Insurability, Financial Fitness, and GM Organisms

September 2003

SUSTAINABILITY COUNCIL of NEW ZEALAND

CONTENTS

Prepared by

Sustainability Council of New Zealand

Researchers

Geoff Bertram

Simon Terry

1. The Need for Financial Assurance

No amount of law reform aimed at encouraging due care on the part of operators will be effective without provisions that ensure the operator has the ability to meet claims – that it is financially fit. An operator with little to lose faces very different incentives from one which is financially exposed to the full potential consequences of its actions.

The US has extensive experience with strict liability provisions for environmental damage and Boyd notes:

> "strict liability fails to induce efficient precaution and effective compensation when firms are undercapitalised relative to the financial obligations implied by their liability." [1]

Alberini and Austin found, in an econometric study of US states, that firms in strict-liability jurisdictions were smaller and less capitalised, indicating that:

> "firms have developed behavioral responses to avoid liability, when they are strictly liable for releases of hazardous chemicals into the environment. In states with strict liability, greater spill severity and frequency are associated with smaller production units (our proxy for firms with fewer assets), whereas this association is not present in states following negligence-based liability. It is possible that in a strict liability regime, firms deliberately select their corporate structures and asset levels to avoid liability, or that small firms have tended to specialize in riskier processes." [2]

In absence of effective restrictions, firms have a clear incentive to evade the intent of strict liability, by undercapitalising relative to their liability obligations, and positioning for exit from the market in the event of serious damages claims. As the Royal Commission noted[3], "The defendant may be a shell company without substantial assets, or may be insolvent." An essential part of any liability regime, therefore, will be institutional arrangements which oblige an operator to put arrangements in place to ensure sufficient financial cover from the commencement of activities sufficient to meet that firm's potential liability for damage in future years.

The HSNO Act does not require ERMA to make any assessment of the ability of an applicant to meet claims for damages. The Act instead places a heavy reliance on controls, with penalties for breach of those controls. Should those controls prove inadequate, as matters currently stand, damages are in principle left to lie where they fall.

The reform advocated in this paper is that financial fitness (assurance of a future ability to pay for damages) should be made a necessary prior condition for securing ERMA consent for activities regulated under HSNO. Financial fitness would be

---

1 James Boyd, *A Market-Based Analysis of Financial Assurance Issues Associated with U.S. Natural Resource Damage Liability,* Resources for the Future, Washington DC, October 2000, p5.

2 Anna Alberini and David Austin, *Accidents Waiting to Happen: Liability Policy and Toxic Pollution Releases* Discussion Paper 99-29, Resources for the Future, March 1999, p.22.

3 Royal Commission on Genetic Modification *Report* Chapter 12 p.319 paragraph 40.

established by setting Financial Assurance Requirements (FARs), involving proof of financial cover of the required form and level for a particular application or activity.

Financial assurance is increasingly a feature of international environmental statutes. In the last decade, assurance requirements have been implemented under many of the most import environmental laws of the United States. Financial assurance is required under the Oil Pollution Act (OPA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), the Safe Drinking Water Act (SDWA), the Outer Continental Shelf Lands Act (OCSLA), and the Surface Mining Control and Reclamation Act (SMCRA).[4]

There are two basic possible forms of FARs: self-insurance and third party cover.

2. Self-insurance

Self-insurance makes the shareholders of the party undertaking the activity (the operator) the primary bearers of loss. There are two principal means of self-insurance.

The most common is a surety bond, paid out of the operator's own capital. This is suitable for relatively short term requirements, where there is relative certainty about the maximum coverage required, and where the demand is small relative to the firm's equity. Outside this scope, it represents too great a drain on the firm's working capital to be a good solution.

The other self-insurance arrangement is one where the operator enters into a contract with the regulator involving undertakings as to the operator's financial fitness to meet any future claims.

Under a self-insurance arrangement, operators have the incentive to structure their ownership and shareholding in such a way as to minimise the amount of potential loss to which their shareholders are exposed, and correspondingly to maximise the transfer of risk onto the victims of any accident, or onto the government. The regulator is therefore obliged to set cover requirements and reliably monitor compliance with those requirements.

Where self-insurance has been adopted, the following are examples of the requirements devised:[5]

- A requirement that two measures of financial strength, "working capital" and "net worth," both be greater than the coverage requirement.

---

4 Boyd, *A Market-Based Analysis of Financial Assurance Issues Associated with U.S. Natural Resource Damage Liability*, Resources for the Future, October 2000, p 1.

5 Boyd, *A Market-Based Analysis of Financial Assurance Issues Associated with U.S. Natural Resource Damage Liability*, Resources for the Future, October 2000, p 4-8.

- A requirement that financial strength be established on the basis of holdings of domestic assets. In US examples, working capital is defined as the value of current assets located in U.S. minus current worldwide liabilities, and net worth is defined as the value of all assets located in U.S. minus all worldwide liabilities.

- Requirements for firms to report annually on financial fitness indicators, with the reports independently audited according to generally accepted accounting practices. More stringent reporting requirements apply to firms whose net worth is not at least ten times the applicable amount. Any changes in a firm's financial status must also be reported.

- A requirement that asset valuation methods used for the purpose of demonstrating self-insurability must be the same as those used in the firm's audited financial statements for Securities and Exchange Commission reporting.

- The requirement that assets used in these calculations be demonstrably unencumbered. The company must specifically identify assets that are unencumbered and tangible (the assets must be in plant, property, or equipment).

A key implementation problem with this form of self-insurance is quickly evident from the above: it is very burdensome on the regulator. It requires a level of monitoring and skills in forensic accounting that exceed ERMA's current capacity. The chief concern however is that losses can only be covered up to the limit of the equity invested in the company. Losses over and above what can be recovered from the process of bankruptcy simply lie where they fall.

A crucial function of a liability regime is to provide incentives for optimal precaution and an optimal limit on the scale of activity. Strict liability provides such incentives efficiently, but under self-insurance, it can do so only up to the implicit cap imposed by each firm's shareholder equity.

Self-insurance can have a role where there is reasonable confidence that exposures can be quantified ex-ante and that they are sustainable relative to the firm's net worth that is based in New Zealand.[6] This may mean self-insurance can have only a limited role in covering the types of potential liabilities that arise under HSNO. It is most likely to be feasible in laboratory-based activities where the risks of serious damage are least, particularly when those activities are undertaken by highly solvent entities with strong ties to the local economy.

[6] The importance of a domestic asset base was highlighted when the former owners and operators of the Tui mine, which operated from 1967 to 1974 on Mount Te Aroha, simply moved out of New Zealand, leaving taxpayers to confront a massive cleanup in the form of 100,000 cubic metres of toxic material in a tailings dam.

3. Insurance

3.1 Traditional Insurance

The central issue relating to insurance of GM activities is how to utilise competitive market processes to discover the lowest price at which third parties stand ready to bear the risks.

Financial cover may be by way of traditional insurance or other risk transfer mechanisms. Different GM applications will carry different levels of risk and different financial cover packages will be appropriate. Research under conditions of laboratory containment is relatively less risky than release (whether conditional or unconditional). There is evidence that traditional insurers will continue to provide cover for reputable institutions moving into laboratory GM research, and some specialist insurers in environmental damage who cover GMOs are emerging in Europe.[7]

Applications for release of GMOs pose higher levels of risk and there is evidence of reluctance by traditional insurers, mainly because of the difficulty that traditional insurance companies have in forming estimates of expected damage. This was the focus of the Royal Commission on Genetic Modification:

> At the present time, having regard to the difficulty in assessing the risk because of limited knowledge and experience about genetic modification, and the unlikelihood that reinsurance could be obtained, it is improbable that insurers would take on such risks. [8]

Chapter 8 of the recent Law Commission report also reported on discussions with (and apparently restricted to) traditional insurance industry sources such as the Insurance Council of New Zealand, and concluded:[9]

> It seems unlikely that insurance would be available for all GMO development and use. Instead, it may be that some projects will be able to obtain cover (such as contained laboratory experiments) whilst others will not (such as general release of a GMO). Thus, requiring compulsory insurance is likely to block the approval of some projects that might otherwise have received ERMA consent.

Similarly, the UK Government's Agriculture and Environment Biotechnology Commission stated that:[10]

> Insurance for GMOs is currently not well developed. Insurance is generally focused on sudden and accidental damage, for which the risks can be actuarially calculated. Insurance against diffuse environmental pollution such as GMOs might cause, is far more difficult to come by. Insurance firms do not have claims histories to help them assess risks, or to assess the extent of precautions being put

7 Agriculture and Environment Biotechnology Commission, Environmental Liability Development Group minutes, 20 December 2001. <http://www.aebc.gov.uk/aebc/liability_meetings_201201_ minutes.html> 2–3.

8 Commission report, p. 323.

9 Law Commission (2002) p.30 paragraph 115.

10 AEBC paper AEBC/02/07 (2002) p.5 paragraph 27.

> in place by companies, thus making it hard initially to set premiums…. Experience tends to build up over time, and the insurance market tends not to move into new areas rapidly. It would probably not be feasible – even if desirable – to make insurance cover compulsory for those using GMOs.

To the extent that the appraisals cited above represent the results from thorough investigation of the issue, the alleged lack of means to provide financial cover would diminish the desirability of a strict liability/compulsory insurance framework.

In evaluating such findings, however, it is important to bear in mind that traditional insurance is only one of a range of market mechanisms for transferring risk from the party undertaking the risky activity to some third party.[11] Any inquiry into insurability which is limited to seeking the views of traditional insurers will tend to underestimate the availability of risk-transfer mechanisms, and hence to overestimate the costs and difficulty of securing insurance by innovative means.

The most obvious shortcoming of the research undertaken by the Royal Commission, the Law Commission and the AEBC is the absence of any reference to the rapidly expanding literature and practice in the area of securitisation of risk through the issuance of Alternative Risk Transfer (ART) instruments. A brief review of some recent contributions to the literature is provided below, supplementing earlier discussion in *Who Bears the Risk*.[12]

3.2 Required Characteristics of an Insurance Instrument

In framing the insurance issue for analysis, it is helpful to begin by specifying the characteristics which an insurance arrangement would have to satisfy to provide financial cover within a regime of strict liability under which operators would be responsible for making good the costs of damage which they cause to third parties.

Four required characteristics in particular stand out:

- **Deep pockets:** The insurer or reinsurer of the liability risk must have sufficient funds on call to pay out on relevant claims.
- **Flexibility for long-term cover:** The instrument must be flexible enough to be capable of providing cover well into the future, possibly years after the activity itself has ceased, so that damage which becomes apparent a number of years after the activity took place remains covered by the instrument.
- **Moral hazard minimised:** The existence of insurance cover should not translate into incentives for the GMO releaser to act carelessly or at too high a level of activity, leaving the insurer to pick up the tab.
- **Limited exemptions:** The instrument must not be so hedged with exemptions that liability is negated for all but a narrowly-defined class of damages.

---

11 The term "risky" is here used broadly to refer to outcomes which cannot be perfectly predicted in advance, whether because they are governed by some probabilistic process (as with the type of risks covered by traditional insurance based on actuarial principles) or because they are subject to genuine uncertainty about either or both of the scale of damage and the likelihood of its occurrence.

12 Pages 42-48.

Typical traditional insurance policies lack the second of these characteristics – the ability to provide surety of cover into the future. This is because of their tendency to be written on a year-by-year basis, whether providing cover for claims lodged during the year in question, or for actions taken during the year which later resulted in claims (usually only within some quite short period of time).

Traditional policies are also notorious for exemption provisions which have the effect of excluding precisely the low-probability/serious consequences events which potentially arise with HSNO activities.

To perform the function of providing assured compensation as well as incentivising firms to exercise due care, insurance cover taken out by would-be operators to cover their activities must remain "alive" for long enough to give confidence to potential victims and residual risk bearers that the cover can be activated when required, possibly long after the particular firm has disappeared. It must allow uncontested recourse to adequate funding in the event that damages are awarded against the original operator. And it must not be cluttered with obstacles to actually securing redress once liability has been established.

The challenge for the financial sector is to come up with risk-transfer instruments which deliver these required characteristics, and to determine the terms and conditions on which these instruments would be available to cover GMO-related activities. The challenge for policymakers is to frame the new HSNO legislation and accompanying regulations in a way that facilitates the emergence of efficient capital-market solutions to the insurance problem.

3.3 Alternative Risk Transfer (ART) Instruments

Market-based solutions to the problem of risk-bearing have been fundamental to the successful development of modern economies. The limited-liability joint stock company, for example, provides an institutional framework for ownership of firms under which willing investors accept the risk of losing their total capital stake in the firm's activity, but no more. The risk in this case is not predictable in the probabilistic sense, and capital markets have always channeled funds into high-risk as well as low-risk ventures, with the former attracting those investors with a taste for adventure (the uncertain prospect of large gains).[13]

Traditional insurance companies agree, for a price, to bear the costs of adverse outcomes which can be predicted to occur with some well-defined probability. The role of such insurance is to pool familiar risks across a population of risk-averse individuals. The risk of a very large and ill-defined ("ambiguous") loss with very low probability will obviously be harder (more expensive) to insure against than, say, ordinary house fires or motor accidents, and this will be reflected in higher insurance

[13] Marshall, A., *Principles of Economics* 8th ed 1936, p.400: "…an adventurous occupation, such as gold mining, has special attractions for some people: the deterrent force of risks of loss in it is less than the attractive force of chances of great gain, even when the value of the latter calculated on the actuarial principle is much less than that of the former …. [T]o the average price, therefore, we must add a recompense for uncertainty, if that is unusually great…."

premiums for such business and greater reluctance of traditional insurers to accept the transfer of risk. At some point on the riskiness spectrum traditional insurance becomes costlier than alternative risk-transfer arrangements, and the rational response for those seeking to transfer risk is to utilise those alternatives.

Capital markets provide a price mechanism to guide such choices. In general, the cost of transferring any risk corresponds to the discount which the world capital market places on the relevant risk-transferring financial instrument. The only risks that are genuinely "uninsurable" (in the sense that no third party can be found willing to bear the risk for a price) are those for which no risk-transfer instrument can be sold to world investors at any price. All other risks are transferable ("insurable") at some price.

A recent extensive review of insurance-related capital market innovations by Swiss Re opened with the statement:[14]

> [m]any insurance industry participants believe that capital markets have the potential to bear some types of insurance risks more efficiently than insurance markets.

and went on to argue that:[15]

> [t]here is vast market potential for capital market insurance solutions linked to non-catastrophe risks. If these solutions fulfill their potential, the range of risks that are deemed insurable will expand.

New financial instruments developed to transfer insurance risk to capital markets enjoyed a boom in the mid 1990s, followed by slower expansion in 1999-2000, but by 2001 the worldwide market in insurance derivatives had expanded to an estimated US$12.6 billion[16], still small relative to the estimated US$80 trillion worldwide derivatives market[17].

Insurance-related financial derivatives, in common with a wide range of other derivative instruments, allow the issuers to "unbundle risks and allocate them to the investors most willing and able to assume them".[18] A strong trend towards transfer of insurance risks to the capital market occurred in the US in the wake of Hurricane Andrew and the Northridge earthquake – events which exposed a shortage of reinsurance capacity, coinciding with a continuing series of billion-dollar-plus natural catastrophes during the remainder of the 1990s.[19]

---

14 Swiss Re, *Capital Market Innovation in the Insurance Industry*, Sigma report 3/2001, p.3.

15 Ibid p.4.

16 Ibid p.3.

17 US Treasury Secretary Larry Summers, testimony before the Committee on Agriculture, Nutrition and Forestry, US Senate, 10 February 2000, hearings on "Over the Counter Derivatives Markets and the Commodity Exchange Act", available at http://agriculture.senate.gov/Hearings/Hearings_2000/wl00210/0029sum.htm.

18 Alan Greenspan, testimony before the Committee on Agriculture, Nutrition and Forestry, US Senate, 10 February 2000, hearings on "Over the Counter Derivatives Markets and the Commodity Exchange Act" , available at http://agriculture.senate.gov/Hearings/Hearings_2000/wl00210/0029gre.htm.

19 Swiss Re, *Capital Market Innovation in the Insurance Industry,* Sigma report 3/2001, p.13 Figure 6.

> The basic logic is compelling. Publicly traded stocks and bonds have a total market value of US$60 trillion. Imagine that securities investors were to add securities linked to catastrophe risks to their stock and bond portfolios. A US$250 billion event would represent less than 0.5% of the global market portfolio. Fluctuations of this magnitude are a normal daily occurrence in securities markets. Capital market insurance solutions also offer advantages for non-catastrophic lines of business, not only for issuers but for investors.[20]

The typical structure of a capital-market insurance transaction is as follows[21]. The party facing the risk (the customer) purchases an insurance contract from a retail insurer, which in turn enters into a reinsurance contract with a special purpose vehicle (SPV). An SPV is typically structured as an independent charitably-owned trust that is licensed as a reinsurer in an offshore location such as the Cayman Islands or Bermuda, and its sole purpose is to engage in the business relating to the specific securitisation operation. (Its counterparties in the various transactions are thus exposed to no risks other than those of the particular insurance risk being transferred.)

The SPV issues insurance-linked securities sufficient to cover the full amount of the potential payout in the event of a catastrophe. (Note that the size of the bond issue then places an implicit cap on the level of insurance cover.) Once the bonds have been sold to investors, the SPV is in possession of funds derived from (i) the reinsurance premiums, and (ii) the sale of the bonds. All of these funds are invested in default-free (risk-free) securities such as US Treasury bonds. At this stage, therefore, sufficient funds are in hand to pay out the full amount of the reinsurance contract in the event that a catastrophic event occurs. The interest rate on the insurance-linked bonds will correspond to the risk-free rate earned on the assets in which the funds are "parked", plus whatever risk margin is required for successful flotation. The reinsurance premium is set to cover this margin.

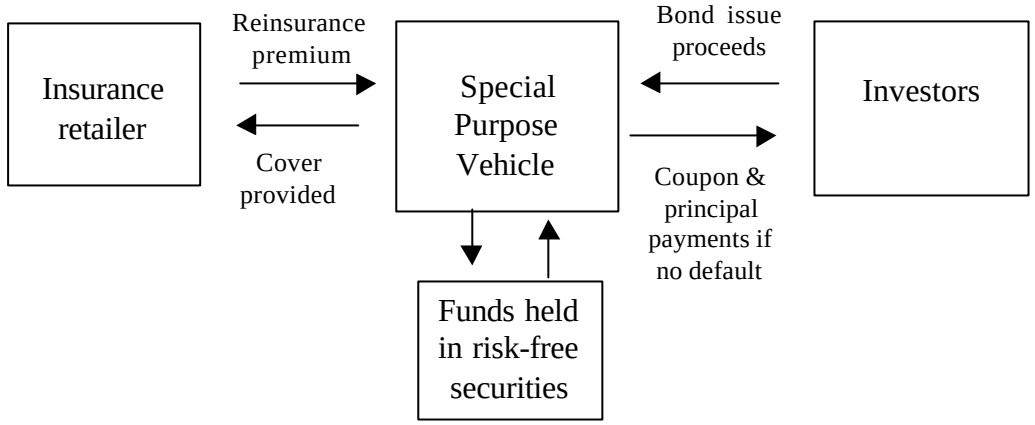
If no catastrophe eventuates, then the bondholders receive their principal and coupon payment at the expiry date of the bonds. If a catastrophe occurs which causes the reinsurance contract to be activated, then the SPV "defaults"[22], in full or in part, on the bonds and cashes up its portfolio of risk-free securities to fund payment to the insured party to cover its losses. The investors bear the loss.

---

20 Ibid p.13. Note that even an extreme New Zealand GMO-related catastrophe would be likely to fall within Greenspan's US$250 billion benchmark for "less than 0.5% of the global market portfolio". New Zealand's annual GDP is currently around NZ$110 billion, equivalent to say US$50 billion. Capitalised to a present value at 7% this amounts to roughly US$700 billion. Even a GMO-related ecological catastrophe requiring complete evacuation of both islands would impose less than this in foregone earnings because many productive assets should be able to be transferred out with the departing population, and human capital would be transferable. Hence the elimination of all economic activity in New Zealand would be unlikely to cost global risk-bearers more than 0.5% of their total portfolio. This extreme high-cost outcome has extremely low probability, and hence ought to be readily marketable as a risk.

21 Based on Belonski et al 2001 pp.5-7, Cox et al 2000 pp.155-167, and Froot 1999 pp.14-16..

22 Since the terms and conditions on which the bonds were issued includes provision for full or partial non-payment of interest and/or principal in the event of disaster, this is not a default in the usual sense.



The outcome of this structure is that the reinsurance transaction is fully collateralised; the SPV cannot default on the reinsurance contract, and hence the counter-party risk inherent in traditional reinsurance is eliminated.

It is important to note that although the market for insurance-linked securities has to date been dominated by catastrophe bonds, "the line of insurance is immaterial to the capital market – it does not have to be catastrophe risk….. [I]nvestors will demand these bonds because their returns have low correlation with stock returns. There may be many kinds of insurance risks that have low covariance with the stock market." (Cox et al 2000 p.163). Four cat bonds issued during 1997 and 1998 were priced at 400-450 basis points above LIBOR in a market which was still nascent.[23]

The SPV vehicle in various catastrophe-bond transactions described by Cox et al (2000) has commonly been a captive reinsurer owned by an insurance or reinsurance company.[24] Many insurance companies (about 3,000 worldwide)[25] are themselves captives, set up by companies with risk exposures in order to secure access to the international reinsurance market. McCulloch reported the existence of at least nine New Zealand-owned captives in the mid-1990s, set up by large companies such as Telecom, Coalcorp, and Fletcher Challenge. The use of these vehicles by companies in New Zealand, as elsewhere in the world, arises from their ability to access the reinsurance market:

> Generally it is not possible for a commercial organisation seeking insurance to access the reinsurance market directly. This is because reinsurers will usually be restricted from offering insurance to the public by the legislation of the jurisdiction in which they are based. Accordingly, only insurance companies will generally have access to reinsurance markets. Therefore in order for a non-insurance company to access the reinsurance market it is necessary for the company to contract with reinsurers through a captive.[26]

---

23 *Insurance Linked Securities*, Swiss Re, from www.swissre.com, p. 19.

24 "A 'captive insurance company' is nothing more than an insurance company which is owned by its insureds. Such companies derive the name since they have a 'captive' market…. A 'pure' captive is a company which has only one owner and which insures only its owner (and its owner's affiliates)". (McCulloch 1996 p.125

25 McCulloch p.126.

26 McCulloch p.128.

By insuring through a captive, "insurance can be provided for certain risks which the normal insurance market will not accept".[27]

It would seem, therefore, that unwillingness by normal insurance companies to underwrite the risks of GMO-related accidents ought not to be interpreted as leaving GMO developers deprived of any means of securing insurance cover in order to qualify for ERMA approval. A GMO developer (or a consortium of such developers) can set up a captive insurance company to write insurance contracts for GMO risks, and the captive could in turn establish an SPV for the purpose of issuing insurance-linked securities sufficient to underwrite the risks. While possibly novel in the New Zealand setting, such arrangements are increasingly familiar internationally and have been well documented by mainstream reinsurers.

Certain areas of genetic modification technology are readily insurable in the traditional way. This includes laboratory experiments, and of technologies which are well-established and for which well-informed risk assessments are therefore possible. (As experience of a new technology accumulates, insurance usually becomes cheaper and easier.)

3.4 Matching ARTs to the Required Insurance Characteristics

Listed above were four key characteristics that will be required to provide insurance cover for GMOs.

Taking first the deep-pocket requirement for GM insurance, it is logical to expect that the alternative risk-transfer instruments discussed above would be issued and traded on world capital markets through special-purpose vehicles established for the purpose. Even very large exposures by New Zealand standards would be miniscule relative to world market volumes and appropriately-designed instruments ought to be saleable without difficulty.

Taking next the requirement for the ART instruments to be long-dated, international financial markets have long been familiar with instruments that are deliberately designed to endure for decades or even centuries – British Government consols (perpetual or undated bonds paying a fixed coupon rate) have been in circulation since 1751 and were the major part of the UK government debt in the early twentieth century (they are currently around 1% of outstanding gilts according to statistics issued by the UK Debt Management Office). However, major governments no longer issue undated stocks to fund their sovereign debt (although arguably the emergence of a new market demand for such stocks as a hedging instrument for ART schemes could change the supply position in the future). It is nevertheless easy to procure thirty-year risk-free securities (US Treasury bonds), so the design and issuing of risk-transfer instruments with up to a thirty-year term would be straightforward.[28]

---

27 McCulloch p.128.

28 Longer-term ART arrangements would face the difficulty of making the transition to a replacement risk-free asset not later than thirty years out, which would expose the fund to interest-rate risk. This would need to be provided for in the small print of the offer documents – probably by a provision for the coupon rate on the ART bonds for years 31-60 to be indexed

More difficult than designing the instrument is working out how to secure the stream of reinsurance premiums from the GMO promoters to ensure that throughout the term the risk premium is paid to the investors holding the instruments. Obviously, if an ART has been issued to global investors with a coupon rate comprising the risk-free interest rate plus a risk premium, with the risk premium setting the size of the annual reinsurance premium payable by the captive insurance company, then some party must be contractually bound to meet the cost of this premium for the period of cover.

Hence there is likely to be a case for requiring operators to post financial bonds sufficient not only to perform the usual main function of such bonds (to cover any insurance excess, provide a direct source of funding for compensation, and as an important device to mitigate the problem of moral hazard which arises when a firm is able to transfer all its environmental risks to third parties). Bonds may need to be sufficient to also underwrite premium payments for the contractual term of whatever ART instruments have to be issued to insure the activity to an acceptable level.[29]

4. Conclusion

For a liability regime to be effective, arrangements must be in place to ensure that compensation can be paid to injured parties.

Certain low risk GM activities will be insurable in the usual way. For the more extreme, low-probability risks, it makes sense to look beyond the local retail insurance market to consider whether the global capital market could assume such risks at acceptable cost. New Zealand's economy is small relative to the global market for financial derivatives, and local GM project risk is not correlated with other global market risks. These factors ought to make it straightforward to place risk-transfer bonds on the market.

GM project risks are therefore not "uninsurable", and there are no insuperable barriers to the imposition of strict liability and financial fitness requirements on companies applying to release GMOs.

to the issue rate for new US Treasury bonds at the date of expiry of the first thirty-year tranche.

[29] The issue would be considerably less difficult if the captive insurer were set up collectively by the GMO industry on the basis that all participants would mutually underwrite each others' premium-paying obligations (so that default by any one firm by reason of exit from the market would be made up for by a levy on the others). However, a robust regulatory regime arguably requires greater certainty regarding the ongoing payment of premiums on outstanding ART bonds.

References

Agriculture and Environment Biotechnology Commission, *Liability for GMOs: Draft Scenarios*, paper AEBC/02/11, 2002, available at http://www.aebc.gov.uk/aebc/aebc0211.html.

Agriculture and Environment Biotechnology Commission, *Liability Sub Group Draft Paper on Issues for Discussion*, paper AEBC/02/07, available at http://www.aebc.gov.uk/aebc/aebc0207.html.

Alberini, Anna, and David Austin, *Accidents Waiting to Happen: Liability Policy and Toxic Pollution Releases* Discussion Paper 99-29, Resources for the Future, March 1999, p.22.

Baumgartner, Rico, Henry Hsiao, Loredana Mazzoleni and Peter A. Keller, *The ART of Project Finance*, Swiss Re New Markets, 2000, 14pp.

Belonski, Gail, David Laster and David Durbin, *Insurance-Linked Securities*, Swiss Re 2001, available at http://www.swissre.com/INTERNET/pwswpspr.nsf/fmBookMarkFrameSet?ReadForm&BM=http://www.swissre.com/INTERNET/pwswpspr.nsf/vwAllbyIDKeyLu/MBAR-4V9GUY

Boyd, James, *A Market-Based Analysis of Financial Assurance Issues Associated with U.S. Natural Resource Damage Liability* Resources for the Future, Washington DC, October 2000.

Cox, Samuel H. Fairchild, Joseph R. and Pedersen, Hal W., "Economic Aspects of Securitization of Risk", *Astin Bulletin* 30(1):157-193, 2000.

Froot, Kenneth A., "The Evolving Market for Catastrophic Event Risk" *Risk Management and Insurance Review* 2(3):1-28, 1999.

McCulloch, Stewart, "Captive Insurance Companies: Do They Provide 'Insurance'?", *VUW Law Review* 1996.

Shimpi, Prakash, Durbin, David, and Laster, David S. (eds) *Integrating Corporate Risk Management*, Texere, New York, 2001.

Swiss Re, *Insurance Derivatives and Securitization: New Hedging Perspectives for the US Catastrophe Insurance Market?* Sigma report 5/1996, 24pp.

Swiss Re, *Alternative Risk Transfer (ART) for Corporations: A Passing Fashion or Risk Management for the 21st Century?* Sigma report 2/1999, 42pp.

Swiss Re, *Natural Catastrophes and Man-Made Disasters in 2001: Man-Made Losses Take on a New Dimension*, Sigma report 1/2002, 24pp.

Swiss Re, *Capital Market Innovation in the Insurance Industry*, Sigma report 3/2001, 37 pp.