Risk Management and Climate Change: The Role of the Financial Services Sector

A background paper

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Introduction

Major climatic events (bushfires, floods, earthquakes), whether related to ongoing climate change or not, have recently drawn attention to the substantial destruction of wealth which results. They have also highlighted the important need for mechanisms for appropriate risk-sharing of losses and rapid restoration of the affected physical and social capital, as well as mechanisms for inducing investment and behavioural decisions which involve adaptation to the consequences of climate change.

Two aspects of climate change are relevant in this regard. One is the potential for longer run gradual changes in productivity and viability of certain activities (in particular locations) due to climate change. This has implications for investment decisions, the financing thereof, and management of the risks arising from lack of knowledge about precisely how the economic effects of climate change may evolve. The second is the potential for more, and more extreme, catastrophic events as a consequence of climate change. Historical experience and risk modelling based thereon may then prove inadequate for assessing future risks.

The financial sector plays a fundamental role in developing mechanisms for adaptation to climate change and risk sharing arising from resulting effects. At one level, financial institutions have significant direct exposures to such wealth losses, due to loans or insurance which have been provided to affected individuals and businesses, as well as equity investments in affected businesses. At a second level, the financial sector is the principal way (other than government transfers) in which such losses can be redistributed throughout society (such as by insurance arrangements), thereby smoothing the impact on affected groups and facilitating risky investments via enabling *ex ante* risk transfer. At a third level, the design and pricing of insurance and other financial contracts is particularly important in potentially influencing investment / adaptation decisions through the signalling or information role of financial prices and incentives they create.

In some cases, government policy may be required to establish particular financial markets (such as for emissions trading) creating prices which may lead to behavioural change with desirable climate change mitigation effects as well as adaptation responses. Whether establishing such markets rather than relying on explicit tax/subsidy mechanisms for influencing behaviour is a contentious issue.

More generally, government has a key role through its decisions regarding infrastructure development (and the financing arrangements involved) and the tendency for it to be looked upon (and take the role) as insurer of last resort in the face of major disasters.

There are also more fundamental roles for government. Governments, and the legal system, determine the allocation of property rights, and decisions in that regard can have significant effects on incentives of individuals to take actions to ameliorate the impact of climate change, or assist in its mitigation. Currently "ill-defined" property rights may be subsequently determined by, for example, judicial decisions which impose costs on businesses whose actions are judged to contribute to climate change consequences adversely affecting other businesses or lifestyles. The potential exposure of business to such "known unknowns" and consequences for insurers and stakeholders (including investors and lenders) in those businesses are an important consideration for financial institutions.

How significant are the risks to financial institutions from potential judicial decisions on disputed property rights related to climate change, and what strategies should be put in place to deal with these risks?

It is also widely accepted that there are two "imperfections" in the discount rates used by the private sector in making investment and savings decisions. One is the behavioural tendency for individuals to apply excessively high discount rates to long term costs and benefits and also to low probability but high impact events. Private sector investment decisions are thus unlikely to give adequate attention to the long run effects of climate change. Campaigns to increase awareness of such effects, and government incentives (such as taxes or subsidies) to incorporate allowance for such effects in private sector decision-making, are among the strategies which may offset this "imperfection".

What are the most appropriate government strategies for overcoming private sector underweighting long term climate change factors in investment decision making?

The second "imperfection" is that discount rates used by the private sector in investment decision making are, because of taxation, above the social rate of time preference (adjusted for risk). There is also a substantial degree of support for the premise that governments should determine discount rates for major social projects on

normative grounds – and in doing so, choose low values which give do not underweight the consequences for future, unborn, generations.

These issues are not uncontroversial, as recent debates around the choice of a discount rate in the Garnaut Report, or acceptable rate of return chosen in the implementation study for NBN Co. have illustrated. But they do raise the important question of the appropriate role for government policy in undertaking major projects relevant to climate change adaptation and in influencing private financial sector decision making.

How should governments deal with normative decisions regarding discount rates in making infrastructure decisions and in public-private partnerships?

In the face of considerable uncertainty about how climate change will affect exposure to natural disaster climatic events (scale, frequency, distribution etc) and the potential for long run impacts on productivity and wealth accumulation, several questions need to be addressed.

1. What is the appropriate division of roles and responsibilities for individuals, financial institutions, and governments in taking account of climate change impact on future risks and returns in investment decisions? Who should be responsible for providing relevant information and how should advice be provided? How do behavioural biases affect decision making in this regard?

2. What is the appropriate mix of *ex ante* preparation and *ex post* responses to climate change consequences? This hinges partly on the extent to which decision making (location, safety levels etc) can moderate the potential consequences of climatic events (and the costs associated with making such decisions). The moral hazard consequences of *ex post* actions also need to be considered. Collective action needs imply a particular role for governments – and may be reflected in particular regulatory requirements which impose costs on the private sector. For financial institutions and others involved in long term investment decisions, the allocation of risks from climatic events between stakeholders in new wealth creating investments is an important consideration, as is the impact of uncertainty about the pace and effects of climate change on assessments about the financial viability of such investments.

3. What financial products are currently and potentially available to enable risk reallocation and influence desirable adaptive behaviour? What are the appropriate regulatory requirements associated with these? How can these best be designed to overcome behavioural biases which can lead to underinsurance and to prevent decision-making which aggravates potential social and private losses from climatic events? Does the financial sector have any special role to play in mitigation of climate change through design of financial products and markets?

These issues are addressed in the following sections of this paper, and some were considered by a recent Productivity Commission Inquiry (see Box 1).

BOX 1: The Productivity Commission Report *Barriers to Effective Climate Change Adaptation*

The Draft Report completed in September 2012 provides some discussion of the finance sector role. Its discussion of financial sector aspects is primarily on the insurance industry and identifies issues such as:

- government taxes and levies as an impediment to effective insurance arrangements
- the public good nature of information such as risk mapping and thus the potential role for government in its development and dissemination
- the potential negative effects of government subsidisation of insurance premiums via reducing incentives for adaptation
- the potential negative effects of *ex post* government provision of funds to those uninsured against climatic events via reduced incentives to insure
- potential benefits from improved disclosure in insurance contracts

It is, perhaps, noteworthy that the only submissions to the Inquiry from the finance sector were from insurance companies and associations.

1. What Roles and Responsibility for the Financial Sector?

It is possible to consider the particular role of the financial sector with regard to four objectives. These are:

- Mitigation of climate change (via reducing anthropogenic determinants of climate change through creation and pricing of financial products, development of financial markets, investment decisions)
- Adaptation to climate change (via product design and pricing and other activities which affect investment, location and other decisions in ways that reduce the losses arising from climate change)
- Risk sharing (via pooling and transfer of risk of loss from climate change)
- Recovery (via enabling those suffering loss to rapidly take remedial actions)

Arguably, there is only a limited role for private sector financial institutions to play in the mitigation of climate change. Profit maximization in a competitive (or contestable) market does not allow entities to adjust prices (or other contract terms) for negative externalities which are created by the actions of the other party to the contract. Competitors would be able to undercut any such "socially aware and active" financial institution, except in a small range of circumstances.

Such institutions could, of course, simply elect not to deal with, or provide finance for, potential customers who are thought to be acting in ways which have adverse climate change consequences. As suggested by studies of returns to SRI funds, this restriction does not necessarily reduce the private returns to such financial institutions – provided that they are not a major part of the market, nor that the activities they shun do not constitute a major part of the investment opportunity set. Unfortunately, these conditions essentially mean that the effects on mitigation of climate change are minimal. And any tendency for such "socially aware and active" institutions to grow in relative importance is likely to be offset in a free-market capital market by the profit opportunities created for entry by other institutions to finance those "undesirable" activities.

To what extent have financial institutions adopted strategies in dealing with customers which incorporate consideration of adverse climate change consequences from customer actions?

One case where a role in mitigation is possible is if there are private costs or benefits which are relevant to the financial product and which are highly correlated with the negative externalities. One example (discussed later) is "pay as you drive" motor insurance, in which drivers who travel high mileages have both a larger detrimental impact of the environment and higher risk of accident. Although the environmental impact is not priced directly in such insurance, its correlation with the priced factor (miles driven) means that a mitigating effect arises from the design of the financial contract. Another example is if "green buildings" are less susceptible to losses due to water damage, fire etc. Installation of solar power may reduce the risk of business interruption for a company if its conventional power source fails.

Are there many opportunities for financial institutions to design and price products such that customers have incentives to take actions consistent with climate change mitigation?

Another case is where coalitions of dominant financial institutions can be formed who agree to incorporate environmental considerations into decision-making and who are sufficiently dominant in their marketplaces, such as through lower cost structures due to size, to prevent other non-complying institutions from increasing their market share. To the extent that complying involves some cost, the coalition members are agreeing to forgo some part of private profit which would otherwise accrue to them. The UNPRI and Equator Principles are reflective of this approach, although also relevant to the next case.

A third case is where financial institutions can, by establishing a reputation for taking climate change / environmental considerations into account, attract a clientele of customers who care about such issues and are thus willing to accept contracts with financial terms which may thus be inferior to those available elsewhere.

Is there a sufficient potential clientele of customers who will be attracted to financial institutions who establish a reputation for acting in ways which help mitigate climate change, and what strategies are required to develop such a clientele?

Finally, financial institutions which do not have a pure profit objective may be able to incorporate climate change / environmental factors into their decision making processes. However, if operating in markets in competition with profit-oriented

entities, the private cost of incorporating such social factors into decision making falls on the owners of the entity.

Financial markets can have a potential role in mitigation of climate change. The introduction of markets for emissions is a case in point, although government legislation is required to attract (or coerce) participation in such markets. This is one example of governments creating (or limiting) particular property rights which can be traded in a market.

Are there other financial markets which governments should consider creating by establishing and allocating particular tradeable property rights in order to help mitigate climate change?

While prices established in such markets can influence current output choices and investment decisions, it is also important to note that forward prices can provide signals about market views on the likelihood and extent of the consequences of climate change.

Are there other mechanisms which can be used to aggregate information about potential climate change effects in ways which will provide valuable signals and influence financial and investment decisions?

Undoubtedly, the financial sector can play a significant role in encouraging adaptive behaviour. Investments in projects and firms (either by way of equity or debt financing) need to be made in the context of assessment of expected returns and risks – such that consequences of climate change for those factors needs to be understood by financiers. Similarly, the pricing and terms of insurance contracts can exert strong adaptive influences.

Risk pooling and transfer is, of course, a core economic function of the financial sector, either through insurance, intermediation or financial markets. Here there is a major role for the financial sector, which is potentially increasing because of a wider range of risks associated with climate change. For example, suppliers of certain products designed to meet climate mitigation targets (wind power, household appliances, carbon storage etc) may be at risk of failing to meet contract terms and standards. Potential liability of firms and/or directors for failing to meet legislated standards is another area, as is the highly uncertain area of claims which might be

made against businesses for contributing to climate change which adversely affects business or lifestyle of the claimants.

What additional business risks are associated with climate change that could warrant the development and introduction of new financial products and markets for risk pooling and transfer?

Speedy resolution of claims and restitution following climatic events is also an area where financial institutions, particularly insurers have a role.

How could current arrangements for insurance claims resolution and payout be improved for dealing with major climate related disasters?

In all of these areas, ongoing technological change and financial innovation is broadening the range of potential financial products and markets which can be developed to increase the role of the financial sector in dealing with climate change.

2. Long Term Investments and Funding

Climate change is a long term phenomenon which means that its implications are likely to be undervalued in financial and investment decision-making, where it is known that individuals typically underweight the distant future. It is also the case that individuals tend to underweight (ie apply high discount rates to) low probability/ catastrophic events.

For private sector investments, climate change involves increased uncertainty about future cash flows from investments. This is particularly relevant for industries such as agriculture, but also for such sectors as tourism. Not only may gradual climate change affect long term viability, but more and more extreme climatic events may increase the riskiness of investments. Whether this requires that private sector investors should apply higher discount rates in evaluating investments subject to climate change risk is unclear. Finance theory suggests that only non-diversifiable risks should affect the required rate of return. While adverse climatic events may be correlated with (indeed possibly cause) economic downturns, and thus have some non-diversifiable elements, the extent of this risk factor is unclear. And, it should be noted, adopting a higher discount rate in evaluating investment proposals makes particular assumptions about the evolution of risk over time which may mean that inadequate weight is given to longer term consequences.

Consequently, it would seem appropriate for decision-makers to incorporate possible consequences of climate change in estimation of expected future cash flows. Increased risk of major disruptive climatic events can be incorporated by including the cost of relevant insurance premiums in cash flow projections. Longer term consequences can be incorporated by simulations of alternative climate related scenarios to determine expected cash flows – noting that arrival of new information may warrant changed investment strategies which should be incorporated in the modelling, and thus placing particular value upon strategies which allow for flexibility.

Should climate change risk be reflected in the required rate of return used in the evaluation of private investment projects?

Have financial markets reflected increased risks arising from climate change in their valuations of relevant industries and firms?

Do insurance markets currently provide appropriate price signals for the cost of hedging future cash flow consequences of climate change?

Where climate change ultimately leads to the failure of a firm or industry, stakeholders suffer losses. Currently, there do not appear to be any financial products available which apportion risk of loss in firm failure differently when that failure could be attributable to climatic factors relative to other unrelated factors. Given the disparity of community views on the likely consequences of climate change for industry (and society) this appears to be a significant market failing (ie an incomplete market). If some investors are willing to bear the risk of climate change losses cheaply (because they do not view them as likely or significant), there is an opportunity to spread climate change risk efficiently by designing investment products which appeal to this group. While such investors might be expected to take on climate risk by investing in industries which they perceive as undervalued due to risk aversion of other investors, this involves an exposure to a combination of factors rather than just to climate change risk. If instead, firms were to issue securities which had payoffs linked to climate change indicators or consequences for the firm, the existence of a significant group of investors who are sceptical of climate change could reduce the cost of funding for the firm.

Is there scope for firms to issue securities with payoffs linked to climate change indicators or consequences which could reduce their funding costs by allocation of such risks to investors who place low weight on such risks?

Would this be preferable to the firm hedging against such risks by insurance or use of other derivative contracts?

The role of scientific uncertainty about climate change is particularly relevant to investment and regulatory decisions, but these have differing consequences for private and governmental investment decision-making. Further differences arise from the fact that the private sector will not generally voluntarily take into account externalities (such as increased pollution and irreversible environmental degradation) associated with particular investments.

One consequence is that the private sector may make particular forms of investments too early from a social perspective given the extent of scientific uncertainty. While private decision-makers will generally (or should) take into account real options such

as the option to defer an irreversible physical investment, they will not take into account scientific uncertainty – except insofar as its resolution would have direct consequences for the private returns on the investment. Where such resolution may confirm the extent (or otherwise) of harmful externalities associated with that particular type of investment, relative to choice of other, higher private cost, available technologies, such investments may be made too early from a social perspective. Encouraging incorporation of such externalities into private investment decision making may be achieved by government actions (such as carbon taxes or creation of emissions markets).

How can the private sector be induced (or required) to take into account social externalities in making investment decisions where there is scientific (and community) uncertainty about the extent of the social costs involved?

But taking such actions prior to resolution of scientific uncertainty is at odds with the standard message of the real options literature which is that there may be gains from deferring decisions. At a social level this "early action" approach has been proposed under the term the *Precautionary Principle (PP).* Gollier and Treich (2003) observe that "the main idea of the PP is to encourage the prevention of a risk before that full scientific information is available about it. An active decision must thus be made before scientific evidence, conversely to the usual timing of decisions". In the usual approach to investment under uncertainty it is optimal to wait until after the arrival of new information before making sunk (irreversible) investments. Gollier and Treich note that "decision-making related to new environmental or technological risks must take into account those important characteristics of the problem: long time horizon, stock externalities, possible irreversibilities (physical and socio-economic), large uncertainties and future scientific progress". Irreversible (or partially irreversible) "stock externalities" (such as pollution), environmental irreversibility, and capital irreversibility, all need to be taken into account, with the optimal decision depending upon the relative importance of these factors.

Governments making large scale infrastructure investments can take into account the various irreversible considerations. This may involve decisions to proceed or not, or choices between alternative methods of infrastructure construction and use with different environmental considerations. However, in performing the requisite cost-benefit analysis, there is still the difficult question of the appropriate discount rate to

use. This remains an unsettled question – as evidenced by the use of extremely low discount rates in the Stern and Garnaut Reports on climate change and the criticisms thereof.

What discount rates should the public sector use in assessing the merits of large scale projects aimed at mitigating, or ameliorating the effects of, climate change?

Another complication facing government infrastructure provision which is aimed at ameliorating the effects of climatic events is the behavioural consequences it can induce among relevant parties. Various authors have noted that, in an environment where individuals do not have good information about risks, infrastructure developments such as flood levees may encourage them to build in the affected area in the mistaken belief that all risks have been removed. It may also reduce the visual evidence or affect the historical data in a way that causes individuals to further underestimate the potential risks. Thus, there will be a larger amount of private construction undertaken which, while perhaps protected from mild climatic events (floods), is exposed to major catastrophes.

How do governments ensure that infrastructure investments aimed at ameliorating the effects of climate change (such as building flood levees) do not create moral hazard in the form of encouraging private sector investment in areas now thought to be "protected"?

How do (or should) governments ensure that taxpayers are not exposed to the possibility that unpredictable consequences of climate change renders protection provided by such investments inadequate?

One issue warranting consideration is the extent to which governments should put in place *ex ante* funding arrangements for meeting potential payouts when major disasters occur. Monti (2009) notes that *ex post* funding may be slow, cost-ineffective, untargeted and potentially inequitable, involve an unsustainable fiscal burden, divert resources from other projects, be affected by political considerations, and create moral hazard exemplified in the form of inadequate adaptation and insurance by the private sector. He notes that "Possible *ex ante* solutions include the establishment of dedicated catastrophe funds, market-based or state-sponsored disaster insurance and

reinsurance programs, alternative risk transfer (ART) and alternative risk financing (ARF) tools - such as risk securitization and contingent capital arrangements -

allowing broader risk spreading through capital markets." Dedicated funds may reduce moral hazard (by having explicit payment limits and arrangements – which also may address equity and political considerations). While it might be argued that they reduce the fiscal burden at the time of need – the need to replenish the fund creates similar fiscal costs. Essentially, the difference between such *pre-funding* and *post-funding* is primarily whether one operates with a fund which has a target balance of some positive amount or zero amount. An alternative approach may be to issue government securities with a "catastrophe option" attached, whereby the holder receives a higher than usual interest rate but faces the risk of loss of some (or all) of the principal should a designated catastrophe event occur.

Is there a case for governments to issue "catastrophe bonds"?

Should governments build up contingency funds for use in meeting major disaster expenditure needs?

One reason why governments may consider establishing catastrophe funds is because private insurers may find that climate change related catastrophes create uninsurable risks, due to risk correlation and uncertainties, which if covered may lead to failure of the insurance company. In any event, large scale payouts may create liquidity problems even for solvent insurers. Provision of liquidity in these cases may be a valuable government backstop. But also important is the risk of failures of insurers faced with excessive payouts. The merits of having a government guarantee that such claims will be met, and how that will operate, then becomes a matter of relevance. In Australia, the Financial Claims Scheme provides such a guarantee framework, with funding based on a budget subvention, recovered by an *ex post* levy on other insurers.

Do capital adequacy and other regulatory requirements for insurers adequately take into account the uncertainty surrounding predictability of future climatic events and potential claims?

Is there a role for government to provide some form of reinsurance facility associated with large-scale climatic disaster events?

3. Financial Products

The potential implications of climate change for insurers and financial intermediaries are worth noting. They include:

- Inapplicability of historical models of potential costs for insurers
- Wrong risk rating of some exposures
- Incorrect forecasts of expected cash flows and/or risks

In addressing the implications of climate change for financial market participants, it is worth making the distinction between *risk* and *uncertainty* – the former being amenable to insurance through the probabilistic nature of losses and the latter simply posing unknowable outcomes.

In developing financial products to enable risk sharing and adaptive behaviour it is important to bear in mind behavioural characteristics of households and business decision makers. Also important is recognition of the extent of information and understanding of individuals with regard to potential risks and outcomes. A third issue is the extent to which product design and pricing can influence moral hazard and adverse selection.

It is possible to divide the types of financial products to be considered into those aimed at end-users facing particular risks (such as particular types of insurance) and those aimed at facilitating risk management and funding by insurers or other financial institutions exposed to climate change risks. The distinction is not clear-cut however. Development of derivative markets could, for example, provide the opportunity for end-users to reduce exposure as well as providing insurers with the opportunity to hedge exposures they have taken on.

<u>Insurance and other products for the end-user</u>

Mills (2009) provides an overview of 643 examples of insurance products, primarily from the US, which he had identified as related to climate change risk. Most were in the property and casualty area rather than life or health insurers. Among the insurance products which might be identified as linked to climate change are:

- Pay-as-you drive (PAYD) car insurance and discounts for low-emission vehicles

- Green-building insurance packages
- Risk management products for Carbon Capture and Storage (CSS) projects
- Insurance coverage for less-than-anticipated output from solar or wind sources for electricity providers
- Climate-related micro-insurance
- Liability insurance

Some such products are not targeted at climate change mitigation, but reflect the positive correlation between risk of claim and adverse climatic consequences – such as with PAYD car insurance. Others rely on the assumption of a "halo" effect – that, for example, individuals driving low-emission vehicles are likely to be more risk averse. Others, such as liability insurance innovations and CSS insurance, reflect the emergence of new business risks arising from climate change. Liability insurance could involve such things as provision of cover for a supplier of products which prove ineffective in meeting claimed objectives or for climate related externalities arising from activities.

How innovative have Australian insurers been in offering policies related to climate change?

What are the main gaps in the market?

In examining the design and likely success of financial products, it is important to be aware of possible behavioural biases of potential users and the consequences of imperfect information. For example, it is well known that "under-insurance" is generally prevalent, which could reflect lack of awareness of true risks or behavioural biases. Those biases lead to such things as (Kunreuther and Heal 20xx):

- Underweighting of the future
- Safety first behaviour – only taking actions to mitigate risks which have a probability of occurrence greater than some threshold level
- Overconfidence
- Myopia
- Inertia in adjusting "mental models" in response to new data

Kunreuther, Meyer and Michel-Kerjan (2009) suggest ways to overcome such behavioural biases, noting that it is necessary to "either find ways to de-bias decision makers so as to foster voluntary investments in mitigation, or restrict voluntary choice, such as imposing well-enforced building codes and land-use regulations".

A number of authors have argued the merit of requiring multi-year insurance contracts which are tied to the asset involved rather than the owner. Jaffee, Kunreuther and Michel-Kerjan (2008) argue that "[l]ong-term contracts have the potential to significantly increase social welfare by reducing insurers' administrative costs, lowering search costs for consumers and providing incentives for long-term investment in mitigation measures to protect property."

Their argument is twofold. First, transactions costs and uncertainty are reduced. Second, such an approach induces owners to undertake mitigation actions which would otherwise not occur due to myopia.

Clearly, introduction of such contracts requires government mandate, and the extent to which the perceived benefits would be realized are questionable. More significantly, the risks for insurers of providing long-term multi-year contracts (where some up-front specification of premiums would be required) are much greater than those from annual contracts where premiums can be reset as new information about future risk accrues.

Are long term insurance contracts linked to properties rather than the purchaser feasible or desirable?

An alternative approach may be to use the tax system to encourage individuals and businesses to take out particular forms (and levels) of coverage, as is currently done in the case of health insurance. In contrast, Australian governments have typically adopted tax policies which have worked to reduce the level of insurance – such as via collection of funds for fire services by the application of a fire levy to property insurance premiums.

What types, if any, of government incentives should be provided to induce adequate insurance coverage being taken against climate risk?

A further issue arises in the design of insurance products – specifically the range of events covered within any particular policy. This was the topic of the recent Inquiry

into Flood Insurance, where the issue of compulsory inclusion of flood cover in home insurance was considered, as was the question of making flood cover the default option in insurance packages.

What innovations in the design of insurance products, including default options, to encourage adequate coverage against climate risk should be considered?

Insurer Risk Management and Funding

There are two aspects of insurer risk management and funding which are relevant. First, does the insurance sector have adequate capital reserves to meet potential obligations arising from the consequences of climate change - given the uncertainty associated with assessing those consequences? Second, are there innovative methods for insurers to hedge the risks they face from climate change events? The former was addressed in an earlier section, so this section focuses on the latter issue.

Catastrophe Bonds

Catastrophe (Cat) Bonds provide investors with a higher coupon interest rate in exchange for the potential that all or part of the principal may not be repaid if a particular catastrophic event occurs before the bond's maturity. In that event, the promoter of the Cat Bond (an insurance company) receives the agreed principal amount in return for the premiums it has paid into the trust fund or other vehicle set up to issue the Cat Bond. To protect the investor against credit risk the trust fund invests the principal amount in government bonds or some other risk free investment. Interest it receives on those government bonds plus premiums paid to it by the bond promoter (the insurance company) provide the higher coupon rate for the investor.[1]

Between 1996 and 2008 there were 170 Cat bonds issued (with an average maturity of 3 years) primarily in the USA (Kunreuther and Heal, 2012). Triggers for Cat Bond payments can be indemnity related, index related, parametric, modelled loss or some combination thereof. The appropriate design of such bonds is complicated, because the trigger events cannot be directly related to the claims experience of the bond's promoter, in order to avoid moral hazard and adverse selection problems. But linking

[1] Cummins (20xx) notes that promoters of Cat Bonds have no incentive to invest the available funds in risky securities with higher yields, because this reduces the probability that the funds will be available if the trigger for payout on the catastrophe bond occurs.

the trigger event to some industry/geographical metric of loss events creates a basis risk for the insurance company which promotes the bond whose claims experience may be considerably different.

In principle Governments could issue catastrophe bonds as an alternative to building up a pool of funds in order to meet calls on the budget when a catastrophe hits. The annual cost would be the interest rate of government bonds plus the premium component.

Are there impediments to the development of a market for Cat Bond issues by Australian insurers which warrant policy action?

Exchange Traded Catastrophe and Weather Derivatives

A number of futures and options exchanges have attempted to introduce contracts linked to catastrophes but without much success. Such contracts have been based on an underlying index such as a particular aggregate loss index (for a particular region). The lack of success can be attributed to the basis risk (of the index not reflecting the particular exposures of an insurer) and lack of liquidity – which is something of a chicken and egg problem.

A number of contracts based on weather indices and other climate related variables have been introduced by the CME (and are described in CME, 2011). Weather futures and options (Heating Degree Days (HDD) and Cooling Degree Days (CDD) – involving payoffs based on average temperature over a month relative to a base of 65 degrees for 10 US cities in 1999. Subsequently, Cumulative Average Temperature (CAT) contracts and Frost and Snowfall related contracts were introduced subsequently and for a wider range of locations (including outside the US). Australian temperature based contracts were introduced in 2008. The Table below (sourced from CME (2011) shows some of the potential uses of weather contracts.

The growth of the weather derivatives market has not been outstanding (certainly relative to other derivatives markets). According to the Economist (Feb 4, 2012), "the value of trades in the year to March 2011 totalled $11.8 billion, nearly 20% up on the previous year, though far below the peak reached before the financial crisis took the steam out of the business. In 2005-06 the value of contracts had hit $45 billion." As

well as exchange traded contracts such as those on the CME, there are also over the counter markets.

Economic Sector	Hedgeable Weather Risks
Energy	Reduced and/or excessive demand
Hedge Funds	Making profits on volatile markets
Agriculture	Crop yield, handling, storage, pests
Offshore	Storm frequency/severity
Insurance	Increased claims, premium diversification
Entertainment	Postponements, reduced attendance
Retailing	Reduced demand of weather-sensitive products
Construction	Delays, incentive/ disincentive clauses
Transportation	Budget overruns, delays
Manufacturing	Reduced demand, increased raw material costs
Governments	Budget overruns

Source CME (2011)

Is there scope for development of climate related derivatives on the Australian Securities Exchange?

Hybrid securities

Insurers typically lay-off part of any risk via reinsurance. However, there are other ways in which risk can be shared with other parties. For example, Catastrophe-equity Puts are insurance company issued options which give it the right (in return for payment of a premium) to issue preference shares at an agreed price to the counterparties should a particular catastrophe related trigger be hit. The insurer, does however face the risk that the counterparty may default on the contract.

Insurance Linked Securities (ILS) can be issued by insurers to raise capital and be structured such that payoffs on the security are linked to some insurance indicator. Generally, it can be expected that the indicator is something outside of the control of the insurer. Thus a link to some measure of industry claims experience rather than those of the issuer can be expected.

Are there other types of funding and risk management instruments which insurers can consider?

What impediments to the issue of such securities exist?

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