



Analytical Note

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Assessing the economic and fiscal impacts of climate change in New Zealand

A new framework to support deeper understanding

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Abstract

More fully understanding the impacts of climate change to New Zealand is a critical step in evaluating the potential threats or opportunities posed to New Zealanders' living standards. *Ngā Kōrero Āhaurangi Me Te Ōhanga | Climate Economic and Fiscal Assessment 2023 (CEFA)*, a joint report by the Treasury and the Ministry for the Environment, contributed to this task by collecting, organising and providing information on the economic and fiscal impacts of climate change to New Zealand. The CEFA also presented a framework for assessing these impacts. While new, this framework is strongly aligned with and has built upon a number of international approaches. The CEFA framework categorises climate impacts into two categories: physical and transition. These impacts are then presented as flowing through economic channels to economic impacts and feedback loops. These then flow through to fiscal impacts. An important characteristic of the framework is the influence of choice, including those made by policymakers. This paper serves as a background paper for the CEFA framework. It details the influence of other international frameworks and then walks through the components of the framework, explaining how they fit together to paint a more comprehensive picture. We also consider the framework to serve as a useful guide to identifying areas for further work and deeper understanding. This paper concludes by identifying and suggesting key questions to inform future direction of work in this space.

Introduction

Climate change is accelerating, and its effects are being increasingly felt by New Zealanders and around the globe. Both climate change itself and how New Zealand and other countries respond to the risks and opportunities it presents will have material economic and fiscal implications. While there are things we know for certain, other things remain less certain. The overall cost of climate change will be influenced by how flexible and adaptable both the economy and decision-makers are.

The Treasury's first Wellbeing Report (*Te Tai Waiora*) highlighted climate change as a key risk to the sustainability of future wellbeing.¹ More fully understanding the impacts of climate change on New Zealand is therefore a critical step in further evaluating the potential threats or opportunities posed to New Zealanders' living standards.

Ngā Kōrero Āhaurangi Me Te Ōhanga | Climate Economic and Fiscal Assessment 2023 (CEFA), a joint report by the Treasury and the Ministry for the Environment, contributes to this task by collecting, organising and providing information on the economic and fiscal impacts of climate change to New Zealand.² It highlights both risks and opportunities of physical climate change and New Zealand's transition to a low-emissions and climate resilient future. The CEFA has a particular focus on physical and financial capital given its significance for the Crown's fiscal position.

Within the CEFA, a framework is presented for assessing climate-related economic and fiscal impacts. It identifies sources of climate-related impacts both from physical climate change and the country's low-emissions transition, sectoral and macroeconomic channels through which economic impacts occur and where these flow through to direct and indirect fiscal impacts. Key sources of variability are also identified, particularly those that may moderate or amplify impacts. Choices by decision-makers, including policy choices, are also highlighted as playing a role in determining how economic and fiscal impacts are ultimately realised.

The CEFA presents research and information that spans the breadth of this framework, both undertaken within a New Zealand context, including by the Treasury and others, and internationally. However, there is still much work to be done to deepen the broader understanding of the economic and fiscal implications of climate change. Given the importance of these implications for New Zealand's physical and financial capital, we consider improving understanding in this area to be a key part of a comprehensive approach to better understanding the impacts of climate change across all of our wealth domains.

This paper presents the framework for assessing the economic and fiscal impacts of climate change in New Zealand as published in the CEFA. It also identifies areas we view to be particularly valuable for additional work.³ Importantly, the proposed research agenda is not intended for the Treasury alone. Many, if not most, of the key questions identified will be best answered by those in academia or outside of the public sector, both within New Zealand and abroad.

¹ The Treasury's first Wellbeing Report can be found at <https://www.treasury.govt.nz/publications/wellbeing-report/te-tai-waiora-2022>

² The full CEFA can be found at <https://www.treasury.govt.nz/publications/climate-economic-fiscal-assessment/nga-korero-ahuarangi-me-te-ohanga-2023>

³ Importantly, while this paper speaks to the CEFA framework, it has been written as an independent piece of work by the authors. This paper should therefore be considered as related to, but distinct, from the CEFA (which is a joint organisational report published by the Treasury and the Ministry for the Environment).

A framework for assessing the economic and fiscal implications of climate change in New Zealand

The framework presented in the CEFA focuses on New Zealand-specific impacts and the ways they can affect the economy and the Crown's fiscal position. The intent behind the framework is to summarise and categorise impacts with further links to the source of these impacts, the channels through which they impact New Zealand's physical and financial capital and how sources of variability may influence how they are ultimately realised.

While the framework presented in the CEFA is new, it aligns strongly with existing domestic and international approaches to examining the economic and fiscal impacts of climate change. The following frameworks and approaches were particularly influential:

- the framework for climate risk and opportunity identification developed by the Financial Stability Board's Task Force for Climate-related Financial Disclosures (TCFD) and the Network for Greening the Financial System (NGFS)⁴,
- the approach taken by the United Kingdom's Office for Budget Responsibility in its *Fiscal risks report 2021*⁵
- the approach taken by the Coalition of Finance Ministers for Climate Action in its overview of how climate-related risks may manifest in different sectors of the economy and alter macroeconomic conditions⁶
- the Basel Committee on Banking Supervision's articulation of climate-related risk drivers and their transmission channels⁷, and
- the classification used in New Zealand's first National Climate Change Risk Assessment (NCCRA) (to inform the CEFA's conceptual approach to considering physical climate risk).⁸

This section provides further background on how these frameworks and approaches contributed to the development of the CEFA framework.

Contribution of other frameworks

Financial Stability Board's Task Force for Climate-Related Financial Disclosures

The TCFD's classification of climate-related risks into two broad categories – physical and transition risk – has significantly influenced how public and private sector entities consider climate-related risk.⁹ The CEFA framework has also drawn upon this classification.

⁴ Task Force for Climate-Related Financial Disclosures, 2017 and Network for Greening the Financial System, 2019.

⁵ Office for Budget Responsibility, 2021.

⁶ Dunz and Power, 2021.

⁷ Basel Committee on Banking Supervision, 2021.

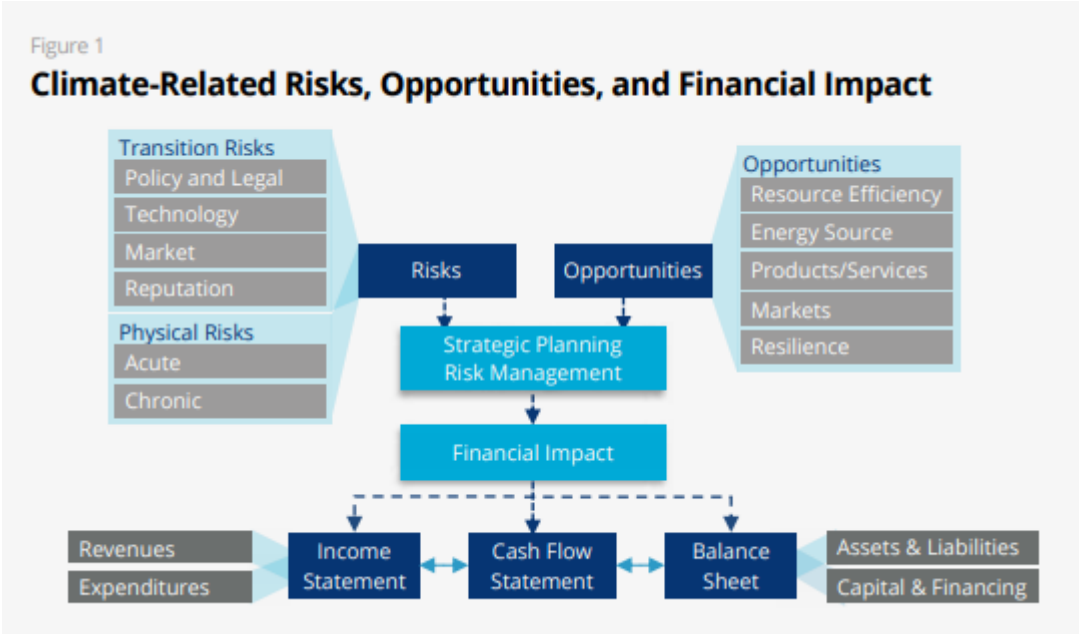
⁸ Ministry for the Environment, 2020a.

⁹ Task Force for Climate-Related Financial Disclosures, 2017.

Given the national and whole-of-economy focus of the CEFA framework, as compared to the TCFD’s organisational focus, the CEFA framework has adapted elements of the TCFD’s classification to this broader context. For example, in addition to classifying physical climate impacts as either acute or chronic (in line with the TCFD’s approach), the CEFA framework also considers a third source of physical impact - adaptation and resilience policies and actions. Another example is the CEFA framework’s representation of ‘preferences and sentiments’ as a source of climate impacts from the low-emissions transition, as opposed to the TCFD classification’s more organisationally focused ‘market’ or ‘reputation’ risks.

Rather than treating risks and opportunities as distinct, the CEFA framework’s focus on impacts means both risks and opportunities can be captured concurrently. The CEFA framework is also focused on how these impacts flow through economic transmission channels, rather than organisational strategic planning and risk management. The role of decision-makers and the importance of choice are key components of both frameworks.

Figure 1 – Climate-Related Risks, Opportunities and Financial Impact



Source: Task-Force for Climate-Related Financial Disclosures, 2017.

Network for Greening the Financial System

The Central Banks and Supervisors Network for Greening the Financial System (NGFS) was launched in 2017 as a voluntary, consensus-based forum to share best practice and contribute to the development of climate and environment related risk management in the financial sector and mobilise mainstream finance to support the transition toward a sustainable economy.¹⁰ Within its first comprehensive report, the NGFS identified physical and transition risk drivers and how they impact the economy and financial system through direct and indirect transmission channels.

¹⁰ Network for Greening the Financial System, 2019.

The CEFA framework’s impact sources align strongly to the NGFS ‘risk drivers’ (which, themselves, align strongly to TCFD’s classification of risks). The CEFA framework also illustrates how these drivers flow through to the economy via transmission channels. While the NGFS framework focuses on the economy and financial system as broadly distinct, the CEFA framework captures the NGFS’ financial system within its economic impact channels.

Figure 2 – NGFS representation of how physical and transition ‘risk-drivers’ flow through to financial stability risks

Figure 1 From physical risk to financial stability risks

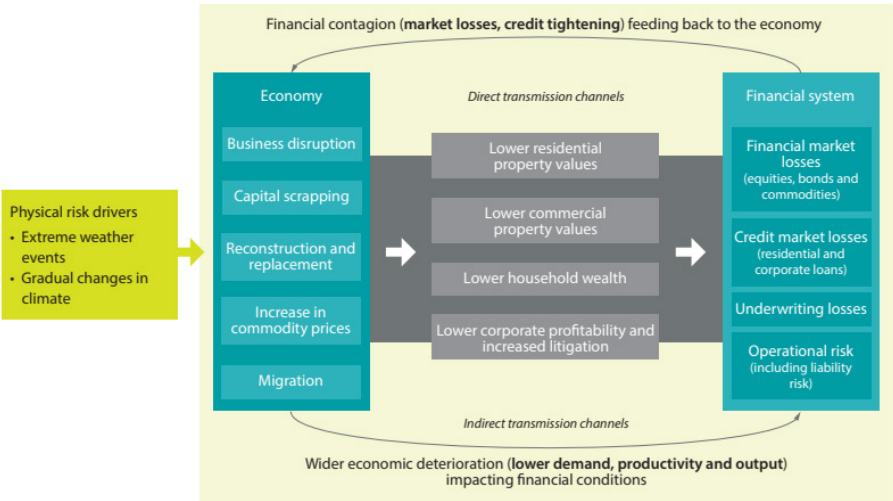
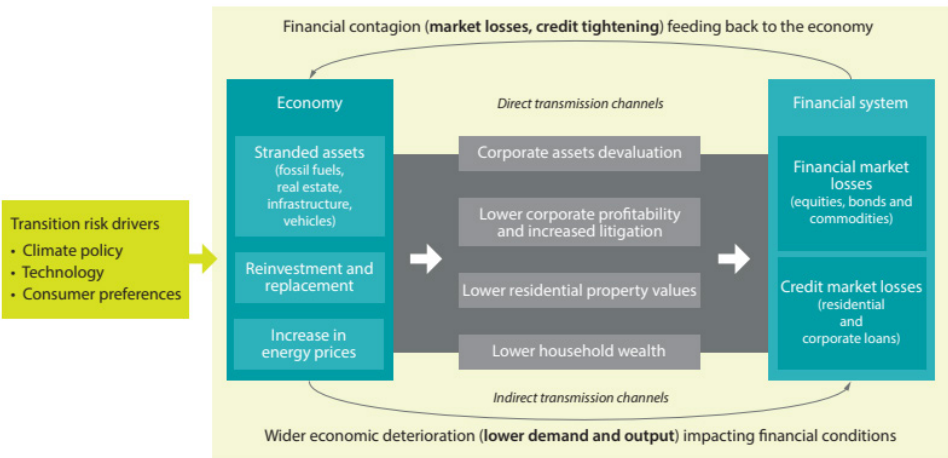


Figure 2 From transition risk to financial stability risks



Source: Network for Greening the Financial System, 2019.

United Kingdom’s Office for Budget Responsibility Fiscal risks report

The United Kingdom’s Office for Budget Responsibility (OBR) *Fiscal risks report 2021* covered several large and potentially catastrophic risks in depth, including the risks to the public finances presented by climate change. It included a range of scenarios illustrating the fiscal impact of different way to get to net zero by 2050 in line with a framework it had developed in its *Fiscal risks report 2019*.¹¹

¹¹ Office for Budget Responsibility, 2021 and Office for Budget Responsibility, 2019.

OBR’s framework also uses the categorisation of climate risk into physical and transition risks. There is a focus on macroeconomic shocks and impacts, on both the demand and supply side. The CEFA framework’s representation of macroeconomic impact channels has drawn on this representation of macroeconomic risks.

Figure 3 – OBR examples of macroeconomic risks from climate change

Table 9.1: Examples of macroeconomic risks from climate change

| Type of shock/impact | Physical risks | | Transition risks | |
|----------------------|-------------------------------|--|---|--|
| | From extreme weather events | From gradual global warming | | |
| Demand | Investment | Uncertainty about climate events | 'Crowding out' from climate policies | |
| | Consumption | Increased risk of flooding to residential property | 'Crowding out' from climate policies | |
| | Trade | Disruption to import/export flows | Distortions from asymmetric climate policies | |
| Supply | Labour supply | Loss of hours worked due to natural disasters | Loss of hours worked due to extreme heat | |
| | Energy, food and other inputs | Food and other input shortages | Risks to energy supply | |
| | Capital stock | Damage due to extreme weather | Diversion of resources from productive investment to adaptation capital | Diversion of resources from productive investment to mitigation activities |
| | Technology | Diversion of resources from innovation to reconstruction and replacement | Diversion of resources from innovation to adaptation capital | Uncertainty about the rate of innovation and adoption of clean energy technologies |

Source: Office for Budget Responsibility, 2019.

Coalition of Finance Ministers for Climate Action

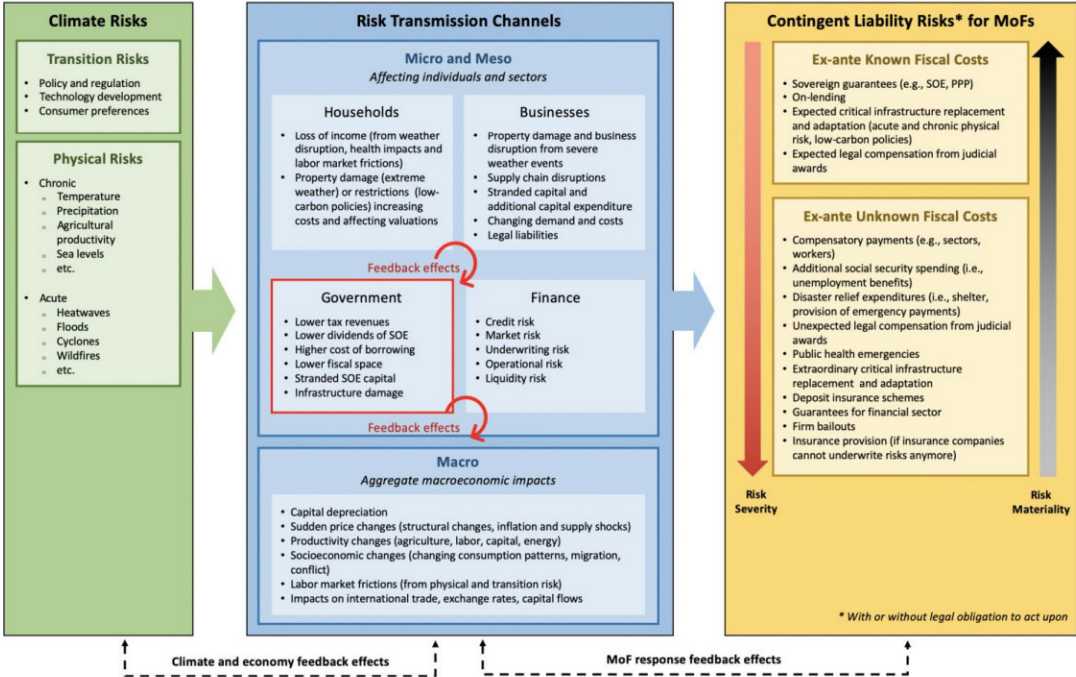
Under the direction of the Co-Chairs of the Coalition of Finance Ministers for Climate Action (CoFMfCA), World Bank authors produced an overview report of climate-related risks for Ministries of Finance focused on how these could lead to higher fiscal costs or trigger contingent liabilities.¹² The materiality of risk is highlighted as being dependent on the interplay of climate-related risk transmission channels, feedback loops, specific country context and climate action measures.

The CEFA framework drew on the CoFMfCA’s work for the classification of transmission channels and role of feedback effects, particularly through policy choices. While the COFMfCA focuses on transmission channels to contingent liability risks for Ministers of Finance (categorised by whether or not costs are known before the event/risk is realised), the CEFA framework focuses more broadly on fiscal impact, categorised by revenue, expenditure and other impacts. However, even while not explicitly referenced by the CEFA framework, it too can inform an understanding of contingent liability risks that New Zealand Ministers of Finance may face.

¹² Dunz and Power 2021.

Figure 4 – Coalition of Finance Ministers for Climate Action representation of climate-related risk transition channels for Ministries of Finance

Figure 2: Climate-related risk transmission channels and Ministries of Finance



Source: Dunz and Power, 2021.

Basel Committee on Banking Supervision

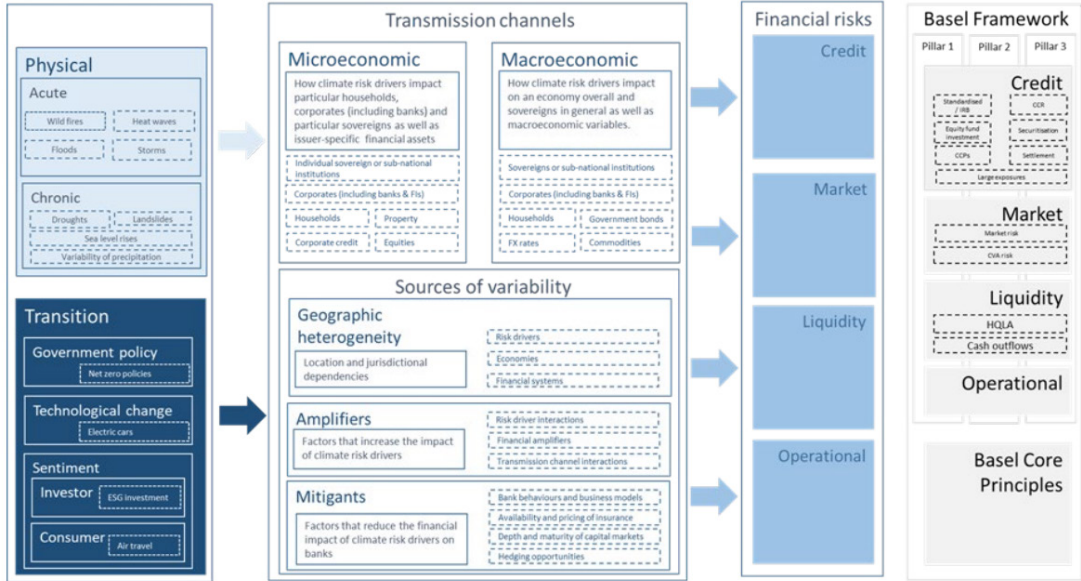
The Basel Committee on Banking Supervision (BCBS) established a Task Force on Climate-related Risks as part of delivering on its broader mandate to support sharing information on developments in the banking sector to help identify current or emerging risks for the global financial system.¹³ The BCBS is therefore explicitly focused on the banking sector.

Despite the focus of the CEFA framework being broader than BCBS', the approaches share fundamentals with respect to the identification of risk drivers, transmission channels and sources of variability. The CEFA framework's representation of variability sources as amplifiers or mitigants is also directly influenced BCBS' representation.

¹³ Basel Committee on Banking Supervision, 2021.

Figure 5 – Basel Committee on Banking Supervision framework for financial risks from climate risk drivers

Figure 1: Financial risks from climate risk drivers



Source: Basel Committee on Banking Supervision, 2021.

New Zealand’s first National Climate Change Risk Assessment

Under the Climate Change Response (Zero Carbon) Amendment Act 2019, a National Climate Change Risk Assessment (NCCRA) must be prepared for New Zealand at least once every six years.¹⁴ The focus of NCCRAs is the risks to New Zealand from hazards that are caused, exacerbated or influenced by the physical impacts of climate change.

The first NCCRA sought to build an understanding of the risks and opportunities posed to New Zealand by long-term trends in the climate and changes in extreme weather.¹⁵ The CEFA’s consideration of physical climate risk draws heavily on the first NCCRA. Within the CEFA framework, the influence of the NCCRA is reflected in the highlighted sub-categories for chronic and acute sources of impact from physical climate risks.

¹⁴ Refer the Climate Change Response (Zero Carbon) Amendment Act 2019 for more detail on requirements regarding NCCRAs.
¹⁵ The purpose of NCCRAs is also to inform a series of National Adaptation Plans (NAPs) which represent New Zealand’s plans and strategies to address the risks identified in the NCCRA. New Zealand’s first National Adaptation Plan was published in 2022 – see Ministry for the Environment, 2022a.

Figure 6 – Illustrative selection of climate hazards to New Zealand, as identified in the first NCCRA

Table B1-2: Key categories (17) of hazards (blue shading) arising from climate change most likely to result in substantial risks to include in the NCCRA (this is not an exhaustive list)

| Hazard (arising from climate change) | Primary climate-related variables | Secondary climate-related variables |
|---|---|--|
| Higher mean temperatures: air and water | <ul style="list-style-type: none"> Higher day and night temperatures Higher mean water (freshwater and marine) temperatures | <ul style="list-style-type: none"> More heatwaves and warm spells Fewer frosts or cold days |
| Heatwaves: increasing persistence, frequency and magnitude | <ul style="list-style-type: none"> Higher day and night temperatures Increase in persistence of maximum daily temperatures above 25°C | <ul style="list-style-type: none"> Changes in seasonal winds Humidity changes from changes in cloudiness |
| More and longer dry spells and drought | <ul style="list-style-type: none"> Low seasonal rainfall Change in seasonal wind patterns Interannual variability (eg, ENSO) | <ul style="list-style-type: none"> Higher day and night temperatures |
| Changes in climate seasonality with longer summers and shorter winters | <ul style="list-style-type: none"> Fewer frosts or cold days Higher day and night temperatures Changes in seasonal rainfall | <ul style="list-style-type: none"> Changes in seasonal wind |

Source: Ministry for the Environment, 2020a.

Overview

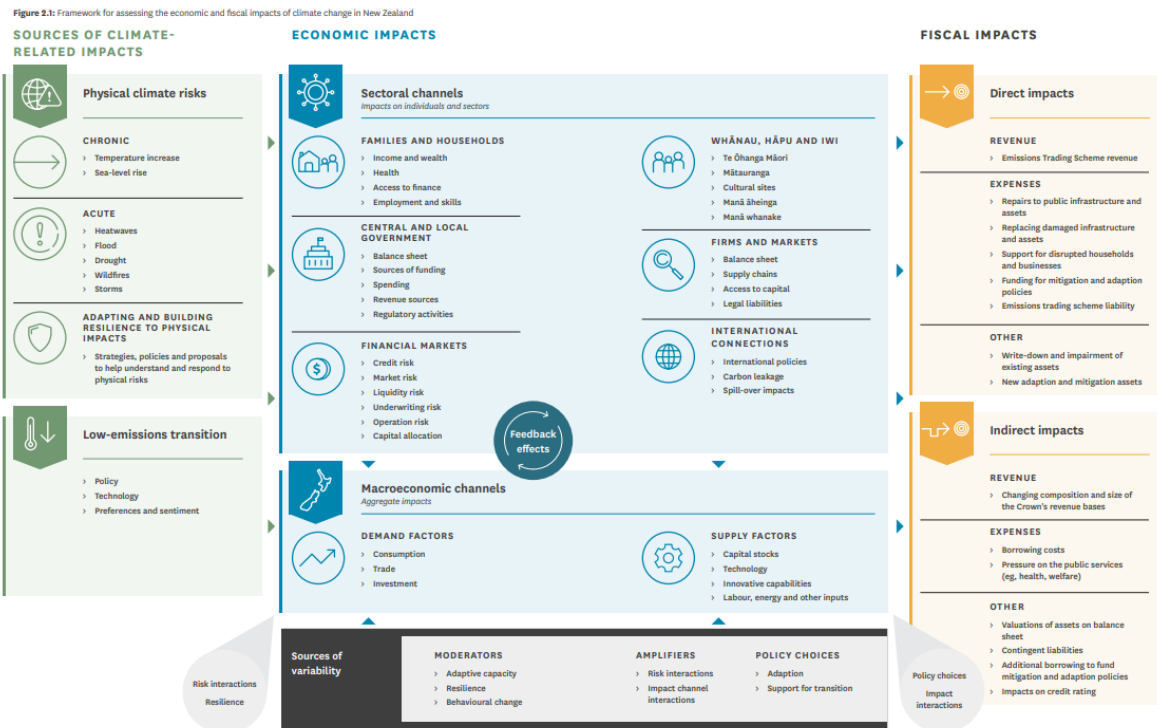
The CEFA framework (the framework) starts with an identification of the *sources of climate-related impacts*, categorised by whether they represent *physical climate risks* or are more broadly associated with the *low-emissions transition*. Within these categories, physical impacts are further classified as being *acute* or *chronic*, or from response to physical risks.

Sources of climate-related impacts flow through *sectoral* and *macroeconomic channels*, capturing economic impacts. The framework further distinguishes individual and sector level channels (eg, households, firms, or whānau, hāpu and iwi) from aggregate impacts, such as those to broader *demand* or *supply factors* across the economy. It also explicitly recognises feedback loops between these sectoral and macroeconomic channels.

With respect to the scale and timing of impacts and who bears them, the framework considers *sources of variability* to influence impacts as potential *moderators*, *amplifiers* or *policy choices* yet to be made. On the impact side, risk interactions and resilience are highlighted as a nexus between sources, economic channels and sources of variability.

Finally, economic impacts flow through to *fiscal impacts*, both *direct* and *indirect*. The framework classifies impact as being on *revenue*, *expenditure* or *other* (eg, balance sheet implications).

Figure 7 – CEFA framework



Source: The Treasury and Ministry for Environment, 2023.

Sources of impact

The framework groups the ultimate sources of climate-related impacts into two broad categories: physical climate change and low-emissions transition. This distinguishes between the impacts caused by a physically changing climate (and any response to that) and those driven by the transition to a low-emissions economy (eg, through achievement of emissions targets).

The impact sources highlighted by the framework can be either independently or jointly realised. The framework acknowledges these (potentially significant) interactions between impact channels (eg, more extreme weather placing pressure on the electricity grid which has implications for strategies to drive the low-emissions transition through electrification).

Physical climate risks

As average global temperatures increase, the Earth’s physical climate changes. These climatic changes have implications for life all over the planet. What these changes are and how they will impact New Zealand will primarily be a function of *global* emissions pathways, the sensitivity of the climate to temperature increases¹⁶, the existence and severity of potential non-linear environmental changes (often referred to as ‘tipping points’) and the resilience of environmental systems.

¹⁶ A standard measure used to capture how sensitive the climate is to temperature increases is ‘climate sensitivity’. This parameter reflects the expected global temperature rise following a doubling of carbon dioxide concentration in the atmosphere compared to pre-industrial levels (The UK Met Office has a good explainer of the term which can be found at <https://www.metoffice.gov.uk/research/climate/understanding-climate/climate-sensitivity-explained>).

On a global scale, New Zealand accounts for 0.17% of global gross emissions.¹⁷ While its efforts to mitigate future climate change through reducing its net emissions can help set an example to encourage and support global efforts, within the context of physical climate change, New Zealand can be considered relatively more of an 'impact taker' than an 'impact maker'. Identifying and better understanding these impacts is therefore a key step in evaluating how climate change will impact New Zealand's living standards, including through impacts to physical and financial capital.

Broadly, the framework classifies these physical changes into two categories: *acute*, or event-related, and *chronic*, or gradual. While both acute and chronic impacts will have implications for economic, social, environmental and cultural wellbeing, the way these impacts are realised and the options to manage and potentially mitigate these risks can differ. The framework also considers a third source of impact related to physical climate risks, driven by actions to adapt and build resilience to these physical changes. It is this third source that New Zealand decision-makers have relatively more influence and control over.

Acute

Extreme (acute) events often bring concentrated, severe impacts in relatively short amounts of time. Examples include inland and coastal flooding, extreme winds, heatwaves, droughts, wildfires and landslips. Cyclone Gabrielle is a specific recent example of such an event. The key implication of climate change for such events is the expectation of increased frequency and severity over time. In this way, climate change can be considered to *exacerbate* extreme events. For example, the Intergovernmental Panel on Climate Change (IPCC) has projected the median projection of the impact of climate change on extreme rainfall events in New Zealand in 2040 is a 5 – 7% increase relative to the period 1986 – 2005, depending on whether the global emissions pathway follows a low- or high-emissions scenario.¹⁸

Climate change is not only likely to mean acute events are more impactful, but that multiple events could occur simultaneously or closer together. This will have implications for the living standards implications of such event(s), particularly where disaster response efforts are hindered either by events being unprecedented in size or sufficiently close together to interrupt recovery efforts.

Chronic

More broadly, as global average temperatures increase, more gradual (chronic) changes to the climate will occur. Examples of more gradual risks associated with a changing climate are increased temperatures, sea-level rise, ocean acidification, changes in rainfall patterns, erosion and saltwater intrusion. The impacts of these are already being felt in New Zealand. For example, the sea level is already 0.2m higher on average than a century ago and the rate of sea-level rise has doubled from an average rate of 1.7mm over the last century to 3.4mm per year.¹⁹ More generally, the country is experiencing

¹⁷ This figure, as presented in the CEFA, draws on New Zealand's Greenhouse Gas Inventory 1990 – 2020, as published in 2022 - see Ministry for the Environment, 2022b.

¹⁸ Sourced from Chapter 11 of the IPCC's Sixth Assessment Report, *Climate Change 2022: Impacts, Adaptation and Vulnerability* – see Lawrence et al., 2022.

¹⁹ Ministry for the Environment, 2020a.

more warm days and fewer frost days and rainfall patterns are changing, with southern and western areas becoming wetter and northern areas becoming drier.²⁰ Shifts in our underlying climate, driven by climate change, have implications for how we do business and how we live our lives.

Adapting and building resilience to physical impacts

The better the acute and chronic risks of physical climate change are understood, the more effectively we are able to understand their wellbeing implications. Becoming more well-informed also supports efforts to adapt to these impacts, including building resilience. Given the important relationship between the physical impacts of climate change and our ability as a society to adapt and prepare for these impacts, the framework highlights strategies, policies and proposals to help understand and respond to physical risks as an additional key physical climate impact source.²¹

While the framework highlights ‘chronic’, ‘acute’ and ‘adaptation/resilience’ as individual sources of climate-related impacts, there is a strong relationship between the three. Underlying chronic change is likely to have implications for the realisation of acute extreme events. Adaptation or resilience actions and policies provide key opportunities to mitigate and moderate (or exacerbate, if not undertaken effectively) these physical impacts. They are also likely to have living standards or wellbeing implications in and of themselves (eg, any distributional or cultural impacts of adaptation policies). The more we understand about these risks and impacts, including relevant feedback loops, the better we can understand wellbeing implications. This can support more effective and efficient decision-making by central and local governments, households, communities, and firms alike.

Low-emissions transition

New Zealand has made several domestic and international commitments in line with global efforts to curb future climate change, including domestic targets under the Climate Change Response (Zero Carbon Amendment) Act 2019 (CCRA) and internationally through its Nationally Determined Contributions (NDCs) under the Paris Agreement. There are multiple ways that New Zealand can achieve its emissions reduction targets, each with different economic and fiscal implications. Reducing New Zealand’s emissions in line with its targets will require fundamental social and economic shifts in the way we live and do business. Policies and actions to reduce emissions across New Zealand’s economy will have wide-reaching wellbeing implications.

How emissions are reduced and from where across the economy will fundamentally depend on several things, including domestic government and broader international policies, relative availability and affordability of lower-emissions substitute technologies and behaviours, general sentiments and preferences of both New Zealanders and global customers of New Zealand’s goods and services. The CEFA framework categorises these into three main impact sources: policy, technology and preferences and sentiments.

²⁰ Bodeker et al, 2022.

²¹ New Zealand’s National Adaptation Plans (NAP), the first of which the first was published in 2022, help set the long-term strategy for climate change adaptation. They focus on key objectives and actions to help reduce the harm caused by climate change and seize the opportunities arising from a warmer climate. See Ministry for the Environment, 2020a.

Policy

Government policies to reduce domestic emissions in line with targets and domestic ‘emissions budgets’ are articulated in a series of Emissions Reduction Plans (ERP), as legislated under the CCRA.²² ERPs set the direction of policies and strategies in the coming years, both economy-wide and across key emitting sectors. Governments have choices regarding the mix and timing of policies, the balance of effort toward net and gross emissions (in particular, choices around land-use change and the role of sequestration) and the mix of spending and non-spending levers used. Governments also have choices around the equity and distributional impacts of the low-emissions transition, including developing policies that may specifically address these.

More broadly, Governments have and will determine the ambition of future targets, including domestic emissions budgets and future NDCs. These policy choices will strongly influence New Zealand’s low-emissions transition, including how far, how fast, and how focused emissions reductions are, and at what cost (economic, fiscal or broader wellbeing). More broadly, international policies, including those that have explicit implications for trade will also serve as sources of impact (eg, carbon border adjustment mechanisms or other carbon pricing policies).²³

Technology

Technology is an important source of impact, particularly with respect to how far, how fast and at what cost the low-emissions transition can be driven. More broadly, technology is a key driver of economic growth. Technological progress allows society to make better use of its resources allowing us to do more with less therefore expanding the economy’s aggregate potential. Such expansion is important for wellbeing and living standards since such expansion can strengthen society’s ability to leverage its physical and financial capital to grow, strengthen and protect its other capitals.

Technological development has been a key driver of anthropocentric climate change. However, it also represents a key opportunity to mitigate further warming and support an effective, efficient and more equitable transition to a low-emissions economy. The role of technology in the low-emissions transition is complex. It is likely to act as both a help and a hindrance. For example, existing technology lock-in can create barriers to emissions reductions. On the other hand, the development and adoption of new lower-emissions technologies can help the economy further decouple growth from emissions. The framework captures this possibility for technology to drive both positive and negative impacts.

Key attributes and characteristics of technologies that inform how economic and fiscal impacts flow through transmission channels include *cost*, *availability*, *general maturity* and *supply chain considerations*, including importation where relevant. Understanding technological cost, opportunities and potential technological barriers (including relevant lock-in) is therefore key to understanding how the low-emissions transition can ultimately impact New Zealand’s economic and fiscal flows.

²² Domestic emissions budgets act as 5-year stepping stones towards New Zealand’s long-term 2050 targets. Refer Climate Change Response (Zero Carbon) Amendment Act 2019 for more detail on how these are set and what is required for Emissions Reduction Plans.

²³ The European Union has recently implemented a carbon border adjustment mechanism to price the carbon emitted during the production of carbon intensive goods entering the EU. More information on its policy can be found at https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

Given New Zealand's relative size and economic make-up, the ability to leverage global technological development is likely to be as, if not more, important than developing technology within New Zealand itself. However, there are likely to be some sectors in which New Zealand has a comparative advantage and heightened incentive to act as a world leader rather than fast follower in developing new, low-emissions technology. Given the significant role agriculture plays in New Zealand's economy and the different approach New Zealand takes within the global sector, technologies to reduce agricultural emissions may present opportunities to lead, rather than fast-follow.

Preferences and sentiments

Economically speaking, preferences and sentiments matter because they are key determinants of demand-side influence (eg, driving demand for both emissions-intensive and low-emissions goods and services). They also strongly influence consumer and household behaviour. This can influence how purchased goods and services are used and what broader actions individuals and communities may take. These actions could either support or hinder the low-emissions transition.

Internationally, global preferences and sentiments can have significant economic and fiscal implications for New Zealand. For example, significant global customers are increasingly demanding more sustainable and lower emission goods.²⁴ This creates a growing pressure on New Zealand exporters to reduce the emissions-intensity of their products.

Impact interactions

As with the framework's highlighted physical impact sources, low-emissions transition impact sources are also strongly related. Preferences and sentiments will be critical determinants of technology uptake and development. How well-aligned new technologies are with consumer preferences will determine how successful its uptake is and, where there are economies of scope and scale, the extent to which costs can decrease over time. Preferences and sentiments also play a critical role in policy development and efficacy, especially where policies are aimed at encouraging more or less of certain behaviours.

Policy and technology also have a strong interrelationship where policies can encourage or discourage the use of certain technologies (including to the extent of requiring or prohibiting certain technologies). Technology can also play a helping or hindering role with respect to policy efficacy.

Within the intersection of these sources of impact from the low-emissions transition there are further interrelationships between domestic and international contexts. For example, domestic policy can be leveraged to support more smooth adoption of international low-emissions technologies that may even have relatively greater alignment with domestic preferences and sentiments than existing domestic technological incumbents.

²⁴ For example, British retailer Tesco has announced its ambition to be net zero by 2050 across its entire footprint (including across its supply chain). See <https://www.tescopl.com/sustainability/planet/climate-change/>

Understanding these impacts, their linkages and feedback loops is critical to furthering our understanding of how the low-emissions transition is likely to impact New Zealand's economy and fiscal position and, ultimately, what implications this may have for the country's aggregate wellbeing levels and living standards.

Economic impact channels

Economic impacts matter because the strength, resilience and adaptability of New Zealand's economy underpin the country's ability to sustain and increase living standards, now and into the future. As highlighted in the Treasury's first Wellbeing Report, our ability to provide health, education and welfare services, fund institutions, invest in housing and preserve the natural environment all depend on the economy performing well.²⁵

A stronger, more flexible and adaptable economy is more likely to continue to grow in the face of climate impacts. It is also more likely to support greater optionality in decisions at all levels – from individual households and firms all the way through to local and central governments.

The framework describes the economic impacts of climate change not only as impacts in their own right, but also as *channels* through which broader impacts can be realised. Given its focus on physical and financial capital the framework explicitly identifies how these channels flow through to the Crown's fiscal position. More broadly these channels can be considered to flow through to both the broader wellbeing domains and the wellbeing 'ends' identified by the Treasury's Living Standards Framework (LSF) and He Ara Waiora (HAW) frameworks.²⁶ While such identification and analysis was out of scope for the first CEFA, it is important to the broader task of understanding the wellbeing impacts of climate change on New Zealanders.

The framework broadly classifies impact channels into two types: *sectoral* and *macroeconomic*.

Sectoral channels

Sectoral channels highlight how climate change can impact individuals and sectors. This includes families and households, central and local governments, whānau, hāpu and iwi, firms and markets, financial markets and international connections. The precise impacts of climate change are likely to vary both across and within these groups. For example, firms and markets with greater reliance on climate-sensitive natural resources are likely to be more exposed to physical climate impacts than others (eg, agriculture, forestry, fisheries and tourism). Given the key role land-based industries play within Te Ōhanga Māori (the Māori economy), climate impacts may be even greater still through the whānau, hāpu and iwi channel than through firms and markets.

²⁵ The Treasury, 2022a.

²⁶ The Treasury's LSF considers the New Zealand's wealth to be held across four domains – Natural environment, Financial and physical capital, Social cohesion and Human capability. The 'ends' of the Treasury's HAW framework are Wairua(spirit), Te Taiao (the natural world – the environment) and Te Ira Tangata (the human domain).

The sectoral channels in the framework paint a picture across the economy – capturing individual level through to firm and central government actor level impacts. Within each channel, several more specific impacts are identified. For example, climate change will have implications for financial markets through the risks (and opportunities) it can present to credit, markets, liquidity, underwriting, operation and capital allocation more generally. For families and households, impacts will be realised through income and wealth levels, health, access to finance and employment and skills.

Bringing impact sources and economic impact channels together, the framework allows for tracking things such as policy decisions to place a price on carbon emissions as part of a low-emissions transition strategy through to implications for the purchasing power of household income, revenue sources for central government, enhanced risk within financial markets for continuing to support more carbon-intensive industries, increased costs for firms and markets and broader implications for international relations and potentially carbon leakage risk.

This example also helps illustrate how impacts flowing through separate sectoral channels can compound upon one another and create secondary impacts. For example, the increased costs for carbon-intensive firms are likely to pass through to prices faced by families and households. How firms manage this cost increase may exacerbate or mitigate the risk of emissions leakage or financial market exposure. How the economy responds to an emissions pricing scheme will have implications for the level of revenue obtained by the central government. This is one of many examples that illustrate the systemic nature of climate impacts and underlines the importance of the framework's recognition of feedback effects across economic impact channels.

Macroeconomic channels

Understanding how climate change impacts aggregate economic indicators helps to provide an overview of the implications of climate change for the health of New Zealand's economy. These can be paired with an understanding of the more granular sectoral channels through which these impacts flow to support a broader consideration of living standards.

How the economy is structured more broadly at the point in time of a given climate impact will have implications for how the impact flows through the economy more broadly. For example, the impact of policy that supports creation of new lower-emissions industries may be hindered or even act as inflationary if demand is heightened, but key production inputs are either expensive or difficult to source (eg, due to broader supply chain or labour market constraints). Furthermore, there are likely to be differences between analyses that take a comparative static (or partial equilibrium) approach (ie, one that explores a given change, holding the remainder of the economy constant) and others that take a broader general equilibrium approach (ie, allowing for consideration of shifts in relative prices across all markets).

Aggregate macroeconomic impacts matter because they affect the wider population, including society's capacity and capability to adapt and respond to broader impact sources. The macroeconomic channels identified in the framework align with the core economic concepts of demand and supply. On the demand side, identified aggregate impact channels include consumption, net exports and investment. On the supply side, capital stocks, technology, innovative capabilities, labour energy and other inputs are highlighted.

The framework's identification of consumption, net exports and investment as key demand components draws from the standard definition of aggregate demand. Aggregate demand reflects the strength of economic activity – the stronger the demand, the more goods and services are typically being traded in the market. Strong demand can support growth through higher levels of employment and, when driven by export growth, reflect robust demand for a country's goods and services in international markets. Strong demand can also create or exacerbate inflationary pressures when an economy is at capacity – this is another reason why taking both a partial and general equilibrium approach to considering macroeconomic impacts can be valuable.

Consumption, investment, and trade matter because together they reflect the amount an economy spends on goods and services. How confident people are to spend and save is a key indicator of economic health. Investment also matters from the perspective of future productivity gains and growth opportunities. Higher consumption reflects higher societal levels of income, wealth and confidence in the economy. Given the key role consumption has in driving aggregate demand, as these things weaken, generally so will aggregate demand indicators.

Aggregate supply is the other side of the macroeconomic coin, reflecting the economy's willingness to produce at various price points. How much firms are willing and able to produce at a particular set of prices in the economy depends on their access to capital stocks, technology, innovation, labour, energy and other inputs, and on input supply prices. The greater and more flexible this access (ie, the less prices have to adjust), the more adaptive the supply-side is likely to be in adjusting to and meeting shifts in aggregate demand.

Within the context of climate change, several impact sources are likely to flow through aggregate supply and demand channels. For example, physical climate change in the form of increased frequency and severity of extreme events such as flooding can have both a negative and positive impact on aggregate demand. Extreme events can erase wealth and create frictions across the economy, inhibiting the flow of goods and services (in particular where they negatively impact key sources of supply). However, increased spending and activity to *respond* to extreme events can also bolster aggregate demand, even if only temporarily.

With respect to the low-emissions transition, Government policy can have large implications for consumer confidence and shifting preferences and sentiments towards lower-emissions goods and services. This could drive a decrease in aggregate demand in the short-term if a lag exists between when such goods and services are demanded and when sufficient quantities are able to be produced and become available in New Zealand.

More specific impacts on both the supply and demand side include implications for hours worked, health and wellbeing impacts on productivity, disruption to land-used for primary production including changes to viable land uses, exposure of productive assets to physical impacts, diversion of capital resources away from innovation, supply chain or other key infrastructure disruptions and general changes to patterns and volumes of trade.²⁷

Fiscal impacts

Future living standards depend on the capital stocks passed down through generations, and on future Governments' ability to borrow, tax and spend. More broadly, a strong government balance sheet is an important, liquid store of resilience. Fiscal strategies are a significant determinant of living standards, now and in the future. The Crown's fiscal position is therefore a key determinant of which choices and strategies future Governments can employ to sustain, invest in and grow capital across all wellbeing domains.

The Treasury publishes a number of stewardship documents, including twice-yearly Economic and Fiscal Updates, monthly and annual Financial Statements of the Government, Pre-election Economic and Fiscal Updates (in election years) and Long-term Fiscal Statements (LTFS).²⁸ The latest LTFS noted the significant economic and fiscal impacts climate change is anticipated to have on New Zealand, both now and into the future.²⁹ A background paper for the 2021 LTFS further highlighted the important link between fiscal strategy and living standards.³⁰

The actual size of climate change's impact on Crown revenue and expenditure will be determined by present and future Governments' policy directions, investment decisions and revenue strategies. Some fiscal pressures are also likely to be less discretionary than others. For example, repairing a Crown-owned infrastructure asset may be less discretionary than spending on various policy programmes.

The framework presents fiscal impacts as being driven through economic impact channels. It classifies them as broadly impacting revenue or expenses, acknowledging that some impacts may not explicitly fall into either of these categories.

Revenue

The impact of climate change on fiscal revenue will depend on changes to broader economic activity that affect the overall tax base (eg, business investment, profitability and consumption). Such indirect fiscal impact is anticipated to be stronger than direct impacts. At present, the majority of direct revenue impact is channelled through the New Zealand Emissions Trading Scheme (NZ ETS). In the future, direct revenue impacts could be realised in other ways, for example if climate or environmental tax policy was amended.

²⁷ For a more comprehensive articulation of how physical climate change can influence the macroeconomy, refer to Table 4.1 in the CEFA, adapted from Batten, 2018.

²⁸ The Treasury's last published economic and fiscal update is the 2023 Half Year Economic and Fiscal Update, found at <https://www.treasury.govt.nz/publications/efu/half-year-economic-and-fiscal-update-2023>. The latest LTFS can be found at https://www.treasury.govt.nz/sites/default/files/2021-09/lfs-2021_2.pdf.

²⁹ The Treasury, 2021a.

³⁰ Hughes, E., 2021.

How climate impacts flow through sectoral channels in particular will have implications for fiscal revenue flows. For example, physical climate change may impact the profitability of businesses in the primary sector. This indirectly flows through to the Crown's fiscal position through loss in corporate income tax. Conversely, policy to drive New Zealand's low-emissions transition can create opportunity for new products or services. This may cause corporate income tax to increase from the expansion of low-emission activities. Where preferences and sentiments combine with policy impacts to heighten consumers' willingness to pay for such goods, further flow-on might occur through the realisation of even higher profits.

Another highlighted area of revenue impact is fuel and vehicle related taxes and duties. Where fossil fuel use is taxed, policies or technologies that drive decreased reliance on fossil fuels (either through increased use of public or active transport or fuel-switching to more efficient or zero-emissions vehicles, such as electric vehicles) will mean lower levels of fiscal revenue.

Expenses

Given the central government's role in directly and indirectly supporting public infrastructure, repairing, replacing or enhancing the resilience of these assets will flow through central government balance sheet channels to be realised as additional direct fiscal expense. Funding for climate policies is also another key source of direct fiscal impact on expenditure (for both mitigation and adaptation). Depending on how Governments chooses to address economic impacts to families, households, firms, markets, whānau, hāpu and iwi from both physical climate change and Government policies to adapt and/or mitigate further climate change, support for disrupted households and businesses could be an additional source of fiscal expense.

Indirectly, depending on how much pressure climate impacts put on the Crown's fiscals, as Governments act to respond to the direct and indirect economic implications of these pressures, the framework notes borrowing costs and broader pressure on public services as key areas of indirect expense impact (eg, health and welfare). As with revenue impacts, policy choice and impact interactions will be key determinants of how these fiscal impacts are ultimately realised in both the short- and the longer-term.

Other

In addition to revenue and expenditure impacts, the framework notes other fiscal impacts that do not explicitly fall into either of these categories. Depending on which choices Governments make as part of their climate responses, new adaptation or mitigation assets could be added to the government's balance sheet. Local government taking additional assets onto their balance sheets is also likely to have indirect implications for central government (eg, in instances where such assets are relatively more exposed to physical climate change). Underlying climate risk may also cause write-downs or impairment of existing assets.

Indirectly, just as climate impacts are anticipated to impact the viability and profitability of various businesses, it is also expected to impact the valuation of assets on the Crown's balance sheet. For example, a Crown financial institution with strong investments in fossil fuels may be re-valued at a lower amount as financial markets increasingly recognise the risk emissions-intensive investments pose to investment portfolios. The significant impact climate change can have on the government's balance sheet was highlighted in the Treasury's latest Investment Statement: *He Puna Hao Pātiki*.³¹

Government policies to mitigate and adapt to climate change as well as Government asset exposure to physical climate change could also influence international perceptions of New Zealand as a borrower, including its sovereign credit rating.

Sources of variability

Multiple factors will influence the scale and timing of the economic and fiscal impacts through the channels discussed above. They will also influence who bears them. These factors are often likely to be complex and will often interact with and compound upon one another. The framework categorises these factors into three groups: moderators, amplifiers and policy choices.

Moderators can dilute or reduce impacts. Examples of moderators include higher levels of adaptive capacity, resilience or broader flexibility in behavioural change, substitutability in inputs to production and flexibility in consumer preferences. An example of a moderator in action might be hazard management systems that can mitigate the impact of extreme events, such as storms or floods, on homes, communities or businesses.

Amplifiers are factors that can worsen or heighten impacts. These can include interactions between climate impact sources as well as interactions between impact channels. For example, families and households may face pressures from damage to their properties from flooding while at the same time facing increased costs of living through rising emissions prices. Similarly, physical risks being realised in different regions concurrently could exacerbate pressures for extreme event response. Depending on which businesses are located where, supply chains could also be disrupted which could heighten pressures on household income or government expenditure.

Choices made by governments, businesses and households, domestically and internationally, will also have implications for how impacts play out.

³¹ The Treasury, 2022b.

Using the framework

The framework is a simplified representation of a complex system underpinned by impacts, feedback effects, interactions and the influence of choice. In the CEFA itself, the framework is leveraged as a way of organising and presenting information on the economic and fiscal impacts of climate change on New Zealand. However, we consider the value of the framework to extend beyond its application in the CEFA.

By organising sources of impact and their effects, identifying areas of interaction and feedback loops and providing a language with which we can articulate how the system fits together, the framework not only supports organisation of information, but also identification of areas for additional work and analysis. Given its strong linkages with international approaches, alongside the characteristics that align it to a New Zealand context, we consider the framework to have further value in supporting communications regarding the impacts of climate change, both domestically and internationally.

While the focus of the framework is on economic and fiscal impacts, it can be used to support further investigation of the impacts of climate change on impact New Zealand's other capitals and wellbeing domains more broadly.

With respect to wellbeing and living standards impacts, we consider the framework to support extension of analysis beyond economic and fiscal impacts and through to broader wellbeing impacts, particularly those identified by the LSF and HAW frameworks. However, we acknowledge that such an approach still considers wellbeing impacts through an economic and fiscal lens. The CEFA framework can therefore be considered an important (but single) piece in the puzzle with respect to developing a more comprehensive picture of the impact climate change will have on New Zealanders' living standards and broader wellbeing.

Furthering our understanding

The CEFA itself presented research and information that spans the breadth of the framework, both undertaken within a New Zealand context, including by the Treasury and others, and internationally. It also highlighted several areas in which future work was seen as valuable.

The authors of this paper have expanded upon these areas of future work as included in the CEFA. In line with the categorisations of the framework, the table below presents the questions that we consider to be particularly valuable in furthering our collective understanding of the impacts of climate change on New Zealand and New Zealanders. Importantly, these questions are not for the Treasury to answer alone and many will fall to those with different expertise and comparative advantage to tackle in the first instance. They will best be answered by a collective of the public, private and academic sectors, both domestically and abroad.

Within the table we have highlighted one to two questions within each section that we see as being particularly important for near-term progression – in many cases by others outside the Treasury.

The remainder of this section expands upon a number of these questions, particularly those which we view as being relatively more important, including those that can support and unlock further work and analysis.

Table 1 – Key questions for further work

| Area for further work | Key questions we see value in better understanding the answers to | Why we see value in these questions | |
|---|--|--|---|
| Deepening our understanding of climate impacts | Physical Climate Change | What does global climate change mean for New Zealand at different levels of warming? (Further deepening our understanding of the climate science) | A deeper understanding of physical climate impacts can unlock our ability to understand how these impact sources flow across the framework through economic and fiscal impact channels as well as through to broader wellbeing impacts. |
| | | What are the global climactic 'tipping points' and how might they impact New Zealand? | |
| | | How do (or might) physical climate impacts compound upon each other? | |
| | | Which physical climate impact(s) are different <u>regions, sectors, or groups/communities</u> anticipated to face? | Being able to disaggregate impacts into more granular impacts allows for more focused consideration on how climate change could impact specific groups of interest. |
| | | What is the exposure of iwi/Māori to the physical impacts of climate change? | Within the New Zealand context there is particular importance in understanding impacts for iwi/Māori to inform analysis of how these flow through to economic and broader wellbeing impacts in particular. |
| | Low-Emissions Transition | How do policies interact within a broader climate policy portfolio, in particular the mix of pricing, regulatory and other policy instruments? | To support current and future Governments to decide on climate polices that support achievement of New Zealand's 2050 targets and interim emissions budgets (eg, ERPs). |
| | | What is the relative incidence of various climate policies across different <u>regions, sectors or groups/communities</u> ? | To provide greater insight into the distributional impacts of transition pathways. |
| | | What are the key technologies (existing or potential future) that could support New Zealand's low-emissions transition? What are the different pathways for uptake over time (including options for different combinations of technologies)? | To support technology policy and better understand how technology can influence economic impacts - across the economy and to specific sectors/groups. |
| | | Are there existing technologies globally that could be applied in a New Zealand context? At what cost? | |
| | | What does New Zealand's Marginal Abatement Cost (MAC) Curve look like and how might this change over time? | To inform modelling of transition pathways and support understanding of transition options and costs. |
| What are consumer preferences regarding low-emissions technologies and choices? How are they formed? How might these impact policy efficacy, technology uptake and/or achievement of climate targets? | To better understand consumer and household behaviour, given the implications this has for impact realisation and policy efficacy. | | |

| Area for further work | | Key questions we see value in better understanding the answers to | Why we see value in these questions |
|---|---|---|--|
| Deepening our understanding of climate impacts (cont'd) | Opportunities for and implications of adaptation and resilience | How can investing in resilience act as a moderator for how physical climate risks flow through to wellbeing impacts? | To support development and implementation of New Zealand's adaptation response and related decision - by central and local governments, private sector firms, communities and individual asset owners. Also, to support better understanding how these impacts flow through to economic, fiscal and broader wellbeing impacts. |
| | | What is the option set for adaptation action and investments? How do options interact with one another? What impact does physical climate change have on their efficacy? | |
| | | Are there particular adaptation actions or investments that are relatively better suited for a New Zealand context? Are there others that are relatively worse suited? | |
| | | Are there differences in how one might think about New Zealand's adaptation response for <i>regions, sectors</i> or <i>groups/communities</i> (iwi/Māori in particular)? | |
| | | What are the relative costs and benefits of different adaptation responses? | |
| Economic impacts | From physical climate change | How does physical climate change flow through to economic impacts at the macro-economic level? | To better understand and inform decisions on New Zealand's adaptation response and potential future impacts to address. |
| | | How does physical climate change flow through to economic impacts on <i>regions, sectors</i> or <i>groups/communities</i>? | |
| | | How does physical climate change flow through to economic impacts on the Māori economy, Māori businesses and iwi/Māori more generally? | |
| | | How might cascading or compounding physical climate impacts (including potential climactic tipping points) translate to economic impacts (at the more aggregate and granular levels)? | |
| | | What is New Zealand's social cost of carbon? | To help inform social cost benefit analyses and provide an understanding of the marginal economic cost of an additional tonne of emissions to New Zealand. |
| | | How is physical climate change anticipated to impact broader economic indicators such as <i>aggregate demand and supply, labour markets, inflation and exchange rates</i> ? | To provide greater insight into how climate specifically impacts the economy in a way that can support policy and business decisions, including industry policy. |
| | | What implications might physical climate change have for New Zealand's investment and trade relationships? | |
| | | How might physical climate change impact specific sectors (particularly with respect to <i>profitability</i> and <i>productivity</i>)? | |
| | | How can adaptation and resilience actions and strategies serve as moderators through the economic transmission channels? | To inform adaptation policy decisions, including investment decisions - by central and local governments, communities and asset owners. |
| | | How do policy decisions, technological development and shifting preferences and sentiments interact with physical impacts to influence economic transmission channels? | |

| Area for further work | | Key questions we see value in better understanding the answers to | Why we see value in these questions |
|--|---|--|--|
| Economic impacts (cont'd) | From the low-emissions transition | What is New Zealand's least-cost transition pathway and what is the associated supporting emissions price vector? | To provide a view of economic optimality as a reference point. |
| | | What are the economic impacts of different transition pathways (including those that are more accelerated, slower or more disorderly)? | To understand and inform decisions on Emissions Reduction Plans (eg.). |
| | | How will different emission pathways impact <i>regions, sectors</i> or <i>groups/communities</i> differently? | |
| | | What role does technology and its potential future costs play in the anticipated costs of different pathways? | To inform technology policy decisions as well as capital investment (by both public and private sectors). |
| | | What emissions price pathways support different transition pathways (for long-lived gasses as well as biogenic methane)? | To inform policy decisions - including on emissions pricing. |
| | | What is the interaction between climate policy and land use within the New Zealand context (in particular, emissions pricing)? | |
| | | What is the economic impact of policies, strategies and actions beyond what is captured in domestic transition pathways to achieve New Zealand's NDCs? | To support decisions on setting and achieving New Zealand's NDCs. |
| | | What opportunities are presented by currently nascent international carbon markets? What implications might these have for the cost of achieving New Zealand's NDCs? | |
| | | What are the implications of low-emissions transition pathways on New Zealand's trade and investment flows? | To support public decisions regarding international trade and investment policies alongside private sector business decisions. |
| | | What level of emissions leakage risk does New Zealand face under current policies? Under different transition pathways? | |
| | | How will shifting global preferences and policy impact the demand for New Zealand goods? How will this impact differ across <i>regions, sectors</i> or <i>groups/communities</i> ? | |
| | | What are the specific implications of different transition pathways for iwi/Māori? | To better understand and inform New Zealand's mitigation response in a way that supports iwi/Māori. |
| What can behavioural economics tell us about low-emissions transition policy efficacy? | To provide additional insight that supports higher levels of policy efficacy. | | |

| Area for further work | Key questions we see value in better understanding the answers to | Why we see value in these questions |
|--|---|---|
| Fiscal impacts | How resilient is New Zealand's fiscal position to climate change? | To better understand New Zealand's fiscal exposure to climate change and therefore inform current and future fiscal management decisions. |
| | How is physical climate change anticipated to impact New Zealand's fiscal position - directly and indirectly? | |
| | How is the low-emissions transition anticipated to impact New Zealand's fiscal position - directly and indirectly? | |
| | How might compounding or cascading impacts (including potential tipping points) impact New Zealand's fiscal position (in the short-, medium- and long-term)? | |
| | How will physical climate change and the low-emissions transition impact key revenue and expenditure sources (directly and indirectly)? | |
| | How does climate change influence how Governments think about fiscal management? | |
| | How can investment in resilience act as a moderator for the fiscal impacts of climate change? | To understand options for addressing anticipated fiscal impacts through resilience investment. |
| | How might climate change impact the Crown's balance sheet - directly and indirectly (including consideration of implicit risk)? | To inform Crown balance sheet management decisions and fiscal management and policy decisions that have implications for the Crown balance sheet. |
| | How might climate change impact the valuation of assets and liabilities on the Crown's balance sheet? | |
| What implications does physical climate change and New Zealand's low-emissions transition have on the country's ability to raise debt internationally? | To inform fiscal management decisions, in particular decisions regarding debt issuance and servicing. | |
| Broader wellbeing impacts | How do the economic and fiscal impacts of climate change translate through to broader wellbeing impacts? | To support a deeper understanding of the wellbeing impacts of climate change to New Zealanders. This can be used to inform fiscal and policy decisions that can help lift living standards for current and future New Zealanders. |
| | How might climate change impact our <i>human, natural and social capitals</i> ? | |
| | How sustainable is New Zealand's wellbeing in the face of climate change? How resilient is this sustainability? | |
| | What are the important inter-generational considerations regarding climate change in New Zealand ? | To more deeply understand and inform an ao Māori approach to considering the impacts of climate change. |
| | How will climate change impact important elements of Māori wellbeing including <i>wairua</i> (spirit), <i>te taiao</i> (the natural world/environment) and <i>te ira tangata</i> (the human domain), in particular <i>mana</i> (power and authority)? | |
| | How might tikanga values or principles help us achieve elements of Māori wellbeing? Including - <i>kotahitanga, tikanga, whanaungatanga, manaakitanga</i> and <i>tiakitanga</i> ? | |

Deepening our understanding of sources of climate impacts

Evaluating the wellbeing impacts of climate change on New Zealand starts with a strong understanding of the sources of these impacts. This can unlock our ability to better understand how these impact sources then flow across the framework through impact channels and on to broader wellbeing impacts.

Physical climate change

Within a New Zealand context, understanding anticipated global impacts and tipping points is important because global action is what will ultimately drive the physical climate change New Zealanders experience. For this reason, we consider answering the question of *what global climate change means for New Zealand at different levels of warming* to be of primary importance.

In addition to anticipated physical impacts at a country level, we also consider answering the question of *how physical impacts may be different across regions, sectors or groups/communities* to also be an extremely valuable area for further work. Being able to disaggregate impacts at a more granular level allows for more focused consideration on how climate change could impact specific groups of interest. This underlying evidence base is critical to support further consideration of the exposure and anticipated economic impacts that flow across our economy and society. Additional granularity is also important to supporting business, household, community and policy decisions, many of which are likely to have their own economic and fiscal implications.

Low-emissions transition

How policies interact within a broader climate policy portfolio and what mix of policies this portfolio should include (including consideration of the role emissions pricing should play) has been the subject of much focus and discussion, domestically and internationally.³² As current and future Governments take decisions that shape New Zealand's low-emissions transition, better understanding policy options, interactions and their implications will support consideration of the implications these decisions have for the economy and fiscal position. We see particular value in further understanding the relative incidence of various policies on different regions, sectors and groups/communities since these will ultimately drive living standards impacts.

Given the role of technology as a key enabler of economic growth and enabler of the low-emissions transition, we support further work to refine our understanding of *which technologies are available in New Zealand, in what amount and at what cost*. From an economist's perspective, this information helps construct better *marginal abatement cost curves*, including how they might shift over time. We view improved marginal abatement cost curves as especially important given the role they play as an input into broader economic modelling of the cost of the low-emissions transition and the implications this might have for the fiscal position.³³

³² Within the New Zealand context, refer Craxton, 2022 and Hall and McLachlan, 2022. More broadly, refer Bennear and Stavins, 2007, Fankhauser, Hepburn and Park, 2010 and Hepburn, Stern and Stiglitz, 2020.

³³ The Ministry for the Environment has contributed to the development of marginal abatement cost curves for New Zealand. See Ministry for the Environment, 2020b. These have been leveraged by the Climate Change Commission and others to support economic analysis of New Zealand's low-emissions transition.

To better understand consumer and household behaviour, given the implications these have for impact realisation and policy efficacy, we also view further work to understand how *consumer preferences* and *behavioural economics* can influence the economic and fiscal impacts of the transition.

Opportunities for and implications of adaptation and resilience

While mitigation policy and action are relatively more well-progressed globally, identifying and understanding actions and strategies to adapt and build resilience to physical climate impacts remains a critical area of future focus. Given the increased realisation of physical climate impacts and the growing importance of considering and taking action to adapt, we support further development of the evidence base around adaptation and resilience to support both public and private sector decision-making.

We see particular value in further developing the *option set for adaptation actions and investments*, understanding *how these interact with each other* and what *implications further physical climate change might have for their efficacy*.

Economic impacts

Understanding the economic impacts of climate change has been a long-standing topic of focus across the academic, public and private sectors.³⁴ Work in this area continues to be valuable to support decision-makers to better understand the choices they face and their implications.

From physical climate change

In line with our view that more deeply understanding what global climate change will mean for New Zealand under different scenarios and how physical impacts may differ across groups or regions, tracking these impacts through to economic impacts is similarly the area in which we see the greatest value to progress work in this space. Examples of more specific projects in this space could include region- or sector-specific ‘damage’ functions (ie, a mapping of how physical climate impacts translate into economic impacts).³⁵ Given the role *adaptation and resilience investment can play in moderating* these impacts, we note the value in considering these impacts in parallel.

At an aggregate level, there is opportunity to expand our consideration of indicators from a strong GDP focus to include aggregate demand and supply, labour markets, inflation, exchange rates and implications for investment and trade. At a more granular level, we encourage additional work on physical climate change’s impacts on firm and sectoral *profitability* and *productivity*.

From the low-emissions transition

The global community and New Zealand have set specific emissions reduction targets. However, to a large extent, *how* these targets are met remains an open question. Domestically, the Climate Change Commission (Commission) has provided several illustrative scenarios for how

³⁴ For a canonical example of a discussion of the possible effect of global warming on the world economy, refer Stern, 2006. For an early example of attempts to combine economic and climate modelling (a class of models now referred to as ‘integrated assessment models’ or ‘IAMs’), refer Nordhaus, 1993.

³⁵ Within this consideration we also see value in progressing consideration of estimating New Zealand’s ‘social cost of carbon’ – an estimate of the economic damage anticipated to result from the emission of an additional tonne of carbon dioxide equivalent into the atmosphere.

New Zealand's 2050 targets can be met.³⁶ While informative, there remains value in *considering the economic impacts of different transition pathways*. We see further value in these pathways both aligning to and departing from the Commission's demonstration pathway, particularly with respect to the *role and potential costs of future technologies*. Exploring transition pathways that are relatively more *accelerated, slower or more disorderly* can provide additional insight.

Within New Zealand's context, we support furthering our understanding of the role of *land-use* in New Zealand's transition. Better understanding land-use is important because of the core importance of land as an input to some of New Zealand's key sectors (eg, agriculture), the role land-based industries play in New Zealand's emissions profile (eg, significant emissions from the agriculture sector and substantive emissions removals from the plantation forestry estate) and the broader importance of land within te ao Māori. Specifically, we see particular value in more deeply exploring the interaction of land-use and emissions pricing.

At a more granular level, additional work on *climate policy impact and efficacy* will be important, particularly from a policy efficacy perspective. This is an area we consider that behavioural economics, alongside more traditional economic analyses, can add value.

Fiscal impacts

Due to the Treasury's role as economic and fiscal advisor and Ministry of Finance, we have a particular focus on *the resilience of the fiscal position*. Given the whole-of-economy nature and magnitude of the anticipated impacts of climate change, *how climate change is anticipated to impact New Zealand's fiscal position – directly and indirectly* – is a focus area from our perspective.

As stewards of the government's balance sheet, we have also identified *how climate change might impact the Crown's balance sheet – directly and indirectly (including implicit risk)* as also having prominence as a key question.

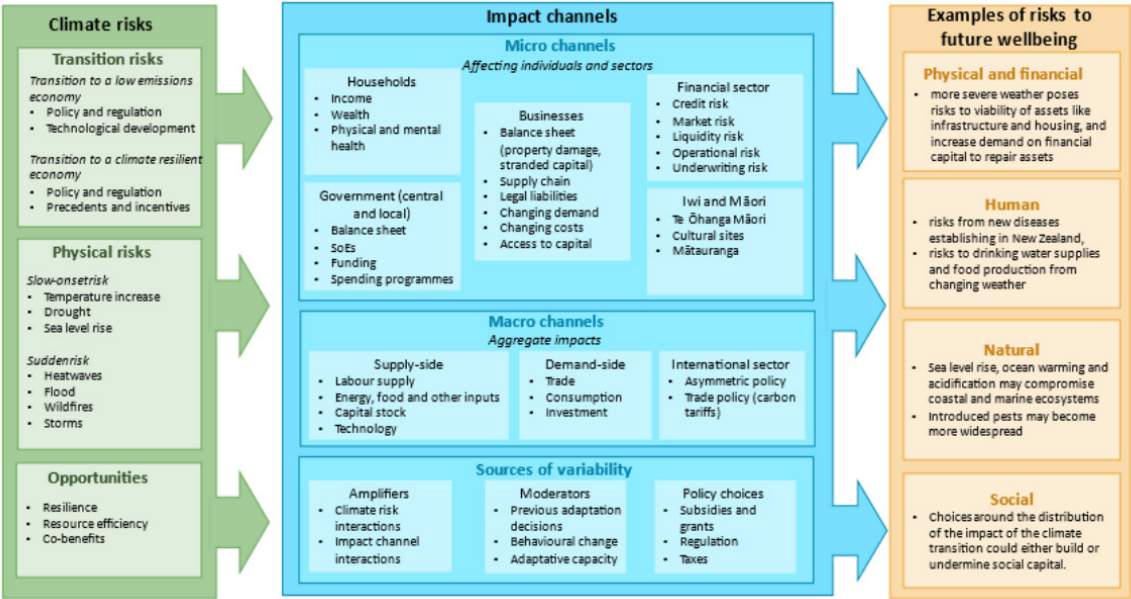
A better understanding of New Zealand's fiscal and balance sheet positions, and any risks to them, helps inform future fiscal management decisions and provides a sense of how resilient New Zealand's finances are to acute and ongoing climate impacts – physical and transition-driven.

Extending to broader wellbeing impacts

Despite the CEFA framework's focus on physical and financial capital, it can help identify potential risks and impacts on broader wellbeing. Considering the impact of climate change on these domains, in addition to the 'ends' of the HAW framework, will be a key component of better understanding the impact of climate change on New Zealander's comprehensive wellbeing. Additionally, relatively greater focus on the more granular impacts and impact channels of climate change can help build a stronger picture of the ultimate implications for climate change on people's lives (eg, on the mana of individuals, whānau and hāpu or the specific impacts of climate change on individuals and households more generally).

³⁶ For example, in its 2021 advice on setting the first emissions budgets and developing the first emissions reduction plan, the Commission modelled a number of possible pathways including a 'demonstration pathway', a 'headwinds' and a 'tailwinds'. See He Pou a Rangi - Climate Change Commission, 2021.

Figure 8 – Risks, impact channels and wellbeing outcomes from climate change



Source: Galt and Nees, 2022.

Conclusion

There is a lot that we know about climate change and how it is anticipated to impact human and natural systems. However, there remains a lot that we are yet to know and many areas in which there are valuable opportunities to grow and deepen our understanding.

The CEFA presented a framework that provided a lens through which to assess climate-related economic and fiscal impacts to New Zealand. While it has drawn heavily on international approaches, it builds on these examples to present something that is both sufficiently consistent with international approaches to support cross-country discussion and tailored to New Zealand’s specific context, to support domestic decision-makers.

At the Treasury, the CEFA framework and the areas of future work it helps identify are a key part of a more comprehensive approach to more deeply understanding the impacts of climate change across all of our wealth domains. Ultimately, it is understanding and capturing how things such as climate change matter for the New Zealanders’ living standards, both now and in the future, that is the Treasury’s core organisational focus.

The development and application of the CEFA framework is a key step in progressing the Treasury’s organisational vision. However, the future work identified in this paper is significantly broader than the work of the New Zealand Treasury. It will take the contribution and work of other government agencies and entities, academia and the private sector, domestically and abroad, to develop the information base upon which effective and efficient well-being aligned decisions can be made in a manner that raises the living standards for all New Zealanders.

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