INFOMETRICS

General Equilibrium Analysis of Options for Meeting New Zealand's International Emissions Obligations

report prepared for

Emissions Trading Group

October 2007

Summary

This paper presents a general equilibrium analysis of a number of possible policies that would meet New Zealand's emissions obligations, both under the Kyoto first commitment period 2008-12 (CP1) and under some plausible international agreement in 2025.

A general equilibrium model takes into account the main inter-dependencies in the economy, such as flows of goods from one industry to another and the passing on of changes in costs in one industry into prices and hence the costs of other industries. It is not a macroeconomic forecasting model. For this reason in all scenarios the total amount of employment and investment in the economy is held constant, with pressure in labour and capital markets being absorbed in the prices of these inputs. This ensures that the economy-wide effects of different policies can be attributed to changes in allocative efficiency and changes in international competitiveness, not to changes in the volume of factor inputs.

For the Kyoto first commitment period the cost to aggregate economic welfare of introducing policies to meet New Zealand's obligations is likely to be less than 0.3% for a range of welfare indicators. If the carbon price is around $25/tonne there is no significant difference between the government purchasing all required emission units from offshore (financed by higher income taxes) without any domestic carbon price, or having an explicit carbon price as part of an emissions trading scheme. This applies even if major emitters that are exposed to international competition receive some free allocation and if agricultural emissions are exempt.

In the longer term, however, an explicit domestic carbon price is clearly a better option than having government responsible for all emissions with no carbon price, as some abatement is cheaper to undertake domestically than purchasing emission units offshore.

Even at around $25/tonne, the probable greater stringency of international obligations means that the cost of meeting those obligations by 2025 is much higher than during CP1. At $100/tonne, private consumption is 2.2% below what it would otherwise be in 2025. At current prices, but allowing for growth in real income between now and 2025, this corresponds to about $800 per person in 2025. Putting this into perspective, however, the overall increment in private consumption between now and 2025 is expected to be around $12,900 per capita. In terms of growth rates the $800 reduces the growth rate from 2.4% pa to 2.3% pa.

As might be expected these results are sensitive to what is assumed about New Zealand's obligations in 2025. Reducing our allowable emissions by 30 Mt CO_2e increases the welfare cost of meeting our obligations by over 50%.

In 2025 relative to 'business as usual', the largest reductions in industrial output occur in oil refining, electricity production, meat processing and dairy processing. It is doubtful, however, whether any of these industries would incur absolute reductions in output relative to the present.

Part 1 of the paper explores a number of policy scenarios for CP1, while Part 2 examines scenarios in 2025. The two main differences between these periods are the amount of emissions to which New Zealand is likely to be entitled, and the exclusion/inclusion of methane and nitrous oxide emissions in an emissions trading scheme. Part 3 looks at a number of sensitivity tests around the 2025 scenarios.

Part 1. The Kyoto First Commitment Period

The analysis takes a snapshot of 2011/12 as being representative of the first Commitment Period (CP1) under Kyoto, while allowing enough time for the transitory effects of policy changes to have largely disappeared. A 'business as usual' (BAU) scenario is developed which represents a picture of the economy and emissions without any carbon charges. The BAU is not necessarily the most likely forecast of what the economy might look like. Rather it is intended to be a plausible projection of the economy that can constitute a frame of reference against which other scenarios may be compared. The BAU does not take into account any of the possible climate change related costs associated with adopting this scenario, such as trade barriers that might arise from non-participation in global efforts against climate change.

The model is then 'shocked' with a number of scenarios:

- **Scenario 1** – An international carbon price of NZ$25/tonne[1] with the government purchasing emission units on the world market to cover New Zealand's excess emissions. The cost of the permits is financed by higher personal income taxes. (Note that this does not necessarily mean that tax rates will be higher than they are currently, only that they are higher than in the BAU scenario)

- **Scenario 2** – A price on carbon of $25/tonne CO_2 in an emissions trading scheme covering all emissions from energy and industrial processes, with free allocation of permits covering around 90% of 2005 emissions for major emitters excluding electricity generators. Emissions of methane and nitrous oxides from agriculture are exempt. Any remaining excess emissions are covered as in Scenario 1.

- **Scenario 3** – As in Scenario 2 with a higher price of $50/tonne of CO_2.

Note that although these scenarios are run as 'shocks' relative to the BAU, it is implicitly assumed that the various policies are implemented early enough for the economy to reallocate labour and investment in response to new price signals.

In all scenarios the following are held constant at BAU levels:

1. Total employment, wage rates endogenous.
2. Total capital stock, user costs of capital endogenous.
3. Balance of payments as proportion of GDP, real exchange rate endogenous.
4. Fiscal surplus, personal income tax rates endogenous.

The first two macroeconomic closure rules imply that the overall level of resource use in the economy is not dependent on climate change policy. Other closure rules are possible. For example instead of fixed employment, wage rates could be fixed at BAU levels. This implies, however, that the long run level of total employment is driven more by the price of carbon and energy than by the forces of labour supply and demand – an unlikely state of affairs.

The third rule ensures that the costs of meeting New Zealand's emission obligations are not met simply by borrowing more offshore, as this is not sustainable. Relaxing this constraint would mean that in the long term New Zealand could run a larger external deficit than it other wise would – not a view likely to be shared by foreign lenders and investors.

The fourth rule prevents the results from being confounded by issues around the optimal size of government. An increase in government revenue from a carbon tax or auctioned emission

[1] The lowest price of emission used in this report is $25/tonne. It was thought that using lower prices would not be useful as many of the metrics could end up being rounded to zero.

permits is not a reason for enlarging government as proportion of GDP. However, other closure rules such as revenue recycling via lower corporate taxes or debt repayment would also meet this objective. Raising spending on say health, would not. If it is believed that government should be larger, then this scenario should be investigated in its own right; it is unlikely that a carbon charge is the most efficient way of doing this.

The following model limitations should be noted:

- *Aggregation bias* – All industries in the model represent aggregations of companies, products and processes, but even with over 50 industries, aggregation bias remains. For example we cannot distinguish between the production of fertilizer and hydrogen in the Chemicals industry.

- *Lumpiness in production* – The model assumes that small increments and decrements in production are possible. For industries that are dominated by a single plant dependent on economies of scale this could be unrealistic, especially with respect to increments in output. However, under a carbon charge increases in output from such industries are unlikely.

- *Pricing* – Being an 'equilibrium' model, unless specifically altered, industries must price their output at the average cost of production. There are no long run economies of scale so marginal costs equal average costs.

- *Costs of Resource Re-Allocation* – The model is an "equilibrium" model. It looks at the situation after resources have been reallocated in response to changes in relative prices and changes in policy. It does not measure transition costs. Hence short term costs to the economy may be under-stated, although by a relatively small amount in a macro-economic sense, if the economy is close to capacity.

Apart from GHG emissions, we do not present the results in levels. Rather they are expressed as percentage changes in real dollar amounts relative to BAU. This reflects the strength of the model being in comparative scenario analysis, rather than in forecasting levels of economic activity. However, results in absolute levels (real 1995/96 prices) are available on request.

With regard to Forestry, all model runs for 2012 are on a like-for-like basis. That is, government is assumed to hold credits and liabilities for both post 1989 and pre 1990 forests, so valid comparisons can be drawn between the scenarios. In particular:

- Post 1989 Forests – No estimate has been made on the macro-economic effect of devolving sink credits and liabilities in this modelling. Devolving sink credits, to the degree this will occur (as it is voluntary), represents a wealth transfer within the economy and would reduce the revenue that the model has available for tax recycling. Importantly, the number of units that need to be purchased offshore by New Zealand, over time, would not change. However, to the extent that liabilities on harvest of forests are reduced as a result of devolution of credits and liabilities, the macroeconomic impact of the decision to devolve sink credits and liabilities will be positive.

- Pre 1990 Forests – The act of devolving deforestation liabilities could see significant emission reductions over the first commitment period which would reduce the need to purchase emission units offshore. These emission reductions have not been taken into account in this modelling. However, they would work to further reduce the macroeconomic impacts under the ETS.

Scenario 1

Government purchases emissions units from offshore, financed by higher personal income tax. From MFE net position report, the *amount involved is $228m per annum, being 9.1 Mt CO_2 at $25/tonne.*

Given no deterioration in the balance of payments, the additional offshore payments by government need to be offset by an increase in the balance of trade in goods and services. of $228m.

As shown in Table 1 exports rise by 0.4% and imports fall by 0.2%, as does private consumption. The main mechanism at work here is the 0.2% reduction in the real exchange rate which enables exporters to sell more quantity, albeit at lower average prices – a movement down the export demand curves. The terms of trade fall by 0.2%.

Note that the model does not simulate the absolute level of prices. It deals only with relative prices. Thus a reduction in the real exchange rate could be manifested as either a devaluation of the nominal exchange rate or as lower nominal domestic prices and wages. Either way the international purchasing power of New Zealand households falls. Measured in world prices GDP declines by 0.2% relative to BAU.

Table 1
Macroeconomic Results

	BAU	Scenario 1 Govt responsible for all emissions	Scenario 2 ETS $25/tonne. Free allocation to industry	Scenario 3 ETS $50/tonne. Free allocation to industry
Emission units required to be purchased off shore (p.a)		9.1Mt	6.8Mt	5.2Mt
Private Consumption		-0.2%	-0.2%	-0.3%
Exports		0.4%	0.0%	-0.1%
Imports		-0.2%	-0.2%	-0.4%
GDP in world prices[2]		-0.2%	0.0%	0.0%
Real wage rate		0.1%	-0.2%	-0.5%
Household average tax rate		1.4%	-1.0%	-2.4%
Real exchange rate		-0.2%	0.0%	0.1%
Terms of Trade		-0.2%	0.1%	0.1%
CO_2 emissions (Gg)	37964	0.0%	-5.9%	-10.1%
Agriculture CH_3 & N_2O	43715	0.1%	0.0%	0.0%
Total (Gg)	81679	0.1%	-2.7%	-4.7%

One might wonder about the low national cost – at just 0.2% of private consumption, but the size of the 'shock' is not particularly large. Over the period 2008-2012 the ETS will apply almost exclusively to carbon dioxide, emissions of which in 2012 are projected in the BAU scenario at 38 Mt. The future price of carbon is unknown, but at $25/tonne the value of

[2] GDP in world prices is considered to be a better indicator of GDP in this case, than if specified in NZ$, because it includes the effect of changes in New Zealand's real exchange rate.

emissions is about $950 million. New Zealand's gross domestic product will be over $200 billion by 2012. Thus the proportion of GDP accounted for by the value of emissions is less than 0.5%. But this portion of GDP does not just disappear. Indeed, the only bits that disappear are:

1. the resources required to pay for the emission rights that New Zealand must purchase on the international market (analogous to giving away some of our exports);

2. the deadweight loss that is generated by the higher taxation required.

In fact (1) does not actually cause a reduction in the volume of goods and services produced by New Zealand. It is simply that more resources need to go into exporting, leaving less for private consumption. So, lower private consumption is the manifestation of (1).

Scenario 2

An emissions trading scheme with a carbon charge of $25/tonne, government purchases units for excess emissions from offshore, financed by higher personal income tax if permit revenue is insufficient. Methane and nitrous oxide are exempt. Free allocation, in most cases equal to 90% of approximate 2005 emissions, applies to the following industries:

- *Dairy processing*
- *Pulp and paper*
- *Industrial chemicals (fertilizer and hydrogen)*
- *Non-metallic mineral products (cement and lime)*
- *Basic metals (iron and steel)*
- *Oil refining*

Analogously, the following industries are also 90% compensated for higher electricity prices:

- *Dairy processing*
- *Wood processing*
- *Pulp and paper (thermo-mechanical pulping)*
- *Basic metals (aluminium)*

Free allocation has two purposes that are often confused.

1. Fairness: In the past businesses have invested on the basis that greenhouse gas emissions were free. Subsequently imposing a price on emissions could reduce the value of such investment, perhaps leading in some cases to stranded assets. Compensation via free allocation should be via a once-only allocation of emission permits equal in value to the change in asset value. There is no economic basis for ongoing free permit allocation. Firms that close should be allowed to sell the allowances and keep the revenue as the compensation is for a lower value of assets, not for lost production.

2. Carbon leakage: Emissions pricing may impede the international competitiveness of some industries. If this leads to lower output from, or even the closure of New Zealand plants, offshore plants would increase production and global emission would not fall. Moreover, an industry once lost to New Zealand might never be re-established, even if at some point in the future most countries impose a price on emissions. In contrast to compensation for stranded assets, in this case free allocation needs to be tied to production as it is the potential loss of output that is the problem.

From a modelling perspective these two types of compensation should be handled quite differently. Compensation for stranded assets is a financial transaction that should not affect pricing decisions, but compensation to maintain output is effectively an output subsidy and so very much a part of production and pricing decisions.

With the exclusion of agricultural non-CO_2 emissions from the ETS during the first commitment period, our analysis suggests that any potential loss in asset values is negligible, although industry aggregation in the model may understate such loss. In contrast, the potential loss of international competitiveness is not negligible (under no assistance).

Hence in our modelling we treat free allocation as an output subsidy, albeit limited to the equivalent of 90% of 2005 emissions in most cases – see box.

Table 1 shows that the carbon charge reduces CO_2 emissions by 5.9% or 2.3 Mt. Thus the cost of units to be bought offshore is about $170m. And with a rising marginal cost of abatement, it is cheaper to undertake some abatement domestically than purchasing units from offshore. This represents a gain from an emissions trading scheme over Scenario 1. Might the gain be higher without free allocation?

Free allocation of emission rights may be thought of as some of the proceeds of auctioned rights being recycled back to industry. Other options for recycling include lower income tax rates and subsidies for growing trees or undertaking research into carbon sequestration. We have not undertaken a full analysis of recycling options, but we consider the welfare effects of recycling via free allocation against the option of recycling via lower income taxes.

Firstly, as noted above, the most important factor determining the welfare effects of a price on carbon is the cost of any emission units that New Zealand collectively may have to purchase offshore. An ETS means that more emission reduction occurs domestically and thus fewer allowances are required to be purchased from abroad. The next most important factor is that producers and consumes face the correct set of relative prices at the margin. Free allocation need not compromise these factors.

Most recycling options then will be a second order issue in terms of the welfare effects of an ETS. Without free allocation households incur a loss in purchasing power because of the lower New Zealand dollar brought about by the increased demand for foreign exchange – to pay for the offshore emission permits.

With free allocation the exchange rate effect is smaller because exports are maintained at a higher level, as free allocation helps to preserve competitiveness. Acting against this, however, is that households must forego some of the tax reductions that would be available if all emission rights were auctioned.

Our analysis shows that these effects are largely offsetting. That is, the loss in private consumption from an ETS is not particularly sensitive to some free allocation of emission rights. However, the model does not fully consider all relevant factors:

1. It ignores the transactions costs of free allocation.

2. Household taxes are modelled as simple average tax rates by household income quintile. Thus the full deadweight loss from progressive income taxation is not fully captured, especially with invariant total employment.

3. Free allocation that is too generous could provide windfall profits to overseas shareholders.

Accordingly, we would expect that over time the welfare cost of the ETS would be reduced if free allocation of emission rights is phased out, other things equal.

Note also that irrespective of the recycling mechanism, the relative welfare gain that is associated with the introduction of an ETS (Scenario 2 v Scenario 1) is likely to be under-estimated somewhat as the model does not include the effect of reductions in emissions from activities not included in the model, such as deforestation.

A domestic carbon price does not decimate the tradable sector. For a given balance of payments constraint (as occurs here) anything that impedes the international competitiveness of the economy will in the long run be offset to at least some extent by an adjustment of the real exchange rate, either in the form of lower domestic prices or a devaluation of the nominal exchange rate.

As shown in Table 2 only Oil Refining and to a lesser extent Non-metallic Mineral Products incur falls in output. (Electricity is not a traded industry.) Underlying these reductions are increases in output prices of 0.7% and 0.4% respectively. It is unlikely that such increases endanger the overall viability of these industries. Note that for Oil Refining free allocation covers its own direct emissions from the refining process, but not the emissions produced when the refined fuels are combusted in vehicle engines. Thus its lower output is a direct result of less consumer demand for liquid fuels.

Table 2
Gross Output

Gross Output		Scenario 1 Govt responsible for all emissions	Scenario 2 ETS $25/tonne. Free allocation to industry	Scenario 3 ETS $50/tonne. Free allocation to industry
Dairy processing		0.1%	0.1%	0.1%
Wood processing		0.2%	0.1%	0.2%
Pulp and paper products		0.3%	0.9%	1.9%
Oil refining and products		-0.1%	-3.7%	-6.8%
Chemicals - industrial		0.2%	0.3%	0.4%
Non-metallic mineral products		0.1%	-0.4%	-0.7%
Basic metals		0.4%	3.3%	6.3%
Electricity generation		0.0%	-2.7%	-5.1%

Scenario 3

As in Scenario 2 with the carbon price doubled to $50/tonne. This also doubles the value of free allocations.

The results confirm one's prior expectation that the higher the carbon price, the greater the welfare cost of meeting a given emissions obligation. Private consumption declines by 0.3% compared to 0.2% in Scenario 2. One might have expected a larger fall, but the negative effects of the higher carbon charge are cushioned by greater domestic abatement. Emissions of CO_2 fall by 10.1% compared to 5.9% in Scenario 2. Hence the cost of emission permits from offshore does not double, rising from $170m to $255m.

Note that a doubling of the carbon price delivers less than a doubling (70%) of the reduction in emissions, indicating a rising marginal cost of abatement.

The free allocations to selected industries are insufficient to offset the effects of the carbon price on other exporting industries, resulting in lower exports than in the BAU. Hence the adjustment on the external account is via lower imports and a small gain on the terms of trade. Imports fall by 0.4% relative to BAU, or double the fall in Scenario 2. Most of the fall is accounted for by lower imports of consumer goods and services.

While the drop in private consumption represents an unambiguous economic loss for New Zealand households, caused primarily by the real resource cost of purchasing emission permits from offshore, the rebalancing of government income improves the allocative efficiency of the economy – enough to prevent GDP measured in world prices from falling, but not enough to prevent private consumption from falling.

Part 2. Beyond Kyoto CP1 - 2025

Following the procedure for 2011/12, we prepare a BAU scenario for 2024/25 which acts as a benchmark against which other scenarios can be compared. The same macroeconomic closure rules are adopted. We continue with the previous scenario numbering.

- **Scenario 4** – Replication of Scenario 1 extended to 2025.
- **Scenario 5** – Analogous to Scenario 2, but with methane and nitrous oxides emissions included. No free allocation.
- **Scenario 6** – As in Scenario 5 with the carbon price at $100/tonne.

Three sensitivity tests are examined in Part 3:

- **Scenario 7** – As in Scenario 6 with a lower international allowance with regard to New Zealand's emissions.
- **Scenario 8** – As in Scenario 6 with a absorption of the carbon price by emissions intensive exporters.
- **Scenario 9** – As in Scenario 6 with international trade prices reflecting international action to reduce GH emissions.

Note that emissions of methane and nitrous oxide are treated as process emissions, implying that reductions in output are the only way to reduce such emissions. Therefore, to the extent that technological change induced by the ETS could reduce emissions, the model's results will overestimate costs.

Scenario 4

Government purchases emissions units from offshore, financed by higher personal income tax. The amount involved is $1540m per annum (emissions of 111.6 Mt CO_2e[3] less an assumed 50 Mt of international allowances[4], at $25/tonne).

---

[3] The model's projection of emissions in 2024/25 without a price on carbon are about 10% above MfE gross projections, (due primarily to faster growth in emissions from agriculture and transport), but below MFEs net emissions. Regardless, given the uncertainties in these projections, the models emission projection represents one of the many plausible/sensible projections that could be used.

[4] The level of allowances that NZ will receive under international agreements is subject to the outcome of future international negotiations. For modelling purposes, this scenario assumes a level that would be broadly consistent with a path that reduces emissions by 50% of 1990 levels by 2050.

Table 3 shows the results. Not surprisingly, with the greater flow of funds offshore the fall in private consumption is much larger than in Scenario 1; 1% compared to 0.2%. The adjustment on the current account is primarily on the export side; exports increase by 1.3% and imports decline by 0.6%, following a 0.8% decline in the real exchange rate to boost competitiveness. The terms of trade fall by 0.6%.

Emissions increase slightly (0.3%) on BAU because of the expansion in exporting industries, which tend to be more carbon intensive than those that sell predominantly to households.

Scenario 5

Uniform carbon charge of $25/tonne on all emissions including methane and nitrous oxide. No free allocation or other concessions.

The carbon price reduces CO_2e emissions by 4.0% or 4.7 Mt, comprising a 5.3% fall in CO_2 emissions and a 3.0% fall in CH_4 and N_20 emissions. Thus the cost of units to be bought offshore is lower at about $1400m.

Private consumption declines by 0.7%, notably less than the fall observed in Scenario 4. This outcome contrasts with the 2012 scenarios (Scenarios 1 and 2) where the imposition of a carbon price does not alleviate the reduction in private consumption, although it does affect international purchasing power.

The difference in Scenario 5 of course, is that the carbon price is more widely applied, generating more revenue for government and thus lowering the pressure on income taxes. Indeed incomes tax rates decline by 2.3%. That this does not moderate the fall in private consumption even more is because of the reduction in real wage rates (0.7%) following the rise in prices caused by the carbon price.

Scenario 6

As in Scenario 6 with a carbon price of $100/tonne.

At a price of $100/tonne the cost of purchasing emission permits on the world market is approximately $4700m per annum. It would be considerably more were it not for the larger reduction in emissions, which fall by 13%.

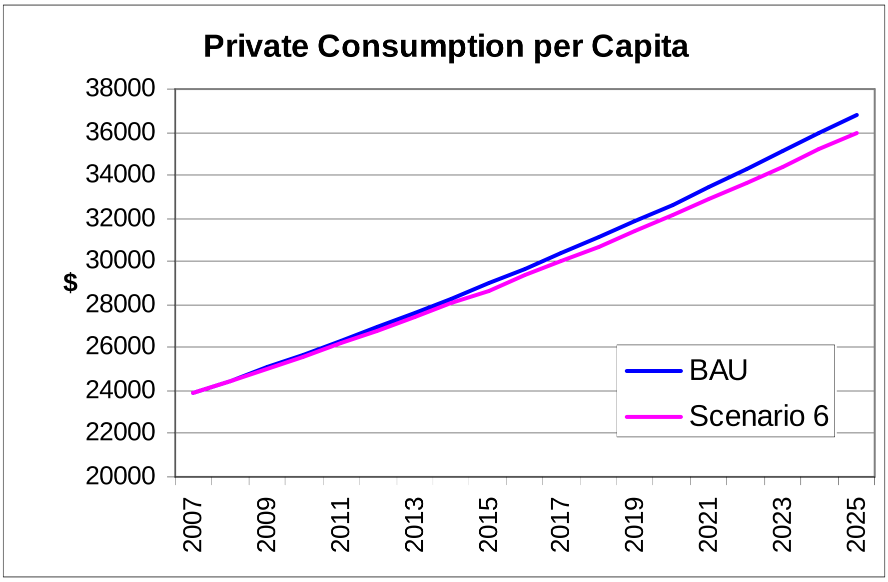
Real private consumption falls by 2.2%, in spite of a significant income tax reduction. At current prices, but allowing for the projected growth in real income between now and 2025, this corresponds to about $800 per person in 2025. The absolute increase in private consumption per capita over the period is projected to be about $12,100, in comparison to the BAU absolute increment of $12,900. In terms of growth rates the figures are 2.4% pa in the BAU and 2.3% pa in Scenario 6. This is shown in the following graph.

Table 3
Macroeconomic Results

	BAU	Scenario 4 Govt responsible for all emissions. 50 Mt International allowance	Scenario 5 ETS $25/tonne. No free allocation. 50 Mt International allowance	Scenario 6 ETS $100/tonne. No free allocation. 50 Mt International allowance	Scenario 7 As in 6 with 30 Mt International allowance	Scenario 8 As in 6 with lower profit	Scenario 9 As in 6 with higher world prices
Emission units required to be purchased off shore (p.a)		61.6Mt	57.0Mt	46.9Mt	66.8Mt	47.6Mt	50.9Mt
Private Consumption		-1.0%	-0.7%	-2.2%	-3.5%	-2.2%	-1.4%
Exports		1.3%	0.1%	0.1%	1.8%	0.1%	0.1%
Imports		-0.6%	-0.8%	-2.8%	-3.5%	-2.8%	-1.7%
GDP in world prices		-0.7%	-0.4%	-1.5%	-2.3%	-1.4%	-0.1%
Real wage rate		0.2%	-0.7%	-2.7%	-2.4%	-2.6%	-2.5%
Mean household tax rate		3.7%	-2.3%	-9.6%	-4.7%	-9.3%	-10.5%
Real exchange rate		-0.8%	-0.4%	-1.3%	-2.3%	-1.3%	0.1%
Terms of Trade		-0.6%	0.3%	1.3%	0.5%	1.3%	2.6%
CO_2 emissions (Gg)	52368	0.2%	-5.3%	-16.4%	-16.3%	-14.6%	-15.4%
Agriculture CH_3 & N_2O	63513	0.4%	-3.0%	-10.9%	-10.5%	-11.0%	-5.2%
	115881	0.3%	-4.0%	-13.4%	-13.1%	-12.6%	-9.8%
International transport	4299	1.6%	-5.5%	-18.1%	-16.4%	-13.5%	-16.0%
Emissions by NZ	111582	0.3%	-4.0%	-13.2%	-13.0%	-12.6%	-9.6%

Table 4
Gross Output

Gross Output	BAU	Scenario 4 Govt responsible for all emissions. 50 Mt International allowance	Scenario 5 ETS $25/tonne. No free allocation. 50 Mt International allowance	Scenario 6 ETS $100/tonne. No free allocation. 50 Mt International allowance	Scenario 7 As in 6 with 30 Mt International allowance	Scenario 8 As in 6 with lower profit	Scenario 9 As in 6 with higher world prices
Meat processing		0.6%	-3.9%	-14.1%	-13.6%	-14.2%	-4.9%
Dairy processing		0.4%	-2.2%	-8.4%	-8.0%	-8.5%	-2.6%
Wood processing		0.9%	0.8%	2.6%	3.8%	2.5%	0.6%
Pulp and paper products		1.0%	0.7%	2.4%	3.8%	2.2%	0.0%
Oil refining and products		-0.4%	-3.6%	-11.7%	-12.1%	-10.5%	-11.3%
Chemicals - industrial		0.8%	-0.2%	-1.1%	-0.1%	-1.2%	-2.1%
Non-metallic mineral prod.		0.3%	-0.6%	-2.4%	-1.9%	-0.7%	-1.9%
Basic metals		1.4%	-1.8%	-7.5%	-5.7%	1.8%	-4.7%
Electricity generation		-0.2%	-2.8%	-9.4%	-9.4%	-8.9%	-9.0%



Although the real exchange rate declines, it is not enough to counter the effect of the carbon price on export competitiveness. Hence the adjustment in the external balance is once again dominated by a reduction in imports.

With the carbon price extended to agricultural methane and nitrous oxide emissions, Meat Processing and Dairy Processing both see substantial falls in output relative to BAU. Relative to 2006/07 though, the reductions in implied growth rates are about 0.8% and 0.5% per annum respectively. See Table 4.

Oil Refining output falls by 11.7% as the carbon price now applies to both oil combustion and to emissions released from refining itself. Similarly, with no free allocation Basic Metals output also declines. In contrast the Wood Processing and Pulp & Paper industries see an increase in output. For these industries, which are not particularly emissions intensive in comparison to say Dairy Processing and Basic Metals, the reduction in the real exchange rate outweighs the cost impact of the carbon price. Although not shown in the table, other industries that benefit from a carbon price, in the sense that their gross output is higher than under BAU are Fabricated Metal Products, Machinery & Appliances, Other Manufacturing, and non-traded industries such as Education.

Part 3. Sensitivity Tests

Scenario 7

As in Scenario 6 with an international allowance of 30 Mt[5] instead of 50 Mt of CO_2e

The difference of 20 Mt in allowances has a significant impact, with both welfare measures showing a marked decline. Private consumption falls by 3.5% compared to 2.2% in Scenario 6. Real GDP in world prices declines by 2.3% compared to 1.5% in Scenario 6.

Overall we infer that the number of emission units assigned to New Zealand is an important parameter in determining the costs to the country of participating in global agreements to reduce GHG emissions. (Note that this does not imply that New Zealand should not

[5] This would represent a path that would have emissions at 50% of 1990 levels by 2025.

participate in such agreements, as we have not considered the potential costs of non-participation such as being subjected to tariffs in export markets.)

Scenario 8

As in Scenario 6 with absorption of the carbon charge in profits by three emissions intensive industries exposed to international competition.

Previous scenarios have all been based on the standard competitive economic model where industries endeavour to pass cost increases onto domestic and foreign consumers, with the final incidence depending on elasticities of demand and supply, and general equilibrium effects. At the level of industry aggregation with which we are working, no demand elasticities are infinite and no product is a perfect substitute for any other product. Thus no industry disappears if a carbon charge is imposed, in the same way that no industry disappeared from New Zealand when industry-specific ACC levies were introduced. Of course some parts of some industries do close. Parts of the clothing industry could no longer compete when tariff protection was reduced, but other parts of the industry have prospered and now produce goods with much higher value-added.

A carbon price may reduce the production of milksolids (or more likely the rate of increase in the production of milksolids as some conversions become uneconomic), but the loss is likely to be manifested in less income from basic commodity exports than in less income from value-added exports. Higher domestic cement prices may encourage some importing of cement at the margin, but there are other aspects of the New Zealand product such as location, delivery times and certainty of supply which mean that not all buyers of cement will switch to importing if cement pries rise by 5%.

Another feature of the competitive model is that industries cannot earn super-normal profits, or indeed earn sub-normal profits. Thus an industry cannot absorb a carbon charge in the form of lower profits. In the long term this would cause the industry to contract, but in the short term an industry may well absorb some costs provided revenue covers variable costs.

We examine this situation in Scenario 8, where three industries; Oil Refining, Non-Metallic Mineral Products (cement) and Basic Metals (steel and aluminium) are assumed to be able to absorb the price of carbon in the form of a lower rate of return. In effect we tell the model that in the BAU the risk premiums for these industries were too high and would fall under a carbon price – a somewhat ironic simulation methodology. Note with regard to Oil Refining only the carbon price related to refining is absorbed, not the entire incremental charge at the pump. This preserves competitiveness with imported refined product.

As shown in Table 3 the only macroeconomic impact is a slightly lower fall in GDP measured at world prices; 1.4% compared to 1.5% in Scenario 6. This comes about because the real exchange rate does not need to fall as much to maintain balance of payments equilibrium (although the difference is less than 0.05%), as competitiveness in three key industries is maintained by absorption of the carbon price.[6]

As shown in Table 4, Oil Refining still incurs a substantial reduction in demand because of higher petrol and diesel prices faced by the consumer. Cement output still declines relative to BAU, but only by a third of the amount that occurs in Scenario 6. In contrast Basic Metals output rises above the BAU level. Quite a large proportion of its output is sold to other industries such as Fabricated Metal Products, which is more competitive in Scenario 9 (relative to BAU) because of the lower real exchange rate. Of course this effect occurs in Scenario 6 as well, but is swamped by the loss of competitiveness of Basic Metals.

[6] Price changes in Oil Refining, Non-Metallic Mineral Products (cement) and Basic Metals relative to BAU are -0.1%. 0.0% and 0.0% respectively.

The expansion of these emission-intensive industries relative to Scenario 6 means that the reduction in emissions in Scenario 8 is somewhat less than in Scenario 6; 12.6% compared to 13.2%. The better position of these industries comes partly at the expense of agriculture, emissions from which fall by fractionally more in Scenario 8.

Scenario 9

As in Scenario 6 with international trade prices reflecting international action to reduce GHG emissions.

The above scenarios are all based on the premise that countries that compete, or could potentially compete with New Zealand's exports on world markets do not impose some form of significant carbon pricing. Similarly for countries that compete with New Zealand goods on the domestic market. This placed some New Zealand firms at a disadvantage.

In this scenario we set competitors' prices for dairy products, meat products, base metals (aluminium and steel), oil products and cement to change by the same amount that the prices of goods from New Zealand industries change in Scenario 6. [7]

While the prevention of a decline in international competitiveness might be expected to increase total exports, in fact they are unchanged from Scenario 6. Exports of dairy and meat products certainly show a marked improvement on Scenario 6, but other exporters such as forestry processors perform worse than in Scenario 2. Tourism exports (not shown) rise by 3.4% in Scenario 6, but fall by 0.6% in Scenario 9. As in Scenario 8 with a fixed supply of factor inputs, the improved position of some industries comes at the expense of others.

Of course there is still a macroeconomic gain due to the lift of 2.6% in the terms of trade. Private consumption falls by 1.4% compared to 2.2% in Scenario 6. Gross domestic product measured in world prices is almost back to the BAU level. The relative welfare gain would have been somewhat greater were it not for the higher emissions in Scenario 9, necessitating another $400m of emission rights to be bought on the international market.

[7] To simplify the modelling, only sectors with particularly high emissions were included.