Climate Change and the risk to Financial Stability

Reality or overreaction?

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tailrisk economics
te maha hoki o nga pihikete

About Tailrisk economics

Tailrisk economics is a Wellington economics consultancy. It specialises in the economics of low probability, high impact events including financial crises and natural disasters. Tailrisk economics also provides consulting services on:

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- Regulatory compliance for financial institutions
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Climate Change and Risks to Financial Stability

Part one: Introduction

Last year the Governor of the Reserve Bank New Zealand, Adrian Orr, identified climate change as a significant risk to the New Zealand financial system, and placed the Reserve Bank at the centre of New Zealand's climate change response. This drew a response from the New Zealand Initiative, which questioned whether the physical impacts of climate change did constitute a systemic risk and whether the Bank was going beyond its mandate in its focus on climate change.

The Bank's position was more fully articulated in the 2020 Annual Report.

Climate risk has far-reaching impacts on the economy and therefore the financial stability that underpins our economy.

Financial stability is best maintained when all relevant risks are adequately identified, priced, and allocated to those best able to manage them. Climate change and its associated risks provide a direct challenge to financial stability, as the risks are material but extremely difficult to identify, price, allocate and manage with accuracy.

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Managing major and systemic risks to the economy, such as climate change, sits squarely within our core responsibilities.

The Reserve Bank is not alone in suggesting that climate change could represent some kind of existential threat to the financial system. Over recent years a number of central banks, supervisors and international financial institutions have made claims that global warming poses a serious risk to financial stability. The Network for Greening the Financial System (NGFS), a club of central banks and supervisors, is pushing a more coordinated international approach. Further, the Ministry for the Environment (MfE) has identified financial stability

as one of the two major economic risks in its recent Climate Change Risk Assessment report.

At first sight it is difficult to understand what is driving the Reserve Bank's concern. The physical risks from climate change to the New Zealand economy are small, and over the period up to 2100 the benefits of a warmer climate may well exceed the costs. While there will be some impacts as the economy adapts to a zero carbon future, economies have always been changing and, with some exceptions, financial systems have been able to accommodate those changes. To cite an obvious example, the US substantially shifted from horse to motorized transport in the space of 20 years, without any one being in charge or worrying about systemic risk to the financial system.

As the physical effects of climate change are slow-moving and relatively predictable over relevant time horizons, we should expect the financial systems to adapt to this changing world, and readily accommodate the impacts of climate events such as a slowly rising sea levels and the occasional stronger storms.

The issue we address in this report is whether climate change is such an exception to this benign adaptation picture, that central banks and supervisors need to respond to the 'challenge' with some urgency. Or is this just a case of the Reserve Bank wanting to be seen to be 'relevant' and getting into the action in what is one of the biggest issues of our time?

In response to a request from the New Zealand Institute to provide the evidence supporting the Governor's systemic risk claim, the Bank provided a list of resources and research papers that 'highlighted' the financial risk of climate change.

Notably absent from the Reserve Bank's list of resources was a 2018 Reserve Bank Climate Change discussion paper that concluded that the physical risks from climate change were manageable. It should have been provided to the New Zealand Initiative but was obviously withheld because it did not support the Governor's systemic risk narrative.

Subsequently, the Bank refused a specific request for its climate change document for months before finally releasing it. We have discussed the content of this document in some detail below.

The main purpose of this report is to assess the papers on the Bank's list and other relevant documents on the impact of climate change on financial systems. We have also focused on climate change risk disclosures, which have become a flavour of the month in regulatory quarters, and are set to become mandatory for larger New Zealand institutions.

The focus of our analysis is on the banking sector, which is the core of the New Zealand financial system. We have paid less attention to risks to the insurance sector because it is generally accepted it can readily manage climate risks by adjusting its exposures and pricing.

Our conclusions are very clear. We have reviewed a large number of documents and despite the best efforts of many supervisors none have been able to come up with convincing evidence that climate change represents a threat, let alone a systemic threat. For example a very recent full scale stress test for France found that the transition costs to a zero carbon economy would at most be four or five basis points and that it did not matter whether the transition was early or late. The physical risks from climate change were so slight that they could not be analysed.

We did find a disturbing pattern of exaggerations and misrepresentations. For example the Bank of England instructed banks, when stress testing, to assume that all river flooding defences would be removed, in an effort to inflate the costs of future flooding events. The United Nations Environment Programme used climate change assumptions for 2100 to assess financial system impacts for 2025 and 2045.

Climate change does not represent some kind of existential threat to the New Zealand financial system. The Governnor is over-reacting. This climate change 'hysteria' is mostly noise, but it might have some efficiency costs for the system, which could be avoided if a more measured approach is taken. The Reserve Bank's role should be to correct and hose down ill-informed responses, not to create them.

This report is organised as follows:

Part two presents our key findings.

Part three is a brief primer on systemic financial risk and climate change.

Part four outlines some of the relevant facts about the physical impact of climate change on New Zealand and possible economic effects. The thrust of the analysis is that there is little that should be a concern to the banking sector, beyond managing the effects of sea-level rise.

Part five reviews the document the Bank tried to hide, its Climate Change discussion paper.

Part six assesses the Reserve Bank's submission on the Climate Change Commission's draft report

Part seven reviews the documents the Bank says informed its thinking on climate change and financial risk. They are

7.1 The green swan: central banking and financial stability in the age of climate change - Bank for international Settlements

This document sets out the philosophical/ ideological arguments for an expansive central bank/supervisor role to combat climate change

7.2 Two documents from the Network for Greening the Financial System (NGFS)

The NGFS is pushing the expansive approach to the central bank's role that the Reserve Bank appears to want to take. The Reserve Bank is a member of the network and appears to be taking its cues from it.

7.3 Climate Change: Why it matters to the Bank of England

7.4 IMF Global Financial Stability Report (April 2020) chapter 5

7.5 'A climate stress test of the financial system': Stefano Battiston, Antoine Mandel, Irene Monasterolo, Franziska Schütze & Gabriele Visent

7.6 'Climate value at risk' of global financial assets: Simon Dietz, Alex Bowen, Charlie Dixon & Philip Gradwell Nature Climate Change volume 6, pages 676–679 (2016)

7.7 IAIS (International Association of Insurance Supervisors). 2018. "Issues Paper on Climate Change Risks to the Insurance Sector"

7.8 Financial Stability Board Stocktake of financial authorities' experience in including physical and transition climate risks as part of their financial stability monitoring

7.9 Commodity Futures Trading Commission's Climate-Related Market Risk Subcommittee of the Market Risk Advisory Committee (MRAC) Managing Climate Risk in the U.S. Financial System.

Part eight reviews some other relevant reports that shed light on the magnitude of possible costs.

8.1 Netherlands: Central Bank climate stress tests

8.2 The impact of climate change on the UK insurance sector
A Climate Change Adaptation Report by the Prudential Regulation Authority

8.3 Finansinspektionen (Swedish banking supervisor): Climate change and financial stability, 2016

8.4 'The Price of Doing Too Little Too Late. The impact of the carbon bubble on the EU financial system'A report prepared for the Greens/EFA Group – European Parliament

Part nine reviews the recently produced Network for Greening the Financial System scenarios paper.

Part ten looks at the costs and benefits of a mandatory climate-related financial disclosure regime. It reviews some bank disclosures and the Reserve Bank's disclosures.

Part eleven considers the benefits and costs of a heightened Reserve Bank response. The issue that is considered is whether this is just a bit of relatively harmless 'fun' for the Governor and Reserve Bank staff, or whether there could be material costs.

Part two: Key findings

Climate change is not a threat to the stability of the financial system
Our review of the literature found very little evidence that climate change will have a very noticeable impact on financial systems, let alone a systemic impact. Even the most ardent supporters of the systemic risk narrative are finding that out when they do the work. A recently published full -scale assessment of climate risk for the French financial system found nothing, or next to nothing.

No case for an expansive Reserve Bank role
The Reserve Bank's case for an expansive role is that climate change can affect the economy; the economy can affect financial stability; hence it is part of their core business. On that basis virtually everything would be the Bank's core business.

The Bank needs to make the case that climate change is genuinely a systemic risk, but it has not. Indeed the analysis that it has done suggests that it is not a substantive issue.

The Bank's role should be to keep a watching brief and hose down the more uninformed inflamatory catastrophist narratives.

The Reserve Bank is not a trustworthy source of information on climate change

The Bank misled the New Zealand Institute when asked to provide its documents on climate change. It withheld its discussion document that concluded that there was not a substantive document.

Since that document was produced the Governor's unsupported catastrophist narrative appears to have become mandatory and there has been no further serious analysis.

Climate-related financial disclosures could result in less efficient climate change mitigation

Basic economic analysis tells us that imposing climate-related physical targets will increase the cost of transition when an efficient carbon pricing scheme is in place.

Mostly these climate-related financial disclosures are just virtue signalling with their attendant costs. But If taken seriously they could actually increase financial risk. For example the NAB reported that it could reduce the emissions intensity of its lending by making loans to highly leveraged property companies.

NGFS analysis lacks credibility

The central bank and supervisor umbrella group, the Network for Greening the Financial System, should not be taken seriously. Its analysis was thin to non-existent, often misleading, irrelevant or simply wrong. The NGFS has recently released long-term modeling of the impact of climate change, which it describes as showing 'unprecedentedly' large negative economic impacts. The reality is that it is based on a single paper that any competent economist would dismiss as technically flawed and even dishonest. The data actually showed that climate change has not impacted on economic output because of adaptation, but this information was ignored. The NGFS is touting what could be described as fraudulent results far and wide to 'educate' the public, governments and businesses.

Part three: A primer on climate change and systemic risk

Climate change risks

The risks associated with climate change are often divided into physical and transition risks. Physical risk can be defined as risk that arises from the material, operational, or programmatic impairment of economic activity and the corresponding impact on asset performance attributable to climate change. Two kinds of physical risks are often distinguished. First, are are risks that steadily evolve over time, for example if the sea level rises. Second is the increase in the incidence of intermittent disaster events such as storms or floods.

Transition risk is defined as the risk associated with the uncertain financial impacts that could result from a transition to a net-zero emissions economy. These risks could arise, for example, from changes in policy, technological breakthroughs, and shifts in consumer preferences and social norms. Of the two risk types, transition risk can potentially be far more important from a financial stability perspective.

Changes in physical risks take place gradually over time, and can be projected using scientific modelling. The time horizon for any material change is typically long, allowing time for adaptive measures that will mitigate the impacts (for example, by building sea walls). This transforms part of the climate change impact from a storm damage to a construction cost risk.

Long time horizons mean that lenders have the ability to adapt their policies to mitigate their risks. Banks can simply decline to lend on houses in areas were the shoreline is advancing. Banks do have current exposures to properties that might have a limited prospect of securing foreshore protection, but these risks, in aggregate, should be minimal. Even if the property were purchased today with an eighty percent mortgage, it will be paid off in 30 years and only forty percent per cent of the principal will be outstanding in twenty years.

The change in financial risk to the bank could, however, preceed the physical event. Beachfront properties typically sell at a significant premium, but this could change if there are concerns about the future availability of insurance or finance. So part of this price reaction will feed through to the present. Again

the current risks to banks are probably very small, as the numbers of properties affected will not be large, and nearly all of the losses will fall on the owners rather than banks.

Transition risks, on the other hand, are much less predictable, both as to their timing and their severity. It is possible to conceive of a wildly 'ambitious' government climate policy response, implemented over a short time horizon, that could stress the financial system. For example consider what might happen if a government decided to push the following:

- A ban on methane emissions on farms from 2030.
- No emissions from internal combustion engines from 2030.
- Tourism permanently cut by 90 percent.
- All buildings to meet highest energy effciency standards by 2025 or otherwise be left emplty.

Or the transition could proceed rather painlessly with market forces (driven by the Emission Trading Scheme), technological changes and tree planting securing the zero carbon objectives by 2050. There would be relatively few policy-driven financial system losses beyond what normally occurs in a competitive market.

Technological and market preference changes are also unpredictable and can have potentially severe consequences. At one extreme it is conceivable that much of the meat and dairy industries could disappear in thirty years with the rise of artificial substitutes and a move in international consumer preferences away from animal products due to climate change concerns These risks are always with the farming industry but they may be perceived to be more pronounced now. However, climate change policy could actually mitigate some of these risks because farmers could switch to carbon farming.

Climate Change and Financial stability

Climate change does pose a financial risk to banks, but so do dozens of other economic, social or natural factors. There is no threat to financial stability if banks lose money, even over a relatively short period of time, on a few dozen or even a hundreds of properties. Rather, for an event to be systemic, banks' losses would have cut through their first line of defence, their annual profits, and then make sufficient inroads into their capital to put the system at a heightened risk of failure. It could take tens of thousands of such loss events to do that and there is no plausible scenario where this might occur over the next thirty years or so.

Impact of climate change on lending

Banks look at the risk of loan losses in two ways. First are the expected losses that arise on average over the life of a loan portfolio. For a residential mortgage portfolio these will be quite low, say .05 -.10 percent a year. The bank will account for this loss in its loan pricing and make a provision for it. Expected losses from weather-related events will, in principle, be included in this process. However, the amounts will be so small that they may not be explicitly taken account. There would have to a weather event and the house would have to be uninsured at the time, (in breach of the loan conditions), and the bank would have to be forced to foreclose and incur a loss. If a bank did perceive that these losses would increase in future then it could increase that provision and adjust its pricing. Any such adjustment should be small. Contrary to popular (and the Bank's) understandings, the best scientific evidence is that flooding risk in New Zealand will not increase over this century. Storm surge flooding will be a growing risk, but in most cases this can be mitigated by enhanced coastal protection of densely populated areas.

The second class of losses are the unexpected losses which which occur in a large cluster over a relatively short period of time (two or three years) generally due to a large macro-economic shock associated with unemployement and a fall in house prices. Banks will hold capital to manage these unexpected losses and will include a capital charge in their loan rates. As noted,in New Zealand bank weather-related event losses are tiny (due to the small size and diversified nature of the events and insurance coverage) and unlikely to change much in absolute terms. So banks should not need to increase their capital in the forseeable future due to climate change. Even if insurance coverage is withdrawn in localised areas the absolute losses to banks from a particular event will still be small.

The importance of the time horizon

Many of the concerns with possible climate change impacts relate to events that might occur over the next hundred years or so. These are not so relevant to banks, which only need to consider a planning horizon out to thirty years or so. The value of their existing security might be affected as markets anticipate future falls in the prices of houses affected by sea level rise prices but these effects should be relatively moderate in aggregate because only a small proportion of houses will be affected. Even if a house were expected to be worth nothing in 50 years time, the expected decline in its value would be six percent per year. As loans are on a repayment schedule it is unlikely that the value of the loan would exceed the value of the security at any point in its life.

The distinctive feature of climate change is that some of the risks, in particular sea-level rise risks are changing over time and banks will need to adjust some of their policies to maintain a preferred level of risk. In principle red-lining particular geographical areas, or introducing location-specific pricing can achieve this. The issues are more likely to be political and reputational than concerns about banks' abilities to manage these risks in a technical sense.

Part four: Impact of climate change on New Zealand

This part is drawn from our review of the National Climate Change Risk Assessment. Note that RCP refers to representative concentration pathways, which are scenarios of the amount of greenhouse gas emissions over a time horizon. RCP 8.5 is a worst-case scenario, which assumes the collapse of the Paris agreement, with coal usage increasing by 6.5 times by 2100.

Table one: Summary of climate changes by RCP

RCP	**4.5**	**6.0**	**8.5**
Temperature			
increase by 2040	0.8	0.8	1.0
increase by 2080	1.4	1.8	3.0
Hot days >25c			
Auckland 2040	36	35	39
2080	48	59	90
Wellington 2040	29	28	31
2080	35	41	61
Overall precipitation	Very small (0-5%) changes in most places		
Dry days	Increases in most places average around 10 days – but variable		
Droughts	Drought was only reported for RCPs 2.5 and 8.5. In general the risk of drought is higher already drought prone areas.		

Moderately extreme daily precipitation (Determined from the 99th percentile on wet days),	Increases over most of the country except for parts of Northland and Hawkes Bay. Increases are small for the remainder of the North Island, larger for the South Island, a largest of all (20 per cent or more) in the south of the South Island.
Very extreme precipitation (Very extreme precipatation is expressed as the percentage increase per degree increase in temperature)	Percentage increases in the incidence of extreme precipitation events fall with the duration of events from about 13 percent for 1 hour to about 6-7 percent for longer duration. 72 - 96 hour events can result in major floods, so the impact on the likeihood flooding is minor.
Storms	Limited information. There may be a minor increase.
Highwinds	An increased incidence of up to 10 percent or more in parts of the country

Overall, the summary does not show a systematic pattern of extreme changes even out to 2100 and we would not expect them to have a material economic impact. It is totally implausible that these changes, particularly out to 2050, could have a systemic impact on the financial system.

Economic and social impacts

There is no substantive evidence that climate change will have major negative social impacts on New Zealand this century. The effects are more likely to be positive than negative. The case for a relatively benign future is made in our National Climate Change Risk assessment document [1]. Some take outs are:

- The increases in extreme climate events are much less than often claimed or insinuated.
- The evidence presented in the IPCC report does not support a conclusion that the global warming impacts would be strongly negative for advanced countries, or even negative at all for New Zealand.
- The present value of costs relating to sea-level rises is not large in relation to the economy.
- The best science is that there will not be an increase in flood damage.
- Health costs are trivial and are more likely to be positive than negative.
- Most importantly, carbon fertilisation will have a positive impact on agricultural production.
- Other things being equal, the terms of trade are likely to turn in New Zealand's favour, as agricultural production in hotter climates is

[1] Tailrisk Ecnomics 2021 The National Climate change Risk Assessment: A case of science denial?

disproportionately affected by temperature increases

All of this was more or less conventional wisdom until a few years ago. But now a catastrophist narrative has taken hold, driven by the MfE and a green political perspective. The scientific and economic facts have not changed but inconvenient documents and perspectives have been driven from the scene.

Part Five: The document the Reserve Bank tried to hide: The Climate Change Overview discussion paper

On 3 November 2020 the Reserve Bank received an OIA request for *'a copy of any research understaken by the Reserve bank in the past 10 years including literature reviews on the cost of global warming as a percentage of GDP*

The Bank identified three papers that fell within its interpretation of the scope of the request. One of the documents was the Bank's 2018 Climate Change discussion paper.

But the Bank refused to make the papers available unless it was paid $114, citing its capacity to charge when requests are made for a large amount of information, when requests are complex or where individuals or organisations make frequent requests.

As the documents had already been identified, the 2018 paper would have been fresh in their minds, and the cost of compliance should have been trivial. It seems obvious that the real reason the discussion paper was withheld was that it did not support the Governor's claim that climate change presented a systemic risk. Indeed it more or less said that it didn't. The Bank was betting that a charge of $114 would put off the requestor, who would not have been aware of the significance of the paper and may not have been prepared to pay a charge for an existing document of clear public interest on principle.

The Head of Financial Policy Analysis, Toby Fiennes, spent two pages explaining his reasoning for imposing a charge, which would have cost considerably more than $114.

About the same time the New Zealand Intiative made a request for the Bank's documents supporting its public climate change pronouncements. The Climate Change discussion paper should have been provided, but it was not.

Later another party also requested the document. The Bank attempted to charge the $114 again and when that ploy was not sustainable, it withheld the paper on the grounds that it was shortly to be published. It was withheld for several months and only released after the threat of a complaint to the Ombudsman.

A review of the Bank's Climate change discussion paper

The paper presented an introductory overview of some key issues relating to climate change and considered the potential implications for the soundness and efficiency of the New Zealand financial system. It went over some general climate change information and then focussed on the on the risks to the banks' two major lending portfolios: housing and dairying. The analysis was mostly a reasonable introductory effort.

Its main 'headline' conclusion was:

Preliminary analysis suggests that climate change need not be a significant threat to the soundness and efficiency of the financial system, provided all risks are proactively analysed, understood (to the extent possible), communicated and appropriately factored into decision-making from the outset.

Impact of sea-level rise (and extreme weather events) on residential property
The discussion on residential property risk started with a Parliamentary Commissioner for the Environment report (based on a NIWA study) that identified buildings and infrastructure 'at risk' from sea-level rise. The Bank updated the value of the of residential buildings located at two heights above sea-level.

the value of residential property that may be materially exposed to sea level rise in the future is over $22bn (property within 0-1.5m elevation), with around $57bn of residential property sitting within 0-3m elevation. This compares to an assumed market value of all New Zealand residential property of around $1,067bn, and therefore represents around 2.1% and 5.4% respectively.

The problem with the NIWA analysis is that it is not very useful for risk assessment purposes. NIWA explained in their report:

The enumerated risk-exposure values here are only elevation-based with no modulation for existing coastal defences/stopbanks or consideration of sea-inundation volumes being able to fully spread inland over wider low-lying coastal plains during storm-tides

Adjusting for these factors makes a substantial difference to an assessment of the number of properties that might be considered to be 'materially exposed'. For example South Dunedin has the largest concentraion of the lowest elevation buildings in New Zealand, but these sit in a bowl and are well protected from the sea. Similarly the large areas of the Netherlands that are below sea level, but which are protected to a 1:2000 risk of indundation, would not be regarded as materially exposed on any reasonable assessment.

Further, from a forward-looking risk perspective, the probability that protection from sea level rise will reduce risk to larger urban areas should be taken into account. Christchurch has about 10,000 buildings that are currently at risk at a 1:100 risk standard, and this risk will increase as the sea level rises. But it is highly unlikely that these buildings and associated infrastructure would be abandoned at a cost of, say, $10 billion, when the cost of providing protection for perhaps 100 years might be $600-700 million.

Detailed analysis would be required to get a better fix on the value of residential properties at a material risk, but what we can say is that the Bank's estimate is overstated by a large margin.

On extreme weather risks the Bank says:

More frequent extreme weather events will impact across the country, but in a less catastrophic fashion than rising sea levels will impact coastal property.

The Bank is largely wrong about this assessment to the extent that it suggests that there will be a material increase in extreme events. The 2019 NIWA paper (which they could not have seen) on river flooding showed that flooding risk would actually fall on average across New Zealand. There will be a higher risk from surface flooding due to more intensive short-term rainfall events, but this may well be offset by planned replacement and upgrading of storm drainage systems. The science suggests that there won't be an overall increase in high winds. Wildfires will increase by perhaps forty percent by 2100 but from a low base, though there might be an increase in the frequency of ex-tropical cyclones.

The paper concludes:

However, even accounting for this broader impact, the scale of the exposures identified here would suggest that the financial system should be capable of absorbing and managing the risks posed to residential property.

If the Bank was better informed on the risks it would have been even more secure in this assessment.

The paper then discusses a number of risks to its central pre-assumption (that there is not a signficant problem for stability and efficiency), for the insurance sector:

• *Competitive pressures or excessive pursuit of short-term profit over long-term resilience by some or all companies might result in climate risks being under-reflected in the pricing and provision of insurance. This could negatively impact both the soundness of the insurance sector and the broader efficiency of the economy by facilitating continued investment in future stranded assets*.

This will not pose a material efficiency cost for New Zealand. As most insurance companies are foreign-owned, under-pricing of risk will be a welfare transfer to New Zealanders.

• *Opportunistic pricing might see some or all insurers use the threat of climate change risks as a basis to increase prices excessively to seek supernormal profits in the short term or strengthen balance sheets. Such an outcome might be positive for the soundness of the sector, but will have a negative impact on efficiency*.

And it concludes:

at this stage, anecdotal evidence would suggest that there is greater risk of the second of these factors emerging.

The authors might add today that this risk will be exacerbated if the Bank continues to overhype the risks climate change poses to systemic stabiity.

Climate change risks and the dairy sector

The assessment of the physical risks to dairy lending concludes that there is not an issue:

The overall impact of climate change on New Zealand dairy farming is uncertain, but is expected to be manageable. Indeed, MPI analysis suggests that there may be a ***positive*** *impact on growth, but with important seasonal and regional differences. This would suggest that in some areas, the changes may result in a more optimal climate for dairying, while other areas may become more marginal or unsuitable.*

The Bank also discusses transition risks:

The second issue relates to if/how government seeks to impose any climate-related regulation on the agricultural sector. If we assume that some additional costs are inevitable in the future as part of New Zealand's broader approach to meeting emissions targets, then it is probably in the financial system's interests for the internalisation of those costs to be initiated earlier, and over an extended period, to enable a smooth transition over time, rather than have the impact back-loaded as a sudden adjustment.

This point doesn't make a lot of sense. From a financial perspective it is obviously advantageous for the industry to pay for as few carbon credits as possible, and to delay the payment for as long as possible. The increased profit can be devoted to reducing debt to the benefit of both dairy farmers and banks. It is important of course that the carbon credit path be well signalled so farmers and banks can respond optimally.

Part six: The Reserve Bank's Submission on the Climate Change Commission's draft report

The Reserve Bank's submission on the Climate Change Commission's draft report provides further insights into its current thinking.

The submission covered five areas of relevance to the Bank's remit:

1. Climate change and financial stability – the nature of risks and pace of change required.
2. The role of finance – recommending greater emphasis on finance/investment to more fully acknowledge the role of finance as an enabler and a potential blocker of climate resilience (barriers, interlinkages, levers).
3. Disclosure as a mechanism to improve the systemic management of climate risks – risk management and transparency.
4. The importance of Investment
Investing at scale: leveraging private investment – recognising carbon bias and unwinding this, improving information.
The need for a 'green' recovery.
5. A Te Ao Māori lens, and the need for a considered and aligned approach.

The Bank's starting position was that:

Climate change and its associated risks provide a direct challenge to financial stability

But there is no discussion or evidence to support this contention beyond the following, which hardly qualifies:

Many of the material costs of our economic decisions are 'externalised' to others, including future generations. Compounding these issues, market participants often take a short-term view in their decision making. Starting now to get on the path to a low emission, climate resilient economy as part of the global effort will help reduce the risks to the stability of the financial system and macro-economy.

Beyond generally cheerleading the Commission's proposals, most of the discussion is directed to enhancing the role of finance in the Commission's final report.

Given the importance of finance and investment as an enabler of change, and the interlinked nature of policy and investment flows, it may be beneficial to draw together these threads in a discrete chapter (or expand the current section 6). This could include the quantum of investment required, the environment required to facilitate these investments and the interplay between the economy, investment/finance and policy (mutually reinforcing or at odds). It could review the efficacy/efficiency/equity of different investment/financial instruments (e.g. subsidies, government bonds, ETS) in particular contexts. It could also highlight the risks to the broader economy/finance system should finance flows fail to be redirected in a timely manner or New Zealand fail to meet its international targets.

And

Barriers associated with climate investments include their long-term, capital-intensive nature, and a high learning curve for investors in new industries. Furthermore associated technologies may feature a higher risk of failure or accelerated obsolescence. Attempts to draw in private sector investment need to directly lower these barriers by providing a 'demonstration effect' and/or transferring or mitigating perceived 'pioneer risk'.

It would indeed have been a good idea if the Commission had paid at least some attention to the costs of its proposals. But it would also have been a good idea if the Bank had at least glanced at the nature of the 'required' investments before forming a view that there was some sort of problem. The big financing cost is the electricification of road transport. Given the Commission's assessment that electric vehicles would be the same price as ICE vehicles by the

early thirties, the Bank should have concluded that there wasn't a financing issue. An electric vehicle will use the same financing mechanism as an ICE vehicle.

A serious walk through of the other investment requirements would not have found any significant or new financing issues.

However, having convinced itself that there is an issue the Bank suggests a look at other ways '*to enrich the consideration of markets and finance'.* This suggests that the Bank thinks there are gains to be made here and that more interventions could be justified.

Mandatory disclosure

The Bank is in favour of mandatory climate-related disclosures.

The Reserve Bank supports the Government's plans for the mandatory disclosure of climate-related financial risks using the Task Force on Climate-related Financial Disclosures (TCFD) framework.

Disclosure is an important instrument to both manage risks and incentivise investments in a climate-resilient economy and is consistent with the Reserve Bank's approach to prudential regulation.

Of particular note is the Bank's support for a particular Commission recommendation,

"Evaluate the potential benefits of mandatory disclosure by financial institutions of the emissions enabled by loans over a specified threshold."

We support this recommendation and agree that evaluation is needed. Consideration needs to be given to growing momentum to expand from initial set of TCFD disclosures to 'forward metrics' that align portfolios to the Paris Agreement. We encourage New Zealand banks to engage with this work.

However, as a regulator, we note that there will be disparities in size, resources and capacity amongst institutions in relation to disclosure. Our expectations are that maturity and sophistication in relation to climate-related disclosure would differ by organisation and it may be challenging to develop consistently useful measures.

Despite these challenges, in our view further disclosure regarding financed emissions makes sense. It would help identify transition risks in the economy and is in step with demands from investors who increasingly see climate risk as investment risk.

While the Bank displays a note of caution here we didn't get a sense that it had really thought through the issues and, in particular, how this disclosure might fit with other policy instruments and what objective it is intended to serve. We discuss some of the issues in part ten below. Our assessment of the NAB's attempt at this form of disclosure is that it could lead to seriously perverse outcomes. The best lending, from an emissions reduction perspective, is highly -leveraged commercial property loans.

We note the work of New Zealand Green Investment Finance (NZGIF), however this is limited by its scale ($100 million) and investment mandate. There is a window of opportunity to take advantage of low interest rates and global capital markets that are awash with liquidity.

The NZGIF recently got a $300 million top up. So far it has made 5 investments and loans totally about $36 million. Its projected 2021-22 costs are about $9.5 million. Aside from a couple of small equity investments (one $1.7 million investment was going to leverage the 'internet of things' to improve climate outcomes), it appears that the loans could readily have been accommodated from existing financing sources. One loan was to fund 10 Tesla 3s for a real estate firm.

Under the Te Ao Māori lens there is the following:

We note that as tangata whenua and Te Tiriti o Waitangi partners, it is essential that iwi Māori voices, and mātauranga Māori is embedded into this work. Mātauranga Māori is a form of knowledge regarded as both 'traditional' but also contemporary, and as representative of the experiences of generations of Māori in Aotearoa New Zealand. Because it goes back centuries, mātauranga can reveal richer things about Aotearoa – including what its climate was like before Europeans arrived – that science alone cannot.

As we are increasingly seeing globally, climate scientists are turning to indigenous communities, partly because they have often been in the same place for centuries. Science, in the traditional Western sense, and Mātauranga Māori knowledge can work in synergy to create more effective solution.

Exactly what these more effective solutions might possibly be, the Bank does not say, and we find it difficult to think of something. The only relevant reference to Maori history and climate change issues that we are aware of is the Maori contribution to New Zealand's total historical emissions. Pre-1840 Maori

were responsible for over 60 percent of total emissions to date. Figure one below is taken from a paper on the Climate Change Commision's website[2]

Figure one: Source of historical emisssions

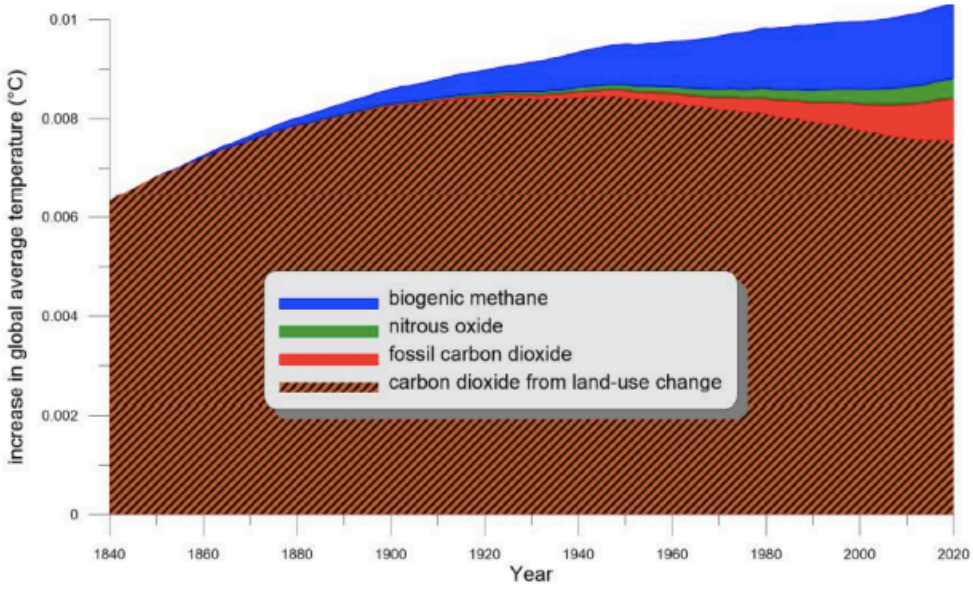


Figure 7: *Estimate of New Zealand's contribution to global warming from emissions until the end of 2019. Figure is taken from Reisinger and Leahy (2019).*

The Bank on the role of the ETS

The Bank pitches in on the respective roles of the ETS and regulations.

Theoretically a price on carbon would drive most emission reduction. However, given the scale of our economy, the nature of investment barriers and the potential impacts for financial stability, we strongly support the advice of the Commission that a cohesive policy response is required including a carbon price, regulation and public and private investment.

We find it difficult to understand what bearing the scale of the New Zealand economy has on the ETS /regulatory mix and we suspect the Bank hasn't given the matter much thought. As noted above there is no evidence that there will be any issues in raising funds for electric vehicles and associated infrastructure and most other changes. There may be a 'shortage' of funds for speculative, uneconomic equity investments but that may be no bad thing.

we view the first type of intervention, namely "emissions pricing and other

[2] Climate science considerations of global mitigation pathways and implications for New Zealand mitigation pathways Piers M Forster (1), Richard Millar (2) and Jan Fuglestvedt (3) 1. Priestley International Centre for Climate, University of Leeds, UK 2. UK Climate Change Committee, UK 3. CICERO, Norway

market incentives to influence choices", as a necessary but not sufficient response. Given the amount that needs to be done, it is very helpful for the report to single out the necessary actions that are time-critical. This highlights a first problem in relying on market pricing, since the ETS does not yet appear to be functioning effectively, and a number of choices that are relevant to a long-term low-carbon economy could be made poorly now, relying on current market signals. The point is well made that "Policy decisions and investments made now must not lock New Zealand into a high emissions path" (page 18 of the Report).

The Bank doesn't go beyond this general fluff to support all sorts of interventions. It would have been helpful for the Bank to explain, amongst other things, why the Commission's most time critical of its recommended interventions (the electric vehicle subsidy) was essential to preserve financial stabilty.

It is not clear what the Bank meant by the statement that the ETS is not functioning effectively. The price of a NZU has doubled over the last year to just under $50 a tonne and is starting to bite. Perhaps it is because the Government has not moved the price in line with several other jurisdictions (the European carbon price is over 50 euros). If the Bank thought that the Government was not moving fast enough on ETS pricing it should have said so.

The Climate Change Commission had a more concerted attempt to defend its regulation-based approach in its final report, but failed to make a reasoned case. For a review of the Commission's arguments see our response to the final report.

Part seven: Review of the documents supporting the Reserve Bank's assessment

7.1 The green swan: Central banking and financial stability in the age of climate change

The 'Green Swan' report from the Bank of International Settlements (BIS) and the Banque de France provides the analytical and philosophical underpinnings for a more expansive role for central banks and supervisors in the fight against climate change. The Governor of the Reserve Bank had an involvement with the preparation of the report and many of his public utterances have been plucked from it.

The reader will probably find this part to be tedious. It was tedious to write. However, as the BIS paper is the bible of the 'central banks will save us from climate change' movement, we felt obliged to present its arguments at some length.

The report makes the case that global warming is 'different' from social and economic problems that prompt other government interventions. It starts with the conventional economic argument that there is nothing for central bankers and supervisors to see here. They should stand aside and let an efficient carbon pricing system do its work.

Climate change is widely considered by economists as an externality that, as such, should be dealt with through publicly imposed Pigovian carbon taxes in order to internalise the climate externalities. Indeed, according to basic welfare economics, a good policy to combat climate change requires such a "price" to act as an incentive to reduce GHG emissions

From a mainstream economist's perspective, a carbon tax that reflects the social cost of carbon (SCC) would make explicit the "shadow cost" of carbon emissions and would be sufficient to induce economic actors to reduce emissions in a perfect Walrasian world. By this analytical framing, central banks, regulators and supervisors have little to do in the process of decarbonising the economic system.

Indeed, the needed transition would mostly be driven by nonfinancial firms and households, whose decentralised decisions would be geared towards low-carbon technologies thanks to carbon pricing. From a financial perspective, using a carbon tax to correctly price the negative externality would be sufficient to reallocate financial institutions' assets from carbon-intensive towards greener capital. At most, central banks and supervisors should carefully scrutinise financial market imperfections, in order to ensure financial stability along the transition towards a low-carbon economy.

This is a sound piece of analysis. There is nothing here that we would disagree with.

However, the report then presents three counter arguments. The arguments, with our comments, are as follows.

Carbon pricing does not work in practice

First, even though conceptually carbon pricing has been recognised as the first best option for decades, in practice it has not been implemented at a level sufficient to drive capital reallocation from "brown" (or carbon-intensive) to "green" (or low-carbon) assets.

The fact that carbon pricing may not have worked well in the past does not mean that tax and/or trading regimes cannot be better designed and calibrated in the future. As it turned out, the report was already out of date when it was released (January 2020). The price of European emission credits had increase from five Euros in mid 2017 to around 25 euros at the beginning of 2020, and credits are currently trading at around 50 Euros.

The reality is that governments have failed to act and will continue to do so unless much broader pressure from civil society and business induces significant policy change. Given the current deficiency in global policy responses, it only becomes more likely that the physical impacts of climate change will affect the socioeconomic system in a rapidly warming world.

The implication here is that if democratically-elected governments fail to 'act' then central banks and supervisors must step into the breach. What gives them the mandate to so is not discussed.

Given that rising temperatures will unleash complex dynamics with tipping points, the impact of global warming will affect our economies in a disorderly yet cumulative manner that, in turn, could trigger unforeseeable negative financial dynamics.

A tipping point in the climate system is a threshold that, when exceeded, can lead to large changes in the state of the system. Climate tipping points are of particular interest in reference to concerns about global warming in the modern era. Possible tipping point behaviour has been identified for the global mean surface temperature by studying self-reinforcing feedbacks and the past behaviour of Earth's climate system. Self-reinforcing feedbacks in the carbon cycle and planetary reflectivity could trigger a cascading set of tipping points that lead the world into a hothouse climate state (source: Wikipedia).

This is an argument about the physical science. It does not in itself lead to a conclusion that this will lead to some kind of financial crisis within a relevant time horizon. Even if there is a physical tipping point sometime in the near future the consequences will not be felt 'the day after tomorrow' as in the Hollywood movie. There will be a lead time, before there is a discernable impact, which will allow financial institutions to adjust their policies and pricing.

The biggest market failure the world has ever seen

Second, climate change is not merely another market failure but presumably "the greatest market failure the world has ever seen", as leading climate economist Lord Nicholas Stern puts it (Stern (2007)). Given the size of the challenge ahead, carbon prices may need to skyrocket in a very short time span towards much higher levels than currently prevail. Moreover, taking climate-related risks and uncertainty seriously (eg by including the possibility of tipping points leading to catastrophic and irreversible events) should lead to even sharper increases in the SCC (Ackerman et al (2009), Cai and Lontzek (2019), Daniel et unintended carbon price adjustments could have dramatic distributional consequences, both within and across countries.

The size of a market failure does not in itself demonstrate a role for central banks and supervisors at this point in time. The armed forces or any other state agency could just as credibly take on the mandate. There is no evidence that carbon prices will have to 'skyrocket' in a short period of time to avoid calamitous outcomes. Even if prices do increase sharply this will be less costly than more or less random intervention efforts.

More to the point of actions by central bankers and supervisors, newly enforced and more stringent environmental regulations could produce or reinforce financial failures in credit markets (Campiglio (2016)) or abrupt reallocations of assets from brown to green activities motivated by market repricing of risks and/or attempts to limit reputational risks and litigations.

All this could result in a "climate Minsky moment" (Carney (2018)), a severe financial tightening of financial conditions for companies that rely on carbon-intensive activities (so-called "stranded assets"; see Box 1), be it directly or indirectly through their value chains. These risks are categorised as transition risks; as with physical risks, they are of concern to central bankers and supervisors. Here, the "paradox is that success is failure" (Carney (2016)): extremely rapid and ambitious measures may be the most desirable from the point of view of climate mitigation, but not necessarily from the perspective of financial stability over a short-term horizon. Addressing this tension requires a broad range of measures, as extensively discussed in this book.

This identifies a possible risk, over coming decades. That is, unrealistically ambitious government action that could damage the economy and hence the financial system. This obviously justifies a role for central banks and supervisors to be well informed so they can warn governments of the consequences of their actions. However, it doesn't necessarily follow that that central banks and supervisors should attempt to immunise the financial system now against the consequences of all possible future government actions. If that were the

approach , it could result in the banking system being so hamstrung that it would be much less efficient in its financial intermediation role.

Third, *the climate change market failure is of such magnitude that it would be prudent to approach it as more than just a market failure. It is a subject that combines, among other things, uncertainty, risk, potentially deep transformations in our lifestyles, prioritising long-term ethical choices over short-term economic considerations, and international coordination for the common good. With this in mind, recent and growing transdisciplinary work suggests that our collective inability to reverse expected climate catastrophes originates in interlocked, complex institutional arrangements, which could be described as a socio-technical system: "a cluster of elements, including technology, regulations, user practices and markets, cultural meanings, infrastructure, maintenance networks and supply networks"(Geels et al (2004), p 3).*

Again we have a long list of suppositions that do not necessarily have much, or anything, to do with banking supervision. It is all a bit hysterical and the authors of the paper would have done well to read the 5th IPCC) report (chapter 10) on the impact of climate change on advanced economies.

For most economic sectors, the impact of climate change will be small relative to the impacts of other drivers (medium evidence, high agreement). Changes in population, age, income, technology, relative prices, lifestyle, regulation, governance, and many other aspects of socioeconomic development will have an impact on the supply and demand of economic goods and services that is large relative to the impact of climate change.

Well-functioning markets provide an additional mechanism for adaptation and thus tend to reduce negative impacts and increase positive ones for any specific sector or country (medium evidence, high agreement). The impacts of climate on one sector of the economy of one country in turn affect other sectors and other countries though product and input markets. Markets increase overall welfare, but not necessarily welfare in every sector and country.

Returning to the Green Swan narrative:

Tackling climate change may therefore require finding complex policy mixes combining monetary, prudential and fiscal instruments (Krogstrup and Oman (2019)) as well as many other societal innovations, as discussed in the last chapter.

The cited papers do not make any sort of case for the development of new 'complex' policy mixes.

*Therefore**, to guarantee** a successful low-carbon transition, new technologies, new institutional arrangements and new cultural frameworks should emerge (Beddoe et al (2009) towards a comprehensive reshaping of current productive structures and consumption patterns.*

For all these reasons, even if a significant increase in carbon pricing globally remains an essential step to fight climate change, other (second-, third- or fourth-best from a textbook perspective) options must be explored, including with regard to the financial system.

Explorations of options is one thing. But to come close to concluding that fundamental changes are required in the financial system, and in virtually everything else, is an enormous leap.

Climate change as a source of financial instability

The report finally proceeds to the climate change/financial system nexus. The scene is set by a further recitation of some possible climate change effects, but with no assessment of their magnitude and significance. There is no detailed analysis of how they would impact on financial stability. Instead some scary 'evidence' is thrown in. For example;

The effects of climate change may be catastrophic and irreversible for human populations, potentially leading to "untold suffering", according to more than 11,000 scientists (Ripple et al (2019)

'Untold suffering' is not a precise or scientific measure of future costs.

The role of central banks

Given the failure of governments to do 'the right thing' the report considers the possibility that central banks should take the lead role.

Given the severity of these risks, (no evidence at all has been presented on these risks at this point to support this), *the uncertainty involved and the awareness of the interventions of central banks following the 2007–08 Great Financial Crisis, the sociopolitical pressure is already mounting to make central banks (perhaps again) the "only game in town" and to substitute for other if not all government interventions, this time to fight climate change.*

But, modestly, this is rejected:

First, it may distort markets further and create disincentives: the instruments that central banks and supervisors have at their disposal cannot substitute for the many areas of interventions that are needed to transition to a global low-carbon economy.

Second, and perhaps most importantly, it risks overburdening central banks' existing mandates. True, mandates can evolve, but these changes and institutional arrangements are very complex issues because they require building new sociopolitical equilibria, reputation and credibility.

Instead central banks are assigned a role which is described as:

co-ordinating agents in the age of climate uncertainty

The case for this role procedes as follows:

Acknowledging the limitations of risk-based approaches and embracing the deep uncertainty at stake suggests that central banks may inevitably be led into uncharted waters in the age of climate change. On the one hand, they cannot resort to simply measuring risks (hoping that this will catalyse sufficient action from all players) and wait for other government agencies to jump into action: this could expose central banks to the real risk that they will not be able to deliver on their mandates of financial and price stability.

In the worst case scenario, central banks may have to intervene as climate rescuers of last resort or as some sort of collective insurer for climate damages. For example, a new financial crisis caused by such "green swan" events severely affecting the financial health of the banking and insurance sectors could put central banks under pressure to buy their large set of assets devalued by physical or transition impacts.

While banks in financial distress in an ordinary crisis can be resolved, this will be far more difficult in the case of economies that are no longer viable because of climate change. A potential intervention as climate rescuer of last resort would then expose in a painful manner the limited substitutability between financial and natural capital, and therefore affect the credibility of central banks.

And the solution is:

we advocate a third position: without aiming to replace policymakers and other institutions, central banks must also be more proactive in calling for broader and coordinated change, in order to continue fulfilling their own mandates of financial and price stability over longer time horizons than those traditionally considered.

Importantly, central banks can engage in this debate not by stepping out of their role but precisely with the objective of preserving it. In other words, even though some of the actions required do not fall within the remit of central banks and supervisors, they are of direct interest to them insofar as they can enable them to fulfil their mandates in an era of climate-related uncertainty

The nub of the argument is that central banks will not be expanding their mandate, they will be defending it. It is necessary to intervene now to avoid the risk that some more extreme form of intervention might be required in a hundred years or so, when the failure to address climate change leads to a severe downturn in the economy.

This is overblown self-interested nonsense. There is no analysis from any serious source that points to developed countries' economies collapsing because of climate change.

The Reserve Bank of New Zealand has jumped on the enhanced role for central banks bandwagon. Its climate change section in the annual report reads as follows:

Climate change. Climate risk has far-reaching impacts on the economy and therefore the financial stability that underpins our economy. Financial stability is best maintained when all relevant risks are adequately identified, priced, and allocated to those best able to manage them. Climate change and its associated risks provide a direct challenge to financial stability, as the risks are material but extremely difficult to identify, price, allocate and manage with accuracy. Managing major and systemic risks to the economy, such as climate change, sits squarely within our core responsibilities.

If managing all major and systemic risks to the economy is within the Bank's core reponsibilities then the Reserve Bank's mandate could be expansive indeed. Any economic or social development that could conceivably pose a risk to the financial system sits squarely within the Bank's core responsibilities. An obvious candidate is the housing market but there could be many others.

Central banks are special institutions

Underpinning the 'Green swan' model is the view that central banks are special institutions that rise above petty and inadequate politics. Central bankers are 'philosopher kings'. When politics fail they must take up the load. They understand what has to be done and within limits, defined by a very broad interpretation of what their prudential mandate requires (almost everything), must set out to do it. Central bankers, and in particular their governors, are special beings. They have superior intellectual capacity, courageously tell it like it is, and are not sullied by personal ambition, greed or any other human foibles.

The green swan philosophy is at odds with the thinking about good public sector management in New Zealand. This is why the purposes of the Reserve Bank in its Act are confined to a specified set of functions.

It also is at odds with the realities of real world decision-making. Institutions are run by people, and their incentives may not be aligned with the 'common good'. There can be bureaucratic as well as market failures.

To put the latter point more graphically, imagine that Donald Trump was Governor of the Reserve Bank of New Zealand (we hear he may be looking for a job). Would a narcissistic, thin skinned, bullying Governor with an overinflated sense of his own abilities and a disregard for legal constraints and institutional conventions, be good for New Zealand if he were allowed to take an expansive view of his job?

Promoting a better understanding of long-term climate risks

One of the central propositions in the Green Swan paper (and many of the documents we discuss below) is that financial markets are not 'getting it' on climate change and are mispricing financial assets. This means that capital is being misdirected and there is a risk of a financial crunch as asset prices fall when they finally get the message.

As Mark Carney puts it: "too rapid a movement towards a low-carbon economy could materially damage financial stability. A wholesale reassessment of prospects, as climate-related risks are re-evaluated, could destabilise markets, spark a pro-cyclical crystallisation of losses and lead to a persistent tightening of financial conditions: a climate Minsky moment" (Carney (2016), p 2). p

However, there is often an obliviousness to what is actually going on in financial markets. For example the Dow Jones US Oil and Gas price index peaked at 8000 in 2014, but is now at about 3700. Tesla, the electric vehicle manufacturer, has a market capitalization of around $800 billion, which is nearly as great as the market capitalization of all other automobile manufacturers combined.

The market is already adjusting, without tipping financial systems into a crisis and without the assistance of central banks.

7.2: Network for Greening the Financial System

As the Network for greening the financial system (NGFS) approach seems to be playing a central role in the Reserve Bank's understanding of climate change

risks to financial stability[3], we also address two of their 'seminal' papers in some detail.

A call for action: Climate change as a source of financial risk: April 2019

This report starts by making the case that climate change is different from other sources of structural change. The argument, not unexpectedly, is similar to that set out in the Green Swan report, because there is an overlap in the contributing authors and institutions.

Climate change is one of many sources of structural change. However, it has distinctive characteristics that mean it needs to be considered and managed differently.

These include:
• Far-reaching impact in breadth and magnitude: climate change will affect all agents in the economy (households, businesses, governments), across all sectors and geographies. The risks will likely be correlated and, potentially aggravated by tipping points, in a non-linear fashion. This means the impacts could be much larger, and more widespread and diverse than those of other structural changes.

These arguments could be made for a number of possible structural changes to the global economy. To name a few:

- Artificial intelligence
- Economic responses to heightened risks of pandemics
- The rise of China as a world power
- The future of free international trade
- Stuff we don't know about yet.

• Foreseeable nature: while the exact outcomes, time horizon and future pathway are uncertain, there is a high degree of certainty that some combination of increasing physical and transition risks will materialise in the future.

The foreseeable nature reduces rather than increases the risk of systemic shocks.

[3] This year we continued to collaborate with the Network of Central Banks and Supervisors' for Greening the Financial System and the Sustainable Insurance Forum. This ensured we had the latest advice on areas such as prudential supervision, macroeconomic research and analysis and portfolio management

• *Irreversibility: the impact of climate change is determined by the concentration of greenhouse gas (GHG) emissions in the atmosphere and there is currently no mature technology to reverse the process. Above a certain threshold, scientists have shown with a high degree of confidence that climate change will have irreversible consequences on our planet, though uncertainty remains about the exact severity and time horizon*.

While is unlikely that climate change will be rolled back (though this is a theoretical possibility) it is not explained why irreversibility, as such, creates systemic financial risks.

• *Dependency on short-term actions: the magnitude and nature of the future impacts will be determined by actions taken today which thus need to follow a credible and forward-looking policy path. This includes actions by governments, central banks and supervisors, financial market participants, firms and households.*

It is self-evident that future climate outcomes will be dependent on government actions internationally, but this is not an argument that climate change is special from a financial stability perspective or a justification for a special role for central banks and supervisors.

Physical risks of Climate change

On the physical risks there is a recitation of the familiar mantras about flooding, heat waves and so on without any attempt to assess their materiality or any acknowledgement that these risks will vary markedly by country.

Extreme weather events impact health and damage infrastructure and private property, reducing wealth and decreasing productivity. These events can disrupt economic activity and trade, creating resource shortages and diverting capital from more productive uses (e.g. technology and innovation) to reconstruction and replacement.

*The **more sophisticated studies** suggest average global incomes may be reduced by up to a quarter by the end of the century. In addition, the increased probability of disruptive events such as mass migration, political instability and conflict in these scenarios means that economic estimates are likely to understate the size and timing of the associated risks.*

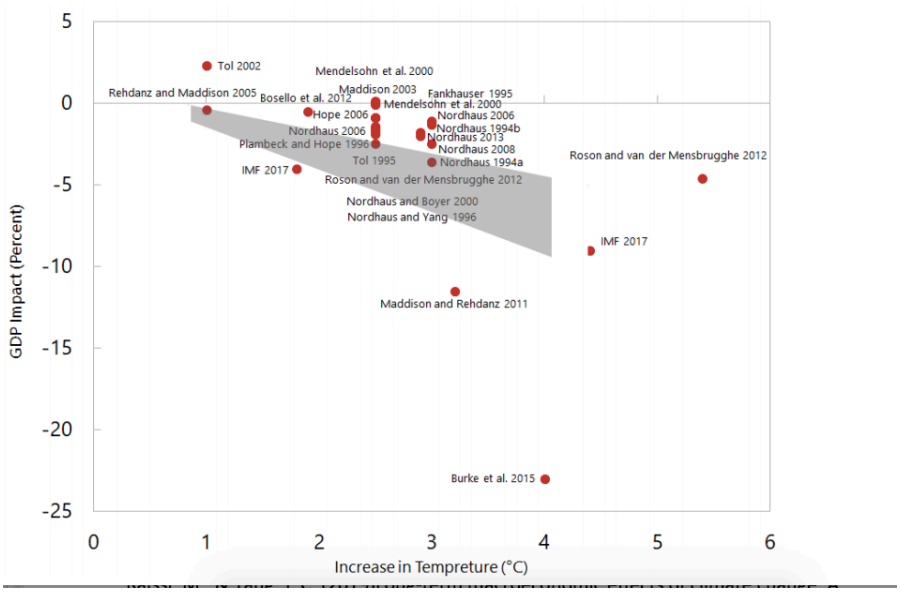
We have previously critiqued this 'sophisticated' study[4], which posited a simple relationship between temperature and GDP, in our submission on the Zero

[4] Burke, Hsiang and Miguel, "Global Non-Linear Effect of Temperature on Economic Production", Nature Vol. 527, pp. 235-239 (12 November 2015).
[4]

Carbon Bill. Its results are driven by a host of small developing countries and has limited relevance for the world economy or for any developed country. Figure two shows that It is an extreme outlier of the literature on the subject. The established literature (including the work of Nordhaus, the Nobel prize winner) suggests that GDP may be a few percent lower than it would be without climate change in developed countries. That is, rather than GDP increasing by around 400 percent by the end of the century it will only increase by 397 percent. This is not the stuff of economic and financial disaster.

In our view the NGFS is either incompetent or dishonest in its representation of the literature.

Figure two: Impact of temperature changes on GDP



Transitional risks

Many of these studies on the transition risks of climate change are partial and often focus on the energy sector. A smaller number of studies are broader in scope, covering transition impacts to entire economic segments. Estimates of losses in these studies are large and range from USD 1 trillion to USD 4 trillion when considering the energy sector alone, or up to USD 20 trillion when looking at the economy more broadly. [5]

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5 See IEA and IRENA, Perspectives for the Energy Transition, 2017.

These loss numbers relating to the energy sector are the capital losses of 'stranded assets', and are not particularly large in relation to the world economy. These impacts are already captured in market prices.

The $20 trillion figure is largely the costs of abandoning or retro-fitting building stocks that do not meet arbitrarily high energy effciency standards. It can be avoided by simply not imposing economically inefficient building standards.

The second major argument is that a wholesale reassessment of asset prices:

'*could destabilise markets, spark a pro-cyclical crystallisation of losses and lead to a persistent tightening of financial conditions, which would constitute a climate Minsky moment*.

As noted above equity markets have already adjusted.

Links between physical and financial stability

'There have been fewer attempts to quantify the physical risks to financial stability rather than for the economy as a whole, but again losses are likely to be significant. Studies estimate that the financial value at risk could be up to 17% depending on the mean average temperature rise.

The reference here is to the Dietz et.al paper which is discussed in detail below. The upshot is that this modelling does not show **any** linkage between asset prices and financial instability. It shows that the value of equities will fall by 2 percentage points by 2100 compared to the non-climate change counterfactual.

There are a few more snippets of information.

Several studies point to a lower arrears frequency for residential mortgages on energy-efficient properties, although borrowers' financial ability and thus repayment capacity is only one of the factors controlled for.

Actually there were just two references.

The China Green Finance Committee (CGFC) found lower NPL ratios for green corporate loans across most corporate industry portfolios.

We wouldn't put too much weight on a single Chinese study.

Moody´s carried out a study in 2018 on infrastructure transactions from 1983 to 2016 in both advanced and developing economies, It found that green use-of-proceeds projects exhibit lower cumulative default risk (5.7%) than non-green use-of-proceeds

projects (8.5%) in advanced economies. However, Moody´s suggests that the difference is likely to be due to subsample characteristics other than greenness.

Or in other words the study didn't support the green is safer hypothesis.

From the above 'analysis' the report makes a 'call for action' and sets out a number of best practice recommendations for central banks, supervisors and policy makers.

The first four relate to central banks and the latter two are recommendations for policy makers. For all the huffing and puffing in the text they don't necessarily amount to very much. A central bank that privately believes that the whole thing is overblown could go along with them in a half hearted way to avoid being identified as some sort of 'denier'.

Recommendation n°1: Integrating climate-related risks into financial stability monitoring and micro-supervision

The NGFS acknowledges that climate-related risks are a source of financial risk and therefore calls on central banks and supervisors to start integrating climate-related risks into micro-supervision and financial stability monitoring.

Recommendation n°2: Integrating sustainability factors into own-portfolio management.

NGFS members may lead by example by integrating sustainable investment criteria into their portfolio management (pension funds, own accounts and foreign reserves), without prejudice to their mandates. This approach could have several benefits:

- *improve investors' understanding of long-term risks and opportunities*
- *Central banks can reduce reputational risks*
- *Central banks may decide to employ part of their investments to pursue non-financial sustainability goals in order to generate positive (societal) impacts, in addition to traditional financial return goals.*

Recommendation n°3: Bridging the data gaps

Building on the G20 GFSG/UNEP initiatives, the NGFS recommends that the appropriate public authorities share data of relevance to Climate Risk Assessment (CRA) and, whenever possible, make them publicly available in a data repository.

Recommendation n°4: Building awareness and intellectual capacity and encouraging technical assistance and knowledge sharing

Recommendation n°5: Achieving robust and internationally consistent climate and environment-related disclosure

Recommendation n°6: Supporting the development of a taxonomy of economic activities.

NGFS Technical Supplement to the First Comprehensive Report.

This paper provides advice on technical elements of central banks and supervisors responses to climate change. Much of it relates to long-term macro modeling.

Amongst the recommendations are:

Undertake macro-economic modeling of the physical and socio-economic impacts of climate change and to assess how different levels of climate change can be achieved.

For New Zealand this would involve replicating the kind of work that has been done by the Productivity Commission, the MfE and the Climate Change Commission. It is not at all apparent how this long-term modelling work relates to an assessment of financial stability. If a model reports that output will be five percent higher or lower in 2100 compared to a non-climate change scenario this would seem to provide no relevant information. We are not aware of any model or theory that an economy with a long-term growth rate of, say, 1.9 percent will have a less stable financial system than one growing at 2 percent.

Next there is a discussion of the effects of the zero carbon transition that puts the costs at between 1 and 3 percent of GDP. Spread over several decades this should not put most economies under undue pressure.

Beyond this the paper just has a discussion of possible linkages between climate change and financial losses with nothing very concrete or useful. There are about 120 references, but not a single one models how a climate change financial stress scenario would unfold, or attempts an assessment of the financial system losses due to physical climate change.

Climate change scenario guide
The technical report includes a 'first-of-a-kind' guide on climate change scenario analysis for central banks and supervisors. If sets out the NGFS reference scenarios.

1. Orderly transition
Net carbon zero by 2050-70. The carbon price increases by $10 per year. Alternative, quicker transitions are described as orderly but as 'more stressful'.

2. Disorderly transition.
In this scenario, climate policy follows Nationally Determined Contributions until 2030. As these efforts will not be enough to meet commitments, the emissions price is increased by US $35 a year after 2030. We note that the European carbon price has increased by about €35 over the last year without any apparent 'disorderly' effects.

3. Hothouse world
This assumes no further policy changes with temperature increases of 2 degrees by 2050 (in excess of ECP 8.5 projections) and 4 degrees by 2100 leading to **substantial physical risks over the medium and long term** (our emphasis).

The extent of these 'substantial physical risks' are not described.

7.3 Bank of England Prudential Regulation Authority (2018), Transition in Thinking: The impact of climate change on the UK banking sector.

This paper starts by setting out the standard mantra on physical and transition risks.

Physical risks can arise from climate and weather-related events, such as heatwaves, droughts,floods, storms and sea level rise. They can potentially result in large financial losses, impairing asset values and the creditworthiness of borrowers.

Transition risks can arise from the process of adjustment towards a low-carbon economy. Changes in policy, technology and sentiment could prompt a reassessment of the value of a large range of assets and create credit exposures for banks and other lenders as costs and opportunities become apparent.

Specifically for banks it is claimed:

Extreme weather events can cause significant losses for homeowners, reducing their ability to repay their loan and damaging the value of the property. For banks this increases the credit risk on their loan books as both the probability of default and loss given default increases.

These potential risks are not linked to the projections of climate change for the UK. However, four case studies are presented to show how the financial risks from climate change are 'already relevant to banks'. The significance of these studies is that they were the first, and as far as we know, the only occasion

where the Bank of England has attemped to put some meat on the bones of its claims that climate change risks to banks are real and material.
Three of these, tightening energy efficiency standards in rented property; coal financing and lending to the automobile sector, arise from the transition to a low carbon economy. Only the fourth, flood risk to residential mortgages, relates to physical risk.

Energy efficiency policy impact

The UK energy effcieny policy is that rented propreties have to reach an E grade efficiency standard by 2023, or they cannot be rented. If the property can not be economically refitted to the required standard or sold to an owner occupier (who doesn't have to meet the standard) then the value will fall to land value. If the property is mortaged then there is a possibility that the bank could incur a loss. As only five percent of rented properties are currently non-compliant, and many of those either will not have a mortgage or can be made compliant at a moderate cost, it is likely that bank losses due to this policy will be very low.

Automobile industry

The biggest exposure to this sector is automobile financing of stg.20 billion. The logic here is that with the shift to electric cars the value of the internal combustion engine (ICE) securities will fall and leasing companies will take a hit on the residual value. The reality is that there will not be an overnight electric car revolution, and there will not be a material affect on industry players. The financial exposures here are relatively short term and as the electric car revolution gains momentum leasing companies can adjust their lease rates to reflect falling ICE second-hand values.

The other identified risk was exposures to the manufacturing industry as electric cars come to the fore. But these risks are probably no greater than the historical norm. The UK is no stranger to failure in the sector.

Impact on the coal industry

It is stated that internationally the top 35 banks have a $75 billion exposure to the coal industry. Quite how this relates to the risk of the UK banking system is not explained. In any event $75 billion is a small number for the world economy.

Risk to mortgage loans from flooding

On the physical risk to mortgage loans from flooding we are just given the following information:

Frequency of heavy rain days (25mm or more) increases by a factor of up 2-3.5 timess in winter and 1-2 in summer by 2080.

The PRA used UK Environment Agency (EA) data on flood risk alongside the Product Sales Database (PSD)55 and found that 8.8% of current mortgage exposure in England is located in a flood risk zone (Chart A). Most of these properties fall within the low risk category (probability of flooding of 0.1-1% in any one year). However both the proportion of mortgages located in a flood risk zone and risk category would be expected to increase on the basis of the estimates discussed above.

We note than in a Lloyds report on climate change and insurance the UK Environmental Agency estimated the cost of maintaining a constant degree of flood risk to be stg. 20 million a year. It would be reasonable to presume that this protection work would be done and banks would not be exposed to an increase in what is a small risk.

Further, in the UK there is a publicly-backed flood protection scheme so there is very little risk that homeowners and banks would become exposed if insurers were to withdraw from the highest risk areas.

On the impact of sea level rises we are told:

Coastal properties will also be impacted by sea level rise and the subsequent increase in storm surge risk. Under a 2^{o} C scenario, sea level in England and Wales is projected to rise a further 21-28cm by 2080.

There is no information on the risk that this poses and what is likely to be done to mitigate it.

On flooding risk, it would have been helpful if banks had been asked to provide their flood loss data and if the Bank has checked whether these losses were consequential. But there was no such analysis.

Conclusion

For all the Bank of England's claims, in several papers and forums, about the increased climate-related risks facing banks this was the best it could come up with, despite trying desperately hard.

7.4 IMF Global Financial Stability Report (April 2020): Chapter five.

Chapter five of the IMFs 2020 Financial Stability Report looked at the effect of climate disasters on equity prices (over the last 50 years) to gain some insights

into the consequences of increases in the frequency and severity of such disasters. It also considered whether equity prices are currently reflecting predicted changes in physical climate risk.

The IMF methodology was first to compare equity market returns immediately before and after large climatic disasters. For advanced economies the price drop is only modest. About two percent on average. The low response is explained in part by insurance penetration.

The next step is to assess whether the possibility of increased future physical risks are priced into equities. To conduct the analysis, economy-specific projections of hazard occurrence from the World Bank Climate Change Knowledge Portal are used. These projections, corresponding to the changes between 1986–2005 and 2020–39, covered the number of extreme heat days, drought likelihood, heat wave likelihood, and the number of extreme precipitation days

They found overall, that there is no evidence to suggest that equity valuations in 2019 were negatively associated with their projected changes in hazard occurrence. There was no relationship between their composite Climate change hazard index and price to earnings ratios.

This should not have a been surprise. Climate disaster losses are small and generally do not impact on listed firms: the changes in hazards by 2039 are projected to be small and will have a limited impact on the incidence of climate disasters. Further, the aggregate PE ratios will mask the reactions of the few stocks that might be sensitive to climatic events. Overall we wouldn't expect an efficient market to be paying too much attention these climate risks.

A second test was a comparison of the results of a stylised version of an asset pricing model that takes into account the impact of climate change on a market-derived risk premium. Their equity risk premiums are as follows:

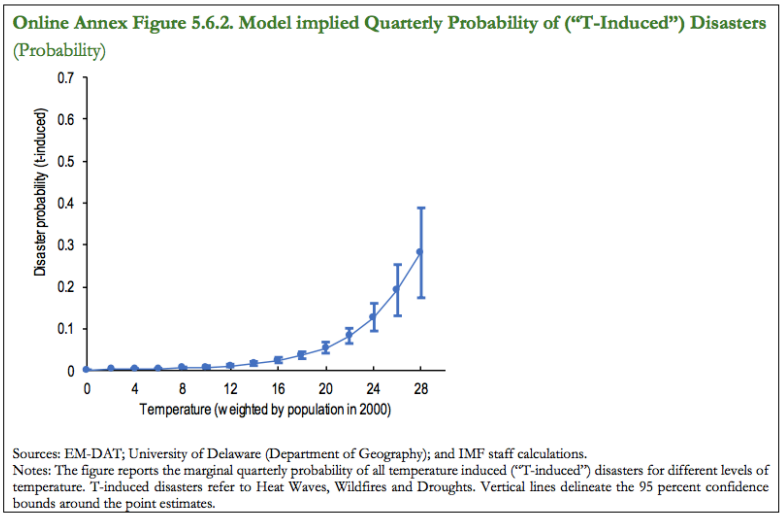
No warming 5.9
RCP 2.6 8
RCP 6.0 11.6
RCP 8.5 13.4

They say that this suggests that equity valuations should be materially lower than they are now because the risk premium should be materially higher, if a high warming scenario were to materialize. All of this depends on construction

of the model and its assumptions which are not clearly explained in the documentation. There is no direct link from the theoretical model to the outputs.

The IMF model is driven by consumption shocks caused by large disasters (which are modelled to be extremely high relative to those experienced in developed countries). Figure three shows the critical relationship between temperature and the probability of a climate disaster. We can't see what is going on when temperatures increase by up to about 1 degree (the highest plausible increase in the time horizon relevant for equity valuations), but we can see that with temperature increases of above around twelve degrees things get very serious, with implications for equity valuations. But no one is predicting anything like a 12 degree outcome.

Figure three: Relationship between temperature and disaster probability



A further test was to compare the returns of firms with highest temperature betas (calculated over 1998-2017). They found that they underperformed the market in 16 countries, and did not in 11. This was regarded as a violation of the efficient market hypotheses.

The presence of such a pricing anomaly indicates that equity investors in most economies have not paid enough attention to climate variables and suggests that they may not be paying sufficient attention to climate change risk either.3

Whether this was really an exploitable anomaly is open to question. The authors did not conduct an 'out of sample' test of their finding. In any event a finding that short-term traders had not on average exploited an apparent anomaly historically has little to say about whether value investors are ignoring relevant data about future climate change risks.

In summary we found that the IMF analysis was misleading and overstated the risks. Even if equity prices, don't 'properly reflect' future climate risks and might retrace at some point in the future, this does not necessarily mean that there is a material risk to the financial system. Equity prices are volatile for all sorts of reasons and normally price retractions are not consequential for the financial system.

The conclusion from all of this jiggery-pokery is that climate change is a source of financial risk to investors that could lead to adverse consequences for financial stability. This is based on the finding that:

current economy-level equity valuations as of 2019 are generally not statistically significantly associated with the currently available proxies of future changes in physical risk.

A few of our readers might be able to follow our description of the IMF analysis. Those without the patience or background should rely on our conclusion that it demonstrates nothing about market effciency and climate change.

7.5 A climate stress-test of the financial system[6]

This six page paper is not available on line but its brevity suggests it had little to say. The results, as summarised in the abstract, were as follows

We find that direct and indirect exposures to climate-policy-relevant sectors represent a large portion of investors' equity portfolios, especially for investment and pension funds.

Additionally, the portion of banks' loan portfolios exposed to these sectors is comparable to banks' capital.

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6 Stefano Battiston, Antoine Mandel, Irene Monasterolo, Franziska Schütze & Gabriele Visent 2017 Nature Climate Change volume 7, pages 283–288 (2017)

The facts about the level of exposures might well be true, depending on how how 'climate-policy- relevant sectors' are defined, but this doesn't constitute a stress test. Being 'exposed' to a risk does not tell us anything about potential losses.

7.6 'Climate Value at Risk' of global financial assets Simon Dietz et. al. 2016

This paper attempted to calculate the impact of climate change on the value of global assets. The results are as follows.

We find that the expected 'climate value at risk' (climate VaR) of global financial assets today is 1.8% along a business-as-usual emissions path. Taking a representative estimate of global financial assets, this amounts to $2.5 trillion. However, much of the risk is in the tail. For example, the 99th percentile climate VaR is 16.9%, or $24.2 trillion.

Cutting emissions to limit warming to no more than 2°C reduces the climate VaR by an expected 0.6 percentage points, and the 99th percentile reduction is 7.7 percentage points.

Including mitigation costs, the present value of global financial assets is an expected 0.2% higher when warming is limited to no more than 2°C, compared with business as usual. The 99th percentile is 9.1% higher.

Essentially the model works by assuming that changes in world GDP directly map to financial asset prices. The implied assumption is that labour and capital bear the costs of climate change equally. It then takes the GDP time paths to the year 2100, with and without climate effects, from the relevant literature, and discounts the differences back to a present value using a discount rate of 4 percent. The difference is the climate VaR. Once we account for the costs of mitigation the net present value of the avoided costs is 0.2 percent of GDP.

The distribution of outcomes is calculated by assuming distributions around the main model drivers and running a Monte Carlo simulation.

We could take issue with many of the assumptions in the model but as the results are trivial this would not be worth the time and space.

It is not entirely clear what point the paper was trying to make. If it was to demonstrate that markets are overvalued because climate change costs are not priced in then it is telling us that there is not much to fear. A 0.2 percent retraction in financial market prices is trivial compared to normal market risks.

If it is trying to make the case that climate mitigation is good business because the net effect is positive then it does not make a very compelling case. Plausible tweaks to any of a number of implicit and explicit assumptions in their model could turn the 0.2 percent gain into a substantial loss.

If the point is to show that there is a small risk that the 'losses' could be materially higher than the mean, as evidenced by the 99th percentile numbers, again they have simply demonstrated that these risks are much less than normal market risks. The 99th percentile VAR for equities over 80 years may not be far short of 100 percent.

In sum there is not much in this paper that contributes to the climate change /systemic risk debate.

7.7 IAIS (International Association of Insurance Supervisors). 2018. "Issues Paper on Climate Change Risks to the Insurance Sector

We have not reviewed this document in detail. It is a mostly higher level issues review that does not add to points made in other documents we have reviewed.

7.8 Bank of England stress testing

In December 2019 the Bank of England released a discussion paper "*The 2021 biennial exploratory scenario on the financial risks from climate change*", which sets out a stress testing framework to explore the financial risks posed by climate change. The stress testing programme has been delayed by Covid 19 but the paper is nonetheless still interesting because it is a development of the NGFA approach, and so might be a precursor of what we might see from the Reserve Bank of New Zealand if it were to follow a similar path.

The basic framework of the stress testing model is as follows:

- It will use a 30 year modelling horizon to 2050 with results at five year rests.
- The Bank will provide the policy, temperture and other physical pathways
- Banks will assess the vulnerabilityof individual counterparties to climate-related risk.

- Banks will spectify management action in response to physical and transitional risks.

There will be three scenarios:

- An early policy action scenario where the transition to a carbon-neutral economy starts early and proceeds in an orderly fashion and the increase in global temperature stays below 2^{o}C (relative to the preindustrial temperature), in line with the Paris Agreement. There will be shocks due to the increase in the price of carbon emissions, but no other macroeconomic shock.
- A late policy action scenario where the global climate goal is met, but the transition is delayed by ten years and must be more severe to compensate for the late start. This results in a macroeconomic shock. This assumption points to the fact that this not a genine fact-finding 'stress test' The key outcomes that a delayed adjustment will lead to 'a significant degree of disruption' to the economy is simply assumed, it does not flow from the modelling itself. Banks will no doubt dutifully deliver the right outcomes, which will be trotted out as support for an earlier transition strategy.
- A 'no additional policy action' scenario where no policy action beyond that which has already been announced is delivered. Therefore, the transition is insufficient and the world fails to meet the two degree target.

The scenarios assume that the rest of the world implements the same policies as the UK. However, the most likely scenario is that the rest of the world (less Europe) underperforms,leading to a worst of both possible worlds outcome for the UK. The worst physical climate change outcome is combined with a relatively expensive transition (amplified by carbon leakage costs as industry relocates to more accommodating jurisdictions). This scenario Is not considered.

The scenario analysis does not look like a traditional stress test with its focus on the impact of the stress scenario on bank income and capital (though provisions are recorded). Rather it looks more like some gargantuan macro-economic long-term forecasting model that combines a lot of very granular information both from the UK and abroad. Banks, for example, are expected to engage directly with corporate clients constituting 80 percent of the book, to generate their outputs. Flooding risk to residential properties have to be assessed at the '4 digit postcode' level.

Participants would perform financial analysis of individual companies. This would include modelling cash flows and collateral values, and should reflect judgements about how companies would be positioned in light of both their underlying risks and opportunities, including an assessment of their current mitigation and adaptation plans.

All this was supposed to be accomplished in three to four months. Whether this exercise produces any useful information, worth the effort, remains to be seen.

To secure the outcome that no action wil generate the worst result it will be necessary to demonstrate that there will be strongly adverse physical climate effects by 2050. This will be achieved, it appears, by fabricating the results in a pretty transparent manner. The relevant discussion reads:

2.12 Absent a rapid transition, some physical risks will crystallise in the period to 2050, but the most material shocks would occur later in the century. To ensure that no additional policy action scenario captures these severe risks but avoid lengthening the modelling period, the Bank proposes to calibrate the 30-year scenario assuming the more material risks anticipated in the period from 2050 to 2080 occur by 2050. As with the other scenarios above, participants would test the resilience of their current balance sheets to this scenario.

So the pre-2050 physical risks won't be what they appear to be, they will be the 2080 risks, just re-lablled as 2050. There is no technical need to do this. It is a simple matter to run the scenarios out to 2080 by having 12 rather than 6 reporting periods. It is also intended to adopt:

a prudent estimate of underlying climate and transition pathways. For example, the scenarios would assume limited development in carbon capture and storage technologies and would take a conservative approach to the sensitivity of temperature to increases in emissions.

This provides ample scope to pump the physical risk loss numbers.

An important issue with repect to property losses due to flooding and sea-level rise is that there is no discussion at all of public responses to mitigate losses. It appears that this will not be taken into account. The effect will be to transform a moderate public cost into a large private cost.

7.9 Commodity Futures Trading Commission's Climate-Related Market Risk Subcommittee of the Market Risk Advisory Committee (MRAC) Managing Climate Risk in the U.S. Financial System

This paper is notable only because it makes the following statement in the executive summary.

Climate change poses a major risk to the stability of the U.S. financial system and to its ability to sustain the American economy.

However there is no substantive analysis in the body of the report to support this conclusion. For the most part the report is a cut and paste of assertions from other reports, in particular the NGFS report

Part eight: Other analysis

This part presents a number of recent studies relevant to an understanding of climate change and systemic risk. Perhaps the most important is the recently published French stress test using the NGFS framework. Transitional risks losses were low and physical risks were too low to be able to be modelled systematically. None of the papers suggested that there will be systemic issues.

8.1 Netherlands Central Bank climate-related stress testing

Flooding stress tests

The DNB has conducted two physical flooding related stress tests involving the breaching of two major dyke systems. The largest event, with a probability of occurance of 1:110 years, costs EUR $57.6 billion. The losses to the financial system were EUR 2.3 billion. Despite the large overall loss, the impact on the financial system would have been very manageable. The estimated financial system losses (not all of which would have been incurred by banks) are equivalent to about a third of banking system annual profits.

Note that the probability of occurance of this shock is not expected to increase with climate change because the Dutch are upgrading their flood protection to maintain the risk at a constant level.

Netherlands energy transition stress test

The DNB stress test[7] of various energy transition scenarios has often been cited as an example of how serious transition risks can be. In particular attention is drawn to a fall in the bank capital ratio of 4.3 percentage points (from a baseline of 15 percent) in the most severe stress test.

The stress test involved the following stress scenarios:

- A technology shock involving a doubling of renewables in the energy mix due to a technological breakthough.
- A confidence shock. Consumer and investment expenditures are delayed due to uncertainty about policy measures and technology changes
- A policy shock: the global carbon price increases to $US100.
- A combined technology and policy shock

The impacts on GDP are shown in table two

Table two: DNB stress test results

Year	GDP relative to baseline		
	Policy shock	Technology shock	Confidence shock
1	-1.2	+1.6	-1.4
2	-3.2	-0.3	-2.7
3	-2.8	-1.0	-2.3
4	-1.2	+0.8	-1.4
5	-0.5	+2.0	-0.6

The confidence shock was artificially, and in our view implausibly, generated by simply assuming falls in consumption and investment and an increase in the costs of capital without any discussion of the drivers behind the assumptions. This scenario should be ignored.

[7] Vermeulen, Schets, Lohuis, Kölbl, Jansen, Heeringa, An energy transition risk stress test for the financial system of the Netherlands, 2018.

The significant scenario is the policy shock. This shock is exacerbated by the monetary policy response assumption. The 10-year bond rate is assumed to increase by 1 percentage point in year one as interest rates are increased to 'fight inflation' following the increase in energy prices. The increase in the 10 year rate seems bizzare. Long-term rates should not be so sensitive to an increase in the policy rate. Further, increasing the policy interest rate at all does not seem to be the most reasonable assumption. The energy price shock could have been treated as a one-off taxation shock and the policy rate left unchanged. The other policy assumption is that government revenue increases due to the increase in the carbon tax are not offset by other tax decreases and/or government expenditure increases. Thus a fiscal contraction is assumed.

So what we have here are the effects of an energy price increase compounded by implausible monetary and fiscal policy responses. The latter two effects probably account for most of the economic contraction.

Impact on the banking sector's financial position

Losses to banks in the policy shock amount to 2 percent of assets. However, half of that relates to the increase in the 10-year risk free rate on the value of banks' long bonds. This is due to an assumption that the banks have an unhedged interest rate position. If that is the case the problem is not the monetary shock related to carbon tax increase but the unhedged bond position that would leave the banks exposed to any monetary policy shock. We doubt that this is the way Dutch banks manage their interest rate risks. The asset position will be hedged elsewhere in the book.

Of the other falls in asset values, three quarters is in non-carbon intensive industries and probably reflects the impact of the monetary/fiscal policy driven contraction.

Finally, the impact on asset values is directly deducted from the banks' capital ratios. This ignores the role of current profits, which provide the first line of defence against losses. These would probably have absorbed the losses.

Summary

The impact of the policy scenario of banks' capital position has been grossly exaggerated, either by the intentional selection of assumptions that increase the impact of the shock, or because of the modellers' lack of undertanding of the economics. We suspect that with more plausible stress testing assumptions (monetary and fiscal neutrality and inclusion of current profits) there would have been no impact on capital ratios.

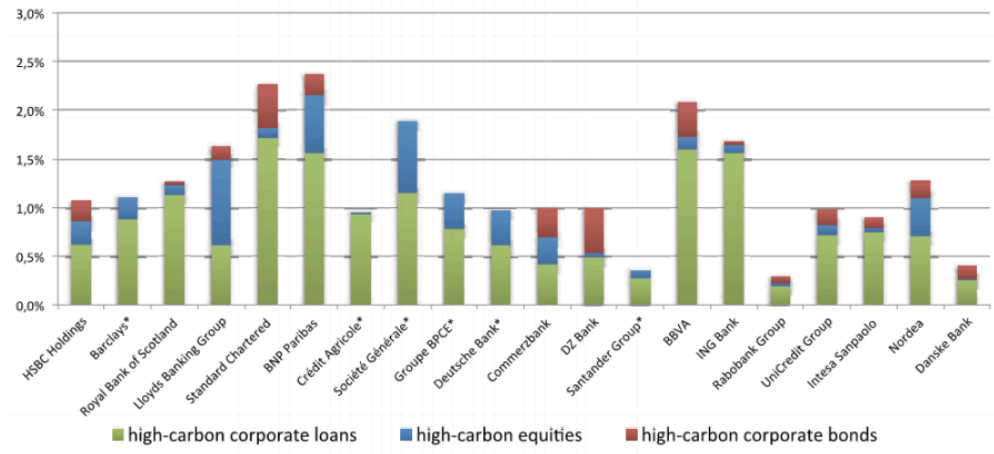
Put bluntly this is a junk stress test, possibly deliberately designed to hype up concerns about transitional risks.

8.2 Weyzig F. et al 2014 The Price of Doing Too Little Too Late: The impact of the carbon bubble on the EU financial system A report prepared for the Greens/EFA Group – European Parliament

This report has been included because it presented the following data on major European banks' exposure to high carbon assets. Despite the rather alarmist title of the paper these exposures were quite low and obviously unlikely to give rise to financial stress, were 'the bubble' to pop.

Figure four: Exposure to high carbon assets

Figure 13. Combined exposure to high-carbon assets as share of total assets, end-2012



** = Excluding corporate bonds due to lack of available data*

Source: Weyzig et al. (2014), Figure 15.

8.3 Finansinspektionen (Swedish banking supervisor): Climate change and financial stability, 2016

The stand out amongst central banks on the physical effects of climate change is the Swedish regulator. In 2016, before the NGFS extreme climate risk paradigm

took hold, they commissioned a report on the likely impact on Sweden [8] . The substance of the report is the following:

By contrast, high-income, high-latitude countries may see some positive physical changes (being in general cooler than is optimal for economic activity) and tend to be less sensitive to climate. Looking at the breakdown of Swedish economic activity by sector (Table 1), climate-sensitive sectors such as agriculture, forestry, energy, tourism and water, and related manufacturing industries, i.e. food processing and manufacturing of wood and paper products, comprise a small share of the national economy.

Even within Europe, the balance of evidence suggests that Southern Europe will see relatively more adverse impacts than other parts of the continent. Indeed, several studies, including one of the most important and rigorous to be carried out at this level of disaggregation (Ciscar et al. 2011), suggest that climate change might be net beneficial to Northern Europe, due in particular to a substantial increase in agricultural production as a result of higher temperatures (Figure 2.3).

Similarly IPCC finds a majority of studies into the agricultural and forestry sectors in Northern Europe report a positive impact on production,

It was refreshing to see some rational thinking from a financial supervisor.

8.4 European Systemic Risk Board: Positively green Measuring the climate change risk to Financial stability 2020

This 56 page report does not live up to its title. There is almost nothing in its pages that measures risks to financial stability.

There are the familiar claims that climate risks are not being reflected in market prices but most of their references on the evidence appear to show that markets are reflecting climate risk.

Bolton and Kacperczyk (2020) find that the stocks of firms with higher total CO2 emissions (and changes in emissions) earn higher returns, after controlling for size, book-to-market, momentum, and other factors that predict returns. ***This suggests that investors are already demanding compensation for their exposure to carbon emission risk****. In the same vein, Alessi et al. (2019) provide some evidence of a significant and negative green risk premium – which the authors label a "greenium", relying on*

[8] The effects of climate change on financial stability, with particular reference to Sweden A report for Finansinspektionen (The Swedish Financial Supervisory Authority) 26th February 2016 Alex Bowen and Simon Dietz Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science

company-level disclosures and the introduction of transparency controls to account for potential "greenwashing" effects – estimating that a reconstructed green portfolio would have outperformed brown portfolios, offering a 20% return compared with a return of just 12% for a portfolio of brown assets over the period 2006-18

Comparing the performance of high-emissions industries in the S&P 500 index before and after the Paris Agreement, Ilhan et al. (2018) ***provide further evidence that investors have actually incorporated new information*** *when assessing risk profiles. De Greiff et al. (2018)* ***also find that the risk premium of fossil fuel firms*** *has increased following the Paris Agreement and that this reassessment can be attributed to increased awareness of transition risks (Delis et al., 2018).*

With regard in particular to oil and gas companies' market valuations, IHS Markit (2015) argues that market mispricing of fossil fuel assets may not be as large as expected, as they are mostly driven by commercially proven reserves that will be monetised over the medium term (within a period of 10 to 15 years) rather than over a longer-term horizon.

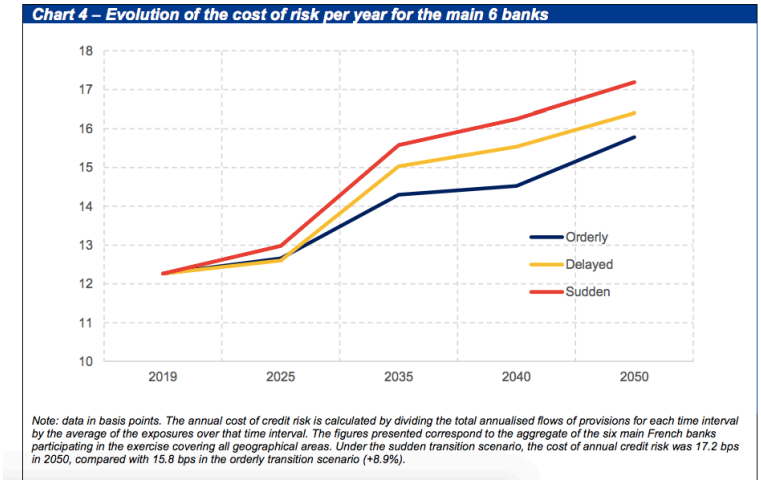
8.5 A first assessment of financial risks stemming from climate change: The main results of the 2020 climate pilot exercise ACPR and Bank de France 2021

This paper presents the results of the first nationwide stress test of French banks and insurers using the NGFS scenarios. It was a signficant result. It demonstrated that, despite all the huffing and puffing about climate risks in the regulatory community, there is really little to worry about.

Figure five shows the increase in losses due to transitional effects, which increase loss rates by between 3 and 5 basis points over 30 years. There was no significant difference between the transition scenarios.

The banks did not produce stress tests results for physical losses, because the results would have been trivial. Losses, such as they were, would have been borne by insurers. To make something of the exercise a plan was made to apply the insurers' reaction function to changes in premiums and coverage policies, to banks' credit risk parameters. It failed. Banks had translated physical risk into credit risk in localised areas where it matters, but hadn't done the work on a national basis, where it didn't matter. It is hard to find systemic risk when it probably don't exist, and banks were reluctant to put resources into vain attempts to find something

Figure five:Cost of risk (basis points) by adjustment scenario



In sum, the first great climate change stress test was something of a fizzer. The lesson to be drawn is that there isn't much risk to find. But no doubt this won't stop supervisors from trying, perhaps even harder. The fact that there wasn't a problem is evidence that there is an even more insidious problem. Climate change risk is good at hiding so supervisors have to redouble their efforts to find it.

8.6 United Nations Environmental Programme (UNEP) 'Navigating a New Climate: Assessing Credit Risk and Opportunity in a Changing Climate

This paper presented the experiences of a working group of 16 of the world's 'leading ' banks in applying scenario analysis to climate-related risks.

The working group tested the potential impacts of climate risk under three scenarios, centred on 2025 and 2045.

However the scenarios were really something of a fraud. The temperature increases used in the modelling were taken from the IPCC estimates for RCPs 4.5 and 8.5 for **2100**. This grossly exaggerated the temperature increases for 2025 and 2045.

But even with these exaggerations the illustrative modelling, by five banks showed very small impacts.

Bank No. 1 (almost certainly the ANZ) showed the following impacts on its agricultural lending portfolio. The one notch (or less) downgrades, in most cases, will probaly mostly amount to a few basis points of credit risk depending on the current rating. In its climate disclosure document the ANZ reported that it incurred very low losses through the great drought and bush fire episodes.

Figure six Loan rating impacts ANZ

INDUSTRY	2020s SCENARIO	2040s SCENARIO	
	2°C & 4°C	2°C	4°C
Mixed farming	1 notch	1 notch	2 notches
Grain	<1 notch	<1 notch	1 notch
Cotton	1 notch	1 notch	2 notches
Horticulture	1 notch	1 notch	1 notch
Beef farming	<1 notch	<1 notch	<1 notch
Dairy farming	1 notch	1 notch	1 notch
Others	1 notch	1 notch	2 notches
Total portfolio	<1 notch	<1 notch	1 notch

Note: Where customer's PD profile deteriorates across the stress test scenarios but the movement is insufficient to shift the rating band by a notch, '<1 notch' is recorded above.

A second agricultural lending rating impact assessment by ITAU UNIBANCO found that a 4 degree temperature change was neutral for most clients.

A UBS case study assessed physical climate risk to one electric utility borrower whose assets are located primarily in the southern United States. The review found a 14.5% impact on the production capacity from incremental climate change in the '2020s' in the 2°C & 4°C temperature increase scenarios, compared to the present-day baseline. What drove the 14.5 percent impact on capacity was not explained very well but it appears that the number was plucked from a generic assessment that they were provided with by the organisers.

A further 0.24% impact on production capacity from extreme weather events is also found in a '2020s' - 2°C & 4°C scenario, driven primarily by heat waves and river flooding. Recall that these were not really 2020s tests. They were 2100 assessments.

STANDARD CHARTERED's case study of Chinese commercial real estate found no appreciable impact on the LTV ratio of loans secured against the properties. Only around a quarter experienced a deterioration of above 1% in

LTV. The risk-weighted asset (RWA) impact at a portfolio level therefore was immaterial.

The RABOBANK case study of Dutch residential real estate lending found an estimated exposure loss value of 0.13%.

Part nine: NGFS Climate Scenarios

In June 2021 the NCFS released its second iteration of its climate scenarios. According to the NGFS:

They represent a true milestone in the race to better understand the risks from climate change.

The main focus is the macroeconomic modeling of mitigation options to 2050 and the subsequent impact of climate change on the world economy out to 2100.

There is almost no consideration of the financial stability implications of the different scenarios.

The outputs that will probably get the most attention are set out in figure x. It shows that the transition costs are higher in a delayed/disorderly transition, which is their description of current policy. The cost is 5 percent of world GDP by 2050. There is no real explanation of the economic model that drives this result and we suspect that the outcome is an artefact of the scenario construction. Extreme policy measures are taken to reach the emissions reduction target after a late start rather than accepting some higher emissions and slightly higher temperature outcomes.

The estimated economic costs, due to higher temperatures under 'current policies' of 5 percent of GDP in 2050 and 13 percent 2100, are drawn from a single recent paper, 'Kalkuhl, M., & Wenz, L. (2020) The impact of climate conditions on economic production. Evidence from a global panel of regions. '

The NGFS claims that:

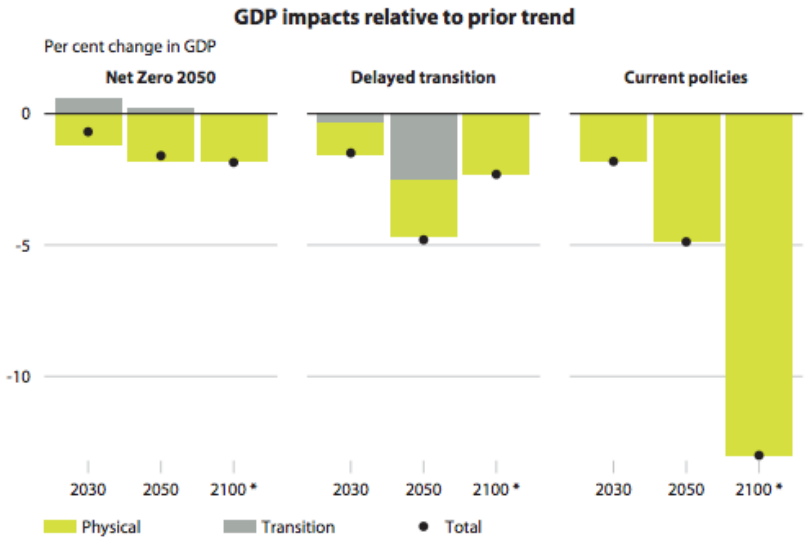
Economic impacts at high degrees of warming would be unprecedented and much more severe than currently estimated.

And that the 13 percent income loss understates the likely costs:

Damage estimates from physical risks only cover a limited number of risk transmission channels. For example, they do not capture the risks from sea-level rise or severe weather. They also assume socioeconomic factors such as population, migration and conflict remain constant even at high levels of warming.

Given the weight the NGFS has placed on the Kalkuhl paper we have reviewed it in some detail and then discuss the additional costs argument.

Figure seven: GDP impacts under different mitigation assumptions



Source: IIASA NGFS Climate Scenarios Database, NiGEM based on REMIND. IAM data and damage estimates from Kalkuhl & Wenz (2020).

Review of Kalkuhl & Wenz

The Kalkunl paper uses a data set of subnational economic output, Gross Regional Product (GRP), for more than 1500 regions in 77 countries to empirically estimate historical climate impacts at different time scales. Three estimates are produced using: annual panel models; long-difference regressions; and cross-sectional regressions.

There are two major technical issues with the paper.

- Income is measured in terms of nominal US dollars converted at the current exchange rate rate. This would account for part of the

extremely high income volatilty. The average nominal annual growth is 7 percent but the standard deviation of this rate is 15 percent. Converting to US dollars introduces a large amount of variability into measured non-US income As the variable of interest is the the impact of climate on real variables, it would have been better to use a real income measure for each country.

- The regional data are not weighted by aggregate income. This can, and almost certainly has, generated results that are biased to small and poor regions' temperature/output relationships. To illustrate, consider a country that has 10 regions. Nine are rural and poor and are heavily impacted by increased temperatures. Assume the data shows a 20 percent impact over the estimation period. Together these regions account for 10 percent of national income. The other region is modern and rich, with a large population and an economy based on IT. Because work is done in airconditioned offices temperature increases have no impact on output. On a national basis the temperature increase has reduced output by 2 percent. But if the regional impacts are aggregated on an unweighted basis national income falls by 18 percent, which is clearly wrong. But this is how the Kalkuhl model works, though in a less pronounced manner. High income regions account for only about 18 percent of the number of regions, but more than 60 percent of world income.

The annual panel model

This model generated the largest relationship between temperature and per capita output and was used by the NGFS to generate the 13 percent GDP impact by 2100. However, all this analysis is showing is that in poor countries with large agricultural sectors, temperature changes can contribute to the year-to-year volatility of output. This this does not necessarily mean that there is the same relationship between slow and anticipated temperature change and trend GDP.

It is widely understood that over the longer time horizons relevant to an analysis of climate change impacts, adaptation will reduce temperature impacts. For example air conditioning will become more common and more heat resistant crops will be introduced.

Further, they did not break the data into high income and low income countries. Other studies have found a short-term relationship between weather and output for poor countries with large agricultural sectors, but not for high income countries.

The long difference model

This model tested the temperature/output relationship over longer time horizons. Earlier 10 year periods were compared with 2005-2014. This is the most relevant test for the gradual climate change temperature impact. They found **no** relationship between temperature and output. This was put down to adaptation and the fact that the temperature changes might have been 'too small' to uncover an impact. This is the key result from a climate change impact perspective but it was simply ignored in the damage curve modelling that the NGFS used for its GDP impact assessment.

The contribution from this paper was that temperature increases do not have a sustained effect on output. But that was not was reported.

Cross sectional regression model

Regional income was modelled as a function of temperature, cumulative oil extraction, distance to coast, distance to rivers, altitude, over 10-year intervals from 1955 to 2014.

It was found that temperature was significant in explaining income differences. A one degree temperature increase was associated with income reduction of by 2 – 4 percent. The positive relationship is not a surprise. Poor countries are disproportionately hot. But correlation does not prove causation.

Simple climate driven explanations of income levels have a long pedigree. For example Montesquieu argued in 'The Spirit of Laws' (1748) that an "excess of heat" made men "slothful and dispirited."

But now most economists are sceptical of simple climate driven models of economic performance and look at a complex combination of history, institutions, culture, unequal allocations of natural resources and so on, to explain differences in income levels between countries. A model that predicts that North Korea should be richer than South Korea and that New Zealand should be much richer than Australia, just because of temperature differences, is not taken seriously. Obviously climate does have an impact in some circumstances. For example in a 2006 study Nordhaus et al[9] found that 20 percent of the income differences between Africa and the world's rich industrial regions can be explained by geographic variables, which include temperature and precipitation as well as elevation, soil quality, and distance from the coast.

[9] Nordhaus et al[9] (2006) Dell, Jones, and Olken: What Do We Learn from the Weather?

But it is quite another thing to argue as Kalkuhl and the NGFS do, that rich countries will be strongly affected affected by slow and anticipated temperature increases because workers (who are mostly protected by airconditioning when necessary) will become increasingly, in Montesquieu's words, slothful and dispirited.

Kalkuhl et al further conclude that as the negative relationship between temperature and GDP is 'stable' over different decades then:

technological change has not reduced the temperature sensitivity of our economies. The long-difference regressions confirm this interpretation: If technological change had weakened this temperature sensitivity in recent times, there would have been a significant positive effect of temperature (level) on decadal growth.

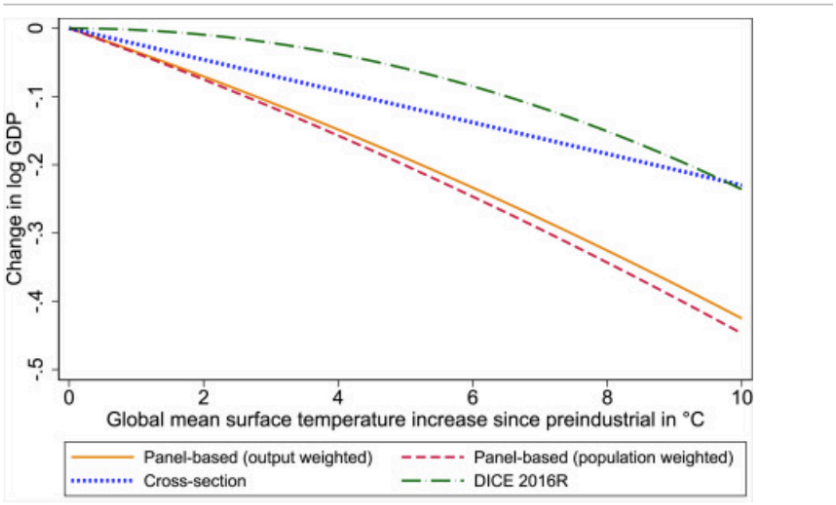
It is not clear what they are talking about here. The key long difference result was that there was no longer-term temperature outcome relationship, possibly due to adaptation, which is technological change.

A close inspection of the cross section relationships, shows that they weren't so stable. There was an economically signficant shift between 1995-2004 and 2005-2014 possibly reflecting the economic take-off by the hot Asian countries, though given the low quality of the data we would be reluctant to draw too many conclusions from their results.

The temperature damage curve

Figure eight shows the temperature damage curves derived from the panel-based and cross sectional models. The DICE model curve is based on more robust bottom-up modelling and analysis by Nordhaus and others.

Figure eight: Temperature Damage curve

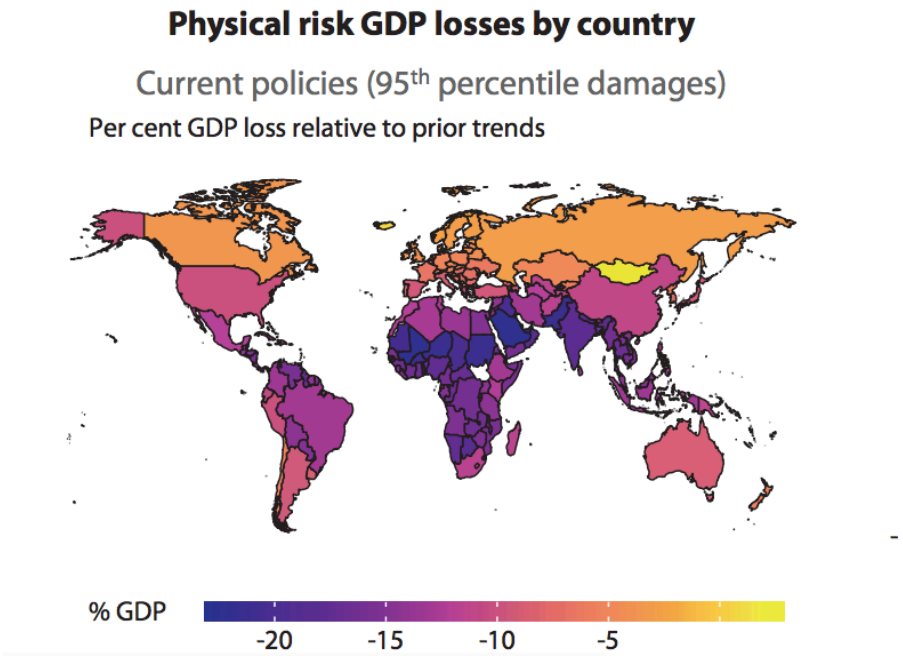


Country impacts

The NGFS presents GDP impacts on a country basis (see figure nine). The figure does not convey very useful information because there is no reference to either a date or the temperature change. However, the figure appears to match the Kalkuhl results for 2100 assuming RCP 8.5.

Hotter countries have a higher sensitivity because the GDP impact is a function of both the average temperature, and the temperature change, in the underlying model. New Zealand appears to have had a GDP reduction of about 10 percent. However, New Zealand modelling suggests there might be small gains primarily due to carbon fertilisation.

Figure nine: GDP impacts by country



Additional costs

As noted above it is stated that there are additional costs not captured by the model.

The methodology does not include impacts related to extreme weather, sea-level rise or wider societal impacts from migration or conflict. For given countries these would likely strongly increase the physical risk.

The methodology does, in principle, take these impacts into account. It is a reduced form model that captures temperature and the other physical changes that are caused by and correlated by temperature increases. The

socioeconomic impacts are likely to be minor in higher income countries so the impact on world welfare should be moderate.

Although some studies capture non-linearities in biophysical processes as temperatures increase, few fully capture the potential risks of tipping points accelerating global warming.

Studies that have assessed the potential impacts from tipping points on policy responses find that emissions prices should be up to eight times higher.

The last point is interesting, but why weren't the studies cited? There is nothing in the references. At the time of writing of this paper, a study 'Economic impacts of tipping points in the climate system' by Dietz, Stoerk, Wagner had just been released. It synthesizes the literature and concludes that the risk of these tipping points occurring increases the economic cost of damages by about 25 per cent compared with previous estimates. This is the relevant result but much less scary than the NGFS eight times claim.

What is almost entirely lacking in the NGFS's narrative is any understanding of the impact of structural change and economic growth of future climate impacts on aggregate GDP. For example agriculture, (which can be vulnerable to climate change in some areas) accounted for 34 percent of India's GDP in 1983-4. It is 16 percent now, and could well be more like 5 percent by 2100.

As countries get richer they will be more capable of adapting to climate change and mitigating its impacts, but no account is taken of economic growth over the 80 years to 2100. It is entirely plausible that per capita GDP of the hot countries of South East Asia, for instance, will grow by an average of, say, 2.5 percent per annum throught to 2100, as they continue to catch up to the developed world. Table three shows the average incomes now and in 2100. 2100 is a different world. The poor countries have become moderately rich.

Table three: Economic projections South East Asia

Country	Current GDP per cap IMF $US	GDP per cap. 2100 2.5% growth $US	Population Million
Vietnam	3610	25992	98
Thailand	7700	55440	67
Malaysia	11600	83520	33
Indonesia	4260	30762	271

Philippines	3650	26280	111

Finally, the claim that a 13 percent fall in GDP is 'unprecedented' is alarmist and inaccurate. If the counterfactual growth rate in the world economy is 2 percent then this rate falls to 1.85 percent when the 2100 income level is 13 percent lower. A change in the average growth rate of 0.15 percentage points over long historical periods is not unprecedented in history. Indeed a change of this magnitude would hardly be noticed and obviously poses no threat to financial stability.

The NGFS seems to have somehow gotten into their heads the notion that the 13 percent decline is a sudden concentrated shock akin to the great depression. And it gives this impression to its readers. But it is not a shock event, it is just the result of a slightly slower growth rate over 80 years.

In our view the modelling the NGFS has relied on is fundamentally flawed and grossly exaggerates the likely costs of temperature increases. It is a backward step in the analysis of the economics of climate change. The NGFS should have been able to pick up on its shortcomings, but it appears that they are more interested in cheerleading and shock revelations than sound analysis of the implications of climate change on financial systems.

Extreme weather risks

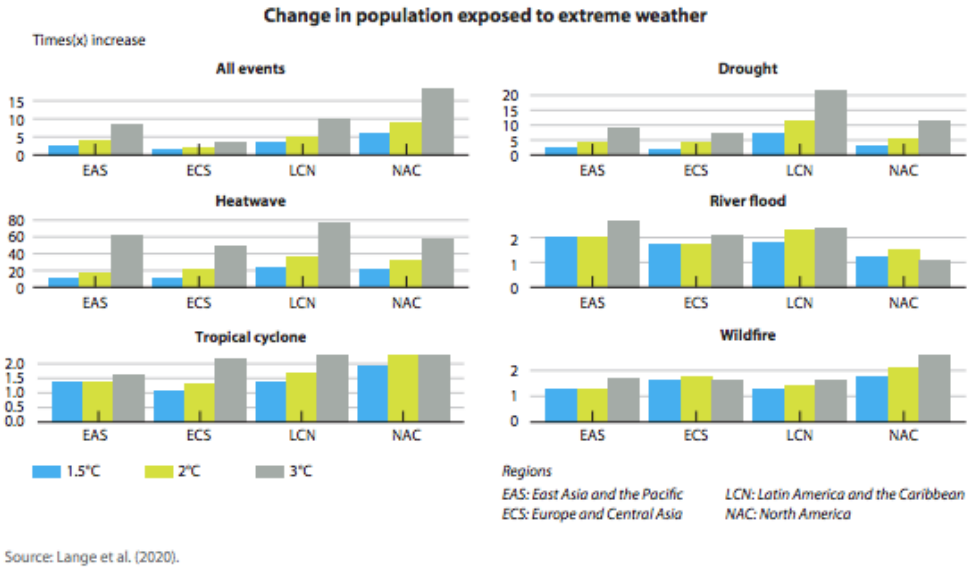
The second major output in the NGFS report were measures of the proportions of populations subject to extreme weather risks: river floods, crop failure, tropical cyclones, drought and heatwaves. The data inputs were extracted from a 2017 paper[10] and an online model has been constructed so individual country results can be downloaded. Figure ten shows the results by major regions. They are presented in terms of proportionate changes in impacts rather than in absolute terms, which makes it more difficult to assess their possible economic significance.

Again it is not very clear why it is the NGFS 's role to be disseminating this data. It is not possible to draw conclusions about the economic, and especially the financial stabilty, implications from it. The logic must be that if they show

[10] Lange, S., Volkholz, J., Geiger, T., Zhao, F., Vega, I., Veldkamp, T., ... & Frieler, K. (2020) Projecting exposure to extreme climate impact events across six event categories and three spatial scales. Earth's Future, 8(12), e2020EF001616.

people enough apparently scary data they will buy the NGFS story that 'bad things' are going to happen and of necessity central banks must be involved.

Figure ten: Exposure to extreme weather by type



Source: Lange et al. (2020).

The New Zealand impacts

Table four presents the New Zealand impacts generated by the NGFS online app. They are almost all trivial, which is further evidence that the Reserve Bank's financial stability concerns are enormously overstated.

Table four: NGFS app. Results New Zealand

	2100 NGFS current policies	Comment
Flooding: Expected increase in costs %	57	Superceded by NIWA 2019 study suggesting decrease in costs
Pop exposed to crop failure %	0.6	Trivial
Pop exposed to heat waves %	0	Zero
Pop exposed to wildfires %	.05	Looks to be overstated on review of NZ evidence
Land exposed to crop failure %	0.1	Trivial
Land exposed to river	.04	Trivial

flood %		

But the Bank has not drawn that conclusion. Its response to the NGFS scenario report[11] is as follows:

Now these scenarios have been published, we are beginning a project to summarise the latest insights on the main financial stability risks, looking across the growing pool of research being done in New Zealand and around the world. We will look at both transitional and physical impacts, and plan to incorporate some results from the NGFS climate change scenarios.

Our analysis will consider who is exposed to the costs, and how banks and insurers will be affected. One output from this will be identifying what has been done already and any data gaps.

Following this project, we intend to do more in-depth analysis of the key risks. For example, impacts of sea-level rise on housing and mortgage lending or the impacts on the agricultural sector.

To assist the RBNZ we will make this report available to them

Part ten: Climate-related financial disclosures

In September 2020, the Government announced its intention to implement mandatory reporting on climate-related risks and tasked the External Reporting Board (the XRB) with developing reporting standards to support the new regime. The comply-or-explain approach to climate-related disclosures will be mandatory for listed companies, Crown financial institutions, large insurers, registered banks and managers of investment schemes with more than $1 billion of assets. Reporting will be based on the Task Force on Climate-related Financial Disclosures (TCFD) framework.

The purposes of mandatory disclosures are described on the MBIE website:

- *ensure that the effects of climate change are routinely considered in business, investment, lending and insurance underwriting decisions;*

[11] Our approach to climate change RBNZ

- *help climate reporting entities better demonstrate responsibility and foresight in their consideration of climate issues; and*
- *lead to more efficient allocation of capital, and help smooth the transition to a more sustainable, low emissions economy.*
- *help New Zealand meet its international obligations and achieve its target of zero carbon by 2050.*
- *help to address climate change risks outlined in the National Climate Change Risk Assessment by making our financial system more resilient.*

The Government thinks that climate change disclosures are an essential part of the net zero journey. Announcing the introduction of the Bill the Commerce and Consumer affairs Minister David Clark said:

"We simply cannot get to net-zero carbon emissions by 2050 unless the financial sector knows what impact their investments are having on the climate. This law will bring climate risks and resilience into the heart of financial and business decision making."

Disclosure is one of those things that every one seems to be in favour of, but there appears to have been no analysis of how it will contribute to meeting New Zealand's net zero target, when we already have an emissions trading scheme and other climate policies.

Disclosure not essential to meet the net zero target

The Minister's claim that an emissions disclosure regime is 'essential' is obviously wrong. The Climate Change Commission projections showed that New Zealand could get to net zero by 2050 with an emissions price of $50. There was no contribution from financial disclosures in their model.

With the ETS, consumers and producers will be responding to the price signals that will drive the right behavior without them necessarily being aware of the emission component of what they are consuming and without them having to record and disclose their emissions. It is just necessary for emissions to be recorded at source in accordance with the ETS rules. Recording and disclosing emissions on both a consumption and production basis is redundant and will result in double counting.

When there is a comprehensive carbon tax or trading scheme a disclosure regime is at best a waste of time and money. It is just an organized form of virtue signaling. To the extent that disclosures change behaviour, then this will not impact on the total amount of emissions. It simply shifts them to more expensive emission reductions. Assume that a corporate board directs a 10,000

tonne reduction in emissions, to demonstrate that it is doing 'the right thing', at a cost of $500 a tonne. This reduces the company's demand for emission credits, reducing the ETS price, which in turn increases emissions by other parties. Total emissions will be the same, but the last 10,000 tonnes will have cost $500 rather than the market price of $50.

At the company level a centralized Board-driven quantitative planning process has been substituted for a market-based system run by the management.

Pushing carbon prices on the rest of the world?

One argument for the disclosure regime is that it is a way of imposing some sort of penalty on producers in countries where there is no carbon tax or effective emission reduction policies. High emitters will face demand pressures as importers seek to reduce their recorded emissions. The problem with the disclosure approach, is that it does not distinguish between products with an embedded carbon tax payment and those that have not paid the tax..

Not consistent with the Paris agreement

The TCFD does not appear to be consistent with the Paris framework in several respects. Paris is based on a production-based emission measurement framework. The TCFD picks up emissions at both the production and consumption levels and there can be multiple counts of the same emission depending on how many upstream and downstream emissions are captured.

Not consistent with New Zealand targets and policy

Corporates are already netting off cheap foreign credits to reach carbon neutrality for their financial reporting, but these credits do not count towards reaching New Zealand's self-imposed domestically-driven targets.

Will be costly

The major banks are 'all in' on climate-related financial disclosure and there will be many corporates and fund managers who will be keen to strut their climate caring credentials. Mandatory disclosure might not cost them anything more than they will already spend. Though this will depend on the enthusiasm with which the XRB approaches its task. It may require many disclosures that are expensive to provide. Many of the 200 affected companies will not be so keen on expensive virtue signaling exercise and will regard it as a waste of resources

In terms of the direct costs the XRB was allocated $17.3 million for the next five years in this year's Budget.

Will not make banks safer

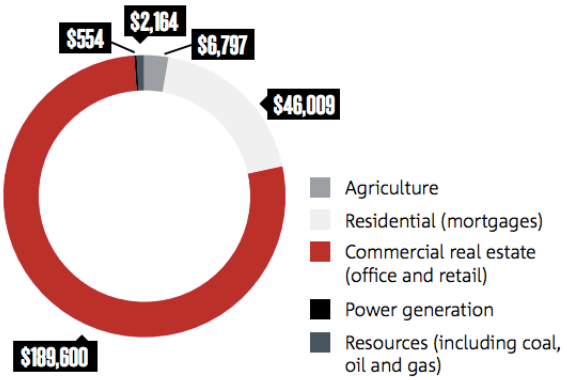
Our discussion on bank climate-related risk and all of the case studies supporting the TCRD showed that climate change risk is generally trivial. In any event, bank disclosures on the amount of borrowers' emissions are a very poor proxy for risk. To understand the real risk requires a detailed understanding of industry, structures and dynamics, which cannot be captured by a simple physical emission metric. A coal burning power station will be a large emitter but might be able to shift a higher carbon price to its customers. On the other hand a tourism operation might have low direct emissions but might be highly vulnerable to increased charges on air travel and a change in consumer sentiment.

Perverse responses possible

If banks were to take some of their metrics seriously there could be some perverse risk impacts. For example NAB has devised a metric based on the emission intensity of its lending. The more dollars of lending per tonne of emissions, the better the performance. NAB's Figure three below shows that power generation lending ($554 per tonne) is much more emissions intensive than commercial real estate ($189,000).

Figure eleven: NAB emissions lending intensity

Figure 3: Dollars lent (EaD) in Australia per tonne of estimated emissions (tCO2-e) generated: Initial sector estimate



This chart represents the estimated Scope 3 GHG emissions attributable to NAB's lending to Australian customers in these sectors. Detailed methodology available in our 2020 Sustainability Data Pack.

NAB could improve its climate performance by more leveraged lending to existing clients (more dollars of loan per tonne of emissions,) or by lending more on commercial real estate. Highly leveraged commercial real estate lending has been the road the road to ruin for many a bank and we wouldn't

expect this to change in the future. Reducing climate-related risk using this metric could markedly increase, not decrease, systemic risk. Hopefully for the New Zealand and Australian banking systems this is just a piece of public posturing not to be taken seriously in actual decision-making.

Unlikely to improve fund managers' performance

One of propositions behind the disclosure regime is that the market has been mispricing climate-related financial risks and that disclosure will improve this. If that were once true, it isn't now. Indeed there is a bigger risk that fund managers will become over-weight on 'green' projects, driving down returns leading to poorer performance of the 'greenest' portfolios.

Incentives to overstate the risks

Banks may have an incentive to overstate their qualitative risks. A report that forthrightly demonstrates that there is 'nothing to see here' risks a bank being labeled as a 'denier', and potentially subject to more regulatory scrutiny or worse. It is easier go along with the programme, agreeing that this is a serious risk issue and that the bank is heavily committed to addressing the issue.

Review of the Westpac NZ Climate Change Risk report

The following is a review of Westpac's recent climate risk report, which may provide some insights into the costs and benefits of climate-related financial disclosures.

It begins a standard statement of commitment to climate-related disclosures.

Westpac NZ believes that relevant, accurate, comparable and timely climate-related disclosure, in line with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations, is important to stakeholders and will help promote efficient capital markets and broader financial system stability.

On governance there is a fairly standard description of governance arrangements.

On strategy:

Westpac NZ takes a holistic approach to understanding the impact of climate-related risks on New Zealand, customers and the bank. This provides better insight into the drivers of risk and how to manage those.

The most important disclosure is a discussion on sea-level rise. To its credit Westpac has acknowledged this potentially thorny issue and shared some of their analysis.

During 2020, Westpac NZ undertook a scenario analysis of its exposure to coastal hazards (flooding and erosion) resulting from sea level rise. The analysis looked at current and future risks out to 2050 under 1.5˚C and 4˚C climate change scenarios (Representative Concentration Pathways RCP2.6 and RCP8.5).

The 4°C temperature assumption is incorrect. This is the worst-case IPCC outcome for 2100, not 2050.

Westpac NZ focused on coastal hazards because the available hazard data is more robust compared to other relevant physical hazards such as river flooding, drought, cyclone risk or wildfire.

Westpac has identified the real risk. The others are trivial from a banking risk perspective.

Based on data provided by the National Institute of Water & Atmospheric Research – Taihoro Nukurangi (NIWA), Westpac NZ identified that 2.3% of its residential mortgage portfolio, 2.1% of its commercial mortgage portfolio and 2.9% of its agricultural mortgage portfolio are potentially subject to heightened risk from these hazards. Heightened risk is defined as annual exceedance probability of 10% or more, as well as general exposure to coastal erosion under NIWA's Coastal Sensitivity Index.

The data indicated that over two thirds of those properties are at heightened flood risk already.

It is difficult to understand this analysis. Heightened risk is described as a 10% probability of exceedance, but insurers are likely to be pulling out when the risk gets to about 1:50. Elsewhere NIWA has reported the number of buildings and other structures 'at risk' against a 1:100 standard, so perhaps the 1:10 is a typo, though it was repeated in the March 2021 disclosure statement. If 2.3 percent of the portfolio is potentially at risk (presumably at some future date) and two-thirds of these are already at a heightened risk, then this implies that 0.12 percent are being inundated each year (10 percent of 1.2 percent). Is this true or has Westpac got its analysis wrong? If it is true why hasn't somebody noticed the widespread physical damage.?

There might be a problem with the NIWA data Westpac is using. NIWA has published data on inundation risk using the 'bathtub' method which assumes that inundation risk is purely a function of height above sea level, ignoring

natural and built protections against sea water ingress. In many New Zealand cities it can substantially overstate the risk. For a discussion on this point see Tailrisk Economics 'The National Climate Change Risk Assessment: A review'.

It is important that Westpac gets its understanding of the data right, lest its public announcements, in particular the following, cause unnecessary concerns amongst borrowers.

In the next five years, property owners may face insurance premium increases, higher excesses, or exclusions of some hazards. In some cases, property owners may be unable to renew insurance. Higher premiums may impact customers' ability to service debt, while inability to adequately insure properties could lower their value. This could create a credit risk to Westpac

Industries exposed to climate-related risk.
Table five shows that Westpac's climate related exposures total $14.7 billion or about 50 percent of its total corporate exposures.

Table five: Westpac NZ's lending exposure to key industries subject to climate-related risks.

INDUSTRY SECTOR	CLIMATE-RELATED RISKS	TOTAL COMMITTED EXPOSURE (TCE)
Agriculture – **Dairy** – **Sheep Beef** – **Horticulture** – **Forestry**	Mix of physical risks, e.g. drought, flooding, erosion, storms, and transition risks, e.g. consumer preferences, regulation, as well as opportunities, e.g. forestry and horticulture.	$10.17b - $6.59b - $2.02b - $1.24b - $0.32b
Oil & Gas – **Mining & Production** – **Supply & Retail** **(e.g. petrol stations)**	Primarily transition risk as demand declines over the long-term.	$0.44b - $0.28b - $0.16b
Transport	Mix of physical risks, e.g. exposed infrastructure, disruption from extreme events, and transition risks, e.g. transition to electric vehicles, hydrogen etc.	$2.05b
Electricity Generation	Mix of physical risks, e.g. dry years, disruption from extreme events, and transition risks, e.g. phasing out of non-renewables.	$2.08b

It is not clear what these disclosures tell us about transitional and physical risks and how Westpac's large exposure to the dairy industry fits with a Paris consistent strategy.

Westpac NZ's ESG approach recognises that due to increasing regulatory and consumer pressure, emissions-intensive sectors will need to align their longterm strategy and capital investment to a low-emissions economy. Customers will need capital to make

this transition. There are risks relating to customers unable to undertake this transition, but opportunities for Westpac NZ to support customers who can, through sustainable finance structures.

Which doesn't tell us very much. Nor is it clear whether the exposures are are to positive or negative shocks. Climate change might be good for the sheep and beef sector because farmers have the option of switching to much more profitable carbon farming.

Metrics and targets.

Westpac has the following targets

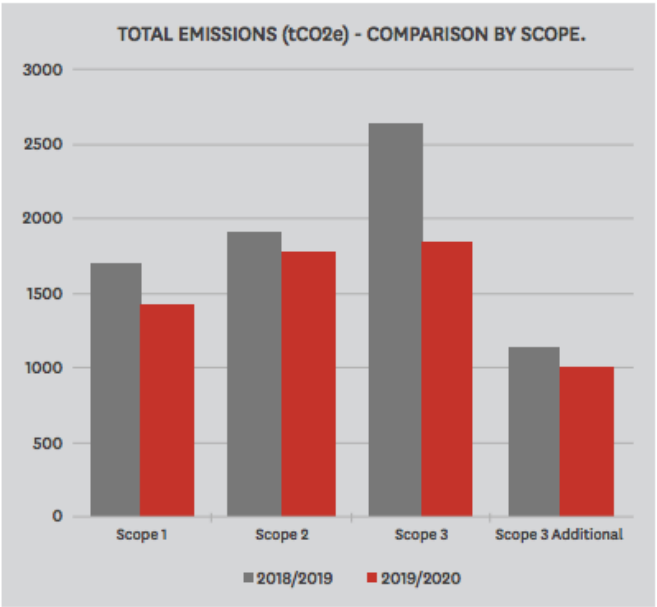
1. *Reduce our operational emissions by 30% by 2025 (2019 baseline).1 19% reduction*
2. *Provide $2 billion in lending to business customers for climate change solutions by 30 September 2020. $1.6b*

And two metrics:

The direct footprint metric

The compoments of the direct footprint metric are not explained but the amount of emissions are trivial.

Figure twelve: Westpac emmissions



Lending metric

The focus is just on lending on fossel fuel mining, which has always been a small part of the portfolio and the decline in the exposure looks good in the

figure. The metrics and targets for the biggest lending portfolios, housing and farming, are missing.

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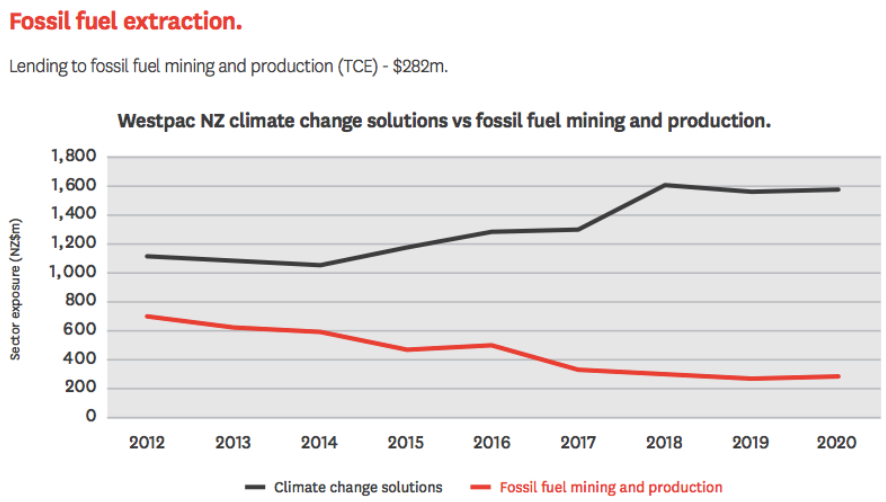
Figure 12: Westpac fossi fuel extraction lending



Scenario analysis

A key part of the TCFD framework is scenario analysis. There is none in the Westpac report. Possibly it is early days and some are coming. As noted above Westpac has identified 2.3 percent of its housing lending portfolio of $55.3 billion as being in some sense at risk from sea-level rise. But the potential loss implications of this are left hanging. Are the possible losses large and concentrated over a relatively short period of time, or they small and spaced out over many years? A scenario analysis would explore those relationships and either put concerns to rest or identify a real problem. Our assessment is that there isn't a substantial issue, but it would be a worthwhile contribution for Westpac to do the modelling and report the results.

Most probably Westpac was waiting for the Reserve Bank stress test and will just go along with whatever hairbrained assumptions are foisted on them.

An international example: Barclays Bank 2020 climate related disclosures

Barclays was a member of the TCRD and has been disclosing on the TCB basis for four years. Their report runs to 31 pages. There are plenty of generalities and corporate speak but little that gave us a sense of the risks. Six percent of the loan portfolio was described as having a 'heightened' risk but this tells us nothing about the actual change in credit risk due to climate change.

Barclays scenario analysis presented two Network of Central Banks and supervisor for Greening the Financial System (NGFS) scenarios over 2020-50.

The first is a disorderly scenario from a zero price for carbon in 2030, to a $US 700 price by 2050. This is an absurd scenario. The European carbon price is already above 50 Euros, so a zero price by 2030 Is extremely unlikely, as is a carbon price of $US700 by 2050. It is then just assumed that this will have a negative effect on GDP, but there is no discussion of how big this shock is and why it occurs. The next step is to divide the loan portfolio by their climate sensitivity and subject them to this macroeconomic shock

The impact on the household sector was calculated by assuming that some areas without flood risk would have material increases in flood risk in the future. This feeds into house prices, which increased credit risk but the consequent losses were described as very small.

All of the reported results of this test were entirely qualitative. We don't know whether there were large quantitative impacts or not, but we suspect there weren't, which is why they were coy about the results.

The second scenario is the 'hothouse world' where no climate action is taken. It focuses entirely on the physical risk. This is the entirety of the description of the test and the results.

The methodologies outlined above have been calibrated to account for additional physical risks. For example, for the flood risk assessment in UK mortgages, we use flood risk assessments for an increased temperature scenario and ***without flood defences****. The results of this stress test highlight specific vulnerabilities, notably to consumers in coastal-lying cities in the US, postcodes exposed to high flood risk in the UK, and counterparties in sectors with vulnerabilities to physical risk*.

The assumption that flood protections would be removed is obviously an absurd contrivance designed to pump the numbers (if they were ever reported). Probably Barclays's thought that was a silly assumption but would have felt bound to adopt this Bank of England 'guidance'.

So what did we lean from this leading bank's scenario analysis?

Nothing.

Metrics and targets

Barclays measure their financed emissions and their primary target is a downward trajectory consistent with an IEA sustainable development scenario, which has become a benchmark for 'Paris compatible path'. It is just assumed that their emissions will follow the path.

The Reserve Bank's Disclosures

The Reserve Bank's disclosures show that its carbon footprint is just over 10,000 tonnes. Most of that is indirect, coming from the purchase of IT and other services. Emissions under the Bank's control amounted to less than 400 tonnes.

The major omission was emissions from consumption facilitated by staff salaries. The expansion in staff numbers and salaries over the last two years will have substantially increased emissions from this source.

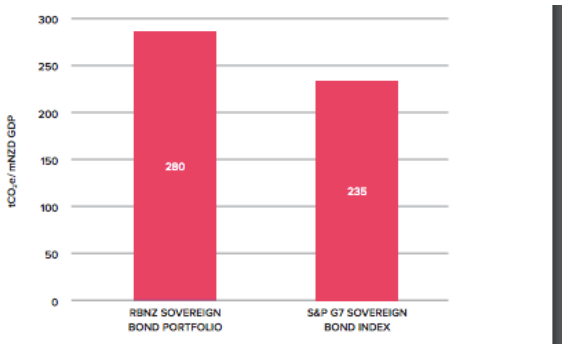
This year the Bank engaged S&P to examine the carbon intensity of the Bank's sovereign bond portfolio. The metric is carbon intensity (emissions/GDP). It includes emissions on the territory plus emissions imbedded in imports (so double counts, because exported emissions are not deducted) and does not appear to account for carbon withdrawals, which are important in the New Zealand context. On this measure the Bank's portfolio was more carbon intensive than the S&P G7 index, in part because of its holdings of New Zealand bonds.

The Bank's response to this information was:

This analysis is useful to give an indication of the relative climate exposures today rather than any targets to aim for. It is also important to consider climate risks on a forward-looking basis.

It might be comforting that the Bank does not appear to be considering divesting its New Zealand Government bonds to improve its performance but otherwise this appears to be a perfectly useless piece of information and a waste of money. If the Bank wanted to know the carbon intensity of diiferent countries to better 'understand' risk it could have got that from the World Bank's table on that measure. For free.

Figure thirteen: RBNZ sovereign portfolio: weighted average carbon intensity



Part eleven: What is the harm?

The case could be made that this is all just a bit of relatively harmless fun for the Governor and the Bank. The disclosure regime is being run by MBIE and MfE and that is where the greatest costs will lie. The Government does not appear to have taken the Governnor up on his offer to be at the centre of everything.

There will be actions that fall within the Bank's purview and banks and insurers can expect some increased costs in complying with data requests and an overblown and largely useless stress testing exercise on the Bank of England model.

The biggest costs will probably be an increase in insurance premiums. Insurers may not be slow to raise their rates, leveraging off the Reserve Bank's overreaction to the true risks. Bank staff identified this as a risk before the Governor's catastrophist narrative took hold.

The wider costs will be more subtle. The Bank is contributing to an eco-system of muddled thinking and hysteria that can lead to increased costs elsewhere in the economy.

Central bankers used to be regarded as 'the adults in the room', sometimes counselling against extravagant claims and doing the analysis to help the public to be better informed. Those days appear to be over

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