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Long-Term Challenges and Opportunities in the Natural Resource Sector

Introduction: New Zealand's natural capital

New Zealand's cultural, social and economic prospects are inextricably intertwined with the health and sustenance of our natural capital.

New Zealand is wealthy in natural resources. We have plentiful, clean water; clean air; fertile soil and a climate well-suited to humans, trees, livestock and agriculture; long coastlines and significant aquaculture resources; significant mineral and petroleum reserves; and extraordinary biodiversity on our land and in our water bodies. The World Bank estimates that New Zealand ranks eighth out of 120 countries and second out of OECD countries in natural capital per capita; we are outranked only by petroleum-exporting countries (World Bank, 2011). While it is still substantial, natural capital in New Zealand has been reduced since the arrival of humans, however, including losses to our lowland forest and reductions in native biodiversity.

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Our natural resources are central to New Zealand's cultural heritage, both for Pākehā and Māori. Māori draw identity and whakapapa from the environment and exercise kaitiaki responsibilities over land and resources. We have a responsibility to recognise this cultural relationship in accordance with the principles of the Treaty of Waitangi.

Natural resources such as land, water and fish provide a large proportion of the inputs to our economic system in 2011:

- export in 2011, export revenue from the primary industries amounted to over $31.5 billion or over 70% of total merchandise export revenue (Ministry for Primary Industries, 2011);
- agriculture and primary industries contribute dover 17% to our gross domestic product (GDP) (Statistics New Zealand, 2011);
- over 70% of our electricity was generated by renewable energies (Ministry of Business, Innovation and Employment, 2013).

The New Zealand economy has grown on the basis of its natural capital stocks and flows and our ability to generate wealth will be dependent on this stock for the foreseeable future.

Strong income growth in emerging markets will support demand for natural resources in the short to mid-term, underpinning demand for New Zealand's exports and reinforcing the importance of the productive sectors for our growth, wealth and living standards. Should we fail to plan to and manage within biophysical resource limits we will undermine the productivity of our primary sector in the long term and limit our growth potential. This will in turn constrain the government's ability to provide for the needs of a growing and ageing population.

The goal of natural resource management and environmental policy is to put in place incentives for efficient resource use by communicating the true value of those resources where feasible

Natural capital in the Crown accounts

In New Zealand natural resource stocks and flows have both direct and indirect impacts on the government's revenues, expenses, assets and liabilities.

Direct impacts

The Crown incurs expenses for natural resource management and regulation, including the cost of managing public conservation areas, regulating fisheries, and cleaning up lakes and rivers with deteriorating water quality. In limited cases the Crown collects revenues from natural resources, including royalties for petroleum and minerals extraction, proceeds from radio spectrum auctions, and taxes on petrol and diesel fuels. In these instances the Crown has asserted a right to manage a resource or regime on behalf of all New Zealanders, including the redistribution of any accrued economic benefits.

The Crown carries liabilities associated with natural resources, including contingent liabilities for our current obligation under the Kyoto Protocol. The Crown also possesses a number of natural resource-related assets, including physical assets such as the conservation estate, Crown-owned forestry and agricultural assets, and non-physical assets such as the stock of international carbon units collected through the emissions trading scheme (ETS).

Indirect impacts

Given the importance of natural resources to our economy, changes in the availability or quality of natural resources for extraction and use will have a significant impact on New Zealand's economic performance, which, commodity prices and all else being equal, will affect government tax revenue. For the same reason, changes to resource management and conservation policies may have indirect impacts on the government's finances in so far as they affect the productivity or profitability of resource-dependent sectors.

Policy options

Some of New Zealand's resources are non-renewable, or finite (e.g. petroleum, minerals); in some cases the benefits of extracting these resources and the risks associated with their extraction may be best managed by the Crown on behalf of all New Zealanders, including future generations. These resources represent wealth that New Zealand already holds: policies should be aimed at realising those assets at a rate and in a manner that will provide the greatest return to the economy as a whole, over time.[1]

Some of our resources are conditionally renewable, meaning that they become degraded, scarce or extinct if they are not valued and managed appropriately (e.g. fisheries, fresh water); some of our resources are unconditionally renewable and our actions will not jeopardise or otherwise affect their flow of goods and services (e.g. solar, tidal energy). If the aim is to manage within various biophysical limits and protect ecosystem values, renewable resource management should aim to draw down the resource at a rate and in a manner that will not exceed the rate at which the resource renews or replenishes. In practice, communities may choose to manage renewable resources so as to protect additional values, such as recreational and cultural uses.

In some cases New Zealand may be called upon to do its part to manage within global biophysical limits for natural resources, as we are bound by the United Nations Framework Convention on Climate Change and the Montreal Protocol on Substances that Deplete the Ozone Layer.

The goal of natural resource management and environmental policy is to put in place incentives for efficient resource use by communicating the true value of those resources where feasible.[2] Advanced natural resource management and environmental policies facilitate better long-term investment decisions, prevent stranded capital, and avoid disputes over ownership and governance. Early non-regulatory policies that build capability for measurement and monitoring can ease the transition to later regulatory policies or market-based mechanisms.

Case studies

The following section of this article present three case studies, intended to illustrate the diversity of New Zealand's natural resource base and, therefore, the challenges we face in designing effective management regimes for its sustenance.

Oil and gas

Petroleum already represents a significant revenue stream to the Crown, with significant upside potential. To maximise the benefits of petroleum production, the Crown needs to carefully consider fiscal terms and ensure robust regulatory settings to maximise economic and fiscal benefits

while managing potential environmental and health and safety risks.

Introduction

In New Zealand the Crown owns the subsurface petroleum resources; any company wanting to prospect, explore or mine petroleum must obtain a permit from New Zealand Petroleum and Minerals (NZPAM). In 2011/12 the Crown collected $335 million in royalties and levies on petroleum, excluding associated corporate tax revenue or indirect taxation revenue – or 0.2% of GDP. However, most of New Zealand's territory is yet to be explored and the potential for further development of petroleum resources may be significant.

Today all petroleum mining and production in New Zealand occurs in the Taranaki basin. Gas generated over 20% of New Zealand's electricity in 2010 (Ministry of Business, Innovation and Employment, 2012).[3] The Ministry of Business, Innovation and Employment estimates that in 2009 the oil and gas industry, including exploration, production and the supply chain, directly contributed $1.9 billion (1.5%) to national GDP (ibid.). In 2011 crude oil was New Zealand's fourth largest merchandise export at $2.0 billion, or over 4% of total exports (Statistics New Zealand, 2012).

Fiscal sustainability – price

From the Crown perspective, the economics of petroleum exploration and production depend on three interrelated factors: price, quantity and risk.

An optimal taxation regime for petroleum is one that is targeted on economic rents, related to profits so as to allow for cost recovery plus an adequate return, and flexible to variations in prices and production and operational costs (AUPEC, 2009). In New Zealand the Crown collects the higher of either a 5% royalty on gross revenues or a 20% accounting profits royalty. Ultimately, the Crown receives approximately 42% of the accounting profit from petroleum field developments as royalty and company tax (Ministry of Economic Development, 2012b).

A study by AUPEC completed in 2009 showed that the New Zealand petroleum fiscal regime is highly competitive against comparator countries, based on data from currently producing fields (Aupec, 2009). Similarly, the *Journal of World Energy and Business* has ranked New Zealand the fourth most fiscally attractive jurisdiction between 1998 and 2007 (Ministry of Economic Development, 2012b). A highly competitive royalties and taxation regime makes New Zealand more attractive than other oil-producing jurisdictions, where all other factors, including distance to markets, are held constant.

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Changes to the fiscal regime for petroleum could be reviewed, particularly in the event that future discoveries increase demand for petroleum exploration in New Zealand.

Fiscal sustainability – quantity

Woodward Partners has valued the royalties arising from currently producing fields and further discoveries based on estimates of in-place oil and gas reserves and a scenario analysis of commercially viable discoveries (Woodward Partners, 2011).[4] The discounted total value between 2011 and 2050 of the Crown's royalty stream from currently producing fields in the oil and gas estate may be estimated at $3.2 billion and from potential future discoveries at $5.3 billion. The valuation of royalties from future discoveries could be as low as $1.6 billion and as high as $10.3 billion, depending on the assumed rate of future industry activity, projected petroleum prices and projected exchange rates (Woodward Partners, 2011).[5]

These discounted valuation figures veil the potentially significant future production and associated real tax revenue in the lower probability scenarios and should be treated as hypothetical only.

Risk

A high degree of aversion to health, safety and environmental risks may effectively limit the extent to which resources can be discovered and extracted by prescribing certain methods that must be used or areas where exploration and production cannot be undertaken.

Environmental risks

Oil and gas exploration and production operations have the potential for a variety of impacts on the environment, including noise; spills, emissions and other discharges; site access and footprint; socio-economic and cultural issues; and interference with other resource users. Offshore, where the majority of New Zealand's potential oil fields lie, exploratory operations may harm benthic and pelagic organisms and marine birds and reduce water and air quality. Development and production processes carry increased risks of soil and water contamination from spills and leaks and ongoing disruption to the local economy (E&P Forum and United Nations Environment Programme, 1997).

The frequency and severity of significant environmental disturbances in New Zealand, including oil spills, has been low historically. According to Maritime New Zealand, fewer than ten 'more significant' marine oil spills have occurred in New Zealand since 1990 and none of these incidents were the result of petroleum exploration or

production activities (Maritime New Zealand, 2013).

In addition to these more localised environmental impacts, oil and gas productiuon and use emits carbon dioxide (CO_2), which contributes to climate change. Were limits or charges on production of greenhouse gases put in place globally, demand for oil internationally would be expected to decrease significantly and we would expect that the economic attractiveness of prospecting in New Zealand would similarly reduce.

Economic growth and efficiency

The economic benefits of enhanced petroleum exploration and production can be observed in terms of GDP, direct royalty and taxation returns, more and higher-paying jobs, investment, regional development and exports.

General equilibrium modelling by New Zealand Institute of Economic Research has shown that a South Island basin development scenario including the discovery of ten new oil and gas fields over 2010–2040 could drive an increase in gross national disposable income of 0.77%, and in GDP of 1.2% on average per annum. The increase in export values results in higher income and improved living standards for New Zealanders, an improvement in the balance of trade, and indirect tax revenues. The upside is restricted by a number of counterbalancing effects, including an appreciation in the exchange rate, which could disadvantage competing exporters, and an increase in net foreign liabilities (Ministry of Business, Innovation and Employment, 2012c; Zuccollo and Ballingall, 2012).

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Health and safety risks

Workplace health and safety legislation plays a key role in ensuring that operators prevent the uncontrolled release of oil and gas at their operations. While an uncontrolled release of oil and gas can result in substantial environmental damage, it can also lead to a major accident, resulting in multiple injuries and fatalities. An external review of New Zealand's health, safety and environmental legislation for offshore petroleum operations conducted in 2010 revealed a number of gaps in the regulatory framework, the majority of which will be addressed by the Exclusive Economic Zone and Continental Shelf Act (Environmental Effects) 2012 and proposed changes to the health and safety provisions under the Crown Minerals Act (Atkins Holm Joseph Majurey Ltd, 2010).

'Dutch Disease' and macroeconomic policy

A significant increase in oil and gas production as a result of new discoveries can have material impacts on the economy. Overall increased wealth can be offset by an exchange rate appreciation that reduces the competitiveness of other sectors, such as import-competing or non-petroleum export industries (e.g. manufacturing, agriculture, tourism). These effects are sometimes collectively referred to as 'Dutch Disease'.

The literature suggests that the optimal policy response to Dutch Disease effects may consist of avoiding pro-cyclicality by preventing increased revenues from flowing through into tax reductions or increased spending; promoting ongoing structural reform; and improving financial regulation and supervision to contain credit booms and asset bubbles (Cordon, 2012; Garton, 2012; Magud and Sosa, 2010; IMF, 2012; OECD, 2012).

Even the lowest probability scenario modelled by Woodward Partners is unlikely to be large enough to trigger these macroeconomic effects. However, in the event of a significant petroleum resource discovery New Zealand should be prepared to consider such measures.

Equity and distribution

Because they are finite, exhaustible resources, the extraction of oil and gas entails obvious intergenerational equity issues: oil and gas should be produced so as to realise the highest returns and those maximised returns should benefit current and future generations. As explained, these characteristics of natural resource rents have encouraged many oil-producing nations to establish sovereign wealth or oil funds, which are designed to manage and invest a nation's wealth accumulated through the sale of natural resources, both to manage macroeconomic effects and the effects of exchange rate appreciation, and to distribute both the benefit of oil wealth accumulated and the risk of price volatility and extraction uncertainty across generations.

Fresh water

While New Zealand has a very large freshwater resource, the quality and the availability of water are deteriorating at the regional and catchment level. Once regions set objectives and limits for the quantity and quality of the water in their catchments, it will be important that they have the regulatory and legislative tools they need to manage within those limits and maximise the value they obtain from the water available for use. Market-based mechanisms, such as tradable water permits and water charges, may be needed in some jurisdictions.

Introduction

Fresh water provides an essential, life-supporting service to our communities

and adds significant value to our economy. In 2004, charges for water supply by local authorities, value-added from irrigation, and value-added from water in hydroelectric power generation amounted to nearly 1.4% of GDP (Statistics New Zealand, 2004).

By international standards fresh water in New Zealand is both clean and plentiful in supply. The OECD ranks New Zealand fourth among OECD countries for volume of fresh water per capita and third for water withdrawal as a percentage of gross annual availability. We currently extract less than 5% of the freshwater resource, primarily drawn from surface waters.

Quality

The state of water quality in New Zealand's rivers is highly variable, and declining in some places. Rivers in urban and rural areas generally have poorer water quality compared to rivers in native forest. Catchment features, such as land cover, climate and geology, have a large influence on water quality, which highlights the significant contribution of non-point sources, such as run-off from agriculture, to poor water quality. Water quality is degraded in some lowland areas of Northland, Auckland, Waikato, the east coast of the North Island, Taranaki, Manawatu–Wanganui, Canterbury and Southland, where nutrients could stimulate plants and algae to grow to excessive levels in some rivers, lakes and coastal areas.

Quantity

Quantity pressures are generally a catchment or regional rather than a national issue. In 85% of large catchments there is low allocation pressure on the available water relative to mean annual low flow (MALF); in 8% of catchments, current allocations are greater than the modelled MALF.[6] These allocation bands are modelled on consented water use. This is an important distinction, as the average national actual water use for consumptive takes is estimated to be 65% of consented volume, meaning that consent holders are entitled to use more water under their permit than they are actually using (Aqualinc, 2010).

In 2009 the government commissioned advice from the Land and Water Forum, which ran a stakeholder-led collaborative process to build a consensus view on shared outcomes, goals and long-term strategies for fresh water in New Zealand. Drawing on the advice of the forum, the government introduced a National Policy Statement on freshwater management in 2011 which directs local government to manage water in an integrated and sustainable way while providing for economic growth within set water quantity and quality limits. The government is now in the process of further responding to the recommendations of the Forum and has proposed a number of potential reforms to the freshwater management system (Ministry for the Environment, 2013). Later reforms could include further central government direction and guidance on management approaches, including tools to promote efficient use and alternative allocation models.

Coming decades will be characterised by increasing water scarcity and reduced reliability of water supply and quality in key catchments and regions, at the times of year and in the places where water is in highest demand.

Fiscal sustainability and economic growth and efficiency

Coming decades will be characterised by increasing water scarcity and reduced reliability of water supply and quality in key catchments and regions, at the times of year and in the places where water is in highest demand. Failure to plan for these challenges may entail significant fiscal costs, in the form of both decreased tax revenue from the agriculture sector and increased expenses for ex post clean-up resulting from over-use and under-management. Since 2008, approximately $340 million in Crown funding has been committed to the clean-up of just eight lakes and rivers.

The OECD has suggested that New Zealand continue to encourage the development of market-based mechanisms where possible to manage the supply and quality of fresh water (OECD, 2013). Market-based policies assign, either implicitly or explicitly, a price for water or discharge of contaminants that reflects supply, economic or full costs associated with that use or discharge. These policies include quantity-based controls, such as trading of water permits, rights or quotas, and direct price interventions such as water charges, rent taxes or royalties.

The application of market-based tools to fresh water will be informed by the particular scarcity or quality challenges relevant to the locality. A number of market-based tools are already being employed in New Zealand to manage demand and reduce pollution.

Market-based mechanisms for managing water quality

There is some experience with market-based mechanisms for managing water quality in New Zealand. To address local and national concerns over the potential for decreased water quality in Lake Taupo, the Waikato Regional Council has implemented a cap-and-trade scheme for nitrogen discharges in the catchment. The scheme aims to reduce total annual anthropogenic nitrogen discharges to the lake by 20% by 2020; this target will largely be accomplished through the buy-back of nitrogen discharge allowances by the Lake Taupo Protection Trust at a rate of $0.4 million per tonne.

Trading

There is substantial international evidence that demonstrates that water markets can reveal the value of water to existing and

potential users, generating short-term incentives to use water more efficiently and longer-term incentives to shift water to higher-value uses. Water trading in the southern Murray-Darling Basin contributed over 2% to Australia's GDP in 2009. The total benefits were even greater within the southern Murray-Darling Basin itself, where water trading increased gross regional product by over $A370 million in that year, indicating that water trading maintained productive capacity within the southern Murray-Darling Basin, rather than shifting it to other areas of Australia.

In the New Zealand context, there may be only a few regions that will surpass limits for water takes and otherwise possess the prerequisites for trading. Trading has taken place in a number of regions experiencing water shortages, including Canterbury, Hawkes Bay and Otago, often as shares within irrigation schemes that have a single consent or bilaterally between farmers or brokers.

Charging

Water taxes have been successfully implemented in other jurisdictions with significant success. A study undertaken by the European Commission in 2011 found that volumetric charges on drinking and industrial water in the Netherlands and Cyprus have reduced consumption by between 8% and 40%, depending on user group (European Commission, 2011).

Six of 66 New Zealand local authorities meter and volumetrically charge across the whole of their jurisdictions,[7] and an additional eight meter and volumetrically charge across parts of their jurisdictions.

Equity and distribution

Generally speaking, the most significant market benefits of water extraction and contamination accrue privately to businesses, like manufacturers and farms, which require water as an input to production or rely on the ability of water bodies to absorb contaminants that are by-products of production processes. These firms have a significant incentive to secure consents to take and discharge to water. As a result, more passive recreational and cultural users, whose water use isn't monetised or easily valued, have relatively less influence over the availability and quality of freshwater resources.

Decisions about policy for managing fresh water quality have implications for intergenerational equity, as some discharges take years or even decades to reach water bodies and affect the water's quality, and costs incurred by current taxpayers may not realise water-quality-state benefits for many years. Good planning now, which imposes lower-level costs over longer transition timelines, can avoid damage to water bodies which may be either too costly or impossible to correct in the future.

New Zealand emits only 0.2% of global greenhouse gas emissions. For this reason, our mitigation policies will be most effective in contributing to a global solution to the extent that they encourage larger-emitting nations to take action.

Climate change

New Zealand faces challenges and information barriers in reducing its greenhouse emissions and adapting to climate change. *While the shape of international policy post-2020 remains unclear, it will be economically important that New Zealand contributes its 'fair share' of global mitigation in step with other countries and maintains its competitive advantage in those areas where our production is less emissions-intensive.*

Introduction

As an island nation with a long coastline and an economy reliant on primary production, New Zealand is vulnerable to changes in the climate. While New Zealand may not be as severely affected by climate change as some countries, impacts may include an increased frequency and intensity of natural hazards and extreme events, such as floods, landslides droughts, hot days, storms and coastal erosion (Joshi et al., 2011; Ministry for the Environment, 2008).

New Zealand emits only 0.2% of global greenhouse gas emissions. For this reason, our mitigation policies will be most effective in contributing to a global solution to the extent that they encourage larger-emitting nations to take action.

New Zealand faces significant challenges in reducing its greenhouse gas emissions. Nearly 50% of our emissions come from the agriculture sector, where fewer abatement options are available. The forestry sector has large potential for carbon sequestration in the short term, but carbon stored in wood products is emitted at or over time after harvest.

Our non-agricultural sectors are relatively carbon-efficient: New Zealand's emissions intensity – emissions of fossil CO_2 per unit of economic output – is close to the OECD mean and far below that of the rapidly developing Asian economies. New Zealand's electricity is over 70% renewable, including hydroelectric, geothermal and wind power, and may reach nearly 90% renewable by 2040 (MBIE, 2013).

Transport-related emissions comprise a high proportion of our total emissions from fuel combustion relative to other countries and the OECD mean. There are currently few lost-cost emissions reduction options in the transport sector, and consumer demand tends to be more price-inelastic.[8]

Unlike many other developed nations, New Zealand has a growing population: between 1990 and 2009 the population rose by 30%, making New Zealand the second fastest-growing developed country. The population is expected to be have grown more than 60% from 1990 by 2050 (Statistics New Zealand, 2009). A larger population drives increases in total emissions.

The nature of future international climate change commitments, and their

relation to domestic action, is unclear. Negotiations under the United Nations Framework Convention on Climate Change have recently agreed that a global deal should be negotiated by 2015, to enter into force from 2020. New Zealand has recently announced a target to reduce emissions to 5% below 1990 levels by 2020.

Opportunities do exist for New Zealand firms to realise lower-carbon growth while staying globally competitive. Government and the private sector can tailor investments in energy and transportation infrastructure in coming decades towards lower-emitting outcomes. It may be possible to realise growth while avoiding emissions increases by making smarter, longer-view investment and research and development decisions in the short to medium term.

Fiscal sustainability

Both domestic greenhouse gas mitigation policies and international commitments to reduce emissions have financial implications, which are both driven by and in turn have an impact on New Zealand's emissions profile. New Zealand's emissions profile is cyclical as a result of our large plantation forestry industry: as forests grow they absorb or sequester carbon, and as they are harvested the carbon stored in the trees over their lifetime is released.

Domestic mitigation policies

New Zealand has already taken action in adopting and implementing the ETS. The ETS was designed to assist New Zealand in meeting international climate change commitments at least cost and to reduce New Zealand's net emissions below business-as-usual levels by placing obligations on emitters to surrender units in relation to their emissions.

While the ETS is a useful tool for delivering international emissions reduction units, New Zealand's limited low-cost mitigation potential effectively restricts the scheme's ability to drive significant domestic emissions reductions. Economic modelling has shown that an increase in the price of carbon from $0 to $25 may reduce gross emissions by only 6 million tonnes of carbon dioxide equivalent (CO_2e) by 2040, or 5% below business as usual.[9]

The ETS can be calibrated to be fiscally neutral to the Crown over the long term. On this basis, emitters would surrender in aggregate no more than the number of units and/or cash necessary to satisfy New Zealand's international commitments.

International commitments

When New Zealand made its commitment under the Kyoto Protocol, the commitment was treated as a financial liability equivalent to the difference between the total projected emissions over 2008–2012 and the target level. New Zealand has recently committed to reducing emissions to 5% below 1990 levels by 2020, and this commitment will likely entail fiscal costs to the extent that our net emissions exceed the target over the period.

If ETS settings are attuned to deliver international commitments, climate change policy will be fiscally sustainable over the long term as business and consumers pay the emissions tab. However, this tax burden will have growth implications and associated longer-term fiscal implications, particularly in the event that New Zealand takes earlier, more aggressive action than its competitors.

Adaptation policy

As New Zealand's emissions are such a low percentage of the global whole, it will not be possible for our actions to meaningfully decrease the probability of catastrophic events. In the long term, large-scale events entailing high global damages may impact on New Zealand economically and fiscally, suggesting the increasing importance of maintaining prudent debt levels and investing in resilient infrastructure.

The importance of the primary industries in New Zealand makes our economy relatively more susceptible to shifting weather patterns and changing climatic conditions, suggesting a need for better and more information on the likely impacts of climate change and early investment where viable infrastructural and preparedness options exist (Treasury, 2002). Likewise, the proximity of significant infrastructural assets, urban centres and residential properties to the coastline gives rise to fiscal risks.

Economic growth and efficiency

Decisions about whether and how to reduce greenhouse gas emissions have real implications for New Zealand's economic growth, in both the short term and the longer term.

Studies have suggested that, at a global level, the benefits of strong, early action far outweigh the potential long-term combined costs of climate change damage and mitigation required to avoid dangerous climate change (Clarke et al., 2009; Stern, 2006). In the context of concerted global action, under which developed and large-emitting developing economies alike provide comparable, clear incentives to their domestic industries to reduce the greenhouse gas intensity of production, ambitious climate change policy in New Zealand will encourage innovation, fuel economic growth, and ensure that our goods and services remain competitive in the global marketplace.

At present, however, concerted international action is still under negotiation. In this context, aggressive, unilateral policies will entail negative effects on productivity growth and income for developed countries in the short term, primarily as shifting human and capital

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resources to work on mitigation reduces the resources available for producing other goods and services (Garnaut, 2011; Mendelsohn, 2009; OECD, 2008).

The closer in step we are with competitors, the lesser the relative impact on our growth. Modelling has suggested that consistent action across the rest of the world reduces GDP impact relative to business-as-usual by between 30% and 50%, compared to a scenario under which New Zealand takes strong action to reduce emissions ahead of the rest of the world (Ballingal, Schilling and Stroombergen, 2011).

Equity and distribution

The distribution of the ETS tax burden will remain, in the near-term, highly differential by sector, as the ETS assigns varying degrees of responsibility for emissions to various industries, taking into account the availability and cost of mitigation options and exposure to international markets. This distribution is relevant within generations.

When designing and implementing climate change policies we must also consider the distribution of costs between generations. Early, ambitious action ahead of international competitors will be highly costly to current generations and may yield only marginal cost savings for future generations. Conversely, action that is behind international competitors could save costs now, but to the detriment of future generations.

Conclusion

New Zealand is wealthy in natural resources, and these resources will be a determinant of our social, cultural and economic development. Our resource endowment is very diverse and resources should be managed in ways that reflect this diversity.

In order to use and protect this natural resource advantage we need to:

- *Know more about what resources we have.* The more and better-detailed information we have about the resources we have, their current use and their future demand, the better able we will be to assess and value our natural capital stocks and flows, conduct an informed public debate on the use of our resources, and design effective management frameworks to protect and utilise them sustainably.
- *Think carefully and creatively about how and when we use them.* As non-renewable resources are consumed and demand for renewable resources increases, we need to improve environmental management tools and financial mechanisms. These improvements will ensure resources flow to their highest-value uses and promote sustainable long-term growth.

1 The literature on 'strong' and 'weak' sustainability has introduced the concept of 'critical natural capital', or capital which performs important ecosystem services and that cannot be substituted for other types of non-natural capital (e.g. fresh water, climate, and soil). This natural capital may be considered non-renewable when its consumption or use surpasses a threshold, as its degradation beyond this point gives rise to exceptional economic, social or ecological costs (de Groot et al., 2003; Dietz and Neumayer, 2007).

2 It is often true that ascertaining the true and comprehensive value of natural resources can be difficult or impossible in practice, as the values derived are both market and non-market values, which are sometimes in conflict with one another.

3 This analysis assumes $100 per tonne carbon dioxide (CO_2).

4 The valuation of forecast royalties from future discoveries draws on a complex model of forecast future discoveries and production developed by the Ministry of Business, Innovation and Employment. The model performs a Monte Carlo analysis, using a number of probability-weighted inputs to generate several hundred scenarios, where each scenario sets out a unique forecast of the total producing fields in each of the eight frontier basins, their revenues, profits and royalties.

5 Valuations are derived using a discounted cash flow approach with a weighted average cost of capital of 8.89% for current basins and 11.85% for future discoveries. Estimates exclude any corporate tax revenue. Estimates for future discoveries based on the mid scenario with probabilities of 10%, 50% and 90% are combined according to Swanson's Rule, which assumes constant or slightly reducing industry exploratory activity and slowly increasing petroleum prices. Six oil price paths and three gas price paths were applied; oil prices in 2030 across the scenarios range from $US50 to $US200 per barrel by 2030. Gas is assumed to be sold domestically in NZ dollars; oil is assumed to be sold internationally in US dollars at a long-run average exchange rate of 0.600.

6 Water availability is based on mean annual low flow (MALF), which assesses the surface water-level conditions during the driest part of the year and assumes that all allocated water is taken. The MALF is modelled for stream segments by NIWA, and the most downstream value in each catchment is assigned to the catchment. The consented water allocation includes consumptive surface water sources (i.e. it excludes storage, groundwater and non-consumptive takes), which captures 60% of all consented consumptive allocation in New Zealand in 2010.

7 These are Whangarei District, Auckland Council, Tauranga City, Carterton District, Nelson City and Tasman District.

8 Note that these costs are technology-dependent and that technological breakthrough could significantly decrease the costs of abatement and increase the economic viability of various mitigation options.

9 Emissions projections sourced from the Ministry for the Environment; assumptions include AR4 global warming potential values and central GDP, oil price and exchange rate forecasts.

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