Risk Management and Climate Change:

The Role of the Financial Services Sector

A report on the outcomes of the VCCCAR-ACFS Risk Management and Climate Change: The Role of the Financial Services Sector think tank. The think tank was sponsored by the Insurance Council of Australia and the Suncorp Group. Principal authors of this report are Professor Kevin Davis (Research Director, ACFS) and Mr Martin Jenkinson (Research Officer, ACFS).

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Executive Summary

The *Climate Change and Risk Management: The Role of the Financial Services Sector* think tank held on Wednesday the 5th of December brought together members representing the financial sector, government and policy makers, climate scientists and academics to discuss the role the financial sector can play in managing and adapting to a more volatile environment and to explore how greater collaboration between the parties can reduce the total cost of adaptation.

The increased frequency of major climatic events in recent years, whether related to ongoing climate change or not, have drawn attention to the potential wealth destruction that can result from an insufficient understanding of, planning for and insuring against major climatic events.

The financial sector plays an important role in providing additional information on the short-term risks associated with investment decisions through the price signals embedded in bank loans and insurance premiums. However, these contracts are generally relatively short-term in nature and therefore fail to provide information on the potential long-term effects associated with climate change. The funds management and superannuation sectors could potentially play a role in providing additional information on long-term climate risks through their investment decisions and the subsequent effect this would have on asset prices. However, current incentive structures, which focus on the short-term performance of fund and investment managers, have potentially limited the prevalence of Environmental, Governance and Sustainability (ESG) factors in the investment decisions of these organisations.

While the factors that have led to the increased frequency of extreme climatic events remain debated, a number of initiatives can be implemented to reduce the total cost associated with events of this nature. These initiatives include ensuring that market prices of general insurance products are left unfettered and are commensurate with the riskiness of the asset being insured, the elimination of policy settings and actions that may provide incentives for businesses and individuals to take on excessive risk. Most importantly, greater collaboration by governments, scientists and the financial sector is required to ensure that

high quality, fine-scale information on climate risk is made available to promote informed decision making and risk management.

Key findings

1. Activities that can improve preparation, avoidance and response to extreme climatic events include: Information collection, analysis and dissemination to determine the extent of risk; risk mitigation such as policies to deter risky behaviour and infrastructure projects that may reduce the impact of extreme events; disaster response such as the co-ordination of emergency services and ensuring that necessary resources are available to impacted areas; and, financial support such as additional funding for affected areas and insurer of last resort capacity.

2. Contrary to the generally accepted notion of climate change being a gradual smooth change from one point to another, empirical evidence suggests that the change is best characterised by a series of large and sudden 'steps'. Furthermore, in between each 'step' is a large amount of volatility which results in large random spikes of climatic events. Hence, anticipation and management of rapid changes in extremes may be of more value than managing for long-term gradual changes because of the potential to avoid large, unanticipated damages

3. The 2011 *Climate Change Scenarios – Implications for Strategic Asset Allocation* report by Mercer[1] suggests that climate policy risk could add as much as 10 per cent to total longer-term portfolio risk. However, as a result of current product design and incentive structures, the financial sector generally has **a short-term focus**. Therefore, the financial sector does not currently give sufficient consideration to the implications of long-term climate change.

4. Governmental response in terms of risk mitigation related to climatic events takes a longer-term focus but has not seen enough investment. Potential risk mitigation infrastructure can include dams or levees in flood prone areas and prescribed-burning to reduce fuel loads and maintenance of access tracks and fire breaks to decrease the risk of bushfires.

[1] Mercer (2011), Climate Change Scenarios – Implications for Strategic Asset Allocation, p7.

5. When planning for long-term 'irreversible' investments in the face of uncertainty it is important to factor in the value of real options into any cost-benefit analysis. A real option provides the investor with the opportunity of either ending the project or changing the use of the long-term assets in the event that either of these yield a higher present value than that of the original plan. A project is therefore acceptable if the benefits are greater than costs including the value of real options extinguished.

6. Extreme climatic events are not unprecedented. However, factors such as the increased value of assets and urbanisation of coastal and bushland areas, have led to an increase in the total cost associated with extreme climatic events in Australia. The combination of increased intensity and frequency of events in a changing climate, increased exposure and increased financial value of assets is likely to result in unprecedented losses when these events occur.

7. Sole reliance on the insurance sector to assume this risk is becoming unfeasible. A holistic **risk management strategy** that identifies potential risks and deters risk taking behaviour by individuals and businesses is required to reduce the potential total cost associated with extreme events.

8. Insurance sends a very important price signal for risk in the community. Therefore government policy should be careful to ensure that price signals are not artificially skewed by government intervention. The **quality and availability of information** is essential to the creation of an adequate risk management strategy and in assisting the decision making process of governments, financial sector participants, businesses and individuals. Collaboration between content creators, information distributors and end users of information is necessary to improve the usability, granularity and accessibility of climate risk information to end users.

9. Current policy may be resulting in pricing inefficiencies in the insurance market. Furthermore, government policies or actions which compensate for risky behaviour may create perverse incentives for individuals to assume excessive risk. Policy should be reviewed to ensure that **government incentives encourage prudent behaviour** and that the potential for **moral hazard is minimised.**

Research Needs

1. An analysis of the dichotomy between the long-run incentives of investors – Including ESG concerns - and the short-term incentives of investment professionals.
2. Investigation of the extent to which information on climate risk provided by governments and climate scientists is implemented into financial models and conversely, to what extent price signals and other risk related information generated by the financial sector is utilised by policy makers.
3. An empirical study on the effect that government actions such as acting as insurer of last resort have had on risk related decisions by individuals and businesses.
4. Research on the information gathering tools and the granularity of data used for premium pricing decisions made by general insurers and how this is changing.
5. An investigation of the potential viability for longer-dated general insurance products.
6. An exploratory piece on the current impediments to a viable market for the trading of climate risk securities.

Policy Recommendations

1. Development of systems to provide greater availability and improved distribution of information related to climate risks.
2. A cost-benefit analysis of the fire-service levy incorporated into house and business insurance policies and the impact this may have on underinsurance.
3. A review of the government's role as insurer of last resort and ex-ante guidelines by which insurer of last resort status will be activated.
4. Ongoing reviews of minimum building requirements and specifications for high risk areas to deter concentration of risk.

1. Introduction and Overview

The climate change adaptation think tank brought together thirty four participants representing the financial sector, government sector and policy makers, climate scientists and academics. The discussion focused on climate change, extreme climatic events and the role that the financial services sector can play in adaptation to, and the distribution and management of risks that emerge from, these issues.

The key objectives of the think tank were to raise awareness of the role financial services can play in adaptation to climate change, to explore how the financial sector can assist in managing climate related risks, and also identify areas in which the sector must adapt products and practices as a result of these factors.

Several key issues were identified in the day's discussion.

(a) A Short Term Focus

The financial sector has not been a major contributor towards promoting actions to mitigate or adapt to long term gradual climate change. The insurance industry tends to provide short term (annual) contracts such that pricing and terms do not take into account the longer run consequences of climate change. While some fund managers have taken long term climate change risks into account in portfolio selection, they have been in the minority, and their actions have not led to exposure to long term climate change being built into asset prices – which would provide incentives for companies to undertake adaptive behaviour. Similarly lending institutions such as banks generally make loan commitments for short to intermediate periods, such that exposure to long term climate risk is not a consideration taken into account in risk assessment or pricing. More generally, while many financial institutions commit to various ESG principles, there is little evidence that the extent of adverse climatic externalities from the activities of the firm in question are taken into account when funding decisions are made.

Such a short term focus is also a concern when investment decisions such as for infrastructure are taken into account. Infrastructure assets have life-spans of several decades or more, and are thus potentially exposed to the impact of climate change on usage patterns and operating and maintenance costs. Whether such risks are appropriately taken into account in investment decisions (through recognition of real options), or whether

pricing and funding arrangements provide adequate incentives for significant stakeholders to incorporate such risks in their planning, are open questions.

(b) Extreme climate events: risk management

Australia has always been a country with significant exposure to extreme climatic events, but climate change threatens to make the historical data on which risk assessment and pricing decisions are based less relevant for the future. Even in the absence of an increase in climatically-induced extreme events, insurers face changing risks from an increase in inappropriate location and other risk-taking decisions being made by customers. Traditionally insurers manage the risks associated with such infrequent events by accumulating adequate capital buffers, reinsurance, and *ex-post* recoupment of losses arising from claims payouts from premiums received prior to being hit with claims from the next major event. Several factors call the viability of the last source of risk management into question. One is the potential for competitors in a global market, who were not exposed to losses from prior events to undercut premiums. A second more important threat is the possibility of a rapid sequence of extreme events preventing the restoration of reserves and threatening insurer solvency, or requiring substantial increases in premiums – which can, if risks are not well understood, lead to individuals and businesses undesirably reducing their level of insurance coverage.

(c) Information provision and distribution

The importance of information provision to enable good decision-making is increased in a situation where change is occurring. Government agencies and researchers are continually acquiring more information about the risks associated with climate change, and technological change is making increased precision of risk assessment possible – such as reflecting characteristics of individual properties rather than geographical regions. One challenge lies in how to most effectively make this information widely and readily available in forms which make it useable by individuals and the financial and business sectors.

One component of that challenge lies in community understanding of the nature of risk – with many instances recounted of cases such as individuals believing that a 1 in 100 year risk meant that it would be 100 years before another risk event would occur, rather than meaning that there is a 1 per cent probability that it could happen in any year. More

generally, it is felt that individuals are not provided with adequate information (in a useable form) about their potential exposure to climate related risks when making their largest financial decision – purchase of a family home.

A second challenge is the need to integrate risk models used by the financial sector with risk information produced by climate scientists – with the former typically reliant on specific quantitative probabilistic inputs which may not be readily available from the latter, where scenario modelling may provide limited information on underlying probabilities. Enhanced quantitative information is also important for the design of, and incentives for use of, risk management products such as weather derivatives.

(d) Incentive structures and Coordination

For individuals and private enterprises, price signals such as the cost of insurance or funding costs provide incentives to adapt to climate change risks. Such price signals can be impeded by government interference in markets, such as has been the case with fire-service levies being incorporated into house and business insurance policies. The resulting higher insurance costs can lead to under-insurance particularly when those who are uninsured or under-insured still receive the benefit of the fire protection services.

Governments face challenges on, at least, two levels in creating appropriate incentives. The first is moral hazard arising from government actions. *Ex ante* actions to partially ameliorate risks (such as building flood levees) may lead individuals to underestimate risks and make location decisions which lead to excessive risk of loss. Similarly, *ex post* actions involving compensation to those suffering losses may, by creating expectations of such actions, also reduce incentives to take actions to avoid risks or take out private insurance against such risks

The second challenge lies in providing appropriate incentives within budgetary agencies to take actions to reduce potential losses. Generally it can be expected that insurance costs will fall when measures are taken to reduce the risk of loss. If, however, the budget process leads to lower funding for agencies when insurance costs fall, incentives to take such actions are diminished.

2. The Process and Discussion

The think tank was broken down into three themed sessions. Each involving a series of presentations and a break-out session during which key questions were explored.

Executive director of Sustainability Advisers and former CEO of VicSuper, Bob Welsh began the day by sharing his experience in adapting VicSuper's investment portfolios to better manage their carbon exposure. Bob noted that while the challenge presented by climate change is a large one, through collaboration, humans have invariably found ways to rise above the most difficult of challenges.

Professor Roger Jones from Victoria University's Centre for Strategic Economic Studies highlighted the risks posed by the non-linear nature of climate change. Alain Baillie from the Department of Treasury and Finance outlined the role of government and the delineation of responsibilities amongst the different levels of government in regards to climate change adaptation while Professor Harry Clarke of La Trobe University provided insights into factors that shape the decision making process involved with government long-term capital investments.

Further presentations by Dr Richard Fuller of Mercer, Annabelle Butler of the Suncorp Group, Karl Sullivan from the Insurance Council of Australia and Daniel Churilov of the Victorian Managed Insurance Authority all provided insights into the current strategies and tools being used by financial sector participants to adapt to the risks being posed by climate change and increasingly frequent climatic events.

3. List of Participants

Robert Ades	
Alain Bailie	Department of Finance and Treasury
Pip Best	Ernst & Young
Tony Biancacci	VicRoads
Annabelle Butler	Suncorp Group
Lisa Carapis	Centre for Resources, Energy and Environmental Law
Daniel Churilov	Victorian Managed Insurance Authority
Harry Clarke	La Trobe University
Ian Cossens	VicRoads
Kevin Davis	Australian Centre for Financial Studies
Richard Fuller	Mercer
Joe Garbutt	Garc Consulting
Jefferson Gibbs	KPMG
Lee Godden	Centre for Resources, Energy and Environmental Law
Andrew Gray	Australian Super
Felicity Hamerston	Department of Sustainability & Environment
Ben Honan	Suncorp Group
John Houlihan	Department of Sustainability and Environment
Dougal Hunter	Australian Securities Exchange
Roger Jones	Centre for Strategic Economic Studies
Rod Keenan	Victorian Centre for Climate Change Adaptation Research
Robert Lamont	Aon
Ben Maclean	Productivity Commission
Deborah Ralston	Australian Centre for Financial Studies
David Rissik	National Climate Change Adaptation Research Facility
Alex Sanchez	Insurance Council of Australia
Harvey Stern	Bureau of Meteorology
Diane Suennen	Victorian Managed Insurance Authority
Karl Sullivan	Insurance Council of Australia
John Trowbridge	Chairman of the Australian Government's 2011 Natural Disaster Insurance Review
Stewart Turner	Productivity Commission
David Walland	Bureau of Meteorology
Bob Welsh	ESG Climate Change Committee
Celeste Young	Victorian Centre for Climate Change Adaptation Research

4. Presentations

Speaker 1: Bob Welsh, Executive Director of Sustainability Advisers and President of the Environment Protection Board

Bob has 30 years of experience in business strategy including roles as Chairperson, Director, Chief Executive and a member of various executive teams. Formerly founding Chief Executive of VicSuper, now one of Australia's fastest growing multi-employer public offer superannuation (pension) funds, Bob is a world renowned leader in sustainable investing and in placing sustainability at the core of business strategy.

Bob was the founding Chairperson of the Investor Group on Climate Change Australia and New Zealand and is a pioneer in fostering the development of low-carbon investment strategies.

Key points:

- Vicsuper's move toward climate risk adaptation began with the realisation that climate change and carbon exposure posed a great risk to beneficiaries of the fund particularly those beneficiaries with investment horizons of more than 20 years.
- The first challenge for VicSuper was to quantify a cost of carbon. Vicsuper commissioned a study which found that carbon intensity across the ASX 200 equated to a cost of 1 per cent of turnover, 0.44 per cent of market cap and 3 per cent of earnings. The exposure to individual companies varied greatly around this benchmark.
- Through a strategy of tilting a percentage of portfolio holdings away from high carbon intensity investments, Vicsuper managed to bring down their exposure to carbon risk without impacting investment returns.
- While the challenge associated with climate change adaptation is indeed large, collaboration, determination and a strong will from such a diverse group of people provides hope.

Session 1 – The Assumption of Risk: Who should be responsible?

Speaker 2: Alain Baillie, Department of Treasury and Finance

Alain has worked in the Victorian Treasury since 1998 holding positions in economic policy and forecasting, superannuation policy, taxation policy, intergovernmental relations (in particular the 2010 Review of the Commonwealth Grants Commission methodology for GST distribution) and most recently water and climate change policy.

- The key role of government is to provide public goods, assets and service delivery. Risk should be managed by those with greatest knowledge of them and therefore asset owners should be expected to take greater responsibility, rather than relying on government to act as an insurer of last resort. However, in order for individuals to be in a reasonable position to make optimal decisions there has to be greater availability of information related to an individual's risk position.
- It is important for government to work with insurers, climate scientists and other parties to create a greater pool of quality information and to create initiatives to distribute this information.
- Each level of government has a specific responsibility in managing climatic risk:
    1. The *Commonwealth Government* is the key supplier of national climate data for other levels of government. It is the responsibility of the Commonwealth government to ensure the economy is flexible and resilient so that resources can be allocated to climate change adaptation.
    2. *State Governments* are responsible for the provision of local and regional information such as sea level projections and bushfire/flood overlays. State Governments should also deter risky behaviour through state planning and building regulations. They should also encourage individual agencies to think about the risks they face and how best to manage the risk.
    3. *Local Government* should use the information provided by the other levels of government to manage the potential risks of climate change and climatic events to their constituents, deter risky decision making within their jurisdiction and build community resilience. It is key for local governments to appropriately define

planning and development regulations and to share information with councils that share similar characteristics to build a deeper understanding of potential risks and mitigation strategies.

Speaker 3: Professor Roger Jones, Centre for Strategist Economic Studies, Victoria University

Roger Jones is a Professorial Research Fellow at the Centre for Strategic Economic Studies (CSES) at Victoria University, joining VU in early 2009. Previously he worked for CSIRO for thirteen years to early 2009. Trained as a physical scientist, he now applies an interdisciplinary focus to understanding climate change risk, bridging science, economics and policy, particularly in developing methodologies for assessing adaptation and mitigation strategies for managing climate change risks. These have been used widely in Australia and internationally, contributing to the Australian Climate Change Adaptation Strategy, the United Nations Development Program Adaptation Policy Frameworks and a range of individual projects.

- There is a major difference between disasters that can be forecast somewhat reliably compared to disasters with a much greater degree of uncertainty such as earthquakes, volcanoes, tsunamis, financial crises.
- Contrary to the generally accepted notion of climate change being a gradual smooth change from one point to another. Empirical evidence suggests that the change is best characterised by a series of large and sudden 'steps'. Furthermore, in between each 'step' is a large amount of volatility which results in large random spikes of climatic events.
- Despite what empirical evidence shows, most discourse around climate change continues to focus on the gradual change. For example the Productivity Commission states, "Within limits, the impacts of **gradual** climate change should be manageable"
- The commonly accepted notion of climate change may distort strategies and adaptation plans being implemented by both financial sector participants and governments.

- Managing for rapid changes in extremes may be of more value than managing for long-term gradual changes because of the potential to avoid large, unanticipated damages

Session 2 – Investment Decisions: Considering risk in good times and bad

Speaker 4: Dr Richard Fuller, Senior Responsible Investment Specialist, Mercer

Dr Richard Fuller is a Senior Specialist with the Responsible Investment Unit of Mercer's Investment Consulting business. Richard's work for clients extends across the ESG field and includes policy development and implementation in relation to corporate governance standards and practices (including share voting and company engagement), evaluation of environmental and social issues in the investment process, ESG integration by fund managers, and fund manager evaluation.

- While superannuation funds and institutional investors have in general made progress in regards to accounting for climate change and climate risk in investment decisions, there could be more action by these investors to lower portfolio exposure to risks induced by climate change.
- The 2011 *Climate Change Scenarios – Implications for Strategic Asset Allocation* report by Mercer suggests that climate policy risk could add as much as 10 per cent to total portfolio risk.
- In recent times a greater interest in sustainable equities and unlisted assets such as agriculture and timberland is being shown by institutional investors. Assets of this nature can help to diversify a portfolio's exposure to climate risk.
- Professionals and leaders with skills and awareness in sustainability are becoming increasingly in demand in the institutional investor space.

Speaker 5: Professor Harry Clarke, La Trobe University

Harry Clarke is Professor of Economics at La Trobe University. Harry obtained his PhD from The Australian National University. His main teaching and research interests are in applied microeconomics - particularly climate change, population, environmental and transportation economics. In the climate change area Harry has worked mainly on agricultural and biodiversity adaptation problems, strategic issues of international policy

design and the design of carbon taxes. He recently co-authored the Henry Taxation Review's report 'Reforming Taxes and Charges in the Australian Transport Sector' and has authored major reports on population and immigration economics.

- When planning for long-term 'irreversible' investments in the face of uncertainty it is important to factor in the value of real options into any cost-benefit analysis. The traditional cost-benefit analysis model states that if benefits are greater than costs, the project should be undertaken. A real option provides the investor the option of either ending the project or changing the use of the long-term assets in the event that either of these yield a higher present value than that of the original plan. This alters the cost benefit formula to accepting a project if the benefits are greater than costs inclusive of the value of real options extinguished as a result.
- In the case of government investments in infrastructure that may mitigate the impact of climate induced events, two factors need to be considered. First, what value is placed on achieving the desired level of protection (such as adequate water availability). Then any particular project able to achieve that outcome needs to be compared against available alternatives. A desalination plant is a case in point. Using figures from the Productivity Commission report the cost of the recent Melbourne desalination plant equates to approximately $200 annually per Melbourne household. Therefore the question should be posed, is $200 a reasonable price for insurance against drought and could the market provide a better cost alternative?

Speaker 6: John Trowbridge, Chairman of the Australian Government's 2011 Natural Disaster Insurance Review

In 2011, John Trowbridge was the Chairman of the Australian Government's Natural Disaster Insurance Review, which issued its report in September 2011. Prior to that, John completed a four year term as Executive Member of APRA, where he had carriage of life and general insurance and executive remuneration. John has spent the majority of his career as a consultant, having founded Trowbridge Consulting in 1981 which became a leading actuarial and management consulting firm in Australia and Asia during the 80s and 90s. He has also held senior executive positions with two major Australian based insurers and served as a member of the Australian Treasurer's Financial Sector Advisory Council from 1998 to 2004.

- Responses to extreme climatic events can be placed in three broad categories:

1. Categories of activity:

    1. Financial support including additional funding for affected areas and insurer of last resort capacity.
    2. Risk mitigation such as policies to deter risky behaviour and infrastructure projects that may reduce the impact of extreme events.
    3. Information collection, analysis and dissemination to assist individuals in assessing climate risk when making decisions.
    4. Disaster response such as the co-ordination of emergency services and ensuring that necessary resources are available to impacted areas.

2. Sources of support

    1. Key stakeholders in affected areas such as businesses
    2. Charitable organisations and philanthropists
    3. Insurers

3. Candidates for response

    1. Businesses as business needs as they are crucial for economic activity.
    2. Community needs such as schools, roads and other vital infrastructure which are essential to the lives of residents in the affected area.
    3. The assets of individuals such as homes and other property

- In regards to governmental actions related to climatic events, risk mitigation as a category of response is something that has not seen enough investment. Potential risk mitigation infrastructure can include dams in the case of flood prone areas and fire-tracks to decrease the risk of bushfires.
- There are examples of individual initiatives that aim to provide better information to residents and prospective residents of risk prone areas. One example is the Brisbane City Council's free Floodwise Property Reports which provide detailed flood information on suburbs in Brisbane. However, there is potential for a more co-

ordinated action to collect, analyse and disseminate information related to climate risk.

- Non-purchased insurance sources of support including charities who distribute money to people who do not have insurance and the government's role as insurer of last resort may provide incentives for individuals to undertake more risk or underinsure, increasing moral hazard.

Session 3 – Insurance and Risk Management: Now and in the future

Speaker 7: Annabelle Butler, Executive Manger – Public Policy and Stakeholder Management, the Suncorp Group

- In 2011, the Suncorp Group processed more than 100,000 natural hazard insurance claims across Australia and New Zealand equating to $25.5 million dollars in claims every day. Due to the extreme number of claims related to natural disasters and the increasing size of the average claim, the average insurance premium for house insurance has increased from $100 in 2001 to around $300 in September 2011. The increasing cost of insurance, far exceeding CPI, is a mounting concern and is a clear indication that the overall risk that insurance companies are assuming is increasing. Therefore, while insurance can spread risk across parties, alternative measures must be taken to reduce total risk.
- In addition to climate change, factors contributing to the increase in total risk include:
    1. *Economic growth* which has resulted in a major increase in the value of the underlying assets that are being insured.
    2. *Urbanisation* to coastal areas more prone to natural disasters. 87 per cent of Australians live in urban areas with 80 per cent of Australian's living within 50km of the shoreline.
- In order to reduce the size and cost of total risk a national program of disaster management built on the principles of prepare, prevent, respond and recover should be implemented. By having a strong understanding of the risks that face individual areas, improved council planning of infrastructure projects and minimum building

specifications for residential and commercial property built in a particular area could reduce total risk. This would reduce the cost of insurance which would diversify any residual risk.

Speaker 9: Daniel Churilov, Manager Risk Research and Development, Victorian Managed Insurance Authority

As the VMIA's Research and Development Manager, Daniel is focussed on identifying emerging risks relevant to the Victorian Public Sector to position the VMIA as a risk management thought leader. Daniel is also working on developing and implementing the most suitable risk management products and services for the VMIA's

- The Victorian Managed Insurance Authority provides insurance services and risk management advice to Victorian public sector organisations and the Victorian government. The key objective of VMIA is to reduce the total cost of risk to the state of Victoria and in doing so reduce their own exposure to large claim payouts.
- The greatest losses to VMIA have been caused by climate-related events, particularly bushfires. VMIA is undertaking a three-part strategy to reduce the total cost of insuring against the risks posed by climate-related events:

    1. *Anticipating the risk and exposure to climate change* through improved tools and techniques for anticipating climatic events.

    2. *Understanding the risk and exposure to climatic events* through mapping and analysis of individual assets and organisations.

    3. *Managing the risks and exposure to climatic events* through strategic partnerships, ongoing dialogue and the provision of detailed information to key personnel at Victorian public sector organisations and the state government.

5. Key Points Identified in Break-Out Sessions

The following section highlights some of the key-points that were derived from the three break-out sessions of the think tank.

Session 1 – The Assumption of Risk: Who should be responsible?

What is the role and responsibility of individuals in managing and accepting risk?

Given the current informational landscape it is very difficult to place excessive responsibility on the individual for the management of climate induced risk. This is because individuals are at the end of the value chain and do not have the same access to or ability to utilise information as either financial market participants or governments. Even in choosing risk management products, individuals may not have the required skills to make an informed decision.

- In order to overcome this problem it is important to ensure that there is higher quality and greater availability of information related to the risks associated with the purchasing of key assets. (for example, the family home)

There also needs to be a more proactive approach from individuals in taking responsibility and some risk management measures in terms of the way they approach their own lives and portfolios.

- Strategies for addressing this issue included regulatory incentives, price signalling tax incentives and a greater focus on local governments to provide messages and information on the potential risks facing a community.

What is the role and responsibility of government in managing and accepting risk?

Due to the paradox between the short-term horizons of general insurers and the long-term implications of climate risk and climate change it should be the government's role to create incentives for financial sector participants to create longer dated risk management products as well as ensure adequate information is available for individuals to understand the value of such products.

- There may be the potential for governments to promote the development of markets that trade longer dated risk based securities or issue their own disaster

linked bonds. A major problem that currently stands in the way of greater development in the long-term risk market is that there is a disparity between the models that climate scientists create (which present a range of scenarios) and the models that finance professionals require to price such products (which require quantification).

The government must also deter individuals from emotional biases that may lead to individuals taking on moral hazard such as purchasing a home in a high risk area and then leaning on the government as lender of last resort.

- One solution proposed to this problem is to regulate mandatory insurance on home ownership. The higher price of mandatory insurance in high risk areas would deter moral hazard and potentially reduce the number of people living in risk prone areas.

What is the role and responsibility of the financial sector in managing and accepting risk?

The key role of the financial sector is to provide an appropriately priced suite of products to distribute risk throughout the economy. Through the appropriate pricing of insurance products, insurers provide information to both government and individuals on the risks associated with various locations and asset classes. It is not the responsibility of insurers to provide insurance when the risk is too high.

- There could be greater scope for collaboration between insurers and government to share information on risk beyond those provided via price signalling. For example, rather than the information used by insurers, which is generally conducted at a geographic level, there is scope for collaboration in developing a mechanism for generating greater information of individual assets at the micro-level. There is also scope for insurers to get feedback from both individuals and governments on other areas where they may be demand for risk sharing products.

Session 2 – Investment Decisions: Considering Risk in good times and Bad?

Is the investment/finance community taking enough account of climate change in their short-term and long-term asset allocation and lending decisions?

In general the financial services sector is factoring in short-term risks posed by climate change and climate risk. For example, price signals related to investments and insurance appear to take into account climate change and climate risk to some extent. Banks also appear to be taking these risks into account in their lending decisions through higher loan-to-valuation ratios.

There is less evidence of the financial sector taking into account longer-term climate risk. The sole-purpose mandate imposed on institutional investors means that any investment must be done with the intention of creating better outcomes for the beneficiary. Therefore, an institutional investor must be able to quantify the climate risk in terms of investment returns. There is some evidence that this is occurring in the carbon space via the price signals on carbon being sent by government however to what extent are institutional investors taking account of other forms of climate change risk?

- In order to address this paradox between the short-term and the long-term it is important to ensure that beneficiaries are financial literate. This may lead beneficiaries to demand increased exposure of their portfolios to investments that are less susceptible to climate risk or climate policy risk. These investments can provide a long-term hedge against adverse climatic events and policy decisions.

- It is also important to reconcile the long-term objectives of superannuation and pension funds with the incentives of stock brokers, asset consultants and investment managers who's performance is often evaluated over short-term horizons.

Is the corporate business community (and government in the funding and financing of long-term projects such as via public-private partnerships) taking enough account of climate change in their short-term and long-term investment decisions?

Uncertainty around climate policy risk such as the recently instated carbon tax has made it more difficult for corporates to make long-term investments in fixed capital assets. While there has been a move by corporates toward more energy/climate conscious investments

there is little evidence to suggest that corporates are factoring resilience to climate change and climatic events into their capital investment decisions.

- A real options approach was cited as one strategy that could be utilised to deal with uncertainty around long-term investment decisions. A real options approach incorporates the value associated with the option of either discontinuing construction/use of an investment in favour of either selling it or using it for an alternative purpose if the value of the real option is of higher value than its current value in use. Incorporating real options into the decision making procedure allows for more flexibility and the ability to react as uncertain events unfold.

What combination of ex-post and ex-ante measures should be implemented to improve government responses to major climatic events?

More preparedness is required by governments to address the aftermath of climatic events and to ensure that they have the required resources to call upon. In the event that climatic events become more frequent and diverse, governments also have to be wary of the potential that the market for insurance products may fail.

- It was noted that the government should also focus on current impediments that may deter prudent risk management behaviour at the individual level. One example of this is stamp duty which may deter individuals from moving to a less risky house. Identifying and removing these impediments may lead to more prudent behaviour and assist in reducing the costs associated with extreme climatic events.

Session 3 – Insurance and Risk Management: Now and in the future

What is the role for regulation in creating the right incentives for creation of insurance products related to climate change and climatic events?

The role of regulation is to create the right incentives for insurers to provide products that assist in climate change adaptation and to provide sufficient information to allow individuals to make informed choices around their risk position.

- Greater regulatory guidelines for contracts such as product disclosure statements could be enhanced to give individuals a greater understanding of the terms and conditions of insurance products. Governments could also devise stricter guidelines for the insurer of last resort provision to deter moral hazard.

How is uncertainty regarding climate change impacts affecting the development and take up of insurance products?

Uncertainty around climate change is leading insurance companies to hold greater capital reserves to protect against losses. This in turn leads to higher premiums which may be dissuading some individuals from purchasing general insurance products.

How are financial institutions (banks/insurers/funds managers) protecting themselves from the risks arising from their exposure to the consequences of climate change?

As mentioned previously, one strategy that insurers have been using to protect themselves against climate related risks is to increase capital buffers. In addition, insurers are increasing their holdings of liquid and devising new ways to re-distribute risk through innovative financial contracts and products. Examples of these include catastrophe bonds and weather related derivatives. Many insurers will only underwrite a partial payout if it is determined that a particular area or group of assets is exposed to an extremely large risk, or that the risk to assets may be highly correlated.

- While insurers are devising strategies to adapt to climate risk at the portfolio level, more needs to be done to allow insurers to make better risk decisions at the micro or individual policy level. Better information gathering, distribution and sharing between financial sector participants, governments and scientists may be able to assist in this regard.

How can better climate change knowledge/information be provided to create a better understanding of climate risk to facilitate the creation of improved and correctly priced risk management products?

- Parametric products such as weather derivatives can be used as a tool to distribute climate risk but they must overcome a number of challenges to see wider acceptance and use. These challenges include reliable and quantifiable information related to climate change and climatic events and a a reliable index that can be used as a benchmark against which derivative products of this nature can be priced.

Appendix 1: Survey Evaluation of the Think Tank

Nine participants completed an evaluation of the event. Based on responses, the group break-out sessions were viewed as the most beneficial aspect of the think tank. A number of participants noted that the calibre and diverse backgrounds of the experts who were involved in the think tank were key factors in ensuring the sessions were of value. The survey responses also suggest that the relationships built in the room would extend beyond the think tank and could assist in future adaptive planning by participants and their organisations.

Participants recommended that future think tanks should have a smaller number of presentations and that the discussions could have been more focussed specifically to the financial services sector. It was also noted that a greater representation from the banking sector would have been of value.

It was suggested that as follow ups to the event, a written response from one of the think tank participants to the original background paper would be of value and that a second think tank specifically focused on creating policy recommendations would be beneficial.

Overall, the think tank was very well received by participants with all participants rating the forum as either good or excellent as a forum for discussing climate adaptation issues.

Appendix 2: Think Tank Background Paper

Risk Management and Climate Change:

The Role of the Financial Services Sector

December 5, 2012

Melbourne, Vic.

A background paper by the Australian Centre for Financial Studies prepared for the VCCCAR – ACFS Risk Management and Climate Change: The Role of the Financial Services Sector Think Tank. The principal author of this report is Professor Kevin Davis, Research Director, Australian Centre for Financial Studies.

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1. 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.

2. 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.

3. 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?

4. 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.

4.1 Insurance and other products for the end-user

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, 2012):

- 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?

4.2 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.[2]

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

[2] Cummins (2012) 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.

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 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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