nzier
authoritative analysis

The impact of the proposed Emissions Trading Scheme on New Zealand's economy

Public discussion document

NZIER working paper 2008/02

April 2008

Preface

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield.

NZIER is also known for its long-established Quarterly Survey of Business Opinion and Quarterly Predictions.

Our aim is to be the premier centre of applied economic research in New Zealand. We pride ourselves on our reputation for independence and delivering quality analysis in the right form, and at the right time, for our clients. We ensure quality through teamwork on individual projects, critical review at internal seminars, and by peer review at various stages through a project by a senior staff member otherwise not involved in the project.

NZIER was established in 1958.

Authorship

This report has been prepared at NZIER by John Stephenson and Chris Schilling, and reviewed by Dr John Yeabsley. The assistance of Brent Layton, Johannah Branson, Jean-Pierre De Raad, Patrick Nolan and Trinh Le is gratefully acknowledged.

We are indebted to the team at the Centre for Policy Studies at Monash University in Melbourne Australia for their assistance in pulling together the ORANI-NZ model and adapting it for use in modelling climate change policy measures. The input of Dr James Giesecke, Professor Mark Horridge, Professor John Madden, and Professor Philip Adams were indispensable in getting our research project from ideas to practical application.

Our work has benefited considerably from two workshops at which a range of stakeholders representing industry and union interests and academics and other researchers provided us with feedback on our approach and assumptions and helped with funding. We hope we have addressed the issues raised by workshop participants and where we have omitted some issues, we will address them in future work.

8 Halswell St, Thorndon
P O Box 3479, Wellington
Tel: +64 4 472 1880
Fax: +64 4 472 1211
econ@nzier.org.nz
www.nzier.org.nz

Executive Summary

New Zealand should meet its Kyoto liability at least cost

New Zealand has made commitments to reduce greenhouse gas emissions under the Kyoto Protocol. New Zealand's commitments should be met "at the lowest achievable long-term cost" (MfE and Treasury, 2007).

The Climate Change (Emissions Trading and Renewable Preference) Bill introduces an Emissions Trading Scheme (ETS). Under the scheme, the main emission-producing sectors would be made responsible for reducing their emissions and helping New Zealand meet the Kyoto liability. Firms would be allocated permits to emit a defined quantity of greenhouse gases. Firms that emit more than their permits must buy extra permits; firms that emit less can sell their surplus permits.

The main alternative is that New Zealand pays for all its Kyoto liability out of general taxes – essentially Government buys recognised emission reductions abroad or in New Zealand.

In its current design, the ETS is not least cost

Market instruments, such as tradable emission permits, are generally preferred over this alternative because they attach the cost of emitting to the emitting activity, provide flexibility to reduce emissions at least cost, and create a continuous incentive for improvement. An emission trading scheme *could* meet the Government's objective of meeting Kyoto obligations at least cost, but *only if* its design takes account of the extent to which our trading partners also face these costs.[1]

The regulatory impact statement attached to the Bill states that the "macroeconomic impact, as represented by a variety of indicators is very small. This is consistent with the message that the impact under Kyoto would be around 0.1 percent of GDP" This statement also reports that the modelling has shown that in the long run an "ETS reduces the impact of meeting our international obligations over the case where government remains responsible for all emissions. For example private consumption fell by 1 percent in the scenario where the government is responsible but only 0.7 percent under an ETS."

Our analysis, however, shows both that the costs are greater, and that the design proposed in the Bill is not least cost. This is primarily because the ETS, as currently designed, does not adequately deal with New Zealand's exposure domestically and in export markets to competition from producers in countries that do not face the costs of their emissions.

[1] A full analysis of the design issues and preconditions for a New Zealand Emissions Trading Scheme are covered in NZIER (2007).

Model compares impact of an ETS to paying for liability out of taxes

We adapted an internationally recognized and respected CGE model to the New Zealand setting. Key assumptions have been tested with industry specialists and reflect best practice. The approach here is different from other work because it:

- captures some of the adjustment costs in the economy
- incorporates information on abatement costs specific to New Zealand
- quantifies the risk of 'leakage', where "New Zealand will incur economic costs while the global environment suffers" (Kerr, 2007)

The analytical framework used is to model the New Zealand economy in some detail, and forecast the hypothetical future state of the economy without any attempts to meet Kyoto targets. We then consider the impacts of an ETS as proposed and compare this to the New Zealand Government paying for emissions reductions out of general taxation.

Short term, the proposed ETS would reduce employment and profits

In 2012, the economic impact of the ETS and the cost of New Zealand's Kyoto liability is a:

- $900 million reduction in GDP (0.5%)
- $600 reduction in an average household's spending (0.8%)
- reduction in employment equivalent to 22,000 jobs (1.0%)

Most of these costs come from the way the ETS works through the economy, rather than from paying directly for the remainder of New Zealand's Kyoto liability.

Of the $900 million reduction in GDP, $800 million is directly attributable to the ETS. That is the ETS would cost 8 times more.

Long term, living standards will be lower than they would have been

Longer term, once the free allocation of emission credits have been phased out and the ETS covers substantially all greenhouse gas emissions, including those from agriculture, the ETS is four times more costly than the alternative of paying directly out of taxes for emissions reductions.

In 2025, the combined economic impact of an ETS and the cost of paying for an international emission reduction obligation (in today's prices), is a:

- $5.9 billion reduction in GDP (-2.1%)
- $3,000 reduction in an average household's spending (-3.0%)
- reduction in hourly wages equivalent to $2.30 per hour (-6.7%), or $90 a week for someone working 40 hours a week

Of that $5.9 billion reduction in GDP, $4.6 billion is directly attributable to the ETS.

Of course, GDP per capita would still be 42% higher in 2025 than it was in 2007. But that is still less than Australia's GDP per capita today. That highlights that it is critical to seek least cost solutions before committing to *any* increase in cost on the economy.

…yet emission reductions are not as large

Moreover, for all the additional cost that an ETS imposes on the New Zealand economy, New Zealand achieves 5% less emissions reductions, in terms of contribution to global emissions, than we could achieve if we funded emissions reductions elsewhere in the world or at home.

As proposed, the ETS is not a least cost climate change solution…

This is for two reasons. First, New Zealand production becomes more costly and less competitive compared to production elsewhere in the world leading to reductions in emissions in New Zealand but increased emissions elsewhere in the world. Second, our emissions reductions are expensive. Cheaper alternatives are available elsewhere.

Thus, the ETS as currently proposed is not the least cost solution for mitigating the impacts of climate change.

This finding is in line with earlier work by NZIER:

> *The reality is that it may prove cheaper to pay emitters in another country to reduce emissions rather than to achieve any reduction within New Zealand*. (NZIER, 2007)

…unless producers in other countries also pay for their emissions

The main reason is our assumption that New Zealand producers exposed to import competition or New Zealand exporters are unable to increase their prices to reflect the cost of climate change mitigation policies. If climate change measures are adopted elsewhere in the world such that that assumption no longer holds true, then we would need to revise our analysis.

Agriculture will be hit hardest through reduced competitiveness…

The proposed ETS would increase costs largely in export industries, especially the agricultural sector. In the agricultural sector in 2025:

- dairy farming declines 12.9%
- dairy land prices fall 40.6%.
- sheep and beef farming declines 6.6%

- the price of land used in sheep and beef farming falls 23.4%

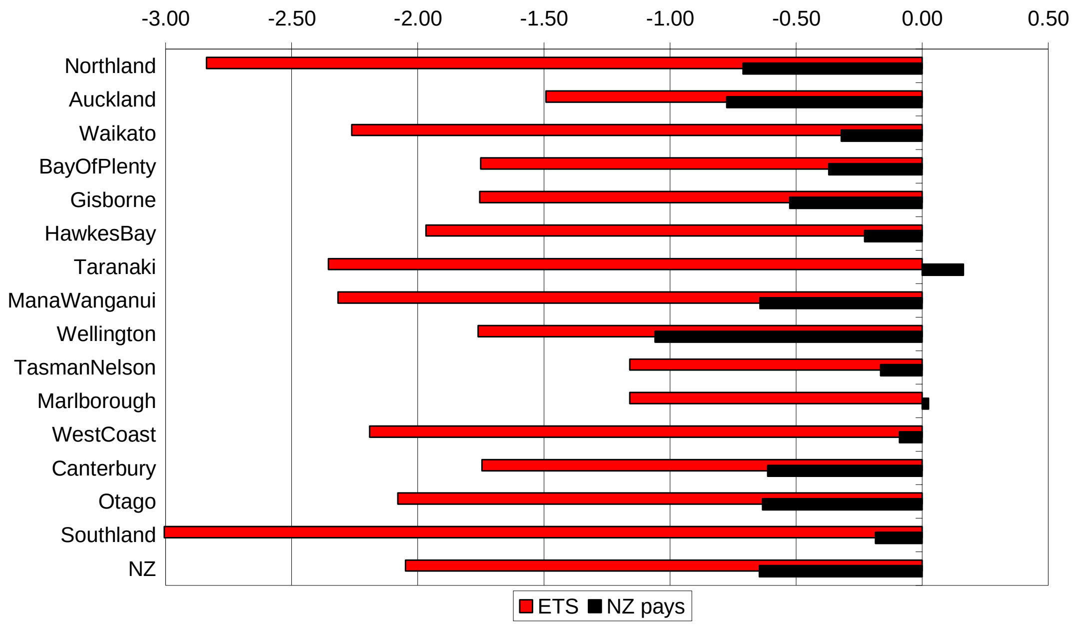
The impact on the agricultural sector is also a major source of leakage – where emission reductions occur in New Zealand only because our production is replaced with production elsewhere in the world. Our analysis suggests that the ETS would cause leakage from the pastoral sector to more than the equivalent of 3 million tonnes of CO_2 – around a quarter of the emission reductions resulting from the ETS.

Another sector heavily affected is basic metals manufacturing. Investment declines, plant, machinery and equipment, and other capital falls by 6.5%, and there is a 3.4% reduction in employment.

…and rural regions will shoulder a larger burden than urban centres

Impacts on regional GDP, 2025

% change to what might otherwise have been



Source: NZIER

Variation in impacts of the ETS across different industries also means quite variable impacts across New Zealand's regions - as regions have different concentrations of industries. The regional economies of Northland and Southland contract more than others, because both regions have significant concentrations of agricultural production and substantial employment in other large industries shrunk by the ETS – basic metals (aluminium) manufacturing in Southland and petroleum refining in Northland.

Regions with high concentrations of service industries and public sector employment, such as Auckland and Wellington, do not contract by as much as more rural regions.

The right permit allocation scheme would reduce the cost of an ETS

The impacts of an ETS change considerably when partial free allocation of emissions permits are not phased out. In 2025, an ETS with indefinite free allocation reduces GDP by 1.2% compared to 2.1% under the ETS with free allocation phasing out. Emissions reductions are 4.2% compared to 10.4% under phased out free allocation, but leakage of emissions of almost 2,900 kt CO_2-e are completely eliminated.

This result arises because indefinite free allocation of permits at initial allocation levels – i.e. not entirely free allocation – cuts the harm to export competitiveness.

We find that costs to the economy are more sensitive to changes in the quantity of permits allocated freely to industry and agriculture than to assumptions about emissions reductions from technology change.

Our research confirms conclusions from other qualitative reviews

The Government commissioned review of the proposed ETS reached conclusions that are similar to ours (Kerr, 2007):

> *…several very important aspects of the proposal require further development… [including] …the need for clear thinking on interred leakage and allocation issues; how to achieve a smooth, low risk transition; (p.1)*
>
> *Any policy used to address leakage should be simple and closely targeted. It should be designed to phase out as other countries regulate their emissions. (p.7)*
>
> *In the agriculture sector, [output-based or intensity-based allocation] could simultaneously address the question of how to freely allocate units that intend to compensate for capital losses (loss of land values). (p.7)*

Previous research reports have come to similar conclusions (Skilling and Boven (2007) and Castalia (2007)).

Implications

We find that, as long as there is no comprehensive global commitment, paying directly for emissions reductions out of general taxation is cheaper and more effective than the ETS as is currently designed. Our results are robust to sensitivity testing.

This means that if the Government intends to proceed with the ETS, then it should amend the allocation and phase-out rules to minimise the costs to the economy.

NZIER (2007) has already suggested how the issue of permit allocation could best be dealt with to minimise unnecessary costs to firms facing international competition. We have proposed:

- New Zealand firms subject to international competition from producers likely to be facing no or limited effective emissions charges should receive a gratis allocation of emission entitlements.
- To incentivise the firm receiving the entitlement to reduce its emissions, but not constrain efficient growth in output, the level of gratis allocation should, if practicable, be based on an international 'best practice' standard per unit of output.
- The 'best practice' standard could be set at the world best standard or at some point, such as, the upper quartile or top decile level for plants in an international peer group for which data are available.

For smaller entities, the information costs of finding and checking peer group data may be too great, and their gratis allocation could be based on some percentage less than 100% of their historical emissions per unit of output. They should have the option of having their allocation determined on the basis of the emissions of an international peer group if they wish, however.

Contents

Appendices

Figures

Tables

1. Introduction

This report considers the impact of the proposed Emissions Trading Scheme (ETS) on New Zealand's economy.

We consider the impacts compared to what would happen if the Government paid for reductions in greenhouse gases anywhere in the world. We also consider what the impacts of an ETS would be if Government did not phase out free allocations of emission units as is currently envisaged.

To date there has been a significant amount of research considering New Zealand specific issues relating to climate change and climate change policies. Our research differs from most of the existing research in that it evaluates the quantitative impact of **the ETS as proposed in the "Climate Change Bill"** as opposed to a more general assessment of a hypothetical emission mitigation strategy or general trading system.[1]

In our view there has been insufficient research investigating the Government's choice of design for an ETS in New Zealand.[2] Our research is intended to go some way towards rectifying this, although further work will still be needed.

While a quantitative analysis of the proposed ETS has already been carried out by Infometrics (2007), that analysis assumed (unconventionally) very limited impact on the productive side of the New Zealand economy and as a result understated both the short and long term effects of the proposed ETS.

The regulatory impact statement attached to the Climate Change Bill referenced the Infometrics (2007) analysis, stating that the "macroeconomic impact, as represented by a variety of indicators is very small. This is consistent with the message that the impact under Kyoto would be around 0.1 percent of GDP" This statement also reports that the modelling has shown that in the long run an "ETS reduces the impact of meeting our international obligations over the case where government remains responsible for all emissions. For example private consumption fell by 1 percent in the scenario where the government is responsible but only 0.7 percent under an ETS."

As noted in the Government commissioned review of the proposed scheme (Kerr, 2007):

> *The costs and structural shifts could be significantly higher than the Infometrics report implies. (p.8)*

[1] See for example, NZIER (2001), or McKibbin and Pierce (1997)

[2] At least, insufficient research that has been made public. There may have been significant analysis done behind the scenes.

Our analysis is still likely to understate the overall costs and structural shifts in the economy caused by the proposed ETS but the extent of the understatement will be less compared to the Infometrics (2007) study; see section 4.2 for a more in depth discussion of how our approach differs from that used in the Infometrics (2007) study.

We also add to existing research by paying special attention to plans for the allocation of emission permits under the proposed ETS. We evaluate the effects of phasing out of free allocations of emission permits by 2025 – the default mechanism for permit allocation in the proposed scheme – compared against an alternative more accommodating allocation plan.

The way that emissions permits are allocated is a very important design feature of the ETS. Firms facing international competition (whether from competition from imports or competition in export markets) will have difficulty competing if New Zealand places a cost on their emissions but their competitors do not face equivalent emission costs. If reduced competitiveness leads to production shifting from New Zealand to other countries without the same constraints on emissions this can lead to the perverse situation where New Zealand bears a cost without any commensurate reduction in global greenhouse gas emissions.

The Government commissioned review of the proposed ETS noted that allocation issues required “further development” (Kerr, 2007). Our analysis is intended to shed light on just how important (or unimportant) such “further development” is.

To provide context to our report, we begin with a discussion about the nature of greenhouse gas emissions in New Zealand, New Zealand’s international obligations to reduce emissions and the role of an ETS in New Zealand in contributing to global reductions in greenhouse gas emissions. We also provide a summary of the ETS and how it is expected to work.

Our analysis is quantitative and our results come from an applied “General Equilibrium” model of the New Zealand economy. This kind of model incorporates the many different interrelationships in an economy and provides a net read out. It is well suited to evaluating the way that the impacts of an ETS flow through the economy.

The model we use is not a magic crystal ball for telling the future – no model is – but it certainly has as much information in it for understanding the impacts of an ETS on the economy as any other analytical approach currently available. We discuss the model in Section 3.

In Section 4 we describe the scenarios that we have evaluated and discuss some of the assumptions we have made to help us evaluate the ETS. The assumptions we discuss include the likely price of greenhouse gas emissions that firms will face under an ETS and our view of what the economy will look like in the future without an ETS.

Of course, some of our assumptions can have large impacts on the magnitude of our results, so following discussion of our results in Section 5 we summarise how sensitive our results are to some key assumptions (Section 6). In the context of sensitivity analyses we also consider how sensitive the economy is to variations in one core design feature of the ETS – the quantity of allocations of emission permits to firms. This sensitivity helps us to gauge just how important free allocation is to the balance of impacts on the NZ economy and the potential for reduced greenhouse gas emissions due to the ETS.

2. The climate change challenge

2.1 Kyoto commitments require action[3]

New Zealand has an obligation to respond to climate change under its international commitments embodied in the United Nations Framework Convention for Climate Change and the Kyoto Protocol.

In 1992 the international community recognised the potential negative impacts of climate change impacts by adopting the United Nations Framework Convention for Climate Change (UNFCCC). This aimed to stabilise greenhouse gas concentrations at a level that would prevent major human-induced interference with the climate system and implied major reductions in global emissions compared to current levels and future business as usual (BAU) projections.

By the mid 1990s it became clear that the Framework Convention targets were not being met, largely because the Convention lacked teeth to give them effect. In December 1997 UNFCCC parties signed the Kyoto Protocol, which would commit developed countries to legally binding emission reduction obligations. It also provided for flexibility mechanisms to enable these commitments to be traded between countries so that emission reductions could be located where they were least costly to achieve.[4]

The aim of the Protocol was to reduce the emissions across the developed country participants to around 5% below their level in 1990, as a first step towards deeper and more widespread reductions in future periods. New Zealand's primary obligation is to monitor its emissions of the six Kyoto greenhouse gases over the years 2008 to 2012 and ensure that on average they are equal to or less than 1990 emissions, or otherwise take responsibility for emissions above that level.[5]

[3] Most of the discussion below is from NZIER (2001).

[4] There are three flexibility mechanisms under the Protocol: International Emissions Trading, between countries or individual companies; Joint Implementation, whereby reductions undertaken in one developed country receive entitlements transferred from another; and the Clean Development Mechanism, whereby developed countries can create additional assigned amounts through achieving certified emission reductions in developing countries.

[5] The greenhouse gases are methane, carbon dioxide, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. In compiling national inventories the gases are converted to carbon dioxide equivalents. Methane and carbon dioxide are by far the largest components of New Zealand's inventory.

Each country has an assigned amount of emission entitlement based on a historical level of emissions. To meet its Kyoto obligations New Zealand will have to show that it has sufficient assigned amount to match its reported emissions at the end of the commitment period. To do this it will have to reduce its domestic emissions, buy assigned amount from other countries, or generate new assigned amounts through the creation of carbon sinks by new tree planting.

By allowing entitlements to be traded between nations, emission reduction should take place up to the point where the marginal cost of abatement equals the marginal cost of alternatives, which is in turn reflected in the international price of emission entitlements.

Under Kyoto, emission rights can be traded amongst countries, and from that market an international emission price can arise. New Zealand, as a small participant, will have to accept that price. In other words, no matter what policy New Zealand pursues, the international permit price will not be affected. Stated differently, New Zealand will be a price taker in the market for emissions permits.

As all participating countries will therefore face the same international price of emission entitlements, such a system will tend to relocate abatement to those countries where it can be achieved at least cost. However, a feature of the Kyoto Protocol is that, at least for the first commitment period, not all major emitting countries will face binding emission restraints. Developing countries will not face any restriction on their emissions, and will obtain a cost advantage over comparable production in the participating developed countries until participation in the Kyoto mechanisms broadens to truly global coverage. It is intended that this will occur some time after 2012.

At a minimum, the government, as a party to the Protocol, will have responsibility for New Zealand’s excess emissions, which it can either discharge by buying emission entitlements on the international market, or by encouraging domestic emission abatement or sink creation. All of these options are likely to impose costs on the government, which it can recover through general taxation spread across the community. Alternatively, the Protocol allows it to devolve responsibility for emissions to New Zealand entities and individuals through direct measures, such as emissions trading by domestic entities or the imposition of a carbon tax. Such measures would be more selective and have costs that fall particularly on those whose actions create the excess emissions.

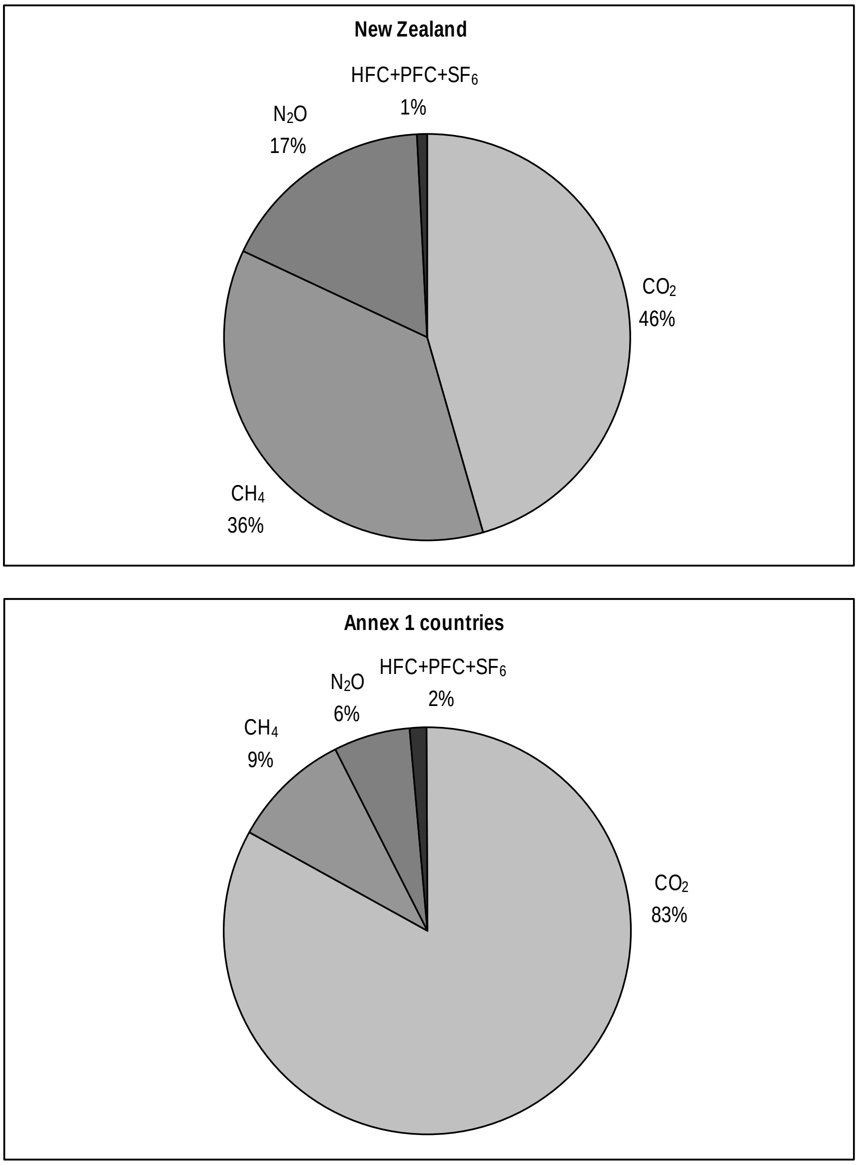
2.2 Greenhouse gas emissions and the NZ economy

The make-up of New Zealand’s emissions is peculiar compared to most other countries, especially other developed or rich countries. That is because most of our emissions come from agriculture and animals in particular.

In other countries, the main sources of emissions are typically from producing energy – whether for industry or for transport or homes.

Figure 1 Greenhouse gas emissions by gas

Carbon dioxide equivalents

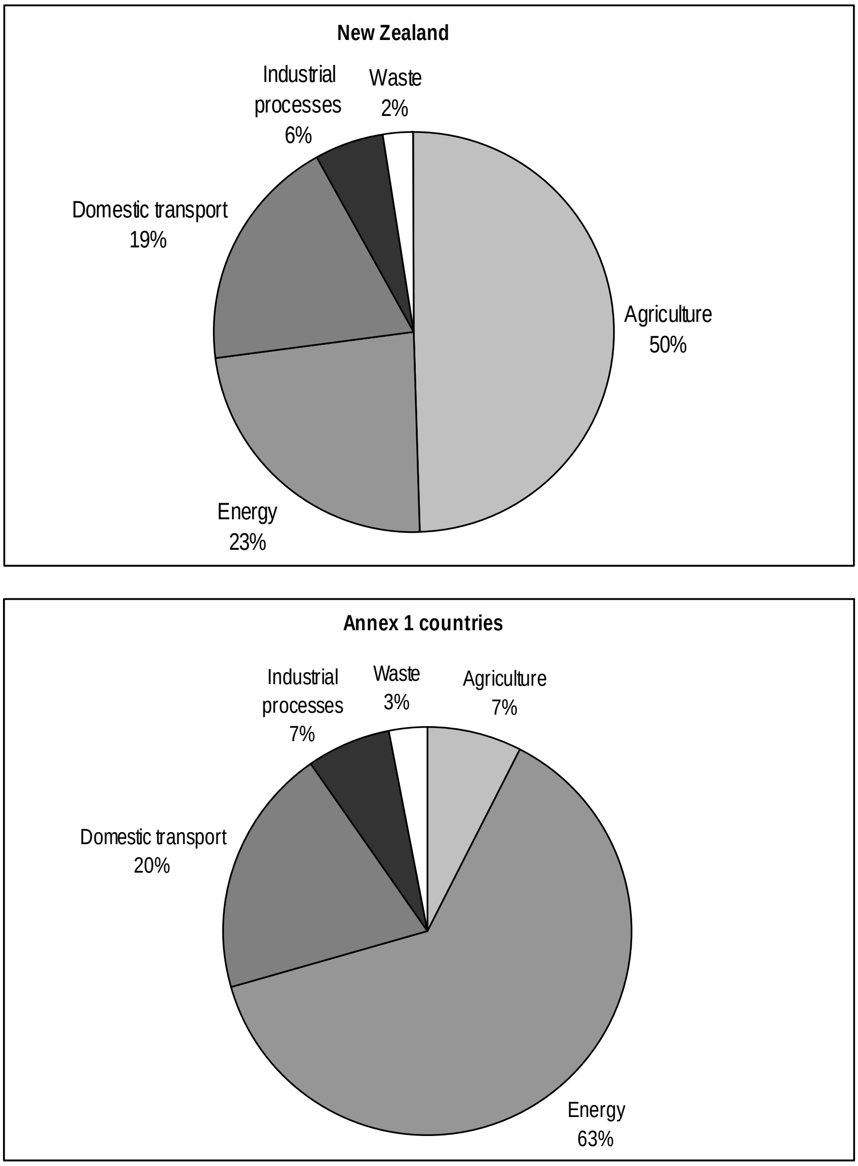


Source: Ministry for the Environment (2006b), United Nations Framework Convention on Climate Change (2006)

The Kyoto Protocol counts six gases in assessing anthropogenic greenhouse gas emissions – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), two groups of synthetic gases known as hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). In 2004, New Zealand's emissions of these gases, defined in terms of carbon dioxide equivalents, was around 75 million tonnes (United Nations Framework Convention on Climate Change, 2006). This followed average annual emissions growth of 1.4 per cent over the period 1990 to 2004, compared with a 0.7 per cent decline across all

United Nations Framework Convention on Climate Change Annex 1 countries (OECD countries plus Eastern European economies in transition).

Figure 2 Greenhouse gas emissions by sector
Carbon dioxide equivalents



Source: Ministry for the Environment (2006b), United Nations Framework Convention on Climate Change (2006)

Nevertheless, our emissions remain just 0.4 per cent of the total greenhouse gas emissions of Annex 1 countries – those countries with obligations to reduce emissions under the Kyoto Protocol. Per capita, New Zealand's carbon dioxide emissions are well below the median of Annex 1 countries and less than half the per capita emissions of Australia, Canada and the USA. Per unit of GDP, our carbon dioxide emissions are sixth highest in US dollar terms or twelfth highest in purchasing power parity terms. This suggests that New Zealand has slightly more emissions intensive production than many other countries and may suffer greater economic impacts in reducing emissions to meet targets under the Kyoto Protocol or other agreements.

New Zealand has a quite different emissions profile to other Annex 1 countries, as shown in Figure 1 and Figure 2. Across Annex 1 countries, emissions are dominated by carbon dioxide (83 per cent) and come largely from the energy sector (63 per cent). In contrast, over half New Zealand's emissions are methane and nitrous oxide, which account for only 15 per cent of Annex 1 countries' total emissions. The agricultural sector emits half our emissions, compared with only seven per cent across Annex 1 countries.

2.3 The ETS as a way to address climate change

In releasing its package of climate change proposals, the government announced its decisions "in principle" on the introduction of an ETS (Ministry for the Environment Government, 2007).

The ETS is different to, but not entirely distinguishable from, New Zealand's obligations to reduce greenhouse gas emissions under the UN Framework Convention on Climate Change (UNFCCC). As a participant in the UNFCCC and being a signatory to the Kyoto Protocol which arose out of the UNFCCC, New Zealand has taken on obligations to reduce its greenhouse gas emissions to 1990 levels – in order to play a part in mitigating the negative effects of climate change.

The ETS is one scheme that can be used to address climate change and the idea of emissions trading is also in the Kyoto Protocol. The Kyoto Protocol allows for international trade in emission reductions that could ultimately form the basis of an international emissions trading scheme.

Allowing for trade in emissions recognises that it doesn't matter where in the world greenhouse gases are produced or reduced – any increase or reduction in greenhouse gases will have approximately the same impact on climate change whether it takes place in New Zealand or in Australia or any other country in the world. That being the case, trade in emissions can therefore lead to reductions taking place wherever it costs the least, without compromising the goal of reducing greenhouse gas emissions.

Having a domestic ETS is one way of ensuring that New Zealand can link into any such international trading scheme, although no such scheme has yet emerged.

A domestic ETS also has the benefit of making New Zealand consumers and producers responsive to the amount of greenhouse gases they produce or consume.

A domestic ETS can also help to ensure that any emission reductions within New Zealand will take place in sectors where it is cheapest to make reductions.

A domestic ETS doesn't have the same merits as an international ETS. Taking unilateral action to put a price on greenhouse gas emissions can lead to "leakage", where production shifts to countries that don't impose constraints on emissions. This can even lead to increased greenhouse gas emissions if production relocates to countries that are more emission intensive because, for example, a greater proportion of their electricity is generated from fossil fuels like gas and coal than is the case in New Zealand.

"Leakage" was raised as an issue that requires significantly more attention in the Government commissioned review of the proposed ETS (Kerr, 2007):

> *If significant leakage occurs, some firms and workers in New Zealand will incur economic costs while the global environment suffers. (p. 6)*

That said, the ETS is not the only measure that the Government is pursuing in relation to climate change. Indeed the Government has introduced a package of measures to address climate change and to help meet its international obligations to contribute to minimising the build up of greenhouse gases in the earth's atmosphere. The ETS is just a major part of that overall package.

2.3.1 Basic design

The government's in principle decisions on the basic design of the NZ ETS are:

- the NZ ETS will involve an obligation on participants to hold emission units that match the emissions levels for which they are responsible; a limited number of New Zealand emission units will be issued each year, and the scheme will operate within the global cap on emissions set by the Kyoto Protocol
- the NZ ETS will, over time, include all major sectors (i.e. forestry, transport, stationary energy, industrial processes (non-energy), agriculture and waste) and the six greenhouse gases specified in the Kyoto Protocol
- the NZ ETS will involve the devolution to landowners of both the credits for forestry activities that lead to a removal of carbon dioxide from the atmosphere, and the liabilities for the subsequent release of carbon dioxide into the atmosphere (by harvesting or deforestation)
- the NZ ETS will be introduced across the economy in a staged process to allow gradual adjustment to emissions pricing:
  - forestry will be introduced on 1 January 2008
  - liquid fossil fuels on 1 January 2009
  - stationary energy and industrial process emissions from 1 January 2010
  - agriculture, waste and all other emissions from 1 January 2013
- the NZ ETS will include three types of participants:
  - participants with obligations to surrender emission units to cover their direct emissions or the emissions associated with their products

- participants who receive freely allocated emission units, or receive emission units for eligible afforestation, or hold other emission units that can be traded to other parties
- participants who engage in trading activities to take advantage of market opportunities

- the core obligation will be for participants with unit obligations to surrender to the government one emission unit to cover each metric tonne of eligible emissions in a compliance period (usually a calendar year); the obligation is absolute, rather than intensity-based, so does not vary with the level of output
- the New Zealand Unit (NZU) will be the primary domestic unit of trade; for the first commitment period, NZUs will be fully comparable to, and backed by, Kyoto units by the end of the period for determining compliance
- the NZ ETS will allow both sales to, and purchases from, international trading markets, to aid market liquidity and to provide a safety valve on price
- participants will face binding consequences for non-compliance with their obligations, including penalties and make-good provisions
- the NZ ETS could potentially be augmented by an offset mechanism, which would allow people without ETS obligations to earn emission credits for activities resulting in a reduction in total greenhouse gases being released into the atmosphere
- the NZ ETS will be adaptable to future changes to New Zealand's obligations under the international climate change policy framework post-2012 and continue to function even if there is a hiatus between the end of the first commitment period of the Kyoto Protocol and the implementation of a successor international agreement.

2.3.2 Initial allocation of emission units

The government has decided in principle to allocate NZUs initially through a combination of sale and free allocation. In free allocation, as a form of assistance to business, it has decided in principle that:

- in the forestry sector, the free allocation will be:
  - from 2008 to 2012, 21 million tonnes CO_2-e for plantation forest, plus a relatively small allocation set aside for forest weed control
  - from 2013, an additional 34 million tonnes CO_2-e for plantation forest (i.e. taking the total free allocation to owners of pre-1990 exotic forest land to 55 million tonnes)
- the agricultural sector will be provided with a free allocation equal to 90 per cent of its 2005 emissions
- eligible industrial producers will be provided with a free allocation equal to 90 per cent of their 2005 or, if firms choose, 2003 or 2004 emissions
- over 2013 to 2025, the free allocation pools for industrial producers and agriculture will be reduced each year, on a linear basis (i.e. zero from 2026)

- new sources that begin emitting during the period of the free allocation will not have any access to the pool of free allocations
- firms that cease trading will not retain any free allocations
- no free allocation will be provided to the upstream points of obligation in the liquid fossil fuel and stationary energy sectors (including electricity generators) and landfill operators.

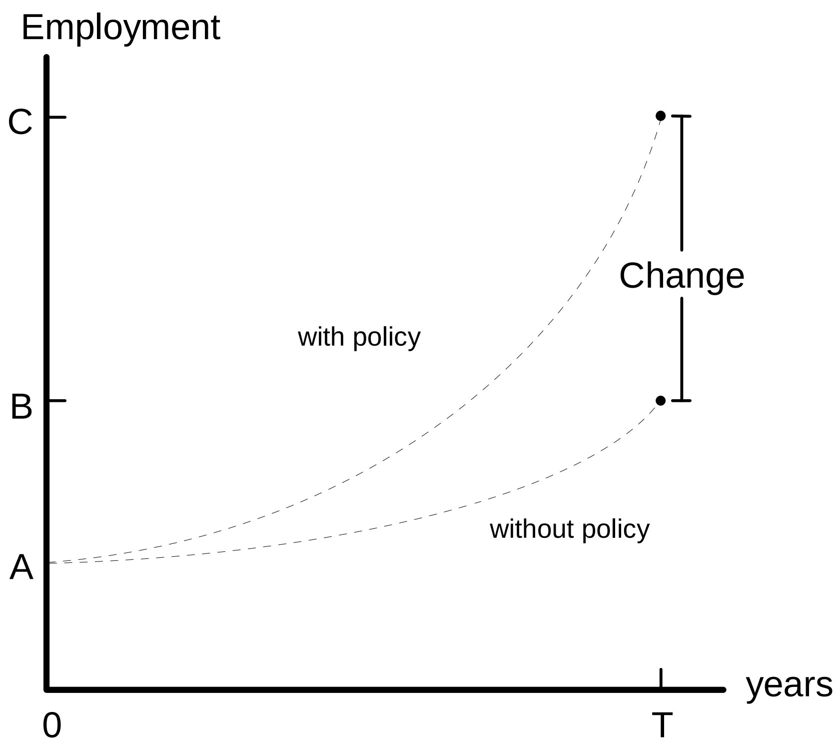
3. Our model of the NZ economy

3.1 ORANI-NZ

3.1.1 Model framework

NZIER has developed a CGE model in conjunction with the Centre of Policy Studies (COPS), Monash University, Australia. The model is a New Zealand-specific version of COPS ORANI-G model (the 'G' stands for 'generic'). The ORANI framework has been extensively used in policy analysis in Australia for nearly two decades, and has been adapted for countries all over the world, including China, Brazil, Ireland and Denmark (COPS, 2008). We provide below a description of some of the key model features, however the interested reader is directed to the COPS website (http://www.monash.edu.au/policy/oranig.htm) for full documentation of the ORANI-G model.

Figure 3 Comparative-static interpretation of results



Source: Horridge, 2008;

3.1.2 Comparative-static modelling

The ORANI model is a static CGE model, designed for comparative-static simulations. ORANI simulation results report the comparative position of the economy after some shock, compared to what might have otherwise been. Figure 3 illustrates an example, plotting employment with and without the implementation of a given policy. Without the policy, employment reaches point

B after T years. With the policy, employment reaches point C after T years. In such a simulation, ORANI would report a percentage change in employment of 100*(B-C)/B (Horridge, 2008).

3.1.3 Using models

There are some important caveats that need to be considered with CGE modelling in general:

- Based on neoclassical microeconomics – this presumes all markets base decisions on relative prices.
- Smooth responsiveness – the model does not capture step-wise industry and economy-wide adjustments but assumes smooth and continuous changes. In reality, industries with large capital resources face discrete production and investment decisions.
- Aggregation bias – the model aggregates the economy into 131 industries and 210 commodities; we suggest that this level of detail is sufficient to capture the key economic issues across the economy, however note that some effects cannot be identified due to aggregation-bias.
- Database dependency – the model status-quo structure is based on the snapshot of the economy provided by Statistics NZ in their latest 2003 Supply and Use Tables, in turn an update on previous more comprehensive input-output tables from 1995/96. Structural changes to the economy over the last 5 years are therefore not captured in the model database. We acknowledge these issues, and highlight the need for more regular release of input-output tables to enhance policy analysis in NZ.
- Comparative static equilibrium analysis – the model reports the likely change in the economy at a given time; it does not capture the gradual implementation effects of a shock as the economy adjusts over time. In the long run, these restrictions aren't important as we assume that the economy can adjust to the desired point. A dynamic model would address some of these concerns, and is a priority for further work.

4. Scenarios

To evaluate the proposed ETS we conduct two kinds of modelling simulations. One simulating the impact of the proposed ETS and a second set of simulations evaluating the cost from NZ Government tax paying directly for emissions reductions without any form of carbon charge or carbon taxation.

The baseline against which these simulations are created is a hypothetical world without any international obligation to reduce emissions. This approach allows comparison of the two different kinds of simulations. The fact that our baseline is hypothetical does not alter the conclusions or robustness of our analysis.

We evaluate the impacts of an emissions trading scheme in the context of a world in which world prices for New Zealand exports do not change to compensate our exporters for the increased cost of producing in New Zealand due to an ETS. This is a scenario rather than a forecast of what other countries will do to reduce greenhouse gas emissions but we think it is realistic, especially in the near term. New Zealand's industries most at risk from loss of competitiveness under the proposed ETS are agricultural industries. Exports of agricultural products make up around half of New Zealand's merchandise exports. It is highly unlikely that other countries will place obligations on their agricultural sectors. Indeed most agricultural exports in the world come from countries that subsidise and protect agricultural production.[6] It is hard to envisage, therefore, a situation arising where world prices for New Zealand's major exports reflect the cost of greenhouse gas emissions.

We refer to our second set of simulations, where we model the impact on the economy of the New Zealand Government paying for emission, as 'NZ pays'. Instead of imposing the cost of emissions on industry, the government pays a "Kyoto obligation" through raising general taxation. As such, all New Zealand tax payers fund emission reductions – hence the use of the phrase 'NZ pays', because the cost of emissions reductions is distributed across New Zealand tax payers.

The 'NZ pays' scenario has many proponents, who argue that global uncertainty of carbon prices, lack of corresponding action from other countries (particularly in agriculture), together with NZ's already high renewable energy levels and world class emissions intensity production technologies, means that leading the world in introducing a broad-based ETS may be a high-risk and costly strategy for the NZ economy.

In our 'NZ Pays' simulations we assume that it does so by paying for emission reductions abroad. This is an extreme case because the Government could also pay for any emission reductions at home which are lower cost than emission reductions abroad. This would lower the cost of any external liability. That being

[6] WTO trade statistics for 2006 show that more than half of world trade in agricultural products came from the US (16%) and Europe (46%).

so, our simulations of the cost of paying for offshore reductions overstates the cost of the Government paying for emission reductions.

Our simulations in which the Government covers any international obligations to reduce emissions also overstates the cost to Government by assuming that Government will have to pay the same price for emission reductions as firms will have to pay. In reality with considerable purchasing power and the ability to seek out the low cost emission reduction projects we would expect the Government to pay less per tonne of CO_2-e than many firms would have to pay.

4.1 ETS scenarios

We have broken down our evaluation of the impacts of an ETS into three time periods:

- The impact in 2012
- The impact in 2015
- The impact in 2025

We model these scenarios by changing the structural parameters of the model to reflect the key factors we expect to be at work during the year in question. The first point in time (2012) deals with the short term adjustment costs of an ETS. At this time emissions obligations are placed on:

- Liquid fuels
- Stationary energy
- Industrial processes

Firms with obligations who are trade exposed receive a free allocation of permits equal to 90% of the 2005 emissions and these allocations include rebates for increased electricity prices.

The second scenario considers the impact on the economy in 2015 of the extension of the ETS to agriculture while some free allocation of carbon permits remains for trade exposed firms. In 2015 the ETS will place obligations on:

- Liquid fuels
- Stationary energy
- Industrial processes
- Agriculture
- Waste industry

The third scenario considers the impact on the economy in 2025 once free allocation has been phased out. The extent of industry obligations remains the same as in the second scenario.

In each of these scenarios we make different assumptions about:

- The way that the shocks flow through the economy.

- The extent of free allocation of permits to trade exposed industries.
- Growth in the economy if there was no ETS.
- Future New Zealand liabilities in international environmental agreements.
- The extent of deforestation.
- New Zealand's baseline emissions in the absence of an ETS.

Below we outline our assumptions.

4.2 The way shocks flow through the economy

To analyse the impacts of an emissions trading scheme or in fact any new influence or "shock" to the NZ economy we need to decide which parts of the economy are likely to adjust over time.

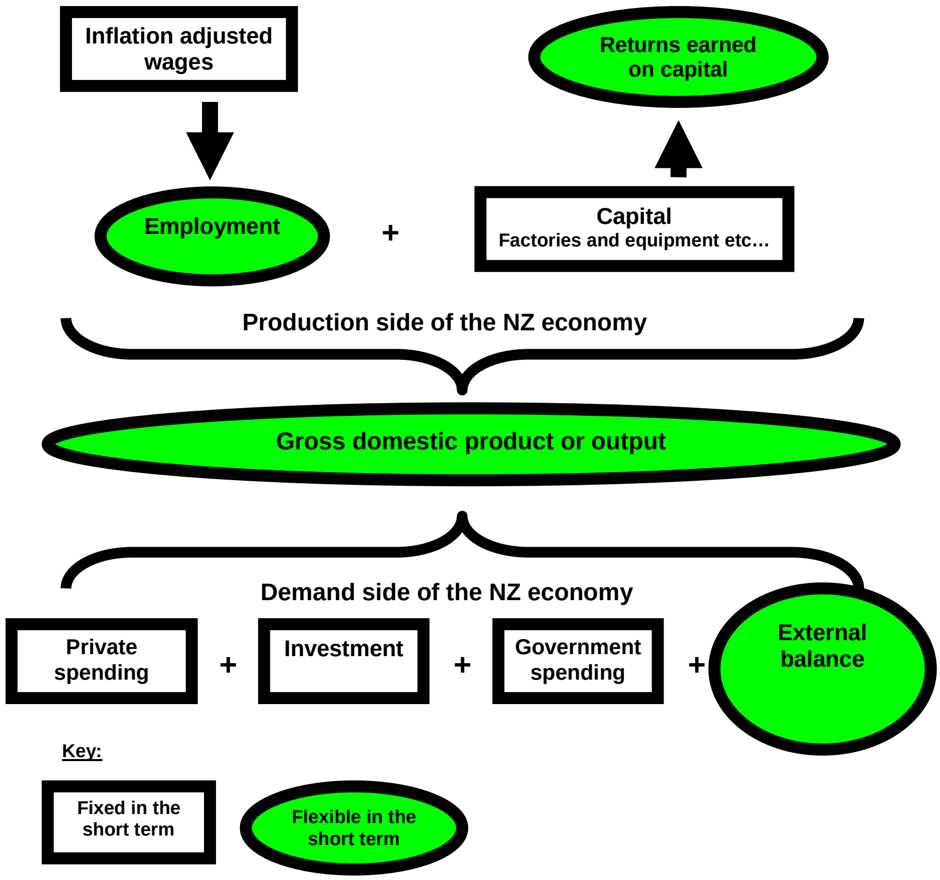
We need to do that because some parts of an economy need quite some time to adjust to new influences. For example, businesses do not tend to close or spring up over night. Owners and operators need some time to adjust their businesses to any new influences in the economy. As such, we impose our judgement about what parts of the economy can and cannot move or adjust in the short term or the long term.

In terms of short term adjustment in the economy over say two to four years we would expect the amount of capital – plant, machinery, equipment and the like – to be fixed or at least relatively inflexible and not to adjust too much.

In reality, businesses do shut down and capital can be destroyed in the short term. Our assumption that capital is fixed in the short term means that our results understate impacts on capital.

In the labour market we would expect wages to be inflexible – a phenomenon referred to as "sticky wages" where wages do not adjust very quickly downwards to new economic influences or shocks.

Figure 4 Adjustment in the economy over the short term



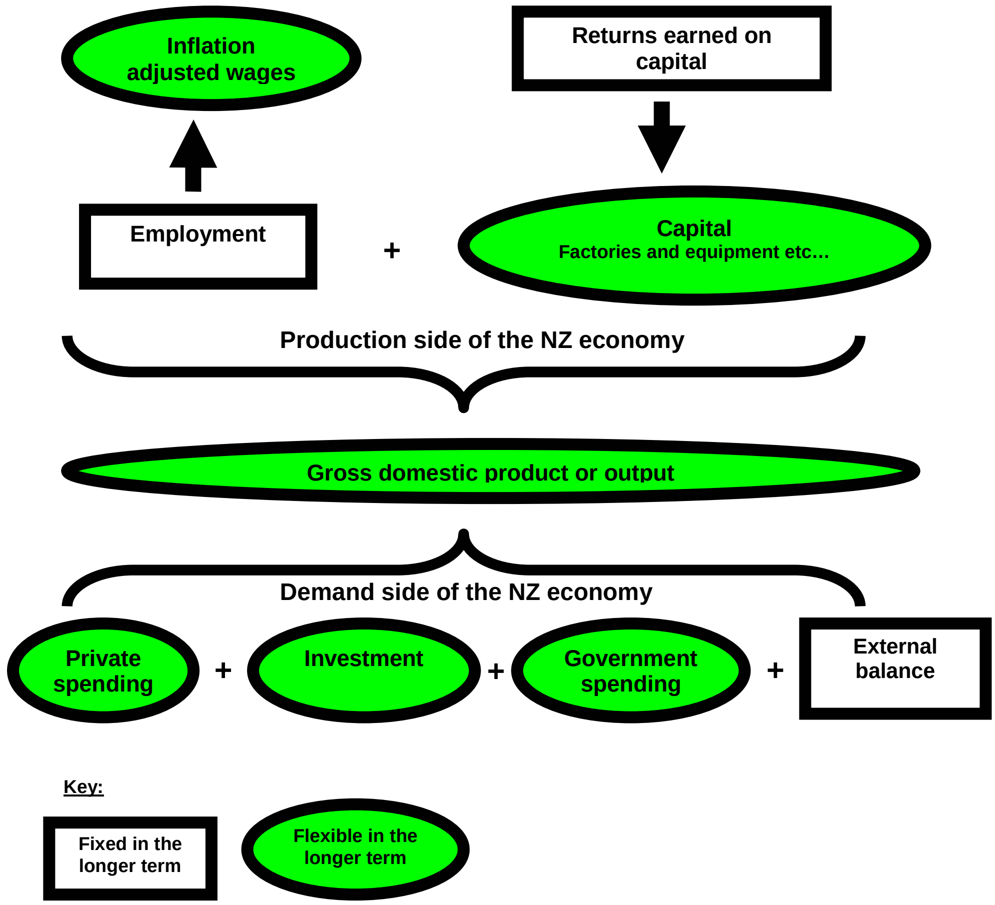
Source: NZIER, Centre for Policy Studies Monash University

With wages and capital fixed in the short term the only things on the production side of the NZ economy that can adjust to help the economy respond to new influences are employment and the rates of return on capital.

On the demand side of the economy government spending, private spending (or consumption), and investment all maintain fixed <u>shares</u> of total demand in the economy while the trade balance adjusts to shocks.

In the longer term, we would expect most of the short term inflexibilities to disappear. Declining rates of return on capital in the short term, for instance, will cause adjustments in the size and composition of the capital stock in New Zealand. That adjustment will take place to the point that returns on capital return to a longer run or sustainable position – i.e. long run required rates of return are fixed.

Figure 5 Adjustment in the economy over the longer term



Source: NZIER, Centre for Policy Studies Monash University

Conversely, the level of employment in the NZ economy will not adjust over the longer term. Rather, real wages adjust to ensure that as many people are employed as possible.

On the demand side of the economy the external balance will return to a fixed long run or sustainable position through changes in real exchange rates and changes in investment flows into and out of New Zealand. As opposed to, in the short term, when the trade balance can get larger or smaller much as we see happening in any given year.

In the longer term, investment demand will adjust to reflect the necessary amount of investment to maintain or meet the adjusted value of capital in the economy. Government and private sector spending (or demand) then adjusts depending on what happens to overall activity in the economy (i.e. GDP).

In both the short and the long run we would not expect adjustments in the Government's fiscal balance – i.e. the balance of what the government spends versus the money it receives. This assumption means we can avoid having to make guesses about changes in Government fiscal policy in the future.

These assumptions have an important impact on the outcome of our modelling. Our analysis will show a shock having bigger impacts on the economy than if, for instance, we assumed that the shock would have no real impact on the amount of productive resources available in the economy.

For example, one research report on the economic impact of the ETS commissioned by the Government (Infometrics, 2007) assumed that even over the longer term there could not be any negative impact on the amount of capital in the New Zealand economy. We take the opposite view.

In our analysis we assume that in 2012 the "shock" from the ETS flows through the economy as a short term shock – as described above.

In both our 2015 and 2025 scenarios we use our view of the way the economy adjusts over the longer term to account for the flow through impacts of the ETS.

It is not clear whether it is better to take a short or a long term view about adjustment when considering the impacts in 2015. There may not be sufficient time between 2008 and 2015 for the labour market to entirely adjust to the impacts of the ETS – i.e. to ensure the work force is fully utilised. At the same time, we would expect some adjustment to inflation adjusted wages and we do not want to overstate the impacts on employment by adopting a short term adjustment scenario.

Similarly, while we would expect some adjustment in the amount of capital available after 7 years, that impact may be more muted than our scenario admits.

To resolve this uncertainty one approach could have been to consider only the shorter term (2012) and long term (2025) impacts of the ETS. The problem with only having two scenarios to consider is that we would not be able to capture the extent to which free allocation of permits helps to mute some of the impacts of the ETS on the overall economy.[7] Therefore we decided to include a 2015 scenario in order to help show the extent to which free allocation helps to minimise the impact of the ETS on the economy.

The 2015 scenario should be compared to the 2025 scenario and be interpreted as showing how free allocation of permits can minimise the impact of the ETS on the economy.

4.3 Rate of growth in emissions

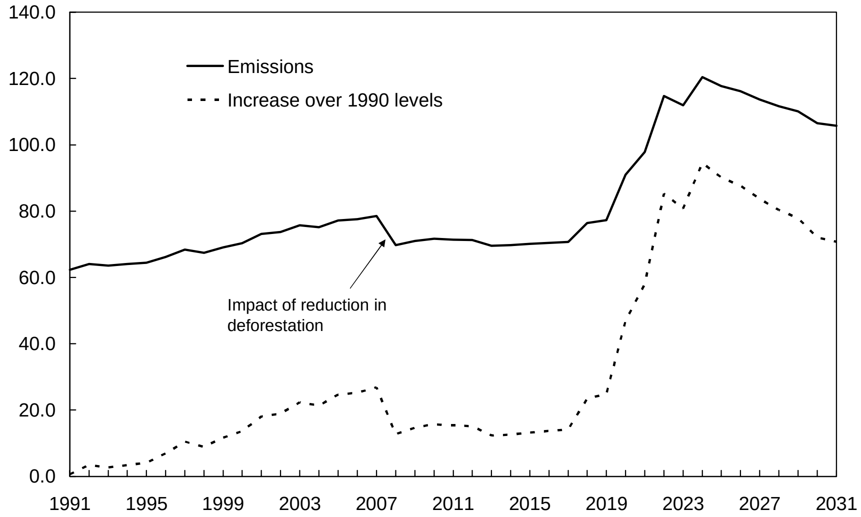
To determine the size of any emissions reductions under the ETS, and to evaluate the size of any free permit allocations, we need to consider baseline forecasts of

[7] While we can capture this by considering a scenario with no free allocation in 2012, this would not include the effect of free allocation to agriculture, which is not brought into the ETS until 2013.

the quantity of emissions in New Zealand between now and 2025. To do this we have used forecasts of emissions from the Ministry for the Environment.[8]

Figure 6 Forecast growth in emissions

Mega tonnes of CO_2-e emissions, net of offsets from forestry



Source: NZIER, Ministry for the Environment

Forecast total growth in emissions is shown in Figure 6. Note that the increase (in mega tonnes of CO_2-e) over 1990 emissions charted as a dashed line shows growth in New Zealand's Kyoto liability between 2008 and 2012 and the extent of any liability that might be imposed in the future in relation to 1990 emissions.

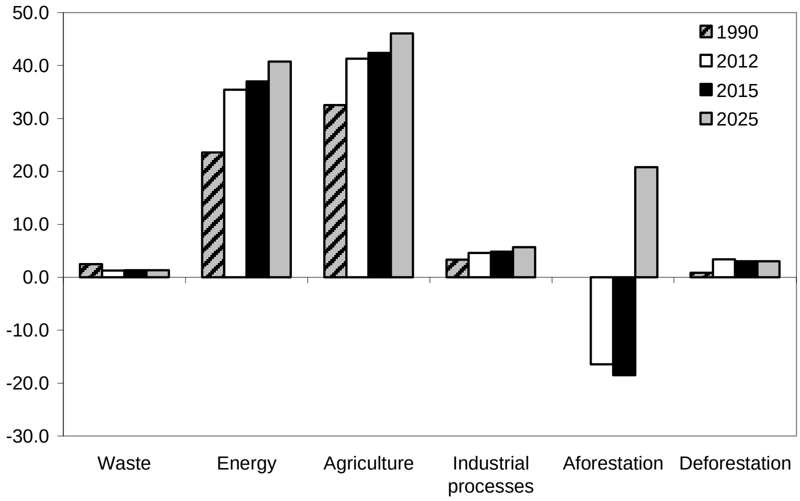
The Ministry for the Environment forecasts also provide a breakdown of emissions by major emitting source (see Figure 7). Those forecasts show a large increase in contributions to emissions from forest harvesting in 2025 (see afforestation in Figure 7) due to cycles inherent in harvesting but limited increases in emissions from deforestation over the entire forecast period.

We have assumed that the ETS will not have any further impact on deforestation beyond what is assumed in the MfE forecasts, i.e. 3 mega tonnes of emissions from deforestation on average between 2012 and 2025. This assumption is useful for this report as it means our approach is comparable to the approach used in the Infometrics (2007) evaluation of the impact of an ETS. In future reports we will give more attention to our own assessment of the likely impacts of an ETS on New Zealand forests and deforestation.

8 We have adjusted the forecast information we received from the Ministry for the Environment to account for the fact that the figures we received did not incorporate reduced deforestation of pre 1990 forests. That reduction is in the "Projected balance of emissions units during the first commitment period of the Kyoto Protocol" (Ministry for the Environment, 2005) so we have used the reduction to ensure consistency with the "official" calculation of New Zealand's Kyoto liability in the first commitment period.

Figure 7 Forecast emissions by source

Mega tonnes of CO_2-e emissions by major emission sources



Source: Ministry for the Environment, NZIER

4.4 Allocation of permits

The details of how permits will be allocated under an ETS are not clear so we have made some assumptions about this. Our assumptions cover:

- which industries will receive free allocations
- the rate at which free allocations for indirect emissions from electricity will be calculated
- the proportion of emissions by industry that will receive free allocation.

As a starting point we assume that free allocation of permits will be capped within an envelope of 90% of 2005 emissions. All other permits will have to be bought.

We have identified the following sectors as ones that are likely to receive free allocations of permits:

- Agriculture (livestock emissions)[9]
- Petroleum refining
- Meat and dairy processing
- Pulp and paper
- Industrial chemicals (including fertiliser)
- Non-metallic mineral products (cement and lime)
- Basic metals (iron and steel and aluminium)
- Wood processing.

[9] Not applicable until agriculture assumes obligations under the ETS in 2013.

Our choice of sectors was guided by the Climate Change Bill, our judgement about trade exposed sectors, and by those sectors identified as receiving free allocation in the modelling work undertaken for Government (Infometrics, 2007).

The proportion of direct emissions that is allocated freely was informed by the Ministry for the Environment's forecasts of emissions by industry.

Where emission forecasts for a specific sector were not available we have calculated their free allocation based on the average across industrial processes.

In the case of free allocations of permits or receipt of rebates to cover increased electricity costs (i.e. indirect emissions), we have calculated this on the basis of 2005 electricity consumption by industry and on the assumption that the marginal emission factor in electricity is 0.6 times the increase in cost from the marginal emitting technology (assumed here to be coal, so ignoring the existence of the Government owned diesel generator at Whirinaki because the plant is only reserve capacity and is not supposed to generate very often).

4.5 Baseline economic forecasts

Baseline economic forecasts that we will use later to gauge the dollar impacts of the ETS are summarised in Table 1. These forecasts are mainly based on trend growth analysis of the New Zealand economy, with an assumption that the NZ economy will continue to grow at around the same trend rates over the next ten to twenty years as it has in the past fifteen years. The only exception to this is that we have drawn on Statistics New Zealand's population projections to produce our forecasts of population growth and growth in the number of households in New Zealand.

Table 1 Baseline economic forecasts

Dollar millions unless otherwise stated

	2012	2015	2025
GDP	215,730	263,260	412,053
Real GDP (2008 prices)	196,939	222,027	290,786
Private consumption	125,690	153,827	242,341
Real private consumption (2008 prices)	121,493	139,558	190,639
Number of households	1,575,300	1,642,479	1,804,294
Employment (full time equivalent employees)	2,278,503	2,350,997	2,609,718
Payments to employees (2008 prices)	91,489	107,232	153,273

Source: NZIER

4.6 International action

To make an assessment of the economic impacts of the ETS after 2012 we have made assumptions about the nature of any successor arrangement to the first commitment period under the Kyoto Protocol. We assume, for simplicity, that the parameters of New Zealand's international obligations between 2012 and 2025 are the same as those between 2008 and 2012 – i.e. we assume that New Zealand must either reduce its emissions to 1990 levels or pay to offset the difference between its emissions and 1990 emissions at prevailing international prices.

We acknowledge that an ETS could continue to operate even if there is not a successor arrangement after the end of the first commitment period under the Kyoto Protocol. Therefore it may be worthwhile considering what the impact of an ETS might be without any further international commitments to reduce greenhouse gas emissions. We have decided, however, to leave such an analysis to one side for the moment because if there is no further coordinated international commitment to reduce greenhouse gases, then having an ETS in New Zealand would be futile. New Zealand is just too small a contributor to global greenhouse gas emissions for us to have an impact on climate change on our own.

To conduct our analysis of the effects of an ETS we also assume in our base case that New Zealand's comprehensive ETS (all gases and all sectors) is not matched by equivalent schemes elsewhere in the world. This is clearly a simplification although to date very few countries have introduced an ETS and no other country has initiated an ETS that is as comprehensive as the proposed NZ scheme.

Our assumption has one main practical impact. That is that, in the absence of equivalent schemes elsewhere in the world (especially schemes incorporating agriculture), New Zealand's trade exposed industries will be at a competitive disadvantage in world markets. As a result exports come under pressure.

By assuming that no equivalent schemes are introduced elsewhere in the world we can also usefully evaluate the consequences of New Zealand forging ahead with an ETS while other countries adopt different strategies. This gives an entry point into understanding the extent of "burden sharing" under any future international arrangements.

4.7 Prices

All of our scenarios are based on an assumed international price of carbon equivalent to \$40 per tonne of CO_2-e in 2008 prices.

There is considerable uncertainty about what carbon prices will be in future. We have chosen NZ\$40 as it reflects our view of the likely price for project based credits in 2012.

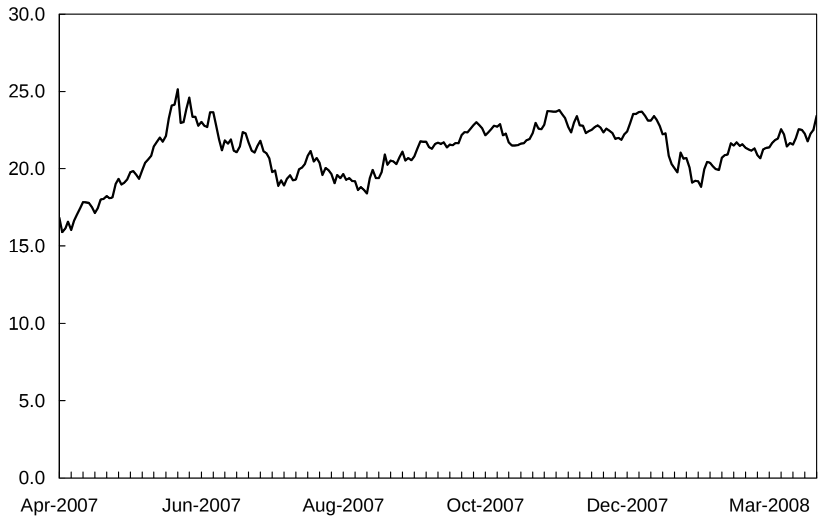
At the moment there are several prices for carbon around the world and most likely there will not be any one price for NZUs in an NZ ETS.

One indicator of future prices for NZUs is the price of European Union (EU) allowances in the EU ETS. Prices for EU allowances (EUAs) traded on the European climate exchange have averaged around 21 euros per tonne of CO_2 in the past two years (see Figure 8).

As the second phase of the EU ETS continues and firms need to find allowances to meet their credits, it is likely that EUA prices will rise. One influential commentator in Europe, Henrik Hasselknippe, Director of emissions trading analysis at Point Carbon, has suggested that carbon prices in the European ETS are likely to rise to an average of 30 euros per tonne of CO_2 between 2008 and 2012.[10]

Figure 8 EU allowance prices

December 2008 delivery of allowances, euros per tonne of CO_2



Source: European Climate Exchange

The price of EUAs in Europe is, however, only an indicator of a likely upper bound on the price of NZUs. The EU ETS has restrictions on the offsets that are able to be used to meet obligations under their ETS and on the use of carbon credits from outside the EU. For these reasons, the ECX EUA price is likely to be above what the price would be if there was a truly global market covering most carbon emissions.

An alternative indicator is the value of Certified Emission Reduction units (CERs). These are credits arising from projects in developing countries that lead to reduced emissions. Such credits have highly variable prices reflecting different risks around the delivery of emission reductions associated with these credits.[11] In a survey of CER prices in 2006 the World Bank found that prices for CERs ranged from USD$7 for CERs where buyers carried much of the delivery risk – i.e. the risk that the projects would result in emission reductions that could be use to offset a buyers emissions – to US$27 for some credits in secondary markets which carried very little or no risk to the purchaser.

[10] The Guardian, http://www.guardian.co.uk/environment/2008/apr/03/carbonemissions.climatechange , April 3 2008

[11] For an excellent summary of the issues around CERs and the Kyoto Clean Development Mechanism (CDM) from which they arise see Carr, C. and Rosembuj, F. (2008) “Flexible mechanisms for climate change compliance: emission offset purchases under the clean development mechanism” available at http://carbonfinance.org/Router.cfm?Page=DocLib&CatalogID=38443.

Our view is that a reasonable estimate of prices for NZUs should put most weight on secondary market CER prices. While primary market CERs have previously traded at much lower prices than secondary market CERs, this in part reflects considerable differences in contracts and risks that purchasers take on. There are considerable transaction costs in finding and administering CDM projects in primary markets. Furthermore, accessing primary credits is likely to be too risky or costly for many NZ firms, which are small by world standards. Primary market credits are most likely to be sourced and put into portfolios by carbon funds who can then sell on those credits into secondary market products that carry less risk than the primary market credits but which are much higher in price than primary CERs.

We would also expect the price of CERs to rise over time. This is because the first projects that are exploited are typically lower cost projects. As these low cost opportunities to create offsets are exhausted there will be upward pressure on prices. Quite what the extent of that upward pressure might be is too difficult to say.[12]

To establish a price to use in our scenarios we settled on considering forward contract prices for EUAs and forward contract prices for CERs on the European climate exchange.

In our view it makes sense to include EUAs in our calculation because it is likely that some gap or premium will exist between spot market NZUs and project based credits.

We looked at forward contracts for delivery of CERs and EUAs in 2012, from prices struck in the first quarter of 2008:

- EUAs for December 2012 delivery averaged 24.5 euros per tonne of CO_2.
- CERs for December 2012 settlement averaged 16 euros per tonne of CO_2.

We chose the mid point between the two – 20 euros – as our central estimate of the price of NZUs in an NZ ETS. To convert this into an NZ dollar value we used our view of the medium to long term value of the NZ dollar against the euro, 0.5 euro per NZ dollar.[13]

[12] Emission reductions are like natural resources and as we would expect prices to grow much as they do for other natural resources as the resource is exploited or extracted. See Hotelling, H (1931) “The Economics of Exhaustible Resources,” Journal of Political Economy, April 1931, 39, pp. 137-175. Of course, the size of the emission reduction opportunities available for use depends on technology and government regulation and this makes it very difficult to gauge the magnitude of upward pressure on prices.

[13] The Euro traded at 0.52 Euro per NZ dollar during March 2008.

5. Results

5.1 Impact of the ETS in 2012

Table 2 Impacts on the economy, 2012

	ETS	NZ pays	Difference
GDP (% change)	-0.5	-0.1	-0.4
Change in GDP ($m, 2008 prices)	-908	-107	-801
Private consumption (% change)	-0.8	-0.5	-0.4
Change in private consumption ($m, 2008 prices)	-951	-522	-430
Change in private consumption per household ($, 2008 prices)	-604	-331	-273
Domestic government spending (% change)	-0.8	-0.5	0.4
Investment (% change)	0.0	0.0	0.0
Employment (% change)	-1.0	-0.1	-0.9
Employment change (Full time equivalents)	-22,193	-1,467	-20,726
Average inflation adjusted wages (% change)	0.0	0.0	0.0
Change in average inflation adjusted wages ($ per ordinary hour)	0.0	0.0	0.0
Payments to owners of productive land (% change)	-1.5	1.1	-2.6
Payments to owners of capital (% change)	-1.7	-1.0	-0.8
Exports (% change in quantities)	0.0	0.7	-0.6
Export prices (% change)	0.0	-0.2	0.2
Domestic prices (% change)	0.1	-0.8	0.9
Imports (% change in quantities)	-0.6	-0.3	-0.2
Inflation adjusted (real) exchange rate (% change)	0.0	-0.8	0.8
Kyoto liability payment ($m, 2008 prices)	299	375	-75
Domestic emissions (% change)	-2.6	0.0	-2.6
Change in emissions (kilotonnes of CO_2-e)	-1,826	0	-1,826
Leakage (kilotonnes of CO_2-e)	56	0	56
Change in domestic emissions net of leakage (kilotonnes of CO_2-e)	-1,770	0	-1,770
Total reduction in global CO_2-e (net of leakage)	-9,315	-9,371	56

Notes: (1) Rows may not sum due to rounding.

Source: NZIER

In this scenario the Government introduces an ETS as currently proposed with:

- obligations on liquid fuels, stationary energy, and industrial processes
- allocation of emission permits is free up to 90% of 2005 emissions to industrial processes – direct and indirect emissions from electricity use
- the price of carbon is assumed to be, on average, NZ$40 per tonne of CO_2-e

- New Zealand’s target Kyoto compliance is a 15% reduction in emissions – reduce or pay for reductions elsewhere in the world.

The overall impact of the ETS and the Government’s offshore payment to cover New Zealand’s Kyoto liability is a 0.5% reduction in GDP. Most of the impact falls on the production or income side of the economy with changes in returns to capital of -1.7%.

There is a reduction in employment of 1.0% or approximately 22,000 jobs, based on our forecast of what employment would otherwise be (see Table 1).

Note that this reduction does not necessarily mean that workers are laid off; rather it is more likely that 22,000 jobs will just not be created.

Inflation adjusted household consumption, declines by 0.8% as a result of reduced household incomes (through reduced employment and lower returns to capital) and reduced purchasing power from higher prices. In 2008 prices that equates to around $600 less spending per household in 2012. Of course, this impact is an average and this figure will be higher for some households and lower for others.

These results compare with much smaller impacts on the economy if the Government pays New Zealand’s Kyoto Liability and does not introduce an ETS – thereby spreading the cost across the New Zealand economy. With an ETS in place the impact on GDP is eight times larger than under an ‘NZ pays’ scenario. Under an ETS the impact on GDP equates to $908 million in 2008 prices. When ‘NZ pays’ the impact is a reduction of only $107 million.

Under the ‘NZ Pays’ scenario, the impact on GDP is less than the cost of New Zealand’s Kyoto Liability ($375 million in 2012). This is because the Government’s offshore payment reduces domestic demand but does not impact directly on the productive capacity of the economy.

Faced with reduced domestic demand, many firms increase the share of product that they send offshore. Of course, in order to do this firms have to accept lower returns and this is reflected in a depreciation in the inflation adjusted value of the New Zealand dollar.

Under an ETS the reduction in employment in 2012 is more than ten times larger than without - although the extent of this difference is masked a little in Table 2 because we have rounded our results up to the first decimal place for presentational purposes.

There is also a small difference between global emission reductions under an ETS and without. Under an ETS there is a -1,826 kt CO_2-e reduction in emissions domestically, leaving a further reduction of -7,545 kt CO_2-e to be paid for from reductions elsewhere in the world. This leads to a gross reduction in emissions of 9,371 kt CO_2-e. There is, however, a small amount of “leakage”, whereby New Zealand production is displaced by production elsewhere in the world. This displacement amounts to approximately 56 kt. Thus the net reduction in global emissions under an ETS in 2012 is 9,315 kt CO_2-e.

In the case of no ETS, New Zealand still pays for a liability equal to 9,371 kt of CO_2-e in 2012.

5.1.1 Industry impacts

Table 3 provides a break down of impacts of the ETS by industry. Industries that are impacted most in the short term are those that serve domestic markets and those that use or produce a lot of fossil and liquid fuels.

Petroleum refining is impacted more than any other industry. Activity declines by 4.0% in 2012 compared with what it would otherwise have been. This is due to declining demand for petroleum products and, to a lesser extent, a loss of domestic market share for its products due to increased costs relative to imported alternatives. While we assume the industry receives free allocation for all of its process emissions (those produced as a by-product of the manufacturing process), the industry still faces general cost increases which reduce its competitiveness relative to overseas petroleum refining and manufacturing industries.

The rate of return on capital in the petroleum refining industry declines 30% in 2012. Impacts on returns to capital are larger across all industries than impacts on employment or impacts on overall activity levels. This is because capital stocks are assumed to remain fixed in the short term. In effect, we assume that as long as firms can find a market for their products (i.e. sufficient demand), they will continue to produce using as much of their available plant and equipment as they can. If demand does reduce, firms can, to a limited extent, scale back production and costs by hiring fewer employees. By our assumption, they cannot scale back on their capital and that means that returns on capital will reduce.

We are also, in effect, assuming that firms will accept any reductions in returns capital and will not exit the market or relocate their production offshore in the short term. This is a simplification and in reality there is a risk that some firms will not accept reduced returns and will exit the market.

Other industries that are heavily impacted by the ETS in 2012 include the transport services industry - incorporating domestic freight and air transport services – mining and quarrying, and electricity and gas supply industries.

Mining and quarrying is most impacted by reduced demand for coal from the electricity industry.[14] Some of that reduced demand is offset by a large increase in quantities of coal exports but declining domestic demand and falling export returns mean an overall decline in mining activity.

---

[14] This result ignores issues such as supply contracts which might lessen the actual reduction in coal fired electricity generation. In our model, coal fired electricity generation declines 22% compared to what it otherwise would have been.

Table 3 Industry impacts, 2012

Percent change.

	Contribution to GDP	Employment	Rental price of capital
Horticulture and fruit growing	-0.1	-0.3	-0.5
Sheep and beef cattle farming	-0.2	-0.8	-1.5
Dairy farming	0.0	-0.5	-0.8
Other farming	-0.1	-0.8	-1.6
Services to primary industry	-0.3	-0.6	-1.1
Forestry and logging	0.0	-0.3	-1.0
Fishing	-0.8	-3.5	-6.7
Mining and quarrying	-1.2	-4.1	-7.6
Oil and gas exploration and extraction	0.0	-0.6	-1.1
Meat processing	-0.2	-0.4	-0.6
Dairy product manufacturing	0.0	-0.1	0.0
Other food and beverage manufacturing	-0.3	-0.8	-1.3
Textiles clothing and footwear	-0.3	-0.6	-1.1
Timber and wood products	0.0	0.0	0.1
Paper & paper product manufacturing	0.2	0.7	1.6
Printing and publishing	-0.3	-0.6	-1.0
Petroleum product refining and manufacturing	-4.0	-14.0	-30.3
Fertiliser manufacturing	-0.1	-0.6	-1.0
Cement and other non-metallic mineral product manufacturing	-0.2	-0.7	-1.3
Basic metal manufacturing	0.1	0.3	0.6
Other manufacturing	-0.2	-0.4	-0.7
Electricity, Gas and Water Supply	-1.5	-7.8	-15.9
Property and construction services	-0.1	-0.3	-0.5
Transport services	-1.2	-2.8	-4.9
Business services	-0.3	-0.9	-1.9
Government and personal services	-0.7	-1.0	-2.6
Other services	-0.3	-0.9	-1.7

Notes: (1) Rental price of capital is equivalent to the average return to capital per unit of capital.
(2) Change in contribution to GDP is equal to the change in an industry's "value added".
(3) Industries receiving some free allocation in *underlined italics*.

Source: NZIER

Other industries that contract are typically ones where their activity is linked closely to the fortunes of the domestic economy and increases or decreases in domestic demand. Business services industries are one example.

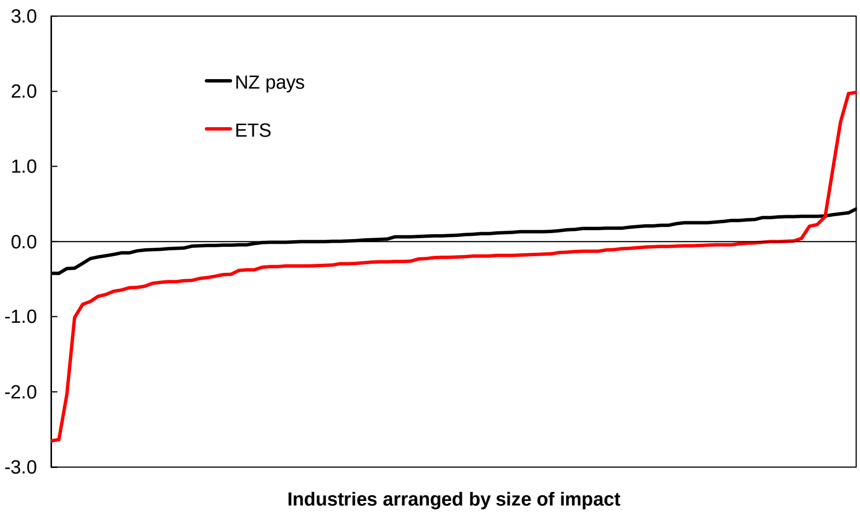
In the short term, impacts on industry are also influenced heavily by the extent of any free allocation of permits. Indeed in some cases, free allocation more than offsets any loss in competitiveness that would otherwise have occurred.

Table 3 shows increased economic activity and employment in some industries receiving free allocation. Those increases in activity are due to free allocations for indirect emissions from electricity use.

To be clear, that result comes primarily from our assumption about the value of free allocations that firms will receive and the value of those allocations relative to increases in electricity prices. Industries that use a lot of electricity will receive some relief from rising input costs, while other firms facing cost increases will not receive any free allocation of rebates to offset their cost increases. One example is the fishing industry, where activity declines 0.8% and employment declines 3.5% in 2012.

Figure 9 Distribution of impacts on industry

Percent change in economic activity by industry. Outliers removed.



Source: NZIER

In addition, there is of course a degree of aggregation bias in our results. In the case of the pulp and paper industry, the result showing an increase in activity disguises the fact that mechanical pulp manufacturing will face larger cost increases than manufacturers using chemical pulping processes.

Similarly, the results for basic metals manufacturing conflate the results for aluminium production and steel production.

A comparison of the distribution of impacts by industry if 'NZ pays' for New Zealand Kyoto liability and there is no ETS versus if there is an ETS, is shown in Figure 9.[15] That shows the extent to which an ETS means many more industries

[15] Large negative impacts on the refining industry and coal fired electricity generation have been removed from the chart so that the distribution of impacts can be discerned. If left in the analysis, it is too difficult to see the relative distributional impacts between the 'NZ pays' versus ETS scenarios.

will contract and that the distribution of the impacts will be felt heavily by a handful of firms compared with a relatively even distribution of impacts without an ETS.

5.2 Medium term impacts with free allocation

Table 4 Impacts on the economy, 2015

	ETS	NZ pays	Difference
GDP (% change)	-0.9	-0.1	-0.8
Change in GDP ($m, 2008 prices)	-1,996	-191	-1,805
Private consumption (% change)	-0.8	-0.4	-0.4
Change in private consumption ($m, 2008 prices)	-1,001	-471	-530
Change in private consumption per household ($, 2008 prices)	-610	-287	-323
Domestic government spending (% change)	-0.8	-0.4	0.4
Investment (% change)	-1.5	-0.1	-1.4
Employment (% change)	0 by assumption	0 by assumption	0 by assumption
Employment change (Full time equivalents)	0 by assumption	0 by assumption	0 by assumption
Average inflation adjusted wages (% change)	-3.6	-0.2	-3.4
Change in average inflation adjusted wages ($ per ordinary hour)	-0.9	-0.1	-0.9
Payments to owners of productive land (% change)	-8.8	0.5	-9.3
Payments to owners of capital (% change)	-1.1	-0.3	-0.9
Exports (% change in quantities)	-1.3	0.5	-1.8
Export prices (% change)	0.3	-0.1	0.4
Domestic prices (% change)	0.4	-0.2	0.6
Imports (% change in quantities)	-1.4	-0.2	-1.2
Inflation adjusted (real) exchange rate (% change)	0.0	-0.2	0.3
Kyoto liability payment ($m, 2008 prices)	149	328	-199
Domestic emissions (% change)	-6.4	0.0	-6.4
Change in emissions (kilotonnes of CO_2-e)	-4,480	0	-4,480
Leakage (kilotonnes of CO_2-e)	930	0	930
Change in domestic emissions net of leakage (kilotonnes of CO_2-e)	-3,550	0	-3,550
Total reduction in global CO_2-e (net of leakage)	-7,269	-8,199	930

Notes: (1) Rows may not sum due to rounding.
Source: NZIER

In this scenario the Government introduces an ETS as currently proposed with:

- obligations on liquid fuels, stationary energy, industrial processes, agriculture, and emissions from the waste industry.
- allocation of emission permits is free up to 90% of 2005 emissions to industrial processes – direct and indirect emissions from electricity use – and agriculture.

- the price of carbon is assumed to be, on average, NZ$40 per tonne of CO_2-e.
- New Zealand's target Kyoto compliance is a 13% reduction in emissions – reduce or pay for reductions elsewhere in the world.

The impact of the ETS on GDP roughly doubles between 2012 and 2015 as a result of declining free allocations to firms that entered the scheme in 2010 and the expansion of the ETS to agriculture.

The change in GDP due to the ETS in 2015 is a reduction of $1.97 billion in 2008 prices or (0.9%). This compares with a -0.1% or -$191 million impact if there is no ETS and the Government simply pays for New Zealand's Kyoto liability. That is, the impact on the economy is nine times larger under an ETS than without.

The net effect of economic impacts starts to shift from the domestic economy to those parts of the economy that are export focused.

Increased costs to domestic production have a marked impact on export competitiveness and see exports decline -1.3%.

We assume that employment is not effected, but inflation adjusted wages decline by 3.6%, which equates to an average reduction in wage rates of around 90 cents an hour in 2008 prices (based on an average hourly wage of $23.10 per hour in 2012 at 2008 prices).

The impact on emissions is much higher once free allocations start to phase out and agriculture is introduced into the ETS. In 2015 domestic emissions reduce by -6.2% or approximately 4,500 kt CO_2-e. This reduces the amount of money that is transferred offshore to reduce NZ emissions to (by assumption) 1990 levels. In 2015 $149 million is transferred offshore to pay for reductions elsewhere in the world, equating to approximately 3,719 kt CO_2-e reduced at NZ$40 per tonne. That yields a gross reduction in global greenhouse gas emissions of around 8,199 kt of CO_2-e.

Around 20% (930 kt) of the domestic reduction is, however, due to New Zealand production being displaced by overseas production. As such the actual reduction in global emissions is 7,269 kt CO_2-e. This compares against a global emissions reduction of 8,199 kt CO_2-e when there is no ETS. That is, without an ETS New Zealand's contribution to global emission reductions is 13% larger than with an ETS.

5.2.1 Industry impacts

In 2015 most of the negative impacts of the ETS fall on New Zealand's export industries.

Table 5 Industry impacts, 2015

Percent change.

	Contribution to GDP	Employment	Capital stock
Horticulture and fruit growing	0.9	2.3	0.3
Sheep and beef cattle farming	-3.2	-4.6	-5.9
Dairy farming	-5.3	-8.5	-9.8
Other farming	-0.6	0.3	-1.5
Services to primary industry	-1.5	-0.7	-2.2
Forestry and logging	0.0	1.5	-0.3
Fishing	-2.1	-2.6	-4.0
Mining and quarrying	-3.1	-4.1	-5.4
Oil and gas exploration and extraction	-0.9	-0.6	-1.8
Meat processing	-2.9	-2.4	-3.7
Dairy product manufacturing	-4.8	-4.0	-5.4
Other food and beverage manufacturing	-0.1	0.6	-0.7
Textiles clothing and footwear	0.9	1.6	-0.1
Timber and wood products	-0.1	0.6	-0.8
Paper & paper product manufacturing	-0.3	0.7	-0.8
Printing and publishing	0.2	1.0	-0.5
Petroleum product refining and manufacturing	-12.1	-9.0	-13.1
Fertiliser manufacturing	-3.4	-2.4	-3.8
Cement and other non-metallic mineral product manufacturing	-1.5	-0.5	-1.9
Basic metal manufacturing	-1.7	-1.0	-2.4
Other manufacturing	0.2	0.9	-0.5
Electricity, Gas and Water Supply	-3.9	-2.8	-4.2
Property and construction services	-1.1	-0.3	-1.6
Transport services	-2.4	-1.7	-2.9
Business services	-0.6	0.3	-1.0
Government and personal services	-0.4	-0.1	-1.3
Other services	-0.4	0.4	-0.8

Notes: (1) Change in contribution to GDP is equal to the change in an industry's "value added".
(2) Industries receiving some free allocation in *underlined italics*.

Source: NZIER

The contribution of pastoral production to GDP declines by between -0.6% and -5.3%, depending on the type of production. Dairy farming declines most from what it otherwise would have been as a result of increases in downstream production and processing costs. In addition, more than 90% of dairy products produced are exported offshore and this means that the dairy industry faces greater risk to its competitiveness than, say, sheep and beef farming as a whole where a larger proportion of product (mainly beef) is sold domestically.[16]

Nonetheless sheep and beef farming contracts 3.2% in 2015. Meat processing also declines 2.9% with a consequent 2.4% reduction in employment in the sector.

These impacts are despite the fact that free allocation is phased out more slowly for agriculture than for other industries.

For other industries that receive free allocations of emission permits, many who have high energy use but relatively low process emissions contract less than agricultural industries in 2015. Activity in the basic metals and pulp paper industries contract by 1.7% and 0.3% respectively. These results mask different impacts on firms within the industry that can only be evaluated with firm level modelling.

Industries with high process emissions whose permit allocations are being phased out, contract quite markedly. Activity in the cement manufacturing industry contracts 1.5% and activity in the fertiliser industry contracts 3.4% - mainly due to reduced domestic demand for their products.

Activity in the horticulture and fruit growing industries expands in aggregate because there is some shifting of resources towards horticulture away from relatively more emission intensive livestock production.

Within horticulture it is pip fruit – apple and pear – production that expands most (by around 2.4%). Other types of production fare less well, especially energy intensive greenhouse production in horticulture.

5.3 Longer term impacts of an ETS

Over the longer term, with all free allocation of emission credits phased out, the negative impact on the economy increases to a -2.1% change in GDP with an ETS compared with a -0.7% impact without. Those changes equate to a reduction in GDP of approximately $5.9 billion (2008 prices) with an ETS compared with $1.4 billion without an ETS, making the impact of an ETS four times larger than without.

The impact of the ETS is felt most strongly in the productive sector, with a reduction in the capital stock of 4.0% and a reduction in returns to productive land of 14.8%.

With an ETS in place real wages decline 6.7%. That equates to a reduction in average hourly wages of around $2.30 an hour in today's prices (based on a

[16] In most general equilibrium modelling it is assumed that imports are not a perfect substitute for domestically produced goods (so called "Armington" assumptions). As such businesses making goods for domestic consumption have an implicit advantage over imports in our results.

forecast average hourly inflation adjusted wage in 2025 of $33.70) and compares to a 1.7% or 60 cent reduction without an ETS.

Table 6 Impacts on the economy, 2025

	ETS	NZ pays	Difference
GDP (% change)	-2.1	-0.7	-1.4
Change in GDP ($m, 2008 prices)	-5,971	-1,362	-4,610
Private consumption (% change)	-3.0	-2.5	-0.5
Change in private consumption ($m, 2008 prices)	-5,462	-4,472	-989
Change in private consumption per household ($, 2008 prices)	-3,027	-2,479	-548
Domestic government spending (% change)	-3.0	-2.5	-0.5
Investment (% change)	-3.4	-0.7	-2.7
Employment (% change)	0 by assumption	0 by assumption	0 by assumption
Employment change (Full time equivalents)	0 by assumption	0 by assumption	0 by assumption
Average inflation adjusted wages (% change)	-6.7	-1.7	-5.0
Change in average inflation adjusted wages ($ per ordinary hour)	-2.3	-0.6	-1.7
Payments to owners of productive land (% change)	-14.8	3.7	-18.5
Payments to owners of capital (% change)	-4.0	-1.8	-2.1
Exports (% change in quantities)	0.0	3.3	-3.3
Export prices (% change)	-0.2	-0.8	0.6
Domestic prices (% change)	-0.9	-1.2	0.2
Imports (% change in quantities)	-3.5	-1.5	-2.0
Inflation adjusted (real) exchange rate (% change)	-1.7	-1.5	-0.2
Kyoto liability payment ($m, 2008 prices)	1,743	2,231	-488
Domestic emissions (% change)	-10.4	0	-10.4
Change in emissions (kilotonnes of CO_2-e)	-12,192	0	-12,192
Leakage (kilotonnes of CO_2-e)	3,001	0	3,001
Change in domestic emissions net of leakage (kilotonnes of CO_2-e)	-9,191	0	-9,191
Total reduction in global CO_2-e (net of leakage)	-52,769	-55,770	3,001

Notes: (1) Rows may not sum due to rounding.
Source: NZIER

Private consumption spending per household in 2025 declines by around $3,000 per household in 2008 prices, a decline about $500 larger than if there is no ETS.

In 2025, we expect the economy and New Zealander's standard of living to be much higher than it is today. If historical rates of growth continue we expect GDP per capita to increase from around $38,700 at the end of 2007 to around $55,000 in 2025 after adjusting for inflation. A -2.1% change in GDP would mean a reduction in GDP per capita from $55,000 down to $53,845 (a change of -$1,155 per person).

At the same time, Australian GDP per capita in 2007 was $51,650 in Australian dollars or $54,450 in New Zealand dollars.[17] So while the New Zealand economy will be much bigger in the future it is possible that it will still be smaller than Australia's economy is today.

5.3.1 Industry impacts

Over the long term, the industry effects from 2015 are magnified as the free allocation has reduced to zero by the end of 2025. The burden of the ETS falls largely on New Zealand's export sector, with agricultural production particularly effected.

Dairy farming contracts markedly in terms of contribution to GDP, down 12.9%. Dairy processing also declines by 11.7% with an associated 10.0% reduction in employment. Sheep and beef farming are similarly affected, down 6.6% on contribution to GDP; meat processing is down 5.7% with a consequent reduction in employment of 4.4%. Under an ETS, important industries within the NZ economy will be significantly affected.

As the free allocation is phased out, energy intensive manufacturing industries are also significantly affected by the ETS. Activity in basic metal and non-metallic mineral product manufacturing reduce contributions to GDP by 5.0% and 3.9% respectively. Fertilizer manufacturing contributions to GDP fall by 7.3%, influenced not only by the full impact of the ETS on production costs but by reduced domestic demand for their products. Petroleum refining and manufacturing is similarly affected as reduced demand for its product see a significant 12.5% reduction in contribution to GDP compared to what otherwise might have been.

Much of New Zealand's farm land loses value as a result of declining profits especially in the pastoral sector. The price of dairy land declines by 40.6% and sheep and beef farm land reduces in value by 23.4% (see Table 8).

Industries that benefit relative to others from the impact of the ETS are horticulture and fruit growing sectors, and textile manufacturing, effectively benefiting from down-turns in other key agricultural and exporting sectors.

The price of horticultural land and forest land also increases in price as the profitability of these sectors (in aggregate) increases relative to other types of rural land use.

[17] Converted using the most recent (2006) OECD purchasing power parities available at the time of writing (NZ$:AUS$ 1.0575). OECD (2006) *Main Economic Indicators*, Volume 2007/11, p.281.

Table 7 Industry impacts, 2025

Percent change compared to what would otherwise have been the case.

	Contribution to GDP	Employment	Capital stock
Horticulture and fruit growing	4.9	10.4	4.3
Sheep and beef cattle farming	-6.6	-9.0	-11.9
Dairy farming	-12.9	-19.8	-22.4
Other farming	0.1	3.5	-0.7
Services to primary industry	-2.0	0.0	-3.7
Forestry and logging	1.7	6.4	2.3
Fishing	2.4	6.2	2.8
Mining and quarrying	-3.8	-4.3	-7.3
Oil and gas exploration and extraction	-1.0	0.5	-2.0
Meat processing	-5.7	-4.4	-7.4
Dairy product manufacturing	-11.7	-10.0	-12.9
Other food and beverage manufacturing	1.4	3.1	0.3
Textiles clothing and footwear	3.6	5.2	1.5
Timber and wood products	2.0	3.6	0.3
Paper & paper product manufacturing	0.7	3.0	-0.3
Printing and publishing	0.8	2.6	-0.6
Petroleum product refining and manufacturing	-12.5	-7.8	-14.1
Fertiliser manufacturing	-7.3	-5.0	-8.0
Cement and other non-metallic mineral product manufacturing	-3.9	-1.7	-4.8
Basic metal manufacturing	-5.0	-3.4	-6.5
Other manufacturing	2.0	3.7	0.6
Electricity, Gas and Water Supply	-4.9	-2.3	-5.5
Property and construction services	-3.4	-1.4	-4.4
Transport services	-1.9	-0.1	-3.2
Business services	-1.8	0.4	-2.8
Government and personal services	-2.4	-1.6	-4.3
Other services	-1.7	0.7	-2.7

Notes: (1) Change in contribution to GDP is equal to the change in an industry's "value added".

Source: NZIER

The tourism industry, which will not face the full cost of its emissions under the ETS, also stands to benefit. Tourism expands by 1.9% because it becomes more competitive through reduced wage bills and a depreciation in the value of the New Zealand dollar.

Table 8 Impact on primary sector land prices, 2025

Percent change compared to what would otherwise have been the case

Land use	Price of land
Horticulture and fruit growing	9.3
Sheep and beef cattle farming	-23.4
Dairy cattle farming	-40.6
Other farming	-2.2
Forestry and logging	5.4
Mining and quarrying	-15.2

Source: NZIER

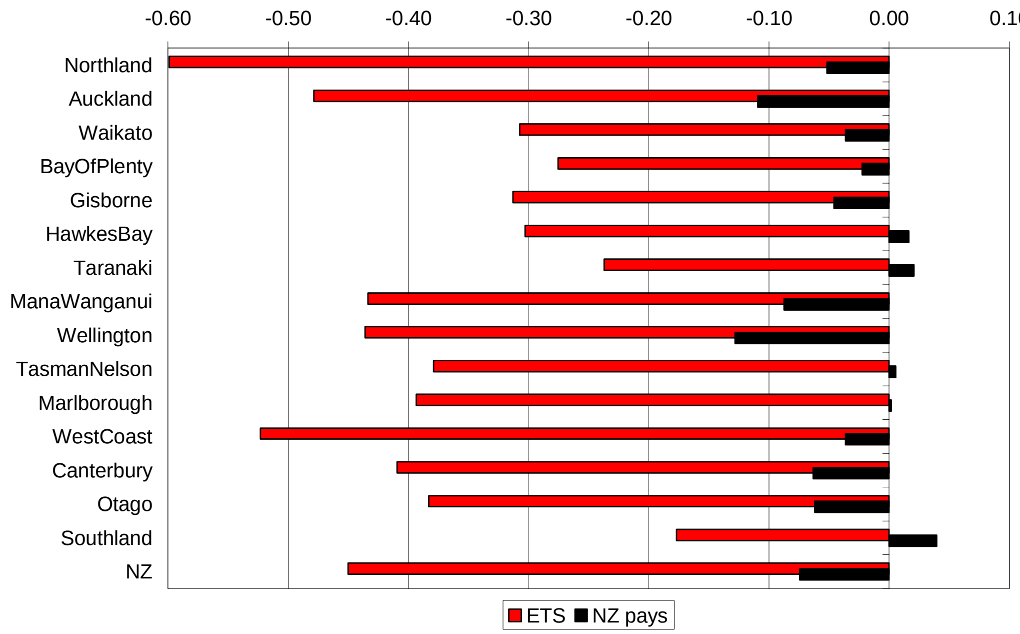
5.4 Regional impacts

The burden of the ETS is not equally distributed around the country, just as emissions are not equally distributed around the country.[18]

5.4.1 2012 impacts

Figure 10 Impacts on regional GDP, 2012

% change to what otherwise might have been



Source: NZIER

The initial effects of the implementation of the ETS to 2012 are felt most largely in Northland and the West Coast, due to the relatively high proportion of petrol refining and coal mining in each region respectively. Regional GDP is expected to fall by 0.6% and 0.5% respectively, compared to what otherwise might be the

[18] Our results of the regional impact of the ETS are broadly consistent with NIWA's map of NZ emissions intensity across TLAs (see http://www.niwa.cri.nz/ncces/projects/ghge)

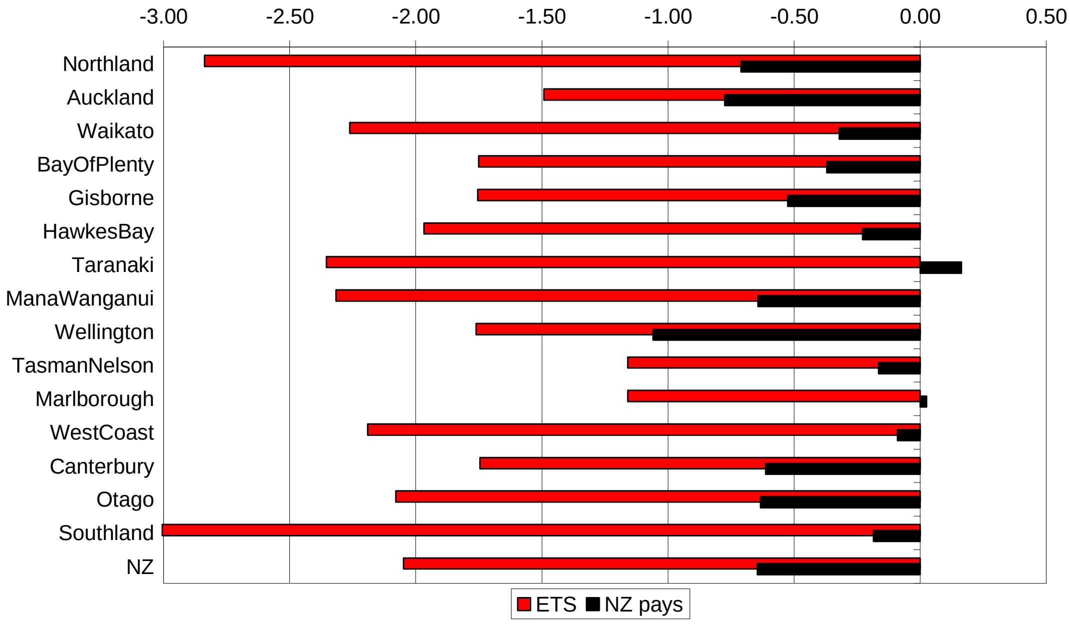
case. The effects of employment losses in petroleum refining and coal mining will also be highly regional. For example, around 75 of the 850 jobs in the West Coast coal mining industry are expected to be lost.[19]

Under an 'NZ pays' scenario, the reduction of GDP is expected to be less than 0.1% across all regions.

5.4.2 2025 impacts

Figure 11 Impacts on regional GDP, 2025

% change to what might otherwise have been



Source: NZIER

By 2025, with a broad ETS and no free allocations to industry, Southland and Northland are the two most affected regions, with GDP estimated to be 3% and 2.8% lower than what might otherwise be the case. Northland continues to be affected by petroleum refining, while both regions suffer from relatively high shares of agriculture. For example, around 25% of total employment in Southland is in dairy, sheep and beef farming, and associated service and processing industries. In Auckland, the same figure is less than 1% (Statistics New Zealand Table Builder, NZIER). As per the previous section, our modelling predicts significant cuts to these industries under an ETS.

In the government pays scenario, the regional impacts are significantly different. The level of impact for all regions is less than under an ETS, while the relative burden-sharing also changes. Wellington and Auckland face a relatively higher share of the burden, while Southland bares a relatively much lower share. This is

[19] Total West Coast coal mining employment numbers sourced from http://www.gowestcoastnz.com/regional/mining/

an unsurprising result, given that the ETS specifically targets emitting industries, which are unevenly distributed across NZ, while a government pays scenario uses increased taxation from the entire population, to meet the Kyoto obligation.

5.4.3 Comments on regional impacts

We acknowledge the 'polluter pays' principle that underlines the ETS, and the subsequent outcome that relatively high-emitting regions will face a relatively high share of the burden. However we point out that such large burdens on regional areas may have significant repercussions. For example, the impact of the ETS on agriculture and related services and processing in Southland could result in employment reductions of around 1000 jobs at a carbon price of $40.[20] There will also be further induced or downstream effects that such large cuts in employment would be likely to have on a local economy the size of Southland.

Similarly, MAF have reported impacts of the ETS on profitability of a standard beef and sheep farm to be -80.3% at $25 carbon price, and -160.5% at $50 (MAF, 2008). Such loses in profitability will also fall disproportionately on regions such as Southland.

[20] Assuming industry employment shares follow trends of the last 5 years.

6. Sensitivity analysis

Sensitivity analysis is useful for a number of reasons. First, sensitivity testing explores the robustness of the results to variations in model parameters. For example:

- Do the results presented in the above section hold (in particular the relative costs of an ETS versus 'NZ pays') with higher or lower carbon prices?

Second, sensitivity analysis allows us to research the functional relationships between parameters of the ETS and effects on the economy. For example:

- Does the ETS impact on GDP increase exponentially with an increasing price of carbon?
- Do emissions reductions increase with an increasing price of carbon or are there diminishing marginal returns?
- How does the amount of carbon leakage change with an increasing price of carbon?

There are a number of model parameters and assumptions that can be addressed with sensitivity analysis. In this work, we investigate three parameters for sensitivity analysis:

- the price of carbon – we assess the way the model results respond to changes in the price of carbon.
- emissions projections, in particular net forestry emissions – forestry sequestration provides a significant offset to New Zealand's total emissions; we test the sensitivity of model results to a more optimistic view of forestry sequestration than the Ministry for the Environment baseline.
- the degree of free allocation – we run a scenario with indefinite free allocation at 2013 levels.
- the potential impact of new emission reduction technologies becoming available.

6.1 Price

Our initial sensitivity test explores the robustness of the results to changes in the price of carbon. To 2012, we select prices at NZ$15 and NZ$55 to provide indicative low and high price possibilities over CP1. Similarly, to 2025 we choose prices of NZ$25 and NZ$70, based on the expectation that the price of carbon will rise over this period.[21] We suggest these prices are neither particularly 'heroic' or 'pessimistic', but provide a reasonable range of 'what might be'. We compare both the ETS and 'NZ pays' scenarios, however for brevity we report only GDP impacts.

[21] See for example Bugnion 2007, a Point Carbon report suggesting that most firms in the EU expect the price of carbon to rise over the long term.

6.1.1 Robustness of key results to price sensitivity

Table 9 highlights the GDP impacts of the ETS and 'NZ pays' scenarios for the range of prices, for each of the analysis years. The results show:

- The GDP impact of the ETS is reasonably proportional to the price of carbon; the range of GDP impact is likely to fall between -0.3 and -0.7% of GDP in the CP1 period, while in 2025 the range is between -1.3% and -3.6% of GDP versus what might otherwise have been.
- The burden of the ETS on the overall economy remains significantly higher than under a 'NZ pays' scenario, across the range of plausible carbon prices.
- As the price of carbon increases, this result becomes even more emphatic i.e. the burden of the ETS increases at a greater rate than the cost of the 'NZ pays' scenarios.

Table 9 GDP impacts at variable carbon prices

% change to what might otherwise have been

	2012 Results		
Scenario	**$15**	**$40**	**$55**
ETS	-0.3	-0.5	-0.7
NZ pays	0.0	-0.1	-0.1
	2015 Results		
Scenario	**$25**	**$40**	**$70**
ETS	-0.6	-0.9	-1.5
NZ pays	-0.1	-0.1	-0.2
	2025 Results		
Scenario	**$25**	**$40**	**$70**
ETS	-1.3	-2.1	-3.6
NZ pays	-0.4	-0.7	-1.1

Source: NZIER

6.1.2 Relationships between impact and price

The relationship between the price of carbon and the ETS impact on GDP, emissions and leakage are summarised Table 10. The key points are listed below:

- For any of the years analysed, an increase in the price of carbon leads to a relatively proportional increase in the impact on GDP.
- For any of the years analysed, an increase in the price of carbon leads to an approximately proportional increase in emissions reductions.
- However, the reduction in emissions do not increase at the same rate as the reduction in GDP, indicating diminishing marginal returns to emissions reduction. The marginal cost metric highlights this by showing the additional cost to the economy of reducing emissions by another one percent. As the

price for carbon and emissions reductions increase, the cost of further reductions also increases. In 2025, the cost of an extra percent emissions reduction is over $100 million more expensive under a price of $70/ton than $25/ton.

- Both total leakage and leakage as a proportion of total emissions reduction increase as the price of carbon increases.

Table 10 Functional relationships: price vs. GDP impact

Units are % change to what otherwise might have been, unless otherwise stated

2012 Results			
Metric	**$15**	**$40**	**$55**
GDP	-0.2	-0.5	-0.7
Emissions	-1.0	-2.5	-3.3
Emissions/GDP	5.9	5.4	5.1
Marginal cost of emissions ($million/1% emissions reduction)	360	408	439
Leakage (Kt CO_2-e)	16	56	88
2015 Results			
Metric	**$25**	**$40**	**$70**
GDP	-0.6	-0.9	-1.5
Emissions	-3.3	-5.1	-8.2
Emissions/GDP	5.8	5.6	5.4
Marginal cost of emissions ($million/1% emissions reduction)	269	273	275
Leakage (Kt CO_2-e)	572	930	1672
2025 Results			
Metric	**$25**	**$40**	**$70**
GDP	-1.3	-2.1	-3.6
Emissions	-5.0	-7.8	-12.9
Emissions/GDP	3.9	3.8	3.6
Marginal cost of emissions ($million/1% emissions reduction)	904	925	1015
Leakage (Kt CO_2-e)	1838	3001	5363

Source: NZIER

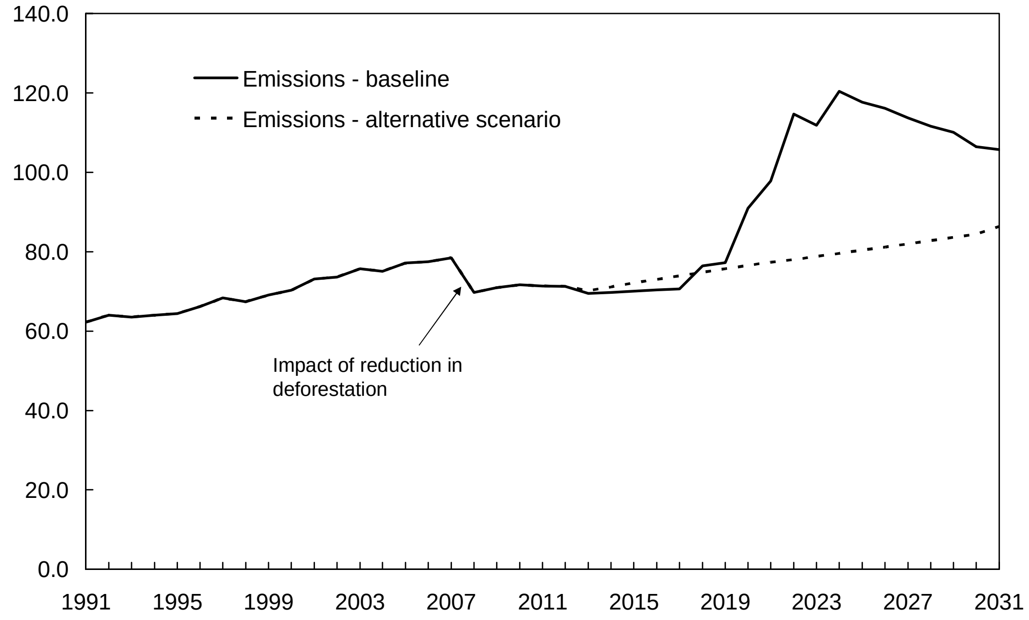
6.2 Emissions projections

Section 4.3 highlighted how the baseline emissions projections, sourced from the Ministry for the Environment, show a large increase in emissions circa 2025 due to forestry harvesting. We use these projections in good faith, however we acknowledge particular uncertainty around forestry emissions estimates. As a sensitivity analysis, we therefore evaluate a scenario where forestry emissions remain at projected 2012 levels. Figure 13 shows this alternative emissions scenario, which results in projected 2025 emissions of 80.4 Mt CO_2-e emissions versus 117.7 mt CO_2-e under the Ministry for the Environment projections. We complete the analysis for 2025.

6.2.1 Robustness of key results to alternative emissions projection

Figure 12 Alternative emissions projection

Mega tonnes CO_2-e, net of offsets from forestry



Source: NZIER, Ministry for the Environment

Table 11 highlights the economy impacts of the ETS and ‘NZ pays’ scenarios under the alternative emissions profile. Table 12 highlights the industry effects of the ETS under the alternative emission profile. The results show:

- Impacts on GDP reduce from -2.1% to -1.6%.
- The impact of the ‘NZ pays’ scenario is reduced from -0.7% to -0.2% of GDP.
- The industry results show that emissions intensive industries contract more under the alternative low emissions scenario. A smaller offshore payment results in a smaller depreciation of the exchange rate, which in turn reduces export volumes. Leakage of emissions increases.
- Reduction in the offshore payment means a reduced taxation burden on household consumption however, and thus service industries and property fare relatively better.

In summary, the domestic effects of the ETS on emitting industries are not improved under a scenario with decreased forestry emissions.

Table 11 Impacts on the economy under alternative emissions projections, 2025

	ETS	ETS – alternative emissions	Govt pays	Govt pays – alternative emissions
GDP (% change)	-2.1	-1.6	-0.7	-0.2
Change in GDP ($m, 2008 prices)	-5,971	-4,711	-1,362	-460
Private consumption (% change)	-3.0	-1.4	-2.5	-0.8
Change in private consumption ($m, 2008 prices)	-5,462	-2,491	-4,472	-1,491
Change in private consumption per household ($, 2008 prices)	-3,027	-1,381	-2,479	-826
Domestic government spending (% change)	-3.0	-1.4	-2.5	-0.8
Investment (% change)	-3.4	-2.9	-0.7	-0.2
Employment (% change)	0 by assumption	0 by assumption	0 by assumption	0 by assumption
Employment change (Full time equivalents)	0 by assumption	0 by assumption	0 by assumption	0 by assumption
Average inflation adjusted wages (% change)	-6.7	-5.6	-1.7	-0.6
Change in average inflation adjusted wages ($ per ordinary hour)	-2.3	-1.9	-0.6	-0.2
Payments to owners of productive land (% change)	-14.8	-16.9	3.7	1.2
Payments to owners of capital (% change)	-4.0	-2.8	-1.8	-0.6
Exports (% change in quantities)	0.0	-2.2	3.3	1.1
Export prices (% change)	-0.2	0.4	-0.8	-0.3
Domestic prices (% change)	-0.9	-0.2	-1.2	-0.4
Imports (% change in quantities)	-3.5	-2.6	-1.5	-0.5
Inflation adjusted (real) exchange rate (% change)	-1.7	-0.7	-1.5	-0.5
Kyoto liability payment ($m, 2008 prices)	1,855	403	2,231	740
Domestic emissions (% change)	-10.4	-10.7	0.0	0.0
Change in emissions (kilotonnes of CO_2-e)	-12,192	-12,564	0	0
Leakage (kilotonnes of CO_2-e)	3,001	-3,434	0	0
Change in domestic emissions net of leakage (kilotonnes of CO_2-e)	-9,191	-9,131	0	0
Total reduction in global CO_2-e (net of leakage)	-52,769	-15,066	-55,770	-18,500

Source: NZIER

Table 12 Industry impacts in 2025: alternative emissions projections

Percent change.

	ETS	ETS – alternative emissions	Difference
Horticulture and fruit growing	4.9	3.1	1.9
Sheep and beef cattle farming	-6.6	-7.7	1.1
Dairy farming	-12.9	-13.7	0.9
Other farming	0.1	-0.7	0.8
Services to primary industry	-2.0	-2.9	0.9
Forestry and logging	1.7	0.8	0.9
Fishing	2.4	0.3	2.1
Mining and quarrying	-3.8	-4.2	0.3
Oil and gas exploration and extraction	-1.0	-1.2	0.2
Meat processing	-5.7	-6.8	1.2
Dairy product manufacturing	-11.7	-12.5	0.9
Other food and beverage manufacturing	1.4	0.8	0.6
Textiles clothing and footwear	3.6	2.2	1.4
Timber and wood products	2.0	0.7	1.4
Paper & paper product manufacturing	0.7	-1.8	2.5
Printing and publishing	0.8	0.6	0.2
Petroleum product refining and manufacturing	-12.5	-11.3	-1.2
Fertiliser manufacturing	-7.3	-8.8	1.5
Cement and other non-metallic mineral product manufacturing	-3.9	-3.2	-0.7
Basic metal manufacturing	-5.0	-6.0	1.1
Other manufacturing	2.0	0.5	1.5
Electricity, Gas and Water Supply	-4.9	-4.6	-0.3
Property and construction services	-3.4	-2.4	-1.0
Transport services	-1.9	-2.6	0.7
Business services	-1.8	-1.2	-0.6
Government and personal services	-2.4	-0.9	-1.5
Other services	-1.7	-0.9	-0.8

Notes: (1) Change in contribution to GDP is equal to the change in an industry's "value added".

(2) Rows may not sum due to rounding

Source: NZIER

6.3 Indefinite free allocation

In this sensitivity, we propose the scenario whereby the government's free allocation of NZ emission permits is continued indefinitely at 2013 levels. Under this scenario, the ETS has been implemented across the full scope of industries intended, including agriculture, however free allocation to 'at risk' industries continues at 2013 levels rather than phasing out to zero as is the current design.

We suggest this is a possible policy position for the government, given an obligation to take up the challenge to reduce global greenhouse gas emissions, but a desire to protect key industries from uncertainty and non-level playing fields in the international market. We provide analysis for 2025.

6.3.1 Results of indefinite free allocation, 2025

In 2025, an ETS with indefinite free allocation reduces GDP by -1.2% compared to -2.1% under the ETS with phased out free allocation. Emissions reductions are -4.2% compared to-10.4% under phased out free allocation, however leakage emissions of almost 3,000 kt CO_2-e are eliminated.

Table 13 Impacts on the economy, 2025 – allocation sensitivity

	ETS	ETS -Indefinite free allocation	Difference
GDP (% change)	-2.1	-1.2	-0.9
Change in GDP ($m, 2008 prices)	-5,971	-3,489	-2482
Private consumption (% change)	-3.0	-2.7	-0.3
Change in private consumption ($m, 2008 prices)	-5,462	-4,928	-534
Change in private consumption per household ($, 2008 prices)	-3,027	-2,731	-296
Domestic government spending (% change)	-3.0	-2.7	-0.3
Investment (% change)	-3.4	-1.5	-1.9
Employment (% change)	0 by assumption	0 by assumption	0 by assumption
Employment change (Full time equivalents)	0 by assumption	0 by assumption	0 by assumption
Average inflation adjusted wages (% change)	-6.7	-4.3	-2.4
Change in average inflation adjusted wages ($ per ordinary hour)	-2.3	-1.5	-0.8
Payments to owners of productive land (% change)	-14.8	-1.4	-13.5
Payments to owners of capital (% change)	-4.0	-2.1	-1.9
Exports (% change in quantities)	0.0	2.0	-2.0
Export prices (% change)	-0.2	-0.4	0.3
Domestic prices (% change)	-0.9	-0.3	-0.6
Imports (% change in quantities)	-3.5	-2.2	-1.3
Inflation adjusted (real) exchange rate (% change)	-1.7	-1.0	-0.7
Kyoto liability payment ($m, 2008 prices)	1,855	2,037	-182
Domestic emissions (% change)	-10.4	-4.2	-6.2
Change in emissions (kilotonnes of CO_2-e)	-12,192	-4,924	-7,268
Leakage (kilotonnes of CO_2-e)	3,001	88	2,913
Change in domestic emissions net of leakage (kilotonnes of CO_2-e)	-9,191	-4,836	-4,355
Total reduction in global CO_2-e (net of leakage)	-52,769	-55,682	2,848

Source: NZIER

A common argument against free allocation is that the burden of emissions is passed back onto taxpayers/consumers, instead of on the emitters themselves. Our results show that the improvement in exports and the domestic economy more than compensate for the extra burden in tax, with household consumption down -2.7% versus -3.0% under no free allocation. This can be best understood from an analysis of wages under each scenario. Full phase-out of allocation causes a significant cut to real wages of -6.7% and subsequent reduction in consumption. With free allocation continued indefinitely, the wage reduction is a relatively modest -4.3%, resulting in a smaller contraction in household consumption.

Table 14 Industry contributions to GDP, 2025

Percent change.

	ETS	ETS – Indefinite free allocation	Difference
Horticulture and fruit growing	4.9	2.5	2.5
Sheep and beef cattle farming	-6.6	0.1	-6.7
Dairy farming	-12.9	-0.6	-12.3
Other farming	0.1	0.6	-0.5
Services to primary industry	-2.0	0.4	-2.4
Forestry and logging	1.7	0.9	0.8
Fishing	2.4	-0.3	2.7
Mining and quarrying	-3.8	-2.2	-1.6
Oil and gas exploration and extraction	-1.0	-0.6	-0.4
Meat processing	-5.7	0.3	-5.9
Dairy product manufacturing	-11.7	-0.4	-11.2
Other food and beverage manufacturing	1.4	0.2	1.2
Textiles clothing and footwear	3.6	2.1	1.5
Timber and wood products	2.0	1.4	0.7
Paper & paper product manufacturing	0.7	3.5	-2.8
Printing and publishing	0.8	0.2	0.6
Petroleum product refining and manufacturing	-12.5	-13.8	1.3
Fertiliser manufacturing	-7.3	0.8	-8.1
Cement and other non-metallic mineral product manufacturing	-3.9	-1.7	-2.1
Basic metal manufacturing	-5.0	1.5	-6.5
Other manufacturing	2.0	2.0	0.0
Electricity, Gas and Water Supply	-4.9	-4.1	-0.8
Property and construction services	-3.4	-2.2	-1.2
Transport services	-1.9	-1.5	-0.4
Business services	-1.8	-1.8	0.0
Government and personal services	-2.4	-2.4	0.0
Other services	-1.7	-1.4	-0.3

Notes: (1) Change in contribution to GDP is equal to the change in an industry's "value added".

(2) Rows may not sum due to rounding

Source: NZIER

By shielding agriculture from the full burden of the ETS, contributions to GDP from dairy farming and dairy processing fall by just 0.6% and 0.4% respectively, compared to 12.9% and 11.7% under a 2025 scenario with no free allocation. Sheep and beef farming, and meat processing contribute slight increases to GDP of 0.1% and 0.3%, compared to reductions of 6.6% and 5.7% respectively with no free allocation. Emissions leakage in these farming and processing industries are eliminated.

Similarly manufacturing industries benefit from compensation for increased production costs; basic metals and fertilizer manufacturing contributions to GDP increase by 1.5% and 0.8% relative to what might have otherwise been under an indefinite free allocation scenario. This is in direct contrast to significant contractions of 5.0% and 7.3% in these industries under a 2025 no free allocation scenario.

6.3.2 Comments on indefinite free allocation

The results presented above highlight how free allocation is a powerful mechanism within the ETS to spread the burden of impact. Free allocation will mean that polluters will not fully internalise the cost of their emissions, however:

- Industries such as agriculture face uneven playing fields when, to the best of our knowledge, no other country has signalled an intention to burden agricultural emissions.
- Leakage issues mean reductions in New Zealand's emissions may not result in reduction in global emissions, and thus New Zealand bares a cost for no global benefit.
- Household consumption is not necessarily adversely effected by increased free allocation to industry. Incorporating economy-wide effects through analysis in a CGE model highlights how reducing the burden on industry can create positive flow-on effects for households, particularly in the case of agricultural industries that drive New Zealand exports.

6.4 New emission reduction technologies

Our model has been created to incorporate information or assumptions about possible new abatement technologies that might become available as a result of the imposition of prices on greenhouse gases. New technologies – or existing ones that make economic sense once an ETS is in place – could provide useful emission reduction benefits and reduce the cost on the economy of an ETS through giving businesses and farmers a way to avoid some of the costs associated with their emissions.

NZIER has been researching the potential for emission reduction through adoption of new technologies and practices. We have found that there are limited opportunities for reducing emissions through technology change in agriculture and given the preponderance of agricultural emissions in New Zealand's emissions profile there are limited opportunities for technology enabled reductions in New Zealand in aggregate.

We have not included emissions reductions through technological changes in our main results as the availability of such technologies is uncertain and controversial. Furthermore, Government is, we understand, currently engaged in research evaluating the potential for emission reductions from adopting new technologies or practices (i.e. abatement cost curves). We will be able to use this information when it is available, but have set the issue aside for further research once we have the benefit of information from Government.

Table 15 Impacts on the economy, 2025 – technology change sensitivity

Assumes 10% economy reduction in emission intensity through new technology and practices and a 20% reduction in agriculture

	ETS	**ETS – with technology change**	**ETS - indefinite free allocation**
GDP (% change)	-2.1	-1.9	-1.2
Change in GDP ($m, 2008 prices)	-5,971	-5,412	-3,489
Private consumption (% change)	-3.0	-2.7	-2.7
Change in private consumption ($m, 2008 prices)	-5,462	-4,855	-4,928
Change in private consumption per household ($, 2008 prices)	-3,027	-2,691	-2,731
Domestic government spending (% change)	-3.0	-2.7	-2.7
Investment (% change)	-3.4	0.0	-1.5
Employment (% change)	0 by assumption	0 by assumption	0 by assumption
Employment change (Full time equivalents)	0 by assumption	0 by assumption	0 by assumption
Average inflation adjusted wages (% change)	-6.7	-6.2	-4.3
Change in average inflation adjusted wages ($ per ordinary hour)	-2.3	-2.1	-1.5
Payments to owners of productive land (% change)	-14.8	-13.1	-1.4
Payments to owners of capital (% change)	-4.0	-3.5	-2.1
Exports (% change in quantities)	0.0	-0.1	2.0
Export prices (% change)	-0.2	-0.1	-0.4
Domestic prices (% change)	-0.9	-0.7	-0.3
Imports (% change in quantities)	-3.5	-3.1	-2.2
Inflation adjusted (real) exchange rate (% change)	-1.7	-1.4	-1.0
Kyoto liability payment ($m, 2008 prices)	1,855	1,623	2,037
Domestic emissions (% change)	-10.4	-18.2	-4.2
Change in emissions (kilotonnes of CO_2-e)	-12,192	-21,459	-4,924
Leakage (kilotonnes of CO_2-e)	3,001	-2,953	88
Change in domestic emissions net of leakage (kilotonnes of CO_2-e)	-9,191	-18,506	-4,836
Total reduction in global CO_2-e (net of leakage)	-52,769	-52,817	-55,682

Source: NZIER

We have, however, tested the sensitivity of our overall conclusions to assumptions about technological change. To do this we have assumed that new technologies are available which can reduce emissions across major emitting industries by an average of 10% and that new technologies or practices can reduce emissions in agriculture by up to 20%.

When we adopt those assumptions in our model the balance of impacts on the economy do not change from our main findings (see Table 15). We find that costs to the economy are more sensitive to changes in the quantity of permits allocated freely to industry and agriculture than to assumptions about emissions reductions. This is because with a, for example, relatively generous assumption of a 20% reduction in emissions intensity in agriculture, farmers' costs increase proportionately more than they would if free allocation is maintained at 2013 levels indefinitely as discussed above (see Table 16).

Table 16 Industry contributions to GDP, 2025: technology change impacts

Percent change compared to what would otherwise have been the case.

	ETS	ETS – with technology change	ETS – indefinite free allocation
Horticulture and fruit growing	4.9	4.2	2.5
Sheep and beef cattle farming	-6.6	-5.5	0.1
Dairy farming	-12.9	-10.8	-0.6
Other farming	0.1	0.0	0.6
Services to primary industry	-2.0	-1.7	0.4
Forestry and logging	1.7	1.4	0.9
Fishing	2.4	1.6	-0.3
Mining and quarrying	-3.8	-3.7	-2.2
Oil and gas exploration and extraction	-1.0	-1.0	-0.6
Meat processing	-5.7	-4.7	0.3
Dairy product manufacturing	-11.7	-9.8	-0.4
Other food and beverage manufacturing	1.4	1.1	0.2
Textiles clothing and footwear	3.6	3.3	2.1
Timber and wood products	2.0	1.5	1.4
Paper & paper product manufacturing	0.7	-0.3	3.5
Printing and publishing	0.8	0.7	0.2
Petroleum product refining and manufacturing	-12.5	-12.3	-13.8
Fertiliser manufacturing	-7.3	-6.2	0.8
Cement and other non-metallic mineral product manufacturing	-3.9	-3.5	-1.7
Basic metal manufacturing	-5.0	-5.2	1.5
Other manufacturing	2.0	1.6	2.0
Electricity, Gas and Water Supply	-4.9	-4.8	-4.1
Property and construction services	-3.4	-3.0	-2.2
Transport services	-1.9	-2.0	-1.5
Business services	-1.8	-1.6	-1.8
Government and personal services	-2.4	-2.1	-2.4
Other services	-1.7	-1.5	-1.4

Notes: (1) Change in contribution to GDP is equal to the change in an industry's "value added".

Source: NZIER

When we assume technology change there is also only limited impact on the amount of leakage caused by the ETS – compared with an elimination of leakage under the indefinite free allocation scenario.

New technologies for reducing emissions would have to produce dramatic reductions in agricultural emissions at low cost before they could offset the costs to the economy of the proposed ETS.

7. Concluding remarks

Our research suggests that the proposed New Zealand Emissions Trading Scheme (ETS) will have larger economic impacts on New Zealand than has been suggested by the Government's analysis.

In 2012, the combined economic impact of an ETS and the cost of paying New Zealand's Kyoto liability, is a:

- $900 million reduction in GDP
- $600 reduction in an average household's spending
- reduction in employment equivalent to 22,000 jobs

Most of these costs can be attributed to the ETS, rather the cost of paying for New Zealand's Kyoto liability. The cost to the economy (i.e. GDP) of the ETS is more than eight times larger than if the Government meets its Kyoto liability through financing emission reductions abroad.

Longer term, the economy has more time to adjust to the impact of the ETS, but our analysis shows that an ETS remains three times more costly than paying for emissions reductions elsewhere in the world.

In 2025, the combined economic impact of an ETS and the cost of paying for an international emission reduction obligation, is a (in today's prices):

- $5.9 billion reduction in GDP
- $3,000 reduction in an average household's spending
- reduction in hourly wages equivalent to $2.30 per hour.

Moreover, for the additional cost that an ETS imposes on the New Zealand economy, New Zealand achieves 5% less emissions reductions, in terms of global emissions, than we could achieve if we funded emissions reductions elsewhere in the world.

This suggests that the ETS, as currently proposed, may not be a least cost solution for mitigating the impacts of climate change.

This finding is in step with earlier work by NZIER:

> *The reality is that it may prove cheaper to pay emitters in another country to reduce emissions rather than to achieve any reduction within New Zealand*. (NZIER, 2007)

Our research goes some way to proving that this is the case.

The main driver behind this is our assumption that New Zealand exporters are unable to increase their prices to reflect the cost of climate change mitigation policies. If climate change measures are adopted elsewhere in the world such that that assumption no longer holds true, then we would need to revise our analysis.

Without equivalent measures being adopted elsewhere in the world the cost of an ETS would fall largely on export industries, especially the agricultural sector. In the agricultural sector in 2025:

- activity in dairy farming declines -12.9%
- dairy land prices decline by -40.6%
- sheep and beef farming activity declines -6.6%
- prices of land used in sheep and beef farming fall -23.4%

The impact on the agricultural sector is also a major source of leakage – where emission reductions occur in New Zealand only because production is displaced with production elsewhere in the world. Our analysis suggests that the ETS causes leakage from the pastoral sector equivalent to more than 3 million tonnes of greenhouse gas emissions.

Another sector heavily impacted includes basic metals manufacturing where investment declines and plant, machinery, and equipment and other capital falls by 6.5%. There is also a 3.4% reduction in employment in the sector.

The variation in impacts of the ETS across different industries also means quite variable impacts across New Zealand's regions - being that regions have different concentrations of industries. The regional economies of Northland and Southland contract more than any other region as a result of the ETS. This is because both regions have relatively significant concentrations of agricultural production and both have substantial employment in large industries that contract due to the ETS – basic metals (aluminium) manufacturing in the case of Southland and petroleum refining in the case of Northland.

The economies of regions with high concentrations of service industries and public sector employment, such as Auckland and Wellington, do not contract by as much as more rural regions.

The impacts of an ETS change considerably when allocations of emissions permits are not phased out. In 2025, an ETS with indefinite free allocation reduces GDP by 1.2% compared to 2.1% under the ETS with phased out free allocation. Emissions reductions are 4.2% compared to 10.4% under phased out free allocation, however leakage emissions of almost 3,000 kt CO_2-e are eliminated.

The reason for this result is that indefinite free allocation (at initial allocation levels, so not entirely free allocation) minimises negative impacts on export competitiveness.

While there is a common argument against free allocation that the burden of emissions is passed back onto taxpayers/consumers, instead of on the emitters themselves. Our results show that the improvement in exports and the domestic economy more than compensate for the extra burden, with household consumption down 2.7% versus 3.0% under no free allocation.

We also find that costs to the economy are more sensitive to changes in the quantity of permits allocated freely to industry and agriculture than to assumptions about emissions reductions through technology change.

That being so, our research suggests that further thought needs to be given to allocation of emissions units and especially to the allocation phase out as currently envisaged in the draft bill.

NZIER (2007) has already suggested how the issue of permit allocation could best be dealt with to minimise unnecessary costs to firms facing international competition. We have proposed:

- New Zealand firms subject to international competition from producers likely to be facing no or limited effective emissions charges should receive a gratis allocation of emission entitlements.
- To incentivise the firm receiving the entitlement to reduce its emissions, but not constrain efficient growth in output, the level of gratis allocation should, if practicable, be based on an international 'best practice' standard per unit of output.
- The 'best practice' standard could be set at the world best standard or at some point, such as, the upper quartile or top decile level for plants in an international peer group for which data are available.

For smaller entities, the information costs of finding and checking peer group data may be too great, and their gratis allocation could be based on some percentage less than 100% of their historical emissions per unit of output. They should have the option of having their allocation determined on the basis of the emissions of an international peer group if they wish, however.

The Government commissioned review of the proposed ETS reached conclusions that our similar to ours (Kerr, 2007):

> *…several very important aspects of the proposal require further development… [including] …the need for clear thinking on interred leakage and allocation issues; how to achieve a smooth, low risk transition; (p.1)*
>
> *Any policy used to address leakage should be simple and closely targeted. It should be designed to phase out <u>as other countries regulate their emissions</u> [emphasis added]. (p.7)*
>
> *In the agriculture sector, [output-based or intensity-based allocation] could simultaneously address the question of how to freely allocate units that intend to compensate for capital losses (loss of land values). (p.7*

Appendix A References

Adams, P., Parmenter, B,. and Horridge, M. (2000) "Analysis of Greenhouse Policy using MMRF-Green." Centre for Policy Studies, Monash University

Bugnion, V (2007) "European Carbon Market 2007." A Point Carbon Report to SAIS Conference, April 20th 2007.

Carr, C. and Rosembuj, F. (2008) "Flexible mechanisms for climate change compliance: emission offset purchases under the clean development mechanism" available at http://carbonfinance.org/Router.cfm?Page=DocLib&CatalogID=38443.

Castalia (2007). "The New Zealand Emissions Trading Scheme: How do we make it work?" November 2007. Accessed 16 April 2008. http://0010102.e-xpert.co.nz/SITE_Default/SITE_x-documents/x-files/28395.pdf

Hotelling, H (1931) "The Economics of Exhaustible Resources," Journal of Political Economy, April 1931, 39, pp. 137-175.

Horridge, M (2008) "ORANI-G: A generic single-country computable general equilibrium model." Centre of Policy Studies and Impact Project, Monash Australia.

Infometrics (2007) "General Equilibrium Analysis of Options for Meeting New Zealand's International Emissions Obligations." Report prepared for the Emissions Trading Group, October 2007.

Kerr, S. (2007). "Review of the proposed New Zealand Emissions Trading Scheme". Motu Economic and Public Policy Research. Accessed 20 April 2008: http://www.mfe.govt.nz/publications/climate/review-proposed-nz-ets-nov07/index.html

McKibbin W & Pearce D (1997) "Impacts on the New Zealand economy of commitments for abatement of carbon dioxide emissions"; Report to Ministry of Commerce, Centre for International Economics, Canberra.

Ministry for the Environment (2005) "Review of Climate Change Policies". http://www.mfe.govt.nz/publications/climate/policy-review-05/html/page1.html

Ministry for the Environment (2006) *New Zealand's Greenhouse Gas Inventory 1990 – 2004*, www.mfe.govt.nz/publications/climate/nir-apr06/nir-apr06.pdf

Ministry for the Environment (2007) *An Emissions Trading Scheme for New Zealand* Speech delivered by John Whitehead to the Journalists Trading Organisation training forum on Sustainability, August 2007 http://www.treasury.govt.nz/publications/mediaspeeches/speeches/emissionstrading

Ministry for the Environment (2007) "Projected balance of emissions units during the first commitment period of the Kyoto Protocol"

Ministry for the Environment and Treasury (2007). "The Framework for a New Zealand Emissions Trading Scheme". http://www.climatechange.govt.nz/nz-solutions/trading-scheme-reports.shtml

Ministry of Agriculture and Forestry (2008) *Projected impacts of the New Zealand Emissions Trading Scheme at the Farm Level*, http://www.maf.govt.nz/climatechange/reports/Projected-Impacts-of-NZETS.pdf

NZIER (2001) "The Economic Effects of Greenhouse Gas Policies: a quantitative evaluation". Report to The Greenhouse Policy Coalition and The Petroleum Exploration Association of NZ, November 2001, http://www.nzier.org.nz/files/187.pdf

NZIER (2007) Emissions Trading Scheme for New Zealand, report to Business New Zealand, www.businessnz.org.nz/file/1188/Emissions%20Trading%20Scheme%20for%20NZ.pdf

NZIER (2008) *Quarterly Predictions*, March 2008.

Skilling, D. and Boven, D. (2007) "We're right behind you: A proposed approach to emissions reduction". The New Zealand Institute, Discussion Paper 2007/2, October 2007.

Saunders, C., Barber, A. and Taylor, G. (2006) *Food Miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry*, Agribusiness & Economics Research Unit research report 285, Lincoln University, www.lincoln.ac.nz/story_images/2328_RR285_s6508.pdf

The Guardian, http://www.guardian.co.uk/environment/2008/apr/03/carbonemissions.climatechange , April 3 2008

United Nations Framework Convention on Climate Change (2006) *National Greenhouse Gas Inventory Data*.

Appendix B Technical detail of the model

B.1 ORANI-G

Our results were produced on a new model of the New Zealand economy based on a tried and tested generic model (ORANI-G) that has been found effective for policy analysis in Australia and around the world. The model has been calibrated to the local setting and loaded with New Zealand data. The assumptions needed are based on consultation with industry specialists and reflect best practice.

The model has been developed with considerable assistance from CGE modelling experts at the Centre for Policy Studies at Monash University in Melbourne Australia.

B.2 Database structure

The model is based on a large database containing the value flows of the economy, as per Figure 13. The database defines the initial structure of the economy, which by definition is assumed to be in equilibrium in all markets. The structure of the database is broadly similar to traditional input-output tables; for example commodities may be used as intermediate input for further production, utilised in investment, exported or consumed by households and the government. Industry costs include the cost of intermediates, margins, taxes and primary factor costs for labour, land and capital. As per the accounting identities in input-output tables, the total value sum of producers' input costs (including margins, taxes, returns to factors and other costs) equates to the total value of output production (the 'MAKE' matrix in the database).

The ORANI-NZ model consists of:

- 131 industries
- 210 commodities
- 14 regions
- 1 household
- 24 occupations

The database has been sourced initially from Statistics NZ 1995/96 Inter-Industry tables, updated using the subsequently released 2003 Supply and Use Tables, and finally 'up-scaled' to 2007 levels using latest Statistics NZ macroeconomic data.

Figure 13 The ORANI-NZ database

		Absorption Matrix					
		1	2	3	4	5	6
		Producers	Investors	Household	Export	Government	Change in Inventories
	Size	← I →	← I →	← 1 →	← 1 →	← 1 →	← 1 →
Basic Flows	↑ C×S ↓	V1BAS	V2BAS	V3BAS	V4BAS	V5BAS	V6BAS
Margins	↑ C×S×M ↓	V1MAR	V2MAR	V3MAR	V4MAR	V5MAR	n/a
Taxes	↑ C×S ↓	V1TAX	V2TAX	V3TAX	V4TAX	V5TAX	n/a
Labour	↑ O ↓	V1LAB					
Capital	↑ 1 ↓	V1CAP					
Land	↑ 1 ↓	V1LND					
Production Tax	↑ 1 ↓	V1PTX					
Other Costs	↑ 1 ↓	V1OCT					

C = 210 Commodities

I = 131 Industries

S = 2: Domestic,Imported

O = 24 Occupation Types

M = 5 Commodities used as Margins

	Joint Production Matrix
Size	← I →
↑ C ↓	MAKE

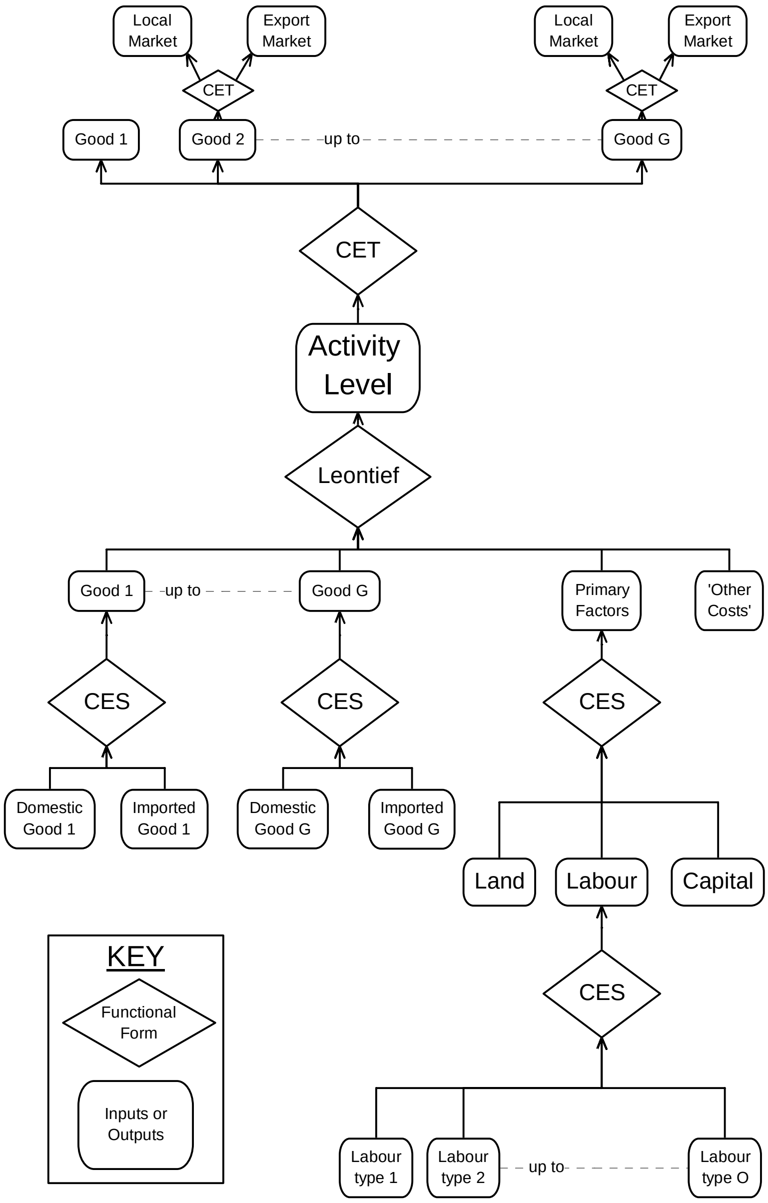
	Import Duty
Size	← 1 →
↑ C ↓	V0TAR

Source: Horridge, 2008; NZIER

B.3 Production structure (Horridge, 2008)

The production structure of the model is presented in Figure 14. Each industry can produce a number of different commodities. Production inputs are intermediate commodities, both domestic and imported, and primary factors labour, land and capital. Working from bottom to top, we see constant elasticity of substitution (CES) production nests for occupations, primary factors and the choice between imported and domestic commodities. In this case, an increase in price moves sourcing towards another input, for example if the price of imports increases, more domestic commodities are demanded in the intermediate sourcing CES nest.

Figure 14 Production structure



Source: Horridge, 2008

At the activity level, intermediate goods, primary factors and other costs are combined using a Leontif production function. This means the proportion of production inputs does not change. On the output side, there are two further constant elasticity of transformation (CET)[22] nests. The production mix of each industry is dependent on the relative prices of each commodity. Similarly, the

[22] A CET function is identical to a CES function except that the transformation parameter has the opposite sign (i.e. increasing price increases output in a CET; in a CES, increasing price reduces demand)

export nest determines local and export market shares depending on relative prices.

B.4 Regional extension

Policy impacts are often unevenly spread across industries and regions. To capture these heterogeneous effects, the model is extended to include a regional component. A 'top-down' approach is used to decompose national impacts to the regional level, using regional employment data as weighting. If a region has a high share of national output, then its regional industry output will be proportionally affected. The exception is industries that produce commodities (mostly services) that are largely consumed within a region. These are deemed to be *local* industries, and it is assumed that their output moves in line with the local demand for the corresponding commodity, rather than with the national industry output. Note that an inherent assumption in the 'top-down' approach is that industries uses the same production technology across all regions (Horridge, 2008).

B.5 NZGREEN

The previous sections have detailed the adaption of the basic ORANI-G model framework for NZ. Further enhancements have been developed in order to model the ETS. These include:

- Incorporation of economy-wide emissions flows by fuel type, including combustion and non-combustion emissions.
- Disaggregation of the electricity generation industry by fuel type to enable the evaluation of relative industry cost changes due to the ETS.
- Ability to introduce abatement at a cost to specific industries.
- Calculation of leakage.

B.5.1 Tracking Greenhouse Gases

Emissions data, sourced from MfE's long-term projections and Greenhouse Gas Inventory 1990-2005, and Statistics NZ energy flow tables, have been included in the model. A section of the emissions matrix is highlighted in Table 17. The first three columns provide emissions from burning fuels. This data is based on the 2003 energy flow tables from Statistics New Zealand with fuel sources aggregated into coal, gas and petroleum products, and scaled to meet MfE's Greenhouse Gas Inventory 1990-2005 combustion emissions. The final *Activity* column are non-combustion emissions, also sourced from the Inventory.

The table tracks emissions through the economy; for example, the majority of emissions from agricultural sectors falls under the Activity or non-combustion column, while electricity generation emissions stem from the fuel source used (e.g. coal or gas) plus a relatively small amount of fugitive or *Activity* emissions.

This comprehensive accounting of emissions allows the emissions intensity of production to be industry and fuel-type specific. Combustion emissions are proportional to fuel usage, while *Activity* emissions are proportional to industry output.

Table 17 Emissions matrix example

Units are kT CO_2-e

	Coal	Gas	Petroleum Products	Activity
Sheep and beef farming	0.00	0.00	298.31	15188.51
Dairy farming	0.00	0.00	248.74	22351.74
Basic metals	1471.93	85.11	61.73	2327.10
Electricity generation – coal	2235.49	0.00	0.00	232.52
Electricity generation – gas peak	0.00	2895.36	0.00	694.39
Electricity generation – geothermal	0.00	0.00	0.00	363.34
Waste	0.00	10.48	0.35	1645.70

Source: MfE, Statistics NZ, NZIER

B.5.2 Disaggregation of electricity generation

The electricity generation industry is disaggregated into gas base-load, gas peak-load, coal, oil, wind, hydro and geo-thermal. Gas, coal and oil type generators are large emitters that face increased costs under an ETS. Non-emitting generators such as wind and hydro are not effected, however fugitive emissions from geo-thermal electricity generation are included. A CES function determines how these relative changes in production costs effects the electricity supply split. In line with previous work, the elasticity of substitution is set at 5.

B.5.3 Abatement

Abatement opportunities are dealt with in two distinct methods within the model.

- Improvement in energy-efficiency at a cost – combustion emissions abatement can occur through energy-saving technological change. The level of abatement for a given price is exogenous to the model. The cost of energy-saving abatement is passed through as an increase in requirement for capital. This methodology is a realistic representation of how abatement occurs in practice: energy-saving abatement requires some investment in new capital e.g. a new light bulb, housing insulation, or a more efficient car.

- Activity emissions abatement – abatement of non-combustion *Activity* emissions are considered in relation to the price of carbon. New technologies are taken up based on estimated abatement cost curves and the cost of abatement is transmitted to the production function through a deterioration in all-input augmenting technological change.

Abatement opportunities for key emitting industries have been investigated through discussion with key industry stakeholders, researchers, and engineers, resulting in the development of industry-specific marginal abatement cost curves. We believe the curves we have developed are plausible, however, for this initial paper, no abatement is included in the modelling scenarios because the extent of abatement opportunities is controversial.

Our assumptions have proved to be very controversial amongst industry and Government officials that we have consulted with. The Government is currently working on its own set of abatement curves for New Zealand and we prefer to wait until that work has been completed so that we can compare it with our results and come up with a best-guess estimate of abatement opportunities. Moreover comparable analysis to ours, commissioned by Government (Infometrics, 2007), did not incorporate abatement so excluding abatement ensures our results are comparable to that existing analysis.

B.5.3.1 Leakage

A further addition to the model for the analysis of the ETS is the inclusion of an emissions leakage calculation. Emissions savings from reductions to exports, together with any emissions reductions from decreased domestic share of the local market are considered leakage emissions – emissions savings for NZ but not for the world. This is based on the assumption that the world market replaces any reduction in NZ exports with supply from some other country. Note that the leakage calculation is most likely a conservative estimate, as it assumes that NZ and the rest of the world have identical emissions intensities of production. For key NZ export industries such as agriculture however, research has shown NZ producers are far less energy intensive than some overseas countries (see for example Saunders et al "Food miles - Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry", Lincoln University 2006).