INFOMETRICS

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

report prepared for

Emissions Trading Group

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CONTENTS

Summary

This report draws together the results of general equilibrium modelling undertaken for the Emissions Trading Group since October 2007, previously described in a number of separate papers. The main conclusions from the research are as follows:

1. Projections of New Zealand's emissions during the first Commitment Period (CP1) imply that emission units will need to be purchased from offshore to cover about 9Mt of CO_2e per annum. At a price of say $25/tonne the implied annual cost is about $225m. Gross domestic product in 2012 is projected to exceed $200 billion, so the impact effect is around 0.1%.
2. At a carbon price of around $25/tonne there is no significant difference in terms of the impact on the standard of living, 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 (ETS). This applies even if major emitters that are exposed to international competition receive some free allocation and if agricultural emissions are exempt.
3. However, the higher the carbon price the greater the cost of free allocation in terms of both efficient emissions reduction and other uses of permit revenue such as income tax reductions.
4. By 2025, with a likely higher carbon price and a tighter international emissions obligation, the welfare cost will probably be an order of magnitude greater than during CP1. A range of scenarios suggests that the loss in private consumption in 2025 will be 1-4%, relative to 'Business as Usual' (BAU). However, by 2025 consumption per capita is projected to be nearly $13,000 higher than in 2005. In other words we will be slightly worse off relative to BAU, but New Zealand is still wealthier compared to 2005 in all scenarios.
5. The ETS does not cause the loss in economic welfare. Rather it is a way of addressing the cost of the Kyoto and future international commitments. By 2025, with a higher carbon price, the ETS is a more efficient way of doing this than having no domestic carbon price and the government purchasing from offshore whatever quantity of emissions rights are required, paid for by higher income taxes. Higher energy prices and lower taxes are better than higher taxes.
6. Important unknowns beyond CP1 are:
    - the size of New Zealand's international allocation
    - the carbon price
    - whether major trading competitors participate.
7. Technological change induced by a carbon price is important. Based on two plausible technologies for the reduction of methane and nitrous oxides in agriculture, every 5 Mt of emission units that do not have to be purchased offshore reduces the loss in private consumption by approximately 10%.
8. Most industries that are projected to have lower output under the ETS than under BAU are nonetheless still likely to grow between now and 2025. Examples are oil refining, electricity production, meat processing and dairy processing. The main exception to this is probably sheep farming.
9. During the transition to a carbon price and without allowing for any mitigating effects of free allocation, around 50,000 FTE jobs could be at short term risk as part of the

one-off economic adjustment cost. This number is small in relation to annual job turnover and in relation to the job losses that occurred during the period of tariff reform in the late 1980s and 1990s.

10. While in proportionate terms the biggest short term impacts occur in industries such as coal mining, oil and base metals, the largest absolute effects are in wholesale and retail trade, construction and business services. Welfare losses are caused less by diminished activity in carbon intensive industries, than by resources being moved out of private consumption and into exports.

Two conclusions from another Infometrics report are also worth mentioning:

11. The more stringent the environmental target (especially if this is higher than our international obligation), the less likely we are to achieve high economic growth rates.
12. Regulations and other measures outside the ETS have the potential to generate large welfare losses because of inconsistent abatement pricing and confusing price signals. The case for non-ETS measures needs to be based on clear demonstration of market failure.

The modelling implicitly assumes that any action or inaction by New Zealand has no effect on how the rest of the world treats New Zealand. For the BAU in particular this may not be a valid counterfactual. For example the EU could impose duties on our exports to Europe if it is perceived that New Zealand is not making an effort to reduce emissions.

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.

It is also assumed that New Zealand cannot pay for offshore emission units by borrowing; that is by running a larger current account deficit.

Part 1 of the paper describes the methodology. Part 2 explores a number of policy scenarios for CP1, while Part 3 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 4 looks briefly at the issue of transition or adjustment costs.

1. Methodology

We use a general equilibrium (GE) model to analyse various scenarios on how New Zealand might fulfil its international emission reduction obligations. A general equilibrium (GE) model is a set of equations that describe how the economy behaves, but some aspects of the economy are especially difficult to simulate. Examples include the government and the total level of investment. Hence in order to close the model – render it solvable – some extra assumptions are required.

A 'business as usual' (BAU) scenario is developed which represents a picture of the economy and emissions without any carbon charges or international emission obligations. 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.[1] 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, described in the following section. In all scenarios the following are held constant at whatever emerges under BAU:

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 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.

Taken together the closure rules as specified above enable us to analyse the effects of emissions mitigation measures on allocative efficiency, the terms of trade, the real exchange rate and so on, and through these variables the effect on welfare measures such as private consumption. If one wishes to claim that say, the total level of employment is indeed determined by the carbon price, then such a scenario can easily be examined as a sensitivity test by changing the labour market closure rule.

[1] The model's projections of the economy in 2011/12 or 2024/25 are similar to those produced by the MED in *New Zealand's Energy Outlook to 2030.* Without a price on carbon, emissions are about 10% above MED/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 model's emission projection represents one of the many plausible projections that could be used.

A Role for Judgement

None of the carbon price scenarios discussed in this report represent particularly large shocks. Even at $100/tonne, the cost of offshore emission units is only a few percent of GDP – not too different from the size of the recent increase in oil prices. Arguably though, for a very large shock or for a number of simultaneous and opaque shocks, some of the above closure assumptions could become unrealistic. To some extent this is a matter of timing – over a long enough period the economy will adjust to most shocks, but to dismiss prolonged periods of unemployment or low investment as merely adjustment costs is disingenuous and disdainful.

Thus the setting of macroeconomic closure rules involves a degree of judgement about what is appropriate in a given set of circumstances. That may be seen a methodological weakness of GE modelling, but it can also be a strength as models enable one to test the importance of closure (and other) assumptions.

Infometrics (2008)[2] illustrates this feature. That research sought to estimate the economic effects of a very high domestic (shadow) price of carbon as a proxy for a range of non-price regulatory interventions outside the ETS, such as the ban on new thermal base load electricity generation and the biofulels mandate.

One scenario adopted the standard set of macroeconomic closure assumptions as delineated above, while another scenario argued that the type and mix of abatement policies would lead to a lengthy period of uncertainty, lobbying, distorted investment, and slower economic growth. Neither scenario was a prediction. What they did was demonstrate that changing certain closure assumptions, notably those that are questionable under a policy mix of inconsistent carbon pricing, had dramatic results. Nevertheless it is still partly a judgement call as to whether that particular policy mix is consistent with that particular mix of closure assumptions. The value of the modelling is in assessing risks and pointing to where more debate and research is required.

The following model limitations should be noted:

- *Aggregation bias* – All industries in the model represent aggregations of companies, products and processes, but even with 49 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.

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[2] Infometrics (2008), *Carbon Mitigation Scenarios*, report to New Zealand Business Roundtable and the Petroleum Exploration and Production Association of New Zealand.

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.

2. 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.

As described above, a BAU scenario is 'shocked' with a number of scenarios:

- **Scenario 1** – An international carbon price of NZ$25/tonne[3] 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.

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.

In no scenarios do the declines in private consumption and gross domestic product relative to the BAU, imply declines relative to 2007/08.

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.

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[3] 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.

Either way the international purchasing power of New Zealand households falls. Measured in world prices GDP declines by 0.2% relative to BAU.

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 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).

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[4]		-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_4 & N_2O	43715	0.1%	0.0%	0.0%
Total (Gg)	81679	0.1%	-2.7%	-4.7%

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

[4] 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.

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)*

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 consider the welfare effects of recycling via free allocation against the option of recycling via lower income taxes.

Free Allocation

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.

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.

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.

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%

3. 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. (Emissions of methane and nitrous oxide are treated as process emissions, implying that without technological advances, reductions in output are the only way to reduce such emissions. See Scenarios 13 and 14 in this regard.)
- **Scenario 6** – As in Scenario 5 with the carbon price at $100/tonne.

Five sensitivity tests on Scenario 6 are then examined in Section 3.2:

- **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.
- **Scenario 13**[5] –as in Scenario 6 with reductions in methane emissions of 10% in dairy, beef and sheep farming, brought about by, for example, breeding for lower emissions.
- **Scenario 14** – as in Scenario 6 with reductions in nitrous oxide emissions of 11% in dairy farming, and 2% in sheep and beef farming, brought about by, for example, the use of nitrogen inhibitors.

3.1 Core Scenarios to 2025

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 less an assumed 50 Mt of international allowances[6], at $25/tonne).

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%

[5] Scenarios 10 and 11 deal with transition costs, presented in Section 4. There is no Scenario 12.

[6] 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.

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 graph below.

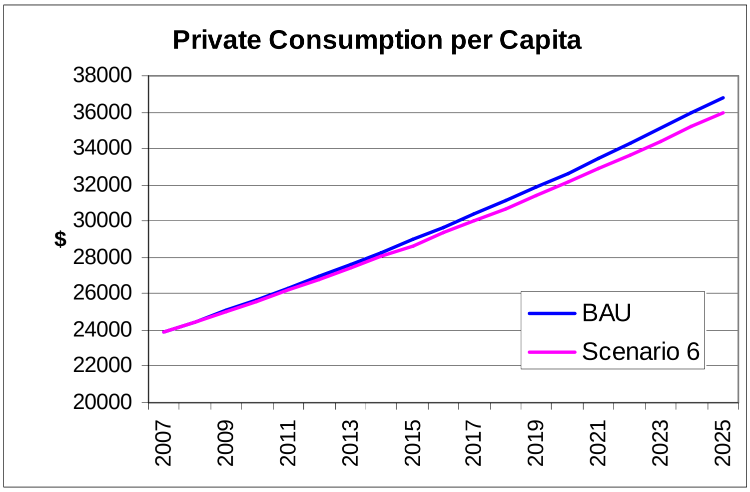


Table 3: Macroeconomic Results

	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_4 & 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%	-	-9.6%

						12.6%	

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.

3.2 Sensitivity Tests to 2025

Scenario 7

As in Scenario 6 with an international allowance of 30 Mt[7] *instead of 50 Mt of* CO_2*e.*

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 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

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

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.[8]

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.

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. [9]

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

[8] 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.
[9] To simplify the modelling, only sectors with particularly high emissions were included.

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.

Scenarios 13 and 14

- **Scenario 13** *–as in Scenario 6 with reductions in methane emissions of 10% in dairy, beef and sheep farming, brought about by, for example, breeding for lower emissions*.

- **Scenario 14** – *as in Scenario 6 with reductions in nitrous oxide emissions of 11% in dairy farming, and 2% in sheep and beef farming, brought about by, for example, the use of nitrogen inhibitors.*

As mentioned previously, while the model incorporates technological change, it does not respond to the carbon price. We simply do not know enough about how technology might develop in response to a carbon price to be able to specify a robust empirical relationship in the model. We can, however, analyse the effects of some specific estimates about such a relationship. In Scenarios 13 and 14 we explore the effects of two different types of technological change that could lower emissions of methane and nitrous oxides in farming, based on what the Ministry of Agriculture and Forestry consider to be plausible under a carbon price of $100 (or less) per tonne of CO_2.

The results are shown in Table 5.

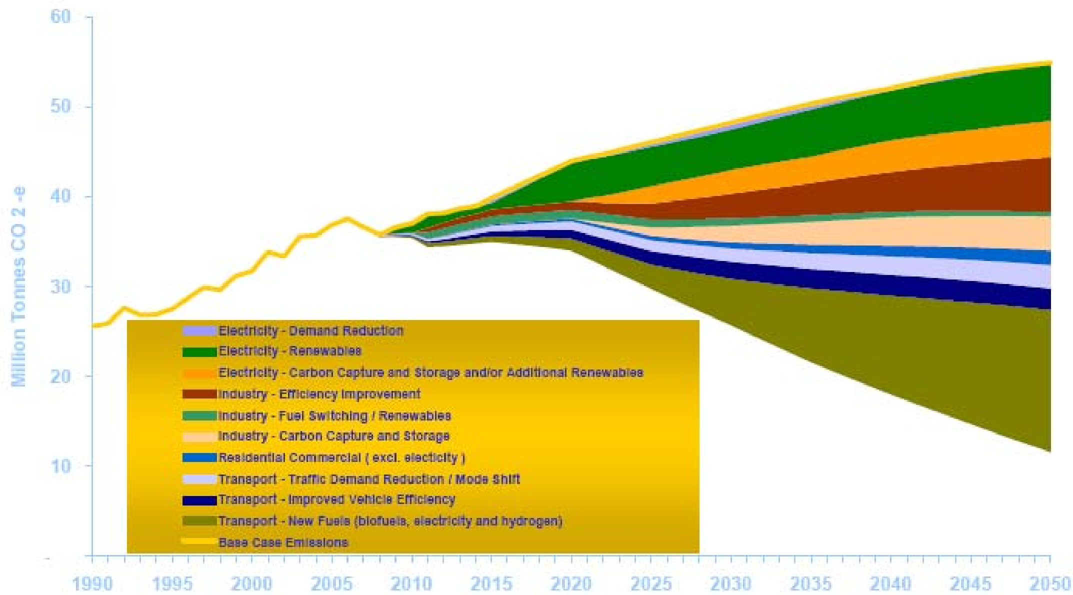
Table 5: Scenarios 13 and 14 Macroeconomic Results

	BAU	Scenario 6	Scenario 13	Scenario 14
		ETS	As in 6 with lower CH_4	As in 6 with lower N_2O
Emission units required to be purchased off shore (p.a)		46.8Mt	41.9Mt	44.0Mt
Private Consumption		-2.2%	-2.0%	-2.1%
Exports		0.1%	-0.1%	0.0%
Imports		-2.8%	-2.5%	-2.6%
GDP		-0.1%	-0.2%	-0.1%
GDP in world prices		-1.5%	-1.3%	-1.4%
Real wage rate		-2.7%	-2.6%	-2.6%
Mean household tax rate		-9.6%	-8.8%	-9.2%
Real exchange rate		-1.3%	-1.1%	-1.2%
Terms of Trade		1.3%	1.3%	1.3%
CO_2 emissions (Gg)	52368	-16.4%	-16.4%	-16.4%
Agriculture CH_4 & N_2O	63513	-10.9%	-18.6%	-15.4%
	115881	-13.4%	-17.6%	-15.9%
International transport	4299	-18.1%	-18.4%	-18.2%
Emissions by NZ	111582	-13.2%	-17.6%	-15.8%

In Scenario 6 the carbon price is estimated to reduce emissions of methane and nitrous oxide by nearly 11%, achieved almost exclusively by reductions in agricultural output. Incorporating two possible technological advances (breeding for lower methane emission and using nitrogen inhibitors) raises this figure to around 19% and 15% respectively. In absolute terms, improved breeding reduces emissions in 2025 by 4.9 Mt (CO_2e), with nitrogen inhibitors reducing emissions by 2.8 Mt.

These decrements translate directly into a reduction in the number of emissions units that New Zealand needs to purchase from offshore. In fact it is this effect that is the main driver of the impact on consumer welfare. In Scenario 6, the reduction in private consumption is 2.2% and emission units covering 46.8 Mt need to be bought offshore. The latter falls by 10.5% in Scenario 13 and by 6.0% in Scenario 14. It is not surprising therefore that the reductions in private consumption in Scenarios 13 and 14 are 2.0% and 2.1% respectively.

If the two possible technologies are approximately additive we would expect the decline in private consumption to soften to about 1.9%, from 2.2% in Scenario 6. One might conclude that the results are not sensitive to the types of technological advances that could occur in agriculture. For any single technology this will generally be true, but emissions reductions in the long term depend on securing successive 'wedges' of reductions as depicted in MED (2007).[10] Some wedges may be small, but can still contribute to a least cost emissions reduction programme.



3.3 The Cost of Abatement

Drawing together the main scenarios above into Table 6 shows that successively doubling the carbon price from $25 to $50 to $100 does not keep on doubling the reduction in emissions. Dividing the emissions reduction by the carbon price and normalising the ratio with respect to Scenario 5, reveals that the initial doubling of the carbon price produces 94.6% of the initial effect on emissions, while doubling it again produces 83.1% of the initial effect.

[10] MED (2007), *New Zealand Energy Strategy Low Carbon Energy Scenario.*

Table 6: Changes in Private Consumption & Emissions v Carbon Price

Scenario	Carbon Price	Private Consumption (% change)	Normalised Effect	CO_2 Emissions (% change)	Normalised Effect	GDP
4	0	-1.0		0.3		0.2
5	25	-0.7	1.000	-4.0	1.000	0.0
	50	-1.3	0.948	-7.5	0.946	0.0
6	100	-2.2	0.828	-13.2	0.831	-0.1
7	100	-3.5		-13.0		0.1
9	100	-1.4		-9.6		-0.2

The nonlinearity is perhaps not as marked as one would expect, a result of the model being based on smooth production functions.[11] However it is not inconceivable that the curvature of the abatement function could switch between concavity and convexity if certain carbon prices lead to break-through technological developments.

Scenario 4 aside, the loss in real private consumption rises in proportion to the change in emissions, not in proportion to the change in the carbon price. If the carbon price produced no reduction in emissions, the losses in private consumption would be greater. That reductions in emissions do occur means that the cost of purchasing emission units offshore does not rise fully in proportion to the carbon price. We may infer therefore that any technological improvements that reduce emissions and that cost less than the carbon price per tonne of emissions foregone (or captured) would have a directly proportional effect on private consumption. Scenarios 13 and 14 demonstrated such an effect.

Real gross domestic product changes little in these scenarios, a consequence of the macroeconomic closure assumptions. Scenario 4, where the government is responsible for all emissions sees a small rise in GDP because export industries are amongst the most productive in the economy. Unfortunately, the increased volume of exports requires a movement down the export demand curves. The associated lower returns cause the observed drop in private consumption. This scenario is allocatively inefficient.

In the graphs below the left most point in each represents Scenario 4 with no carbon price and the government responsible for all emissions. There is no reduction in emissions (a small rise in fact) and a larger loss in private in consumptions than under a $25/tonne price. This is directly attributable to the absence of a price signal – no carbon price means no incentive to reduce emissions, implying the need for more emission units to be purchased from offshore, and so more resources go into exporting at the expense of private consumption.

The red points (circles) represent Scenario 7 where New Zealand has a tighter emissions allowance. Private consumption is significantly lower, but there is little effect on gross emissions – a slightly smaller decline due to the increase in exports.

The green points (squares) represent Scenario 9 where New Zealand suffers no major loss of international competitiveness from subscribing to emissions abatement, as competitor countries adopt similar emission mitigation policies. There is a notable effect on private consumption and on emissions.

The graphs can be used to draw a number of inferences, as shown by the dotted lines. For instance:

[11] The production functions are continuous and differentiable.

1. Reducing New Zealand's international allowance by 20 Mt is equivalent to at least doubling the carbon price to $200/tonne as far as the effect on private consumption is concerned (refer Figure 1).

2. Achieving the same gross reduction in emissions that is obtained with a carbon price of $100 and no action by competitor countries, would require a price of at least $150 if competitor countries also introduce mitigation policies (refer Figure 2).

Figure 1: Private Consumption and the Carbon Price

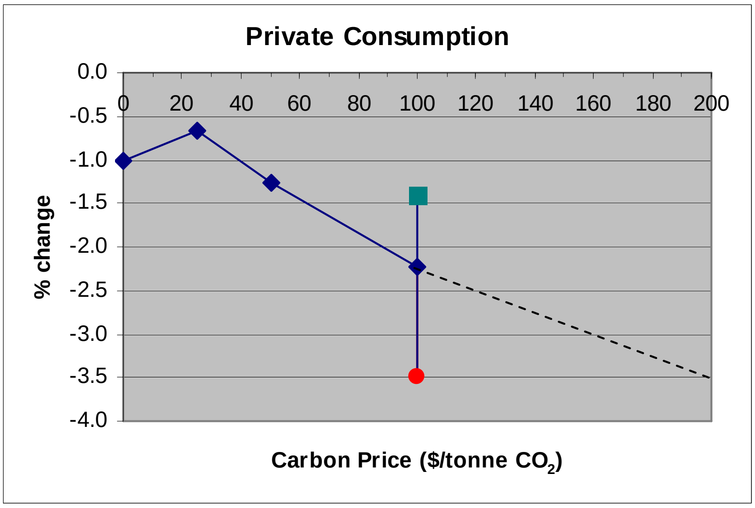
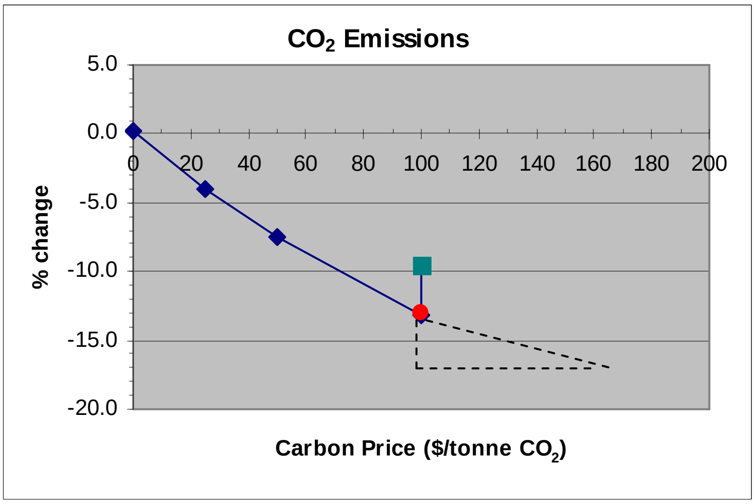


Figure 2: Emissions and the Carbon Price



4. A Stylised Look at Transition Costs Associated with the ETS

Our objective here is to examine the extent to which a general equilibrium approach can provide insights about the transition costs, particularly with respect to employment, that might arise as the economy adjusts to a carbon price.

Our point of comparison is the previous Scenario 5, specified as:

- *A price on carbon of $25/tonne CO_2 in an emissions trading scheme covering all emissions from all industries (including methane and nitrous oxides emissions from agriculture), with no free allocation of emissions rights.*

Here we examine two scenarios, Scenarios 10 and 11, that are analogously specified to Scenario 5 except that the previous factor market closure rules of fixed total employment and fixed total capital stock are relaxed. The real wage rate and the cost of capital are fixed at the BAU levels. Essentially this imposes greater price rigidity on the economy, forcing more of the adjustment to a carbon price onto the level of employment and aggregate investment. This is intended to be more representative of a short run situation.

In Scenario 10 the real exchange rate is free to vary. With higher domestic prices caused by the ETS the real exchange rate can be expected to rise. In Scenario 11 the real exchange rate is prevented from appreciating by endogenising the balance of trade.

Note that neither Scenario 10 nor Scenario 11 allows the cost of the offshore emission units to be financed by borrowing and thus cause a deterioration in the current account.

> *It is stressed that these scenarios are intended to present a guide to the short term transition costs that might arise under the ETS – after relative industry competitiveness has been affected by the carbon price, but before resources have moved between industries. In this sense the scenario is a stylised representation of adjustment costs. It is certainly not intended to be an alternative picture of the economy in 2025 to that presented in Scenario 5.*[12]

Table 7 shows the macroeconomic results and Tables 8-10 show the changes in employment by industry and region.

Private consumption falls by 3.4% in Scenario 10, a direct result of the decline in industry competitiveness. Household tax rates increase in order to restore fiscal balance following the potential decline in tax revenue and increase in expenditure on unemployment benefits.

Higher domestic prices with an unchanged nominal exchange rate implies an increase in the real exchange rate. Once the nominal exchange rate falls, or alternatively domestic (factor) prices fall, the real exchange rate will decline and the macroeconomic picture will eventually look like Scenario 5.

[12] Ordinarily the 'putty-clay' model applies to investment. Capital stock (clay) in one industry cannot move into another industry, but replacement investment for depreciated capital must compete with all other new (putty) investment. For Scenarios 10 and 11 an additional constraint is imposed, namely that no industry can increase its capital stock above the BAU level by more than the implied increment in growth that occurs between 2007 and the 2012 BAU. This effectively tells the model that it can reallocate only 5 years worth of the type of investment that is currently expected, rather than 18 (from 2007 to 2025) years worth. Note that this is an imprecise calculation as no official capital stock data exists for 2007.

Table 7: Macroeconomic Results

	BAU	Scenario 5 ETS $25/tonne. No free allocation. 50 Mt International allowance	Scenario 10 As in 5 with fixed factor prices, endogenous real exchange rate	Scenario 11 As in 5 with fixed factor prices and fixed real exchange rate
Emission units required to be purchased off shore (p.a)		57.0Mt	54.5Mt	55.1Mt
Private Consumption		-0.7%	-3.4%	-4.7%
Exports		0.1%	-2.7%	-0.6%
Imports		-0.8%	-2.5%	-3.4%
GDP		-0.0%	-2.9%	-2.5%
GDP in world prices		-0.4%	-1.6%	-2.5%
Real wage rate		-0.7%	0.0%*	0.0%*
Mean household tax rate		-2.3%	7.2%	8.1%
Real exchange rate		-0.4%	1.4%	0.0%
Terms of Trade		0.3%	1.6%	0.6%
Employment		0.0%*	-2.6%	-2.3%
CO_2 emissions (Gg)	52368	-5.3%	-8.0%	-7.6%
Agriculture CH_4 & N_2O	63513	-3.0%	-5.1%	-4.4%
	115881	-4.0%	-6.4%	-5.8%
International transport	4299	-5.5%	-8.8%	-6.4%
Emissions by NZ	111582	-4.0%	-6.3%	-5.8%

* exogenous

Comparing Scenario 11 with Scenario 10, there is small lift in overall activity as measured by real GDP. Employment declines by 2.3% (46,700 FTE) compared to 2.6% in Scenario 10.

However, when GDP is expressed in world prices it falls by more than in Scenario 10. The lower exchange rate, while boosting exports (0.6% lower than BAU compared to 2.7% in Scenario 10), does so by reducing the international purchasing power of the New Zealand dollar. The volume of goods and services produced in New Zealand rises, but the value of those goods and services expressed in world prices falls. Private consumption falls by 4.7% in Scenario 11 compared to 3.4% in Scenario 10.

As noted in the previous chapter, the 'Kyoto shock' of purchasing emission units offshore leads to a reduction in economic welfare. This reduction is worse if factor prices are inflexible as with a fixed nominal exchange rate the real exchange rate appreciates (Scenario 10). Letting the nominal exchange rate fall in order to prevent the real exchange rate from appreciating (Scenario 11) helps the export sector and GDP (a little), but at the cost of lower private consumption. If consumption is the preferred welfare metric, there is no benefit in having a flexible nominal exchange rate as long as factor prices, and real wage rates in particular, are inflexible.

In other words, while there is no escaping the welfare loss caused by having to buy emission rights on the world market, the cost can be minimised by allowing relative prices to adjust and by resources being able to readily move between industries according to the new profile of relative competitiveness – favouring less carbon intensive industries. Rigid factor prices prevents this adjustment and thus worsens the welfare cost.

In Scenario 10 the fall in employment of 2.6% represents about 52,000 FTE, with about 46,700 FTE in Scenario 11. These figures should be seen as a guide to the temporary loss of employment that could occur during the transition phase. Table 8 shows the distribution of the change in employment by industry, comparing Scenarios 5, 10 and 11 with the BAU. For example, in Scenario 5 employment in Horticulture is 0.2% or 40 FTE below the BAU figure, but Scenario 10 indicates that in the short term employment in Horticulture could fall by as much as 4.1% or 1040 FTE. In Scenario 11 the fall is less than half that amount.

In scenario 10 the industries that face the greatest percentage decreases in employment are coal mining (9.2%); oil and gas extraction and exploration (8.3%); basic metal manufacturing (6.5%) and petroleum (6.1%). In absolute terms the greatest decreases in employment are in wholesale and retail trade (11,240); legal, accounting and other business services (3,490); personal and other services, waste disposal and sewerage (2,790); and accommodation, cafes and restaurants (2,140).

Simply pro-rating the industry changes in employment (in Scenario 10) across regions based on the current region by industry composition of employment (Table 9), reveals that the largest absolute falls are in Auckland City (8,405), Christchurch City (4,873), Manukau City (3,433) and Wellington City (3,028), but the largest percentage reductions are in Waimate and Southland, both at -1%.

It is useful to put these employment effects into perspective. Table 10 shows that the changes estimated in Scenario 10, expressed relative to actual regional employment for the year ended 2006 (not relative to BAU), are generally much smaller than occurred historically, especially between 1986 and 1991.

A 2003 report on the effects of import tariff reform[13] found that while there were noticeable impacts on certain industries (footwear and clothing) there was little evidence of a consistent relationship between tariff changes and changes in industry employment. Essentially the employment effects of tariff reform could not be distinguished from other factors that simultaneously affected employment at the time, such as the terms of trade and monetary policy. Nevertheless the data also suggested that a few industries and/or communities could be adversely affected with the tariff changes then projected.

Carrol et al (2002)[14] found that on average over the 1994-2001 period around 285,000 (18%) jobs are created and 249,000 (15%) jobs destroyed in the New Zealand labour market each year, although these numbers may be biased upwards by changes in company ownership and mergers.

[13] Infometrics (2003), *Review of Import Tariffs beyond 2005*, report to Ministry of Economic Development.

[14] Carroll, N; Hyslop, D; Maré, D; Timmins, J; and Wood, J. (2002), *The Turbulent Labour Market*.

Table 8: Changes in Industry Employment

	Scenario 5		Scenario 10		Scenario 11	
	No.	%	No.	%	No.	%
HFRG	-40	-0.2%	-1040	-4.1%	-510	-2.0%
MLVC	-140	-2.1%	-360	-5.5%	-270	-4.1%
SHBF	-720	-2.4%	-1460	-4.8%	-1260	-4.1%
DAIF	-900	-2.2%	-1690	-4.1%	-1430	-3.5%
OAGR	-470	-1.8%	-1270	-4.9%	-1000	-3.9%
LOGG	90	0.8%	-320	-2.9%	-160	-1.5%
FISH	0	0.0%	-110	-3.7%	-80	-2.7%
COAL	-60	-5.5%	-100	-9.2%	-80	-7.3%
OILG	-10	-4.2%	-20	-8.3%	-10	-4.2%
OMIN	-20	-1.0%	-100	-5.1%	-70	-3.5%
MEAT	-180	-1.3%	-520	-3.7%	-400	-2.8%
DAIR	-20	-0.2%	-190	-2.2%	-130	-1.5%
OFOD	-30	-0.1%	-910	-3.6%	-680	-2.7%
TEXT	-210	-2.7%	-520	-6.7%	-400	-5.2%
CLTH	40	0.4%	-340	-3.6%	-190	-2.0%
FOOT	30	2.7%	-20	-1.8%	0	0.0%
LEAT	-110	-4.4%	-190	-7.6%	-140	-5.6%
WOOD	300	1.0%	-710	-2.4%	-320	-1.1%
PAPR	70	1.1%	-220	-3.3%	-110	-1.7%
PPRM	120	0.5%	-840	-3.4%	-600	-2.5%
PETR	-50	-3.4%	-90	-6.1%	-100	-6.8%
CHEM	10	0.1%	-320	-3.5%	-190	-2.1%
RBPL	40	0.5%	-270	-3.2%	-150	-1.8%
NMMP	-20	-0.3%	-290	-3.8%	-250	-3.3%
BASM	-110	-2.0%	-360	-6.5%	-220	-4.0%
FABM	140	0.9%	-640	-4.0%	-310	-2.0%
MACH	720	1.4%	-1280	-2.5%	-440	-0.9%
OMFG	210	1.1%	-490	-2.5%	-240	-1.2%
EGEN	-60	-2.8%	-110	-5.2%	-100	-4.7%
EDIS	-90	-0.8%	-370	-3.2%	-350	-3.0%
GASS	-20	-1.8%	-50	-4.4%	-40	-3.5%
WATS	-10	-0.3%	-110	-3.5%	-120	-3.8%
BLDG	190	0.1%	-4880	-2.6%	-5580	-3.0%
TRDE	-450	-0.1%	-11240	-3.0%	-10970	-2.9%
ACCR	400	0.5%	-2140	-2.5%	-1410	-1.7%
ROAD	-150	-0.3%	-1490	-3.3%	-1330	-2.9%
WRAI	40	0.4%	-300	-2.9%	-190	-1.8%
AIRS	500	1.2%	-1210	-2.8%	-390	-0.9%
COMM	-20	-0.2%	-360	-2.8%	-330	-2.5%
FIIN	-150	-0.2%	-2160	-3.4%	-2380	-3.8%
OPRS	-10	0.0%	-1540	-3.1%	-1570	-3.2%
SCIT	-10	0.0%	-640	-2.6%	-560	-2.3%
COMP	0	0.0%	-330	-2.8%	-310	-2.7%
LAOB	280	0.2%	-3490	-3.1%	-2770	-2.4%
GOVD	-40	0.0%	-380	-0.3%	-530	-0.4%
SCHL	580	0.4%	-1060	-0.8%	-1030	-0.7%
OEDU	310	0.7%	-290	-0.7%	-140	-0.3%
HOSP	0	0.0%	-810	-1.0%	-1310	-1.6%
OHLT	-10	0.0%	-500	-1.1%	-680	-1.5%
MPRT	60	0.1%	-1410	-3.0%	-1440	-3.1%
PERS	-130	-0.1%	-2790	-2.9%	-3410	-3.5%
TOTAL	-120	0.0%	-52350	-2.6%	-46700	-2.3%

Table 9: Employment Changes by Region (Scenario 10 v Scenario 5)

			Scenario 10		Scenario 5	
			No.	% of yr to Sep-06	No.	% of yr to Sep-06
01	Northland	Far North	-555	-2.6%	-19	-0.1%
		Kaipara	-203	-3.2%	-33	-0.5%
		Whangarei	-872	-2.6%	-18	-0.1%
01 Total			-1630	-2.7%	-70	-0.1%
02	Auckland	Auckland City	-8421	-2.4%	383	0.1%
		Franklin	-578	-3.1%	-48	-0.3%
		Manukau City	-3423	-2.6%	311	0.2%
		North Shore City	-2221	-2.4%	97	0.1%
		Papakura	-491	-2.6%	22	0.1%
		Rodney	-654	-2.6%	13	0.1%
		Waitakere City	-1276	-2.5%	55	0.1%
02 Total			-17064	-2.5%	834	0.1%
03	Waikato	Hamilton City	-1892	-2.3%	87	0.1%
		Hauraki	-165	-3.0%	-25	-0.4%
		Matamata-Piako	-450	-3.1%	-83	-0.6%
		Otorohanga	-142	-3.3%	-37	-0.9%
		South Waikato	-310	-3.1%	-2	0.0%
		Taupo	-460	-2.8%	-11	-0.1%
		Thames-Coromandel	-296	-2.7%	-2	0.0%
		Waikato	-485	-3.4%	-102	-0.7%
		Waipa	-523	-2.9%	-50	-0.3%
		Waitomo	-174	-3.2%	-39	-0.7%
03 Total			-4897	-2.7%	-263	-0.1%
04	Bay of Plenty	Kawerau	-102	-3.0%	26	0.7%
		Opotiki	-94	-2.9%	-14	-0.4%
		Rotorua	-874	-2.5%	17	0.0%
		Tauranga City	-1320	-2.5%	41	0.1%
		Western Bay of Plenty	-436	-3.2%	-62	-0.4%
		Whakatane	-340	-2.6%	-19	-0.1%
04 Total			-3165	-2.6%	-11	0.0%
05	Gisborne	Gisborne	-539	-2.7%	-34	-0.2%
05 Total			-539	-2.7%	-34	-0.2%
06	Hawke's Bay	Central Hawke's Bay	-187	-3.1%	-47	-0.8%
		Hastings	-988	-2.7%	-49	-0.1%
		Napier City	-659	-2.5%	28	0.1%
		Wairoa	-96	-2.8%	-21	-0.6%
06 Total			-1930	-2.6%	-89	-0.1%
07	Taranaki	New Plymouth	-885	-2.5%	-17	0.0%
		South Taranaki	-392	-3.0%	-86	-0.7%
		Stratford	-101	-3.1%	-19	-0.6%
07 Total			-1378	-2.7%	-122	-0.2%
08	Manawatu-Wanganui	Horowhenua	-301	-3.0%	-26	-0.3%
		Manawatu	-251	-2.8%	-34	-0.4%
		Palmerston North City	-1060	-2.1%	55	0.1%
		Rangitikei	-216	-3.3%	-50	-0.8%
		Ruapehu	-189	-2.8%	-27	-0.4%
		Tararua	-264	-3.4%	-68	-0.9%
		Wanganui	-471	-2.5%	-14	-0.1%

08 Total			-2752	-2.5%	-163	-0.1%
09	Wellington	Carterton	-90	-3.2%	-6	-0.2%
		Kapiti Coast	-309	-2.4%	10	0.1%
		Lower Hutt City	-1198	-2.5%	45	0.1%
		Masterton	-277	-2.5%	-13	-0.1%
		Porirua City	-336	-2.1%	21	0.1%
		South Wairarapa	-112	-3.4%	-21	-0.6%
		Upper Hutt City	-263	-2.2%	16	0.1%
		Wellington City	-3015	-2.1%	89	0.1%
09 Total			-5600	-2.2%	141	0.1%
12	West Coast	Buller	-131	-3.4%	-26	-0.7%
		Grey	-200	-2.7%	-12	-0.2%
		Westland	-104	-2.7%	-3	-0.1%
12 Total			-435	-2.9%	-41	-0.3%
13	Canterbury	Ashburton	-510	-3.4%	-96	-0.6%
		Banks Peninsula	-85	-2.9%	3	0.1%
		Chatham Islands	-12	-3.3%	-1	-0.4%
		Christchurch City	-4881	-2.4%	245	0.1%
		Hurunui	-154	-3.6%	-38	-0.9%
		Kaikoura	-53	-2.9%	-5	-0.3%
		Mackenzie	-64	-3.3%	-11	-0.5%
		Selwyn	-351	-2.8%	-64	-0.5%
		Timaru	-584	-2.7%	-41	-0.2%
		Waimakariri	-299	-2.8%	-7	-0.1%
		Waimate	-101	-3.9%	-26	-1.0%
13 Total			-7094	-2.6%	-41	0.0%
14	Otago	Central Otago	-280	-3.0%	-23	-0.3%
		Clutha	-270	-3.3%	-63	-0.8%
		Dunedin City	-1357	-2.3%	61	0.1%
		Queenstown-Lakes	-428	-2.6%	20	0.1%
		Waitaki	-250	-2.8%	-32	-0.4%
14 Total			-2586	-2.5%	-37	0.0%
15	Southland	Gore	-197	-2.9%	-36	-0.5%
		Invercargill City	-655	-2.5%	-7	0.0%
		Southland	-560	-3.6%	-161	-1.0%
15 Total			-1412	-2.9%	-204	-0.4%
16	Tasman	Tasman	-598	-3.0%	-13	-0.1%
16 Total			-598	-3.0%	-13	-0.1%
17	Nelson	Nelson City	-613	-2.3%	27	0.1%
17 Total			-613	-2.3%	27	0.1%
18	Marlborough	Marlborough	-636	-2.8%	-23	-0.1%
18 Total			-636	-2.8%	-23	-0.1%
Grand Total			**-52330**	**-2.5%**	**-110**	**0.0%**

Source: LEED and Business Demography

Table 10: Employment Changes by Region (Scenario 10 v Historical)

Territorial Local Authority (TLA) area	Weekly Hours Worked 86-91	91-96	96-01	Employment Scenario 10
	% change over 5 years			% on Sep 06
Far North District	-15.1%	17.3%	6.6%	-2.6%
Whangarei District	-21.4%	13.4%	5.0%	-2.6%
Kaipara District	-16.4%	9.9%	4.2%	-3.2%
Rodney District	10.8%	31.8%	15.1%	-2.6%
North Shore City	-0.4%	16.5%	7.4%	-2.4%
Waitakere City	-2.1%	18.3%	6.7%	-2.5%
Auckland City	-7.5%	20.8%	10.0%	-2.4%
Manukau City	-8.4%	19.0%	10.7%	-2.6%
Papakura District	-3.2%	12.7%	2.9%	-2.6%
Franklin District	5.9%	19.6%	8.9%	-3.1%
Thames-Coromandel District	1.0%	20.1%	9.4%	-2.7%
Hauraki District	-9.7%	5.3%	2.4%	-3.0%
Waikato District	-11.2%	10.4%	7.6%	-3.4%
Matamata-Piako District	-7.6%	5.0%	-1.4%	-3.1%
Hamilton City	-5.1%	14.5%	6.9%	-2.3%
Waipa District	-2.6%	14.1%	7.7%	-2.9%
Otorohanga District	-10.3%	11.9%	-2.3%	-3.3%
South Waikato District	-20.2%	-7.9%	-1.1%	-3.1%
Waitomo District	-15.8%	7.3%	5.9%	-3.2%
Taupo District	-6.4%	16.2%	5.3%	-2.8%
Western Bay Of Plenty District	0.0%	21.6%	12.7%	-3.2%
Tauranga District	-2.2%	24.4%	19.3%	-2.5%
Rotorua District	-13.3%	14.4%	0.7%	-2.5%
Whakatane District	-12.9%	8.1%	4.5%	-2.6%
Kawerau District	-20.6%	-10.8%	-16.9%	-3.0%
Opotiki District	-18.2%	10.9%	6.7%	-2.9%
Gisborne District	-20.7%	10.4%	1.4%	-2.7%
Wairoa District	-18.5%	3.3%	-0.7%	-2.8%
Hastings District	-8.0%	11.2%	3.9%	-2.7%
Napier City	-13.2%	14.0%	4.3%	-2.5%
Central Hawke's Bay District	-9.0%	16.7%	6.2%	-3.1%
New Plymouth District	-12.4%	6.3%	-2.7%	-2.5%
Stratford District	-18.1%	6.2%	0.8%	-3.1%
South Taranaki District	-14.0%	4.0%	0.1%	-3.0%
Ruapehu District	-23.1%	4.8%	-12.8%	-2.8%
Wanganui District	-13.6%	5.7%	2.3%	-2.5%
Rangitikei District	-15.4%	5.9%	-4.7%	-3.3%
Manawatu District	-1.7%	8.4%	2.0%	-2.8%
Palmerston North City	-5.0%	10.5%	1.1%	-2.1%
Tararua District	-9.6%	2.7%	-0.5%	-3.4%
Horowhenua District	-10.5%	4.1%	2.2%	-3.0%
Kapiti Coast District	10.8%	12.2%	15.4%	-2.4%
Porirua City	-10.9%	1.7%	10.4%	-2.1%
Upper Hutt City	-7.1%	-0.6%	1.7%	-2.2%
Lower Hutt City	-9.9%	4.0%	2.7%	-2.5%
Wellington City	-5.3%	9.8%	5.9%	-2.1%
Masterton District	-11.3%	9.5%	4.6%	-2.5%
Carterton District	-7.1%	5.5%	11.8%	-3.2%
South Wairarapa District	-7.3%	1.6%	12.0%	-3.4%
Tasman District	-2.0%	21.0%	11.3%	-3.0%
Nelson City	-5.5%	19.4%	4.2%	-2.3%
Marlborough District	-0.4%	21.3%	8.1%	-2.8%

Kaikoura District	-13.3%	22.8%	8.3%	-2.9%
Buller District	-15.4%	7.3%	-3.1%	-3.4%
Grey District	-17.2%	10.8%	2.0%	-2.7%
Westland District	-8.7%	9.8%	0.3%	-2.7%
Hurunui District	-4.3%	14.8%	11.1%	-3.6%
Waimakariri District	11.0%	27.5%	16.2%	-2.8%
Christchurch City	-7.0%	15.6%	5.6%	-2.4%
Banks Peninsula District	-7.9%	18.2%	9.0%	-2.9%
Selwyn District	2.9%	16.3%	21.2%	-2.8%
Ashburton District	-6.4%	15.1%	8.5%	-3.4%
Timaru District	-12.4%	12.1%	3.0%	-2.7%
Mackenzie District	-18.9%	26.9%	-1.3%	-3.3%
Waimate District	-10.7%	11.7%	1.0%	-3.9%
Chatham Islands District	-23.2%	3.2%	1.9%	-3.3%
Waitaki District	-8.5%	8.4%	-2.4%	-2.8%
Central Otago District	-13.7%	6.0%	3.3%	-3.0%
Queenstown-Lakes District	10.6%	63.6%	19.5%	-2.6%
Dunedin City	-10.7%	9.9%	1.0%	-2.3%
Clutha District	-10.2%	6.7%	5.9%	-3.3%
Southland District	-10.5%	8.6%	3.9%	-3.6%
Gore District	-9.4%	10.0%	1.4%	-2.9%
Invercargill City	-13.1%	6.1%	-5.3%	-2.5%
NEC				
Total, New Zealand	-7.6%	13.9%	6.2%	-2.5%

Appendix A
Industry Definitions

		Industry
1	HFRG	Horticulture and fruit growing
2	MLVC	Mixed livestock and cropping
3	SHBF	Sheep and beef cattle farming
4	DAIF	Dairy cattle farming
5	OAGR	Other farming and services to agr, hunting & trapping
6	LOGG	Forestry & logging
7	FISH	Commercial fishing
8	COAL	Coal mining
9	OILG	Oil & gas extraction and exploration
10	OMIN	Other mining & quarrying and services to mining
11	MEAT	Meat processing
12	DAIR	Dairy product manufacturing
13	OFOD	Other food processing & mfg
14	TCFL	Textiles, clothing, footwear & leather mfg
15	WOOD	Log sawmilling, timber dressing & oth wood product mfg
16	PAPR	Paper and paper product mfg
17	PPRM	Printing, publishing & recorded media
18	PETR	Petroleum
19	CHEM	Chemical and chemical product mfg
20	RBPL	Rubber and plastic product mfg
21	NMMP	Non-metallic mineral product mfg
22	BASM	Basic metal manufacturing
23	FABM	Structural, sheet and fab metal prod mfg
24	MACH	Machinery and equipment mfg
25	OMFG	Other manufacturing
26	EGEN	Electricity generation
27	EDIS	Electricity transmission & supply
28	GASS	Gas supply
29	WATS	Water supply
30	BLDG	Construction
31	TRDE	Wholesale & retail trade
32	ACCR	Accommodation, cafes & restaurants
33	ROAD	Road transport
34	WRAI	Water and rail transport
35	AIRS	Air transport, services to transport, storage
36	COMM	Communication services
37	FIIN	Finance and Insurance
38	OWND	Ownership of owner-occupied dwellings
39	OPRS	Other property services
40	SCIT	Scientific research & technical services
41	COMP	Computer services
42	LAOB	Legal, accounting & other business services
43	GOVD	Govt administration & defence
44	SCHL	Pre-school, primary, secondary & other education
45	OEDU	Post-school education
46	HOSP	Hospitals, nursing homes, aged accom & other comm care
47	OHLT	Medical, dental and other health services
48	MPRT	Cultural and recreational services
49	PERS	Personal and other services, waste disposal & sewerage svs