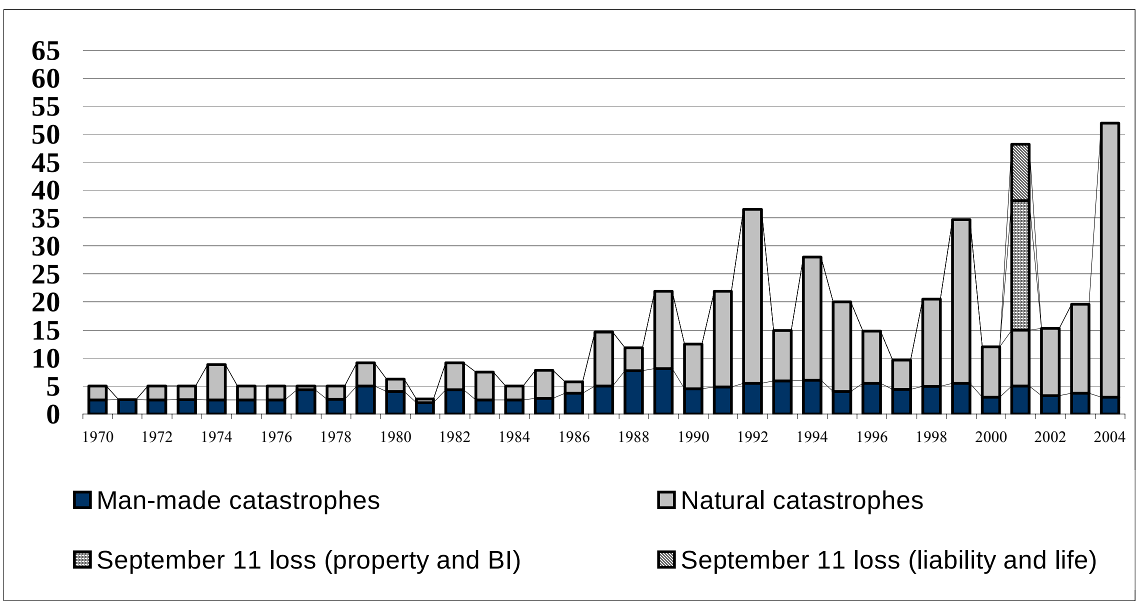
[35] CBO (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC: January.

[36] Includes life and liability insurance losses, but not the $1.1 billion in additional claims by Silverstein Properties (see above). Sources: Hartwig, R. (2004), "The Fate of TRIA: Is Terrorism an Insurance Risk?" *Insurance Information Institute,,* New York, NY.; Bagli, C., (2004) "Tower's Insurance Must Pay Double," *The New York Times*, December 7. p.A1; and CBO (2005), *Federal Terrorism Reinsurance: An Update*, Washington, DC: January.

11.00	Hurricane Ivan	124	2004	USA, Caribbean et al
8.00	Hurricane Charley	24	2004	USA, Caribbean et all
7.80	Typhoon Mireille	51	1991	Japan
6.7	Winterstorm Daria	95	1990	France, UK et al
6.6	Winterstorm Lothar	110	1999	France, Switzerland et al
6.4	Hurricane Hugo	71	1989	Puerto Rico, USA et al
5.0	Hurricane Frances	38	2004	U.S., Bahamas
5.0	Seaquake and Tsunami	280 000	2004	Indonesia, Thailand et al
5.0	Storms and floods	22	1987	France, UK et al
4.6	Winterstorm Vivian	64	1990	Western/Central Europe
4.6	Typhoon Bart	26	1999	Japan
4.1	Hurricane Georges	600	1998	USA, Caribbean

Sources: Wharton Risk Center with data from Swiss Re and Insurance Information Institute

Some of the smaller insurers were forced to declare insolvency due to these events. Those that survived began to rethink what was meant by an insurable risk and the roles of catastrophic models to estimate the likelihood and consequences from specific hazards that might cause damage in specific locations (Grossi and Kunreuther, 2005)[37]. With $49 billion dollars of insured losses due to natural disasters, the year 2004 constitutes the most costly year ever in the history of the insurance industry (Swiss Re, 2005)[38].



[37] Grossi, P and Kunreuther, H. (eds) (2005), *Catastrophe Modeling: A New Approach of Managing Risk*. New York: Springer.
[38] Swiss Re (2005), "Natural catastrophes and man-made disaster in 2004: more than 300 000 fatalities, record insured losses", *Sigma* no 1/2005.

Figure 3.2 Worldwide Evolution of Catastrophe Insured Losses, 1970-2004
(Property and business interruption (BI); in U.S.$ billon indexed to 2004)
Sources: Wharton Risk Center with data from Swiss Re and Insurance Information Institute

Terrorism presents a set of very specific problems regarding its insurability by the private market alone that have similar features to nuclear power. These include the potential for catastrophic losses, the existence of interdependencies and the dynamic uncertainty associated with the risk. All of these factors increase the amount of capital that insurers must hold to provide terrorism risk insurance coverage. The associated costs of holding that capital increases the premiums they would need to charge. The fact that government actions are likely to influence both the will and capacity of terrorist groups to attack (foreign policy, counter-terrorism) and on the level of potential losses poses additional challenges is closely related to the fact that the Nuclear Regulatory Commission influences the degree of acceptability of the risks facing nuclear power plants. The conclusion that emerges from experience with terrorist cover since 9/11/2001 suggests that terrorist risks are not well handled by the insurance market. This was recognized by the passage of TRIA, the Terrorist Risk Insurance Act, which established a role for the federal government similar to that assigned to it in the P-A Act.

Linking Insurance with Third Party Inspections Through Public-Private Partnerships[39]

The Price-Anderson Act needs to be modified by providing a more effective way of monitoring utilities and rewarding those that have undertaken risk reducing measures. Today there is inadequate inspection of nuclear plants due to limited personnel at the NRC and the lack of incentives by utilities to undertake these measures on their own. Lower inspection levels (or other effective methods for compliance evaluation) tend, not surprisingly, to lead to lower compliance rates. (Weil, 1996) They also reduce opportunities for government to find and require firms to correct the sorts of risky practices regulations seek to reduce.

Role of Third Party Inspections

One way to change the situation is to provide economic incentives for utilities to have their plants inspected so that can demonstrate that they are operating safely and be rewarded with a lower insurance premium. The combination of private inspection and insurance is a potentially powerful one for meeting and often exceeding environmental and safety regulations. If an inspection reveals ways that a company can reduce its safety and environmental risks and the costs of undertaking this activity can be recouped in the

[39] This subsection is based on Kunreuther, Metzenbaum and Schmeidler (2006) "Private Inspections and Mandatory Insurance for Managing Safety and Environmental Risks" in Cary Coglianese and Jennifer Nash ed *Leveraging the Private Sector: Management-Based Strategies for Improving Environmental Performance* (Washington, DC: Resources for the Future

form of lower insurance premiums that justify the expenditure, then firms will want to adopt these measures.

Insurers have an economic incentive to conduct inspections that focus on risk reduction because they want to reduce the likelihood of paying a claim and the size of their payments. The insurer's economic survival depends on estimating the risk of future losses accurately, not on assuring compliance with government laws. To the extent that regulations are well-aligned with risk-reducing behaviors, insurers are likely to uncover non-compliance problems and encourage their correction. To the extent that they are not, insurers have little reason to inspect for regulatory compliance

How Inspections Aid Insurers

Insurance is likely to have greater risk-reducing potential if insurers include inspections, along with other forms of risk assessment, as part of the insurance-rating package. Private insurance inspections can play an important role for several reasons. At the most basic level, insured firms will be more aware of environmental and safety risks as well as regulatory obligations. This promises to be especially valuable in areas of health, safety and the environment that are plagued by low inspection levels.

Gathering Risk Information Inspections also enable the insurer to determine what the losses are likely to be as a function of the investments by firms in risk-reducing measures. Insurers can also provide guidance to the firm as to what types of actions would be most profitable for them to assure compliance with regulations and go beyond it. If insurers increase their inspections of a firm's safety practices prior to policy renewals, firms will have incentives to comply with the regulations, at least to the extent they suggest risk-reducing behaviors.

Use of Claims Data to Modify Existing Standards Studying information about claims, incidents, and non-compliance may identify recurring events and high-cost problems needing new laws or standards. If an insurer has a large enough set of clients and can pool information so as not to reveal identities of firms, then it can provide valuable information to the public sector on the types of claims that have been made. This will enable the public sector agency to modify codes and standards in an appropriate fashion.

Rewarding Firms for Reducing Risks Insurers always have the option of raising rates to reflect additional risks that they uncover. Insurers can also bestow reputation-enhancing rewards on firm operating at the highest level of compliance and taking risk-reducing actions beyond their formal obligations. Seals of approval or Gold Stars are valuable to the firm to the extent that customers, employees, or investors make decisions on the basis of safety and environmental records of different organizations. Some commercial partners will see the Gold Star as the designation of a quality operation and favor doing business with these firms. For example, Ford and GM require their suppliers to be ISO14001 certified.

The firm that earns the seal or Gold Star will have an incentive to reveal its third-party commendation to the public as well to the government. Regulatory agencies can utilize this information to target inspections to firms that have not had this official recognition. By reducing the universe of firms for possible inspection, there is a greater chance that those who have not complied with the regulation will be audited by a governmental agency. By raising the probability of a public inspection, more and more firms should adhere to regulations over time.

An insurance commendation is likely to have greater veracity than other sorts of third-party certifications because most third-party inspectors are paid a fee for their services by the inspected firm, and therefore feel a constant tug to keep their customer happy without a strong counter-balancing financial tug to identify risks that may require costly corrections. Insurers, in contrast, have a direct financial interest in reducing risk through their inspections.

Summary and Conclusions

On the general issue of environmental liabilities, it seems clear that the degradation of natural capital in systems as diverse as the climate system or the coastal barrier island systems can lead to significant social costs which are generally not well-covered by current insurance products. These end up as liabilities of the Federal Government by default, often as a part of the portfolio of the Federal Emergency Management Agency.

In the field of nuclear risks, the Price-Anderson Act transfers significant liabilities to the Federal Government. If there is an expansion of the use of nuclear power in the next decade, as some argue is appropriate, then these liabilities could increase further. Although it is clear that the contingent federal liabilities associated with P-A are large, it is hard to be precise about them. We understand fully neither the probability of a major disaster nor its costs. There are however certain things that are clear. One is that the risk is to some degree under the control of the Federal Government, through its control of the Nuclear Regulatory Commission and through its ability to influence the siting of nuclear reactors. There is a lot of evidence that the NRC does not aggressively pursue and penalize mismanagement of nuclear power stations, and that the Federal authorities are not sensitive to the increase in potential costs associated with siting near densely populated areas. There is clearly scope for better management of this aspect of Federal financial risks, possibly by the use of third party safety auditors to supplement the NRC. In addition, the premiums charged to utilities under the P-A Act do not reflect their stations' safety risks: this would be another way of reducing the risk of a disaster. Currently there are few incentives for a utility to improve its safety record.

There do seem to be compelling reasons for thinking that Federal intervention is necessary if the risk of nuclear disaster is to be adequately insured. There are many characteristics of this risk that probably make it uninsurable. But that does not mean that the P-A Act is the best solution, and we have reviewed the way in which catastrophic risks are managed in other areas, such as hurricane, terrorist and earthquake risks. There has been more and more constructive public debate about these risks than about nuclear risks. Typical of most of these areas is a first insurance layer covered by private insurance markets, with government coverage of losses in excess of the private risk cap. In the case of the P-A Act, the private coverage is just $300 million per incident, with a pool insurance vehicle covering the next $10 billion. There is no explicit statement of the government's role and liabilities. The figure of $300 million surely does not exhaust the private coverage available for nuclear disasters: for other areas the private sector provides coverage as high as ten billion or more. More of the nuclear risk could surely be met through the private sector, which would not only reduce the Federal liability here but also provide increased incentives for risk management, sadly lacking currently.