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Macroeconomic impacts of climate change policy

Impact of Assigned Amount Units and International Trading

Final Report to the Ministry for the Environment

22 July 2009

Preface

This report has been prepared jointly by NZIER and Infometrics.

NZIER is an independent specialist consulting firm, established in 1958, that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield. NZIER is also known for its long-established Quarterly Survey of Business Opinion and Quarterly Predictions. It prides itself on its reputation for independence and delivering quality analysis in the right form, and at the right time, for its clients.

Infometrics Ltd is a privately owned and operated company. It offers a range of economic consulting and forecasting services on commercial terms to companies, business organisations and government departments. Since being founded in 1983 the company has built a reputation for rigorous and independent work, delivered on time and within budget.

Authorship

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Key points

Background

- The United Nations will meet in Copenhagen in December 2009 to negotiate global climate change policy. Uncertainty surrounds whether there will be an international agreement, and if so, the size of New Zealand's allocation of Assigned Amount Units (AAUs).
- If an international agreement similar to the Kyoto Protocol is achieved, New Zealand will be responsible for all emissions above its AAU allocation. This means New Zealand must reduce domestic emissions to AAU levels or purchase extra emissions units from other countries, or a combination of the two.
- So the target that New Zealand would seek to commit to could be met through a combination of domestic reductions, including through forestry offsets,[1] and the purchase of offshore permits.
- **With international trading, New Zealand's AAU allowance (and any emissions target that New Zealand might negotiate) is therefore <u>not</u> analogous to a domestic emissions target.**
- The AAU allowance simply determines the extent of our offshore liability (the amount of permits required to be bought from other countries) once domestic emissions reductions have taken place.

Impact of AAUs

- The more AAUs that New Zealand is allocated, the smaller is our "emissions deficit" – the number of emissions permits we need to purchase to meet our international obligations, over and above any domestic reductions.
- The value of the emissions deficit is then determined by the world price of carbon. The higher the world carbon price, the higher the value.
- **Changes to the AAU allocation do not directly affect the price of carbon faced by firms, and thus New Zealand's domestic emissions reductions do not change significantly** – unless there is a change to domestic policy as a result of the change in AAUs.
- The channel through which changes in AAUs affect the New Zealand economy is therefore through a change in offshore payments for permits.
- Buying these permits to fund our emissions deficit comes at a cost. Additional resources are directed towards exporting, making fewer available for household spending.
- This changes the composition of New Zealand's GDP, but affects its level to a lesser degree. There is a substitution between household spending and exporting.
- The main economic cost is on national economic welfare: lower household consumption equates to lower welfare.
- So the effect of an additional AAU allocation on GDP is much smaller than its effect on welfare. Additional AAUs do not reduce the price of carbon faced by

[1] Our models do not examine forestry land use changes in any detail. This is an important avenue for further research. A high carbon price is likely to induce forestry owners to delay harvesting and/or increase new plantation. This would reduce the amount of our emissions deficit.

firms, but simply reduce the number of extra permits required to be bought from other countries.

Modelling results

- Because of the effect on the balance of payments and the exchange rate, **the impact of an extra AAU allocation on national economic welfare (RGNDI) is around 1.7 times the value of the unit at the world price (i.e. an extra allocation of AAUs worth $100 million is worth an extra $170 million of RGNDI)**. This rule of thumb can be used for long run assessment of impacts of various AAU trajectories.
- RGNDI per capita is expected to rise from about $38,500 in 2009 to around $49,000 in 2020, in the absence of any participation in an international agreement on emission reductions.
  - With 1990 levels of AAUs (61.9Mt) and a world price of $100, this would drop to around $48,000.
  - An extra 15% of AAUs (9.3Mt) would soften the impact by around $400 per capita to $48,400.
  - Conversely, 15% fewer AAUs would cause RGNDI per capita to drop by a further $400 to $47,600.
  - A tough target of 40% fewer AAUs with a world price of $200 (a worst case scenario) would cause 2020 RGNDI to fall by $3,000 per person to $46,000.
- In all scenarios, the 2020 target is met by **both** domestic reductions and purchasing further permits from other countries. For example, at a price of $100 with 1990 level AAUs, domestic emissions fall by 16.1% or 14.1Mt. The remaining emissions deficit of 11.7Mt is met through offshore permit purchases. A reduction in AAU allocation by 15% does not change the domestic emissions reductions, but results in an increase of 9.3Mt of the emissions deficit. Under this scenario, New Zealand must purchase 21Mt emissions permits from other countries.
- Provided the carbon price is not too high, it is cheaper for New Zealand to meet its target through buying emissions permits offshore than to reduce domestic emissions.
- Our modelling assumes – for simplicity – that there is no free allocation under domestic policy settings. If free allocation is used, the balance between domestic reductions and offshore permit purchases will alter. **With free allocation, any given target will be met by more offshore purchases and fewer domestic reductions.**
- While changes to AAUs impact welfare through changing New Zealand's emissions deficit, changes to the price of carbon directly impacts the cost of business. An increase in the price of carbon from $25 to $100 has greater impact than a 15% reduction in AAU allocation.

Forestry

- **An increase in carbon sequestration through forestry is equivalent to an increase in allocation of AAUs.** It improves New Zealand's RGNDI by reducing the need to purchase emissions permits from other countries. While our modelling does not include the response of forestry to prices on carbon, **increased sequestration could offset stringent AAU allocations.**

- However **increased forestry will not offset the prices of carbon that firms face and the resulting negative impacts on GDP**. Increased forestry also comes at an opportunity cost if land is diverted away from other productive uses.

Impact of international trading

- **If there is no international trading, and all emissions reductions to 1990 levels must take place domestically, a high (domestic) price on carbon of between $180 and $264/tonne is needed to induce the required emissions reductions.**
- At such a high carbon price, New Zealand's GDP falls by around 4.5% and its welfare by 2-3%. RGNDI per capita in 2020 would fall by up to $1,600 to around $47,400; GDP would fall significantly from $240 billion to $230 billion.
- In this scenario, GDP is more severely impacted than RGDNI, which is the reverse of the AAU analysis. This is because, with no international trading, firms face a very high price on carbon as New Zealand must meet all its emissions reductions domestically. This directly impacts GDP. The marginal AAU analysis, by contrast, effectively considers a change in net foreign liabilities, directly impacting RGNDI, but with no changes to the world price of carbon that firms face.

Impact of a carbon price on our international competitors

- **An international agreement on climate change does not prevent New Zealand from being exposed to competitiveness at risk issues.** Participating countries can design their domestic policies independently – including, if they so wish, to avoid imposing a domestic carbon price altogether and simply fully funding the emissions deficit using tax revenue to buy permits.
- The degree to which New Zealand's domestic policy settings align with those of our competitors (e.g. coverage, timing of entry, free allocation, etc) determines the extent of any competitiveness issues.
- **Eliminating this competitive disadvantage by consistent action across the rest of world reduces the impact on New Zealand by about a third at a low carbon price, and by about a half at a higher carbon price.** Consistent action by the ROW would allow New Zealand to achieve the same level of economic welfare with a more stringent level of AAU allocation. Alternatively, consistent action by the ROW is likely to improve welfare more than an extra 15% of AAU allocation.

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1. Background

In December 2009, the United Nations will meet in Copenhagen, Denmark in a summit to set future direction for climate change policy. Uncertainty surrounds New Zealand's future amount of Assigned Amount Units (AAUs)[1], and if indeed there will be an international agreement moving forward. This report looks at, from a New Zealand perspective, the:

- Impact of changes in New Zealand's allocation of AAUs post-2012
- Impact if there is no international emissions trading and/or no steps taken by our competitors to price carbon.

Note that this report does not seek to compare possible mechanisms for domestic climate change policy such as an emissions trading scheme or carbon tax. While the domestic policy settings are a matter for the New Zealand government, the amount of New Zealand's AAU allocation will be a result of international climate change negotiations. At least in the current debate, New Zealand's choice of domestic climate change policy mechanisms is divorced from the amount of AAU allocation it will receive.

Similarly, under an international trading agreement, domestic emissions targets are **not** analogous to New Zealand's AAU allocation. New Zealand can purchase emissions permits offshore if it is cheaper than reducing emissions domestically, meaning New Zealand's domestic emissions can be greater than the AAU allocation.

To be clear, this report investigates the impact of changes in New Zealand's AAUs under the framework of an international agreement whereby New Zealand takes responsibility for any emissions above a given amount.[2] This is **not** the same as investigating different domestic emissions targets and should not be interpreted as such.

2. Methodology

We employ Computable General Equilibrium (CGE) models from both Infometrics and NZIER. See Infometrics and NZIER, 2009 'Economic Modelling of NZ Climate Change Policy', May 2009 for a full description of the modelling approach and its limitations. Results from both models are presented here.

[1] Under the current Kyoto agreement on climate change, assigned amount units are freely allocated to each participant country. For 2008-2012, New Zealand has been allocated an annual amount equivalent to its 1990 levels of emissions (61.9 Mt). Because AAUs are freely allocated, they provide a maximum level of emissions a country can emit before being required to purchase extra units from other countries.

[2] Taking responsibility' can be achieved through a combination of domestic emissions reductions and offshore purchase (with the exception of scenario 7 which specifically investigates the cost to New Zealand if there is no international trading agreement).

3. Assumptions

We use the following assumptions for the modelling analysis:

- Analysis is for 2020
- New Zealand maintains an ETS in all scenarios[3]
- There is no free allocation[4]
- The Copenhagen meeting has an outcome that revises AAU allocations
- No change in technology or forestry[5] in response to carbon prices

Note that many of the parameters being examined in this analysis are uncertain. The results are indicative of the range of possible outcomes, given certain assumptions, and are provided to allow comparisons to be made between these possible scenarios.

4. Scenario development

The Ministry for the Environment (MfE) provided 11 modelling scenarios designed to explore the two key themes around the impact of AAU allocation and international response to climate change.

Unless otherwise stated, we compare all scenarios with a Business-as-usual (BAU) baseline. This assumes there are no climate change policies or international agreements, and thus no price on carbon or AAUs.

Our BAU baseline projects RGDNI to rise from around $165 billion in 2009 to around $235 billion by 2020. In per capita terms, this is an increase from around $38,500 to $49,000. BAU emissions projections from MfE suggest net emissions will rise to 87.7Mt.

[3] This is purely for consistency in comparing different allocations of AAUs. This report implies nothing about the relative merits of different domestic climate change policy.

[4] We consider an alternative scenario where free allocation is included in the design of the domestic policy in Appendix B.

[5] Our models do not examine forestry land use changes in any detail. This is an important avenue for further research. A high carbon price is likely to induce forestry owners to delay harvesting and/or increase new plantation. This would reduce the amount of our emissions deficit. We comment on the implications of this in the results section.

Table 1 Scenarios

Run	AAU Allocation (relative to 1990)	International trading?	World price (NZ$)	ROW action?	Topic
1	+15%	Yes	$25	No	Impact of AAUs
2	+15%	Yes	$100	No	Impact of AAUs
3	0%	Yes	$25	No	Impact of AAUs
4	0%	Yes	$100	No	Impact of AAUs
5	0%	Yes	$25	Yes	Impact of Int. trading/ROW
6	0%	Yes	$100	Yes	Impact of Int. trading/ROW
7	0%	No	N/A	No	Impact of Int. trading/ROW
8	-15%	Yes	$25	No	Impact of AAUs
9	-15%	Yes	$100	No	Impact of AAUs
10	-15%	Yes	$200	No	Impact of AAUs
11	-40%	Yes	$200	No	Impact of AAUs

Source: MfE, NZIER, Infometrics

4.1 Impact of Assigned Amount Units

Runs 1,2,3,4,8,9,10 and 11 (shaded in grey in Table 1) all investigate the impact of changes to New Zealand's AAU allocation (at different carbon prices) that might result from discussions at Copenhagen and thereafter.

4.1.1 Conceptual framework

AAUs transfer wealth to New Zealand

AAUs are a wealth transfer to the New Zealand government to help meet emissions reductions targets. We model any extra government revenue derived from extra AAUs as being passed on to households via lower personal income taxes; similarly, a reduced amount of AAUs is funded via higher personal income taxes. Note that the level of allocated AAUs does not alter New Zealand's domestic climate change policies.

Changing AAUs cause a reallocation of resources…

Tightening New Zealand's AAU allocation is like the rest of the world deciding that our balance of payments deficit is too large and must be reduced. This requires more of the country's resources to flow into exporting and out of domestic consumption, which lowers imports and thus also helps to improve the balance of payments.

The necessary shift in the allocation of resources is induced by a devaluation of the exchange rate. A devaluation makes us poorer in terms of national income even if there is no change to the national volume of production – real Gross Domestic Product (GDP). One New Zealand dollar of exports buys fewer imports than before the devaluation. Therefore, to purchase an extra AAU, costing say one foreign dollar,

more than one New Zealand dollar's worth of exports is required, further reducing the resources available for domestic consumption.

…and a change in our economic welfare

More intuitively perhaps, for a given level of output, we cannot expect to maintain our standard of living if we have to transfer more of that output offshore. Hence as New Zealand's AAU allowance is changed we expect to see a larger effect on real Gross National Disposable Income (GNDI) than on real GDP.

For these reasons, real GNDI is our preferred measure of economic welfare. It measures the total incomes New Zealand residents receive from both domestic production and net income flows from the rest of the world (Statistics New Zealand, 1999), and adjusts for changes in the terms of trade. This is particularly pertinent for this analysis which includes offshore payment for excess emissions over our AAU allowance. GNDI includes these effects in contrast to the GDP metric which provides an indicator of domestic production but does not capture the impact of international transfers and investment income.

But changes in AAUs don't affect the domestic carbon price

It is also important to note that the amount of AAUs allocated to New Zealand does not directly alter the price on carbon that New Zealand firms face[6]. This means that the level of AAUs does not directly impact on the level of production of New Zealand firms. Given that GDP is a measure of New Zealand firm production, we do not expect changes in the allocation of AAUs to directly impact New Zealand GDP. We also do not expect changes in allocations of AAUs to directly impact domestic emissions reductions.

4.1.2 Scenarios

MfE provides four scenarios for the level of AAUs in 2020 relative to the current Kyoto AAU baseline of 1990 emissions levels (61.9 Mt CO2-e): -40%, -15%, 0%, +15%.

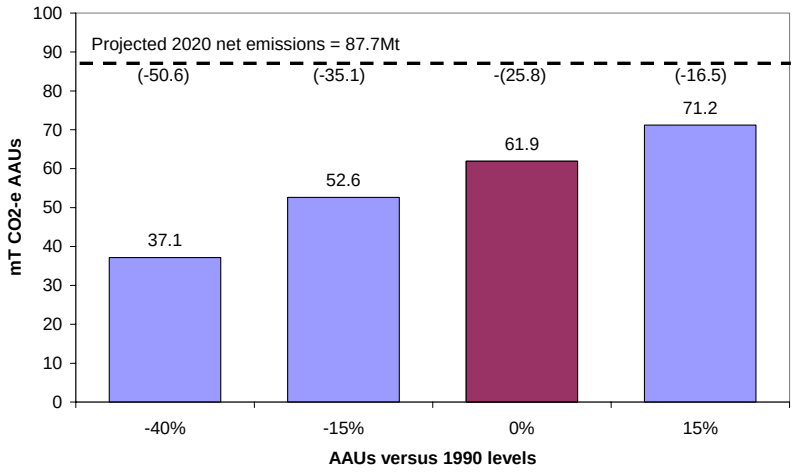
New Zealand's 2020 BAU emissions are projected to be 87.7Mt. Under 1990 levels of AAU allocation, we therefore expect an emissions deficit of 25.8Mt. With an international agreement in place, any deficit can be met by reducing domestic emissions and purchasing additional emissions permits from other countries.

Under the -40% scenario, New Zealand would receive 37.1Mt, leaving a deficit of 50.6Mt. Conversely under the +15% scenario, New Zealand would receive 71.2Mt leaving a deficit of only 16.5Mt.

[6] If connected to an international trading agreement, New Zealand will be price takers of the world price of carbon. If not connected, the price will be a result of the targets set by the New Zealand government for domestic emissions reduction.

Figure 1 2020 AAU scenarios

Bracketed figures indicate emissions deficit



Source: Ministry for the Environment

The value of AAUs is dependent on the world price. We consider the varying levels of AAU allocation at three world prices of carbon: $25, $100 and $200. These values are then fed into our CGE models as shocks, to determine the overall economic impacts of changes to our AAU allocation.

In Table 2, we present the relative costs and benefits of receiving more (in the case of the +15% scenario) or less (in the case of the -15% and -40% scenarios) AAUs at various carbon prices.

It shows that an extra 15% of AAUs is worth $232 million on the world market at a price of $25 and $928 million at a price of $100.

New Zealand's real GNDI is expected to be roughly around $235 billion in 2020, so the value of changes to New Zealand's AAUs equates to around 0.1% of 2020 GNDI at a carbon price of $25 and around 0.4% at a carbon price of $100.

The "worst case" scenario of a 40% reduction in AAUs at a world price of $200 is worth almost $5 billion on the world market, or 2.1% of 2020 GNDI.

Table 2 Value of changes to New Zealand's AAUs

$NZ million

		AAU % change versus 1990			
		-40%	-15%	0%	15%
World price $NZ	$25	-619	-232	0	232
	$100	-2,476	-928	0	928
	$200	-4,952	-1,856	0	1,856

Source: NZIER

4.2 Impact of rest of the world

4.2.1 No international trading

Run 7 considers an alternative scenario in which there is no international trading. New Zealand cannot buy and sell emissions permits. Emissions reductions must be entirely domestic reductions. This means that there is no cap on the per unit cost of reducing emissions.

In the other scenarios it is possible to purchase emissions permits when the cost of domestic emissions reduction exceeds the world price of emissions permits. With this possibility removed we can expect to see an increase in the national welfare cost of meeting any given emissions target, provided that at some point the cost of domestic emissions reductions exceeds the world price.

4.2.2 International trading with action by the rest of the world

Runs 5 and 6 consider a world where an international trading agreement exists, **and all of New Zealand's export competitors face the relevant price on carbon** ($25 in run 5 and $100 in run 6). This is important, as an international trading agreement by itself does not limit New Zealand from being at a competitive disadvantage. In these scenarios, action by the rest of the world is consistent in terms of carbon pricing within each sector. New Zealand can buy and sell emissions permits as is economic. By comparing these runs to runs 3 and 4 respectively, we can consider how consistent action by the rest of the world (ROW) affects the impact on the New Zealand cost of an emissions trading scheme. We also consider action by the ROW relative to the changes in New Zealand's AAU allocations, to provide insight into which has a greater benefit on New Zealand's welfare.

5. Results

5.1 Impact of Assigned Amount Units

5.1.1 Macroeconomic results

Table 3 Impact of AAUs: world price = $25

Percentage change versus BAU, unless otherwise stated (shaded grey)

Run	1	1	3	3	8	8
Model	Infometrics	NZIER	Infometrics	NZIER	Infometrics	NZIER
AAU allocation	+15%	+15%	0%	0%	-15%	-15%
GDP	-0.6	-0.6	-0.6	-0.6	-0.7	-0.6
RGNDI	-0.4	-0.6	-0.6	-0.7	-0.7	-0.9
Real wages	-1.3	-2.4	-1.4	-2.5	-1.4	-2.6
Private Consumption	-0.6	-0.6	-0.8	-0.8	-1.0	-1.0
Domestic emissions (%)	-4.5	-4.6	-4.6	-4.6	-4.5	-4.5
2020 BAU emissions (Mt)	87.7	87.7	87.7	87.7	87.7	87.7
2020 AAUs (Mt)	71.2	71.2	61.9	61.9	52.6	52.6
Emissions deficit (Mt)	*16.5*	*16.5*	*25.8*	*25.8*	*35.1*	*35.1*
Domestic emissions reductions (Mt)	3.9	4.0	4.0	4.0	3.9	3.9
Emissions permits purchased offshore (Mt)	12.6	12.5	21.8	21.8	31.1	31.1

Table 4 Impact of AAUs: world price = $100

Percentage change versus BAU, unless otherwise stated (shaded grey)

Run	2	2	4	4	9	9
Model	Infometrics	NZIER	Infometrics	NZIER	Infometrics	NZIER
AAU allocation	+15%	+15%	0%	0%	-15%	-15%
GDP	-2.0	-2.3	-2.3	-2.4	-2.4	-2.6
RGNDI	-1.1	-1.6	-1.8	-2.3	-2.4	-3.0
Real wages	-4.7	-9.0	-5.0	-9.4	-5.2	-9.8
Private Consumption	-1.5	-1.6	-2.4	-2.4	-3.2	-3.2
Domestic emissions	-14.5	-18.0	-14.5	-17.7	-14.5	-17.5
2020 BAU emissions (Mt)	87.7	87.7	87.7	87.7	87.7	87.7
2020 AAUs (Mt)	71.2	71.2	61.9	61.9	52.6	52.6
Emissions deficit (Mt)	*16.5*	*16.5*	*25.8*	*25.8*	*35.1*	*35.1*
Domestic emissions reductions (Mt)	12.7	15.8	12.7	15.5	12.7	15.3
Emissions permits purchased offshore (Mt)	3.8	0.7	13.1	10.3	22.4	19.7

Source: Infometrics, NZIER

Table 5 Impact of AAUs: world price = $200

Percentage change versus BAU, unless otherwise stated (shaded grey)

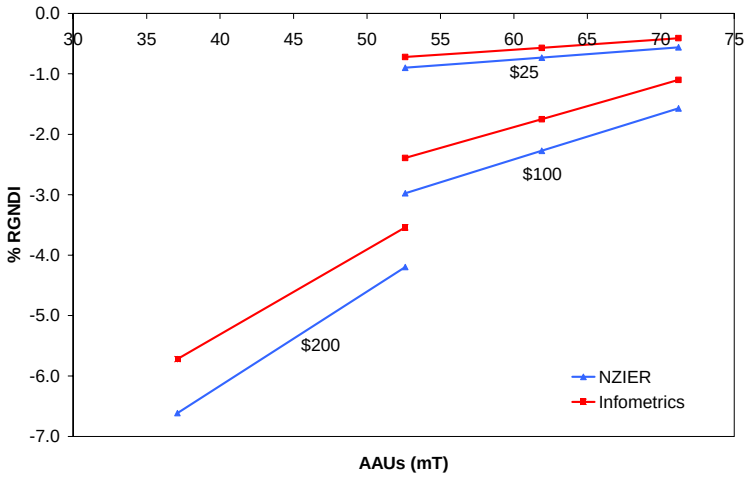
Run	10	10	11	11
Model	Infometrics	NZIER	Infometrics	NZIER
AAU allocation	-15%	-15%	-40%	-40%
GDP	-4.2	-5.0	-4.8	-5.6
RGNDI	-3.5	-4.2	-5.7	-6.6
Real wages	-9	-17.7	-10	-19
Private Consumption	-4.8	-4.3	-7.6	-7.0
Domestic emissions	-24.2	-32.5	-24.3	-31.9
2020 BAU emissions (Mt)	87.7	87.7	87.7	87.7
2020 AAUs (Mt)	52.6	52.6	37.1	37.1
Emissions deficit (Mt)	*35.1*	*35.1*	*50.6*	*50.6*
Domestic emissions reductions (Mt)	21.2	28.5	21.3	28.0
Emissions permits purchased offshore (Mt)	13.9	6.6	29.2	22.6

Source: Infometrics, NZIER

Figure 2 shows how the impact on New Zealand changes with both the level of AAUs and the world price of carbon. At higher prices, the impact on New Zealand increases. Lower levels of AAUs also increase the burden on New Zealand.

Figure 2 Impact of AAU allocation

Percentage change in RGNDI versus BAU



Source: NZIER, Infometrics

Note that the results presented are percentage change relative to BAU. Under all scenarios, the economy in 2020 has still grown significantly from today. For example, even under the most severe scenario of a 40% reduction in AAUs at a world price of $200 (run 11), RGNDI will have grown from around $165 billion today to almost $220 billion by 2020. RGDNI per capita will have risen from $38,500 today to $46,000 in

2020. The absolute level impacts, however, are dependent on the assumptions about domestic policy[7], which this report makes no inference about. We therefore focus on the marginal impact of AAU allocation.

5.1.2 Marginal analysis

The slope of relationships in Figure 2 gives the marginal cost of a marginal reduction in AAUs. In Tables 6-8, we investigate the marginal cost or benefit of being allocated one more or one less AAU for world prices at $25, $100 and $200/tonne respectively, compared to the 1990 level of allocation. In other words we move our point of comparison from the BAU to run 3 or 4.

In Table 6, run 1 involves an extra 15% AAU allocation over 1990 levels, which equates to 9.3Mt. At a carbon price of $25/tonne, this is valued at $232 million. The CGE analysis suggests this leads to a marginal benefit of between $370 million and $394 million in RGNDI (compared to run 3). **That is, for every extra AAU allocated to New Zealand, the benefit is 1.6 to 1.7 times the value of the permits.**

In Table 8, a carbon price of $200/tonne, a scenario of -40% AAUs relative to 1990 equates to 24.8Mt fewer AAUs. This is valued at $4,960 million. The CGE analysis suggests this costs New Zealand an extra $8,134 million to $8,860 million in RGNDI. This is about 1.6 to 1.8 times the value of the permits.

As a rule of thumb we can say that national economic welfare falls by $1.70 for every $1 fall in the direct value of New Zealand's AAU allocation. For example, a tightening of AAUs by 9.3 Mt (15%) at $100 per tonne has a direct value of $930 million, implying a reduction in national welfare of $1,600 million.

In terms of per capita RGNDI the relative effect is of course the same. Using the previous example the $930 million value of the change in AAUs corresponds to about $200 per capita, but the actual reduction in RGNDI per capita is $340.

As presaged in Section 4.1, Tables 6-8 also show that the effect of an additional AAU allocation on real GDP is smaller than on RGNDI. A change in the requirement to purchase AAUs alters the allocation of resources between net exports and private consumption. If the AAU allocation is reduced, the required allocation of resources is effected via a depreciation of the (real) exchange rate. With a lower real purchasing power of the New Zealand dollar, real private consumption and RGNDI decline, even though the total volume of goods and services (real GDP) produced in New Zealand changes by a much smaller amount.

Finally, Tables 6-8 show that AAU allocation does little to impact on domestic emissions reductions, which are largely determined by the price on carbon that firms face. As noted above, changes to New Zealand's AAU allocation does not directly affect the domestic carbon price faced by New Zealand firms, so their emissions behaviour does not alter significantly. Instead, **changes in New Zealand's AAU allocation directly impacts the amount of emissions permits that must be purchased from other countries**.

[7] We assume an all gases, all sectors ETS is in place in 2020.

Table 6 Marginal impact of AAU allocations relative to 1990 (run 3): world price = $25

Run	1	1	8	8
Model	Infometrics	NZIER	Infometrics	NZIER
AAU allocation	+15%	+15%	-15%	-15%
Marginal AAU allocation (Mt)	9.3	9.3	-9.3	-9.3
Value of change in AAUs ($NZm)	$232	$232	-$232	-$232
Impact on RGNDI ($NZm)	$371	$394	-$371	-$394
Ratio RGNDI/AAU value	1.6	1.7	1.6	1.7
Impact on RGNDI (%)	0.2%	0.2%	-0.2%	-0.2%
Impact on GDP (%)	0.0%	0.0%	-0.0%	-0.0%
Impact on domestic emissions (%)	0.1%	0.0%	0.1%	0.1%
Change in domestic emissions reductions (Mt)	-0.1	0.0	-0.1	-0.1
Change in emissions permits purchased offshore (Mt)	-9.2	-9.3	9.4	9.4

Table 7 Marginal impact of AAU allocations relative to 1990 (run 4): world price = $100

Run	2	2	9	9
Model	Infometrics	NZIER	Infometrics	NZIER
AAU allocation	+15%	+15%	-15%	-15%
Marginal AAU allocation (Mt)	9.3	9.3	-9.3	-9.3
Value of change in AAUs ($NZm)	$930	$930	-$930	-$930
Impact on RGNDI ($NZm)	$1,508	$1,612	-$1,508	-$1,612
Ratio RGNDI/AAU value	1.6	1.7	1.6	1.7
Impact on RGNDI (%)	0.6%	0.7%	-0.6%	-0.7%
Impact on GDP (%)	0.3%	0.2%	-0.3%	-0.2%
Impact on domestic emissions (%)	0.0%	-0.3%	0.0%	0.2%
Change in domestic emissions reductions (Mt)	0.0	0.3	0.0	-0.2
Change in emissions permits purchased offshore (Mt)	-9.3	-9.5	9.3	9.5

Source: Infometrics, NZIER

Table 8 Marginal impact of AAU allocations relative to 1990: world price = $200

Run	10	10	11	11
Model	Infometrics	NZIER	Infometrics	NZIER
AAU allocation	-15%	-15%	-40%	-40%
Marginal AAU allocation (Mt)	-9.3	-9.3	-24.8	-24.8
Value of change in AAUs ($NZm)	-$1,860	-$1,860	-$4,960	-$4,960
Impact on RGNDI ($NZm)	-$2,976	-$3,299	-$8,134	-$8,860
Ratio RGNDI/AAU value	1.6	1.8	1.6	1.8
Impact on RGNDI (%)	-1.2%	-1.4%	-3.4%	-3.9%
Impact on GDP (%)	-0.4%	-0.3%	-1.0%	-0.9%
Impact on domestic emissions (%)	-0.1%	0.4%	-0.2%	1.0%
Change in domestic emissions reductions (Mt)	0.1	-0.4	0.2	-0.9
Change in emissions permits purchased offshore (Mt)	9.2	9.7	24.5	25.7

Source: Infometrics, NZIER

5.1.3 Impact of forestry on results

We noted in the scenario development that our models do not capture the response of forestry to a price on carbon. While even a low carbon price is likely to change incentives for land use, uncertainty over long term policy and regulation environments, as well as factor and liquidity constraints make the relationship difficult to estimate.

The Ministry for Agriculture and Forestry (MAF) (2009) suggest that, assuming long term policy certainty, a $20 carbon price could theoretically induce up to 100,000 hectares of new planting per year up to 2020, and prolong rotation lengths. Collectively, this would increase New Zealand's emissions sequestration by up to 30Mt in 2020 (although emissions would increase at a later date if/when the forests are harvested).

The implications of such a forestry response are substantial. Earlier, Table 3 showed an expected emissions deficit of 25.8Mt in 2020 under 1990 levels of AAUs. An extra 30Mt of forestry sequestration would turn New Zealand's 25.8Mt emissions deficit into a 4.2Mt emissions surplus[8]. Effectively, an increase in carbon sequestration is equivalent to an increase in allocation of AAUs. Thus we would expect RGDNI to benefit significantly (as New Zealand becomes wealthier). However because firms still face a price on carbon, GDP would be largely unaffected.

If the forestry response to even higher carbon prices is consistent with those suggested by MAF above, carbon sequestration could offset the negative wealth effect of stringent AAU allocations by eliminating the need to purchase emissions permits from other countries. Note however, that increased forestry will not offset the high prices of carbon that firms face and the resulting negative impacts on GDP.

[8] Depending on future harvesting, post 2020 emissions deficits may be larger however.

Indeed if new forestry planting takes land out of agriculture the negative GDP effect could be exacerbated.

5.2 Results of international trading/ROW action

5.2.1 Impact of international trading

The benefits of international trading are particularly large for New Zealand where emissions abatement is costly. International trading allows New Zealand to buy emissions reductions, at the world price, from offshore – this effectively puts a price cap on emissions. With no international trading, this price cap is no longer available, and all reductions must take place domestically.

With no change to New Zealand's AAUs, the modelling suggests a price of carbon between $180 and $264 would be required to reduce New Zealand emissions back to 1990 levels. The cost to the economy would be around -4.5% of 2020 GDP and between -2.2 and -3.3% of RGNDI.

Without trading the welfare impacts (RGNDI) are slightly less impacted than the productive side of the economy (RGDP) because of a drop in net foreign liabilities. Under a domestic pricing scheme with no international trading, the economy, including the level of capital stocks, contracts. Savings do not drop sufficiently to match the lower investment, leading net foreign liabilities to fall. A lower level of net foreign liabilities leads to a smaller negative impact on RGNDI versus RGDP. This result is almost the reverse of the marginal AAU analysis, where RGNDI was impacted more than RGDP. This can be reconciled by considering the scenario details. In the marginal AAU analysis, a change to New Zealand's AAU allocation is effectively a change in net foreign liabilities, directly impacting GNDI, with no changes to the world price of carbon and therefore the price that firms face. However in this scenario, the lack of international trading causes firms to face a very high price on carbon. This directly impacts GDP.

Table 9 Impact of international trading

Percentage change unless otherwise specified

Run	7	7
Model	Infometrics	NZIER
Carbon price ($NZ/tonne)	$262	$180
GDP	-4.6	-4.4
RGNDI	-2.2	-3.3
Real wages	-10.3	-15.7
Private Consumption	-3.1	-3.3
Domestic emissions	-28.9	-29.4
2020 BAU emissions (Mt)	87.7	87.7
2020 AAUs (Mt)	61.9	61.9
Emissions deficit (Mt)	*25.8*	*25.8*
Domestic emissions reductions (Mt)	25.8	25.8
Emissions permits purchased offshore (Mt)	0	0

Source: NZIER, Infometrics

We stress, however, that at carbon prices of this magnitude the models' parameter and elasticity values may not be valid as they were not estimated over a period with such large implied changes in relative prices. High carbon prices can be expected to accelerate the adoption of low carbon technologies on a wide scale – for example plug-in electric vehicles, more electricity generation from wind and solar power, the use of biofuels from forestry and so on. Such step changes in technology uptake are not well simulated by our models.

Similarly, at such high carbon prices, some firms and/or industries may reach a cut-off point at which they shut down entirely due to the high costs of emissions permits. Technological adoption would tend to reduce the carbon prices required to meet any given emissions obligation, but firm closures would increase the cost of reducing emissions.

5.2.2 Impact of action by the rest of the world

The benefits of action by the rest of the world (ROW) are significant. The cost (in terms of RGNDI) of a price on carbon to New Zealand is reduced by about a third for a carbon price of $25/tonne, and by about a half at $100/tonne, with action by the ROW. Exporters and import-competing firms are no longer at a competitive disadvantage, and output leakage tends towards zero. New Zealand's domestic emissions reductions are lower; the burden of emissions reductions is shared more equitably with other countries.

Table 10 Impact of action by the ROW: $25

Percentage change unless otherwise specified

Run	3	5	3	5
Model	Infometrics	Infometrics	NZIER	NZIER
Carbon price ($NZ/tonne)	$25	$25	$25	$25
ROW?	No	Yes	No	Yes
GDP	-0.6	-0.5	-0.6	-0.4
RGNDI	-0.6	-0.4	-0.7	-0.4
Real wages	-1.4	-1.1	-2.5	-2.3
Private Consumption	-0.8	-0.5	-0.8	-0.5
Domestic emissions	-4.6	-3.5	-4.6	-3.5
2020 BAU emissions (Mt)	87.7	87.7	87.7	87.7
2020 AAUs (Mt)	61.9	61.9	61.9	61.9
Emissions deficit (Mt)	*25.8*	*25.8*	*25.8*	*25.8*
Domestic emissions reductions (Mt)	4.0	3.1	4.0	3.1
Emissions permits purchased offshore (Mt)	21.8	22.7	21.8	22.7

Table 11 Impact of action by the ROW: $100

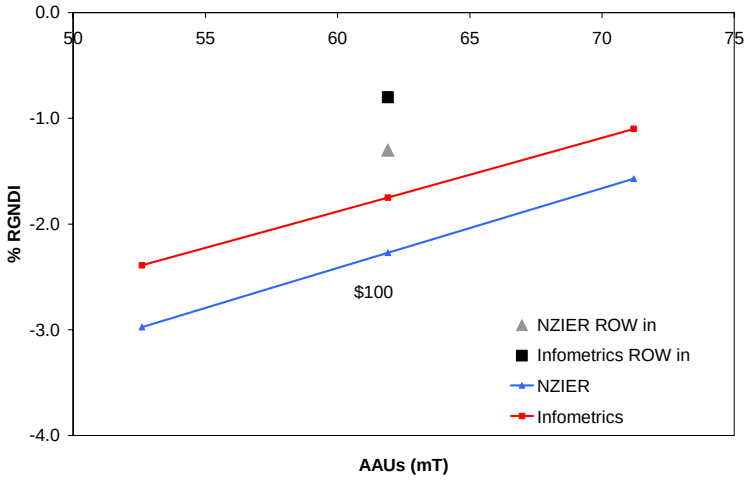
Percentage change unless otherwise specified

Run	4	6	4	6
Model	Infometrics	Infometrics	NZIER	NZIER
Carbon price ($NZ/tonne)	$100	$100	$100	$100
ROW?	No	Yes	No	Yes
GDP	-2.3	-1.6	-2.4	-1.7
RGNDI	-1.8	-0.8	-2.3	-1.3
Real wages	-5.0	-3.8	-9.4	-8.3
Private Consumption	-2.4	-1.1	-2.4	-1.4
Domestic missions	-14.5	-10.9	-17.7	-11.9
2020 BAU emissions (Mt)	87.7	87.7	87.7	87.7
2020 AAUs (Mt)	61.9	61.9	61.9	61.9
Emissions deficit (Mt)	*25.8*	*25.8*	*25.8*	*25.8*
Domestic emissions reductions (Mt)	12.7	9.6	15.5	10.4
Emissions permits purchased offshore (Mt)	13.1	16.2	10.3	15.4

Source: NZIER, Infometrics

Figure 3 highlights that action by the ROW can offset more stringent allocations of AAUs. It takes the $100 scenarios from Figure 2 (analysis of impact of AAUs) and adds the impact of action by the ROW. This shows that action by the ROW improves welfare by more than an extra 15% AAU allocation.

Figure 3 Action by ROW relative to impact of AAUs



Source: NZIER, Infometrics

6. Discussion of results

Impact of AAUs

- The more AAUs that New Zealand is allocated, the smaller is our "emissions deficit" – the number of emissions permits we need to purchase to meet our international obligations, over and above any domestic reductions.
- The value of the emissions deficit is then determined by the world price of carbon. The higher the world carbon price, the higher the value.
- **Changes to the AAU allocation do not directly affect the price of carbon faced by firms, and thus New Zealand's domestic emissions reductions do not change significantly** – unless there is a change to domestic policy as a result of the change in AAUs.
- The channel through which changes in AAUs affect the New Zealand economy is therefore through a change in offshore payments for permits.
- Buying these permits to fund our emissions deficit comes at a cost. Additional resources are directed towards exporting, making fewer available for household spending.
- This changes the composition of New Zealand's GDP, but affects its level to a lesser degree. There is a substitution between household spending and exporting.
- The main economic cost is on national economic welfare: lower household consumption equates to lower welfare.
- So the effect of an additional AAU allocation on GDP is much smaller than its effect on welfare. Additional AAUs do not reduce the price of carbon faced by

firms, but simply reduce the number of extra permits required to be bought from other countries.

Modelling results

- Because of the effect on the balance of payments and the exchange rate, **the impact of an extra AAU allocation on national economic welfare (RGNDI) is around 1.7 times the value of the unit at the world price (i.e. an extra allocation of AAUs worth $100 million is worth an extra $170 million of RGNDI)**. This rule of thumb can be used for long run assessment of impacts of various AAU trajectories.
- RGNDI per capita is expected to rise from about $38,500 in 2009 to around $49,000 in 2020, in the absence of any participation in an international agreement on emission reductions.
  - With 1990 levels of AAUs (61.9Mt) and a world price of $100, this would drop to around $48,000.
  - An extra 15% of AAUs (9.3Mt) would soften the impact by around $400 per capita to $48,400.
  - Conversely, 15% fewer AAUs would cause RGNDI per capita to drop by a further $400 to $47,600.
  - A tough target of 40% fewer AAUs with a world price of $200 (a worst case scenario) would cause 2020 RGNDI to fall by $3,000 per person to $46,000.
- In all scenarios, the 2020 target is met by **both** domestic reductions and purchasing further permits from other countries. For example, at a price of $100 with 1990 level AAUs, domestic emissions fall by 16.1% or 14.1Mt. The remaining emissions deficit of 11.7Mt is met through offshore permit purchases. A reduction in AAU allocation by 15% does not change the domestic emissions reductions, but results in an increase of 9.3Mt of the emissions deficit. Under this scenario, New Zealand must purchase 21Mt emissions permits from other countries.
- Provided the carbon price is not too high, it is cheaper for New Zealand to meet its target through buying emissions permits offshore than to reduce domestic emissions.
- Our modelling assumes – for simplicity – that there is no free allocation under domestic policy settings. If free allocation is used, the balance between domestic reductions and offshore permit purchases will alter. **With free allocation, any given target will be met by more offshore purchases and fewer domestic reductions.**
- While changes to AAUs impact welfare through changing New Zealand's emissions deficit, changes to the price of carbon directly impacts the cost of business. An increase in the price of carbon from $25 to $100 has greater impact than a 15% reduction in AAU allocation.

Forestry

- **An increase in carbon sequestration through forestry is equivalent to an increase in allocation of AAUs.** It improves New Zealand's RGNDI by reducing the need to purchase emissions permits from other countries. While our modelling does not include the response of forestry to prices on carbon, **increased sequestration could offset stringent AAU allocations.**

- However **increased forestry will not offset the prices of carbon that firms face and the resulting negative impacts on GDP**. Increased forestry also comes at an opportunity cost if land is diverted away from other productive uses.

Impact of international trading

- **If there is no international trading, and all emissions reductions to 1990 levels must take place domestically, a high (domestic) price on carbon of between $180 and $264/tonne is needed to induce the required emissions reductions.**
- At such a high carbon price, New Zealand's GDP falls by around 4.5% and its welfare by 2-3%. RGNDI per capita in 2020 would fall by up to $1,600 to around $47,400; GDP would fall significantly from $240 billion to $230 billion.
- In this scenario, GDP is more severely impacted than RGDNI, which is the reverse of the AAU analysis. This is because, with no international trading, firms face a very high price on carbon as New Zealand must meet all its emissions reductions domestically. This directly impacts GDP. The marginal AAU analysis, by contrast, effectively considers a change in net foreign liabilities, directly impacting RGNDI, but with no changes to the world price of carbon that firms face.

Impact of a carbon price on our international competitors

- **An international agreement on climate change does not prevent New Zealand from being exposed to competitiveness at risk issues.** Participating countries can design their domestic policies independently – including, if they so wish, to avoid imposing a domestic carbon price altogether and simply fully funding the emissions deficit using tax revenue to buy permits.
- The degree to which New Zealand's domestic policy settings align with those of our competitors (e.g. coverage, timing of entry, free allocation, etc) determines the extent of any competitiveness issues.
- **Eliminating this competitive disadvantage by consistent action across the rest of world reduces the impact on New Zealand by about a third at a low carbon price, and by about a half at a higher carbon price.** Consistent action by the ROW would allow New Zealand to achieve the same level of economic welfare with a more stringent level of AAU allocation. Alternatively, consistent action by the ROW is likely to improve welfare more than an extra 15% of AAU allocation.

References

Infometrics and NZIER, 2009 'Economic Modelling of NZ Climate Change Policy', May 2009

Ministry for Agriculture and Forestry 2009. Personal communication 21st July 2009.

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Appendix A

Table 12 Summary of RGNDI results

Scenario	AAUs	Int. trading ?	World price ($NZ)	ROW action ?	RGNDI ($NZ billion 05/06 prices)		RGNDI per capita ($NZ)	
					Infometrics	NZIER	Infometrics	NZIER
BAU 2009	N/A	No	N/A	N/A	$165	$165	$38,500	$38,500
BAU 2020	N/A	No	N/A	N/A	$232	$232	$49,000	$49,000
Run 1	+15%	Yes	$25	No	$231	$231	$48,800	$48,700
Run 2	+15%	Yes	$100	No	$229	$228	$48,500	$48,200
Run 3	0%	Yes	$25	No	$231	$230	$48,700	$48,700
Run 4	0%	Yes	$100	No	$228	$227	$48,100	$47,900
Run 5	0%	Yes	$25	Yes	$231	$231	$48,800	$48,800
Run 6	0%	Yes	$100	Yes	$230	$229	$48,600	$48,400
Run 7	0%	No	N/A	No	$227	$224	$47,900	$47,400
Run 8	-15%	Yes	$25	No	$230	$230	$48,700	$48,600
Run 9	-15%	Yes	$100	No	$226	$225	$47,800	$47,500
Run 10	-15%	Yes	$200	No	$224	$222	$47,300	$46,900
Run 11	-40%	Yes	$200	No	$219	$217	$46,200	$45,800

Source: NZIER, Infometrics

Appendix B Impact of free allocation on domestic emissions

Background

This document is an addendum to previous work by NZIER and Infometrics for the Ministry for the Environment. Full modelling details are presented in the earlier research.

We compare the impacts on the New Zealand economy between:

- An ETS with no free allocation, a carbon price of $100, 1990 levels of AAUs, and no action by the rest of the world ("the base case").
- The above scenario with free allocation based on 90% of production to agriculture, dairy processing, wood and paper, chemicals, cement and basic metals.

Results

Table 13 Impact of free allocation (world price = $100; 1990 AAUs)

Percentage change versus 2020 BAU unless otherwise stated (grey shaded area)

Run	4	4	4 FA	4 FA
Model	Infometrics	NZIER	Infometrics	NZIER
AAU allocation	0%	0%	0%	0%
Free allocation	No	No	Yes	Yes
GDP	-2.3	-2.4	-1.3	-1.1
RGNDI	-1.8	-2.3	-1.7	-2.2
Real wages	-5.0	-9.4	-2.5	-5.2
Private Consumption	-2.4	-2.4	-2.2	-2.4
Domestic emissions (%)	-14.5	-17.7	-9.0	-5.5
2020 BAU emissions (Mt)	87.7	87.7	87.7	87.7
2020 AAUs (Mt)	61.9	61.9	61.9	61.9
Emissions deficit (Mt)	25.8	25.8	25.8	25.8
Domestic emissions reductions (Mt)	12.7	15.5	7.9	4.8
Emissions permits purchased offshore (Mt)	13.1	10.3	17.9	21.0

Source: NZIER, Infometrics

Key points

- There is a clear trade off between free allocation and domestic emissions reductions.
- Free allocation lessens New Zealand domestic emissions reductions by roughly half relative to the base case. Depending on the model used, the decrease in domestic emissions falls from between 12.7 and 15.5Mt to 4.8 and 7.9Mt.
- As a result, New Zealand must purchase a greater volume of permits offshore than in the base case.

- With free allocation, the main driver of lower domestic emissions reductions is the more limited change in agricultural production.
- Free allocation reduces the decline in GDP by roughly half. Free allocation compensates firms at a competitive disadvantage under the ETS, increasing New Zealand's level of production relative to the base case with no free allocation.
- RGNDI improves only marginally relative to the base case – the GDP improvement is offset by an increase in the net amount of emissions needing to be purchased from offshore.