Effects of New Zealand's climate change policies on the forestry sector

Stage II: initial quantification

Report to the Wood Processing Strategy Climate Change Group

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Preface

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- by the interaction of team members on individual projects;
- by exposure of the team's work to the critical review of a broader range of Institute staff members at internal seminars;
- by providing for peer review at various stages through a project by a senior staff member otherwise disinterested in the project;
- and sometimes by external peer reviewers at the request of a client, although this usually entails additional cost.

Authorship

This report has been prepared at NZIER by Mary Clarke and Doug James and reviewed by Alex Sundakov. The assistance of industry representatives and government officials is gratefully acknowledged.

EXECUTIVE SUMMARY AND CONCLUSIONS

Four years after its initial drafting, as New Zealand tackles with whether or not to ratify, the Kyoto Protocol on climate change has become the focus of intense and building debate.

The forestry sector, which at first glance could assume would be a winner in an environment where the carbon sink value of its forests can be monetised, is strongly concerned about ratification. Why? Because the outcomes for the sector will be uncertain, mixed and, in some cases, even detrimental.

This is Stage II of a multi-staged investigation into those outcomes. Stage I provided a preliminary assessment, in qualitative terms, of the outcomes that are likely to emerge. The purpose of this report is to put some numbers around, and test, our initial thinking.

Models and scenarios

In preparing this Stage II report we have developed a suite of financial models. Our forest estate model allows us to quantify the impacts of climate change policies on the returns to the owners of our 1.7 million hectare planted forest estate. Our wood processing model enables us to examine the relative competitiveness of various greenfield wood processing investment options. These models are flexible tools that can test any number of market and policy scenarios. Table 1 summarises the assumptions behind the scenarios examined – carbon option 1 (CO1) and carbon option 2 (CO2). We have conservatively picked two carbon permit prices towards the low end of the ranges used in New Zealand and international studies.

Table 1 Scenario assumptions

Scenario	Carbon permit price	Percentage changes relative to business as usual: Energy costs from 2008		Transport costs from 2008	Log/fibre prices		
		Diesel	Electricity			Pre 2008	From 2008
CO1	$48	+4.67%	+4.29%	+0.79%	"Best"	-1%	+4%
CO2	$120	+11.67%	+10.73%	+1.98%	"Worst"	-5%	+1%

How the policies feed through and impact on the earnings from New Zealand's planted forest estate and wood processing investment decisions depends on:

- whether the planted areas constitute a Kyoto or non-Kyoto forest. For them to qualify as a Kyoto forest they must have been newly planted after 1 January 1990;
- whether, after harvest, the trees are restocked or not. If they are restocked then the liability for emitting carbon at harvest can be deferred;
- when climate change polices become effective. The first commitment period is timed to start in 2008; and
- the behaviours of our competitors, particularly those who do not have greenhouse gas emission targets to meet, such as Chile and Russia.

When these considerations are reflected in the modelling process, we find that, under the scenarios modelled, the effect of climate change policies on the forestry sectors is to cause:

- a loss of earnings to owners of non-Kyoto forests, which represents two thirds of New Zealand's planted forest estate;
- gains to owners of Kyoto forests; and
- additional investment in wood processing in New Zealand to become a less attractive prospect relative to previously, and to our non-Annex 1 competitors.

Non-Kyoto forests

A key result of our research is that the owners of non-Kyoto forests are likely to be worse off under climate change policies under a variety of feasible assumptions. The loss of value comes on top of already low rates of return in the sector, rates which are below the weighted average cost of capital.

The loss of earnings to owners of non-Kyoto forests stems from a mixture of falls in log prices pre-2008 (expected under both the "best" and "worst" case scenarios), changes in log yields for trees harvested early, and the carbon tax liability incurred when owners exit from forest growing. Table 2 summarises the losses against business as usual and their causal factors.

Table 2 Impacts on non-Kyoto forests

Dollars billions

	No restocking[2]	Restocking[3]	
		Once[4]	Continuously[5]
Value change[1]			
CO1	-0.7 – -1.7	-0.2 – -1.3	-0.1 – -1.1
CO2	-1.0 – -2.0	-0.3 – -1.4	-0.1 – -1.1
Causal Factors	• log price falls before 2008 • lower yield for trees harvested early • carbon emissions liability for trees planted in the years close to 1990	• log price falls before 2008 • deferred liability for emitting carbon	• log price falls before 2008 • log price increases from 2008 • no exit costs encountered

Notes: (1) These are polar ranges of losses. The lower bound relates to our best case scenario. The upper bound relates to our worst case scenario.
(2) No restocking – do not restock harvested trees, but alter land use.
(3) Restocking – restock harvested trees (this corresponds to no change in land use).
(4) Restocking once only – restock for one additional rotation and, thereafter exit the forestry market.
(5) Continuous restocking – continue to restock indefinitely and so never exit the forestry market.

It would be easy to conclude from this that the strategy of continuously restocking would be the preference of the owners of non-Kyoto forests as, under it, losses are minimised. However, the current low rates of return to forest owners is likely to mean that:

- either they will get out of forestry and switch to a more profitable land use, in which case the first column of losses becomes most relevant; or
- they get locked into forest growing when, had it not been for the exit costs, they would have preferred to switch their land into a more profitable use.

Kyoto forests

Our research shows that the monetisation of carbon sinks will increase the returns to Kyoto forests. The gains to the owners of Kyoto forests arise from the increase in log prices from 2008 (as set out in the price scenarios), the additional income stream from carbon permits earned and, in the case of those who switch to permanent forestry, silvicultural costs avoided. The gains are modified, in the two cases of rotational forestry examined, by the liability incurred for emitting carbon when owners exit from forest growing. The scenarios modelled in the report indicate that permanent forestry is not the preferred option. Table 3 summarises the gains and losses against business as usual.

Table 3 Impacts on Kyoto forests

Dollars billions

	Rotational		Permanent[2]
	No restocking	Restocking	
Value change			
CO1	0.4 – 0.7	0.8 – 1.0	-3.0
CO2	1.1 – 1.4	1.8 – 2.0	0.04
Causal Factors	• transport and energy cost increases • log price increases from 2008 • carbon permits earned • carbon emissions liability	• transport and energy cost increases • log price increases from 2008 • carbon credits earned • liability for emitting lower than for no restocking	• transport and energy cost increases • opportunity cost from not realising log price increases • carbon credits earned • no liability for emitting carbon as trees not harvested • silvicultural costs avoided for recently planted trees

Notes: (1) Refer notes under Table 2.
(2) Permanent forestry – forest owners leave the trees in the ground indefinitely.

In each of the scenarios examined, restocking is the best strategy to maximise earnings. At the low carbon permit price of $48 permanent forestry is the least favoured option in all the planting years since 1990. At the higher price of $120 this dynamic changes from the mid 1990s onwards as positive returns relative to business as usual are possible.

While the model results indicate that the monetisation of carbon sinks increases the returns on Kyoto forests, what the results do not reflect is the impacts of offsetting factors that are likely to emerge in the new operating environment. In particular, some of the gains could be offset by the greater risk faced by forest owners in that the wood processing capacity, to underpin the value of their forests, may not eventuate. Hence, higher returns go hand-in-hand with higher risk, and it is not clear by how much the risk-adjusted rate of return actually increases.

The flipside is that investors may think twice about channelling their monies into wood processing in New Zealand if the long term supply of wood becomes less certain.

Wood supply

The modelling indicates that climate change policies introduce considerable uncertainty into future wood supply from the current planted forest estate in New Zealand. Only small changes in assumptions about log and carbon prices, carbon policy rules, as well as changes in silvicultural regimes, would make permanent carbon forestry the most profitable option. In addition, our current modelling assumes average distance from forest to port or processing facility. The incentive to stay in permanent forestry would be greater for forests that are more remote than average.

Equally, there is some incentive to harvest pre-1990 forests early and, in some cases, to change land use. The incentive would increase for forests that are more remote than average.

Additional wood supplied from future plantings is equally uncertain. Given the gains in earnings for Kyoto forests, it would be tempting to conclude that new forest plantings will be encouraged under climate change policies. However, two areas of risk need to be highlighted:

- It may be possible under the Clean Development Mechanism provisions of the Kyoto Protocol to earn carbon credits for planting in non-Annex 1 countries, such as Chile. Unlike in New Zealand, transport and energy input costs in these countries will be unaffected.
- Forests are traditionally planted close to processing facilities. If investing in the wood processing capacity of New Zealand becomes less attractive relative to non-Annex 1 investment destinations, then new planting levels are likely to decline.

Wood processing

The overall increase in uncertainty of wood supply increases the risks associated with wood processing investment in New Zealand. Hence the hurdle rate of return on such investments would rise. At the same time, the increase in processing costs in New Zealand, relative to its non-Annex 1 competitors, reduces the attractiveness of such investment. Climate change policies will increase energy and transport costs in New Zealand. Both Annex 1 and non-Annex 1 processors will face the same increases in fibre input costs. In the body of the report we use Chile as comparator. The effect of climate change policies is to create or increase the gaps between returns on wood processing investments in the two countries. The gap between the returns available to those who choose to invest in a chemical pulp plant in New Zealand, for example, is a quarter less than the returns available to the same investment in Chile.

If we relate the decline in profitability to New Zealand's existing investment in wood processing (as opposed to new investments in New Zealand versus Chile), we find that the size of the combined losses are between $0.7 billion and $3.4 billion (refer Table 4, over).

Table 4 Impacts on existing wood processors

Dollars million

Processing segment	IRR decline[1]	Estimated capital[2]	Wealth loss
Sawmilling	12.5%-47.0%	475-800	59-376
LVL	1.1%-3.9%	90	1-4
MDF	2.4%-7.6%	250	6-19
Mechanical pulp	21.1%-60.8%	2900-5000	611-3039
Total			**677-3437**

Notes: (1) These are the polar ranges from our best and worst case log price scenarios and low and high carbon permit price scenarios.
(2) Values estimated by industry.

CONTENTS

APPENDICES

FIGURES

TABLES

1. INTRODUCTION

In a report which took a preliminary look at the likely effects of future climate change policies on the New Zealand forestry sector (NZIER 2001a), our analysis challenged popular perceptions that climate change policies will be unambiguously beneficial for forestry because forests sequester carbon. The purpose of this report is to undertake an initial quantitative assessment of the likely impacts.

The reasoning supporting the preconceptions is that climate change policies that allow the carbon sink value of forests to be monetised will increase the financial value of forests. The assumed outcomes of this were that new forest plantings would increase and correspondingly long term wood supply when these trees reach a harvestable age.

The analysis in this report assumes the implementation of an international carbon trading regime, with forest owners being able to sell the value of the carbon sequestered by the forests planted post-1990. This ability to monetise the carbon sink value of post-1990 newly planted (Kyoto) forests unambiguously increases returns on these forests. However, the effects on pre-1990 (restocked and newly planted) and post-1990 (restocked) forests (hereafter referred to as non-Kyoto forests), on wood supply and on the New Zealand wood processing industries are more complex.

In preparing this report, we developed a suite of financial models which allow us to quantify the impacts of climate change policies on forest owners' returns, and on the relative competitiveness of the New Zealand wood processing industries.

This report presents the key results of these models. We should emphasise that the models are flexible tools, which allow any number of market and policy scenarios to be tested. This report discusses some core scenarios, but by no means exhausts all the issues that may need to be considered.

To reiterate, the purpose of the report is to quantify the likely impacts on the forestry sector based on policies that are likely to emerge if the Kyoto Protocol were ratified. In the chapters of this report that follow we:

- Identify and describe the provisions of the Kyoto Protocol of relevance to forestry and wood processing.
- Outline our analytical approach to quantifying the impacts on the forestry and wood processing sectors, and identify the scenarios considered in the analytical chapters.
- Analyse the financial implications of climate change policies on existing forests.
- Assess and compare wood processing greenfields investment decisions in New Zealand and in Chile, the key non-Annex 1 competitor.
- Take a look at the log trade in Appendix A. An appreciation of the dynamics here is important for understanding the implications of a change in the trading environment. Subsequent appendices contain information and data that expand on and inform the content and analysis of this report.

2. THE KYOTO PROTOCOL

2.1 The Kyoto Protocol

The Kyoto Protocol defines a structure for negotiating greenhouse gas emission commitments for successive periods. The overall aim in the first commitment – 2008 to 2012 – is to reduce emissions by at least 5% below 1990 levels. However, commitments differ by country reflecting differences in marginal rates of abatement. New Zealand's commitment target is to reduce emissions to at least 1990 levels. Emission commitment targets have been specified only in respect of developed countries and countries in transition to market economies. Developed countries' targets are specified relative to the 1990 base year; economies in transition have some flexibility regarding their base year of reference. That is, their greenhouse gas emission commitment may be specified relative to a year other than 1990. These countries are identified in an Annex 1 to the 1992 Framework Convention on Climate Change (FCCC) (refer Appendix B). Developing or non-Annex 1 countries are exempt.

The Protocol concerns itself with net changes in greenhouse gas emissions. That is, both gross reductions in sources of emissions and increased removals by sinks are of relevance when accounting for changes in each commitment period. In the first commitment period only forest sinks created since 1990 are relevant. The definition of carbon sinks may widen under the second and subsequent commitment periods. Additional activities that may be agreed to under Article 3.4 of the Protocol include forest management for non-Kyoto forests, grazing land management, cropland management, and revegetation.

The Protocol includes three mechanisms that are key to understanding its impact:

- Joint Implementation (JI) which allows countries to claim credit for emission reductions that arise from investments in other industrialised countries. Although the credits ultimately gain their value under the Protocol from being offset against governmental commitments, this is generally envisaged as a mechanism for promoting international private sector investment in emissions-reducing projects.
- The Clean Development Mechanism (CDM) which is provided for under Article 12 of the Protocol. It allows similar types of emission-reduction projects in developing countries to generate "certified emission reductions" for use by the investor. The Protocol requires that such projects must contribute to the sustainable development of the host country and help these countries contribute to the ultimate aim of greenhouse gas emission stabilisation. The projects must be additional to what would have been undertaken under business as usual.
- Emissions Trading which allows the transfer of parts of countries' allowed emissions between countries.

2.2 Points of relevance to forestry and wood processing

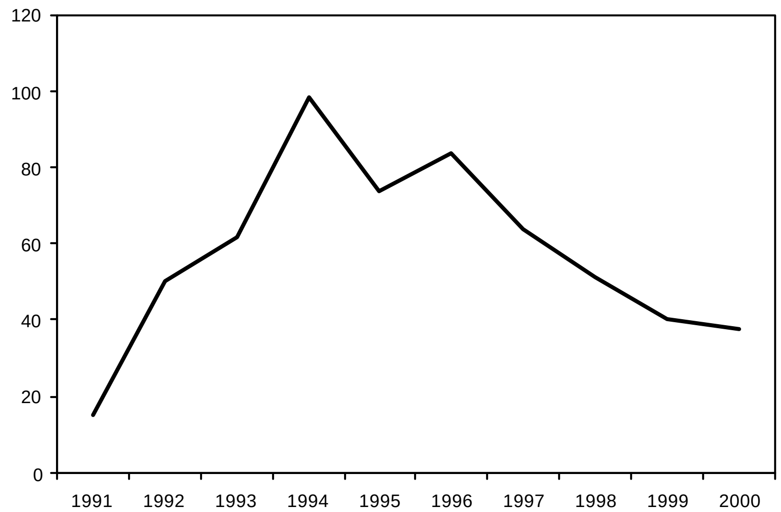
2.2.1 "Kyoto" forests

"Kyoto" forest sinks that qualify for credits must be:

- a forest;
- created through direct human induced activities, such as seeding, planting or promotion of regeneration;
- established after 1 January 1990; and
- established on land that was previously in some other use.

Changes to the taxation treatment of forests, the sale of Crown forest assets, the log price spike and other factors since 1990 have lead to historically high levels of new planting, as Figure 1 illustrates. New Zealand has 570,000 hectares of qualifying Kyoto forests – a bit less than one third of the total planted forest estate.

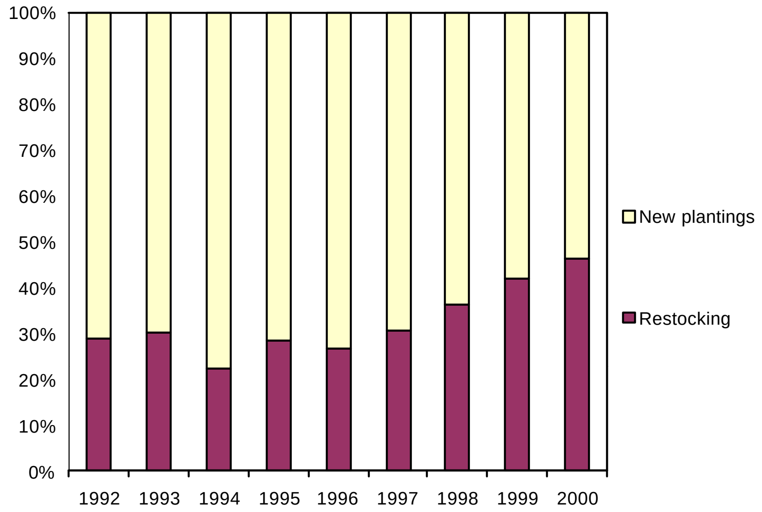
Figure 1 New planting
Thousands of hectares



Source: MAF

The same factors have also contributed to a situation where forests that have been harvested over the period have been restocked. These replanted trees do not qualify as Kyoto forests.

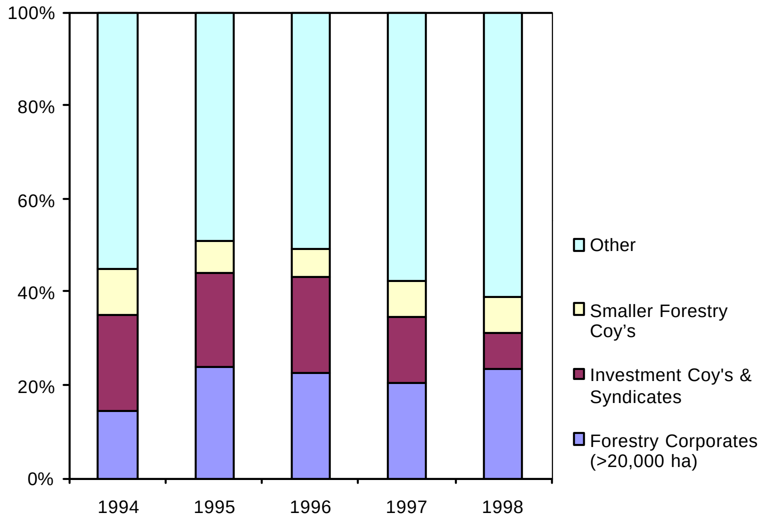
Figure 2 New planting and restocking
Share of total planting



Source: MAF

Data on ownership of the newly planted and, therefore, qualifying Kyoto forests is only available for a limited period – 1994 to 1998. Over that period only 20% of new plantings were by New Zealand's large corporates. The other remaining 80% were planted by investment syndicates, other small forestry companies and other small forest growers.

Figure 3 New planting by ownership category
Percentage



Source: MAF.

2.2.2 Timing

Timing issues will alter the influence of climate change policies on forestry and logging:

- the implications of climate change policies differ according to whether forests were planted before or after 1990; and
- climate change policies will only take effect post 2008, although some sectors may adjust their behaviours prior to this in anticipation of the policies becoming effective. There could well be a range of behaviours, some of which support the intended policy outcomes, and others which have perverse implications.

Table 5 illustrates the importance of timing.

Table 5 Timing considerations

	time of planting ...		
time of harvest ...	**pre 1990**	**post 1990**	
	restocking and new planting	restocking	new planting
pre 2008	no tax	no tax	no tax
	no credit	no credit	no credit
post 207	tax deferred if restocking occurs or the land is left to revert to forest cover	tax deferred if restocking occurs or the land is left to revert to forest cover	if restocking occurs, tax reflects the cumulative carbon less the residual carbon[1], up to but no greater than the carbon credits received between 2008 and harvest year
	If no restocking occurs or land is not left to revert back to forest, tax reflects cumulative carbon in the forest at the time of harvest	if no restocking occurs or land is not left to revert back to forest, tax reflects cumulative carbon in the forest at the time of harvest	if no restocking occurs, tax reflects the cumulative carbon, up to but no greater than the carbon credits received between 2008 and harvest year
	no credit	no credit	credit

The incentives to plant and harvest trees will be different depending on which cell of the above matrix best describes the circumstances of forest growers.

2.2.3 Restocking

Table 5 illustrates the significance of restocking. We have already noted that post 1990 restocking falls in the category of non-Kyoto forests. For non-Kyoto forests, restocking is significant from the perspective that it allows for all the liability for emitting carbon

[1] When a forest is harvested, not all of the carbon stock is immediately released into the atmosphere. Some of the carbon stock remains tied up in the slash, stumps and roots, and is gradually released as the slash, stumps and roots decay over time. The term residual carbon is used to denote the carbon stocks not released into the atmosphere at the time of harvest.

post 2007 to be deferred. The liability can be successively deferred until there is a switching to an alternative land use. Land left idle is not regarded under the Kyoto Protocol as being in an alternative land use, as forests, by definition under the Protocol, are sustainable since the land will revert back to forest cover over time.

Kyoto forests always incur a liability at harvest year for the total carbon removed at the time of harvest. However, this liability will be capped at the volume of credits received by the forest owner between 2008 and harvest year. For Kyoto forests, restocking allows them to reduce the liability for emitting carbon. This amount reflects the difference between the total carbon released (cumulative carbon less the residual carbon) and the volume of carbon credits received between 2008 and harvest year.

2.2.4 New Zealand and our competitors

New Zealand is an Annex 1 country and is subject to climate change policies. Two of its key competitors in forestry – Australia and Russia – are also Annex 1 countries. New Zealand has a target in the first commitment period of returning greenhouse gas emissions to 1990 levels. Russia has the same no growth target but it has some flexibility around its base year, as it is an economy in transition. Australia has a less ambitious target to hit in the first commitment period – its net emissions can be 8% above 1990 levels.

In theory Australia’s target should have an equivalent impact internally as New Zealand’s target. This is because both countries’ targets were determined with reference to their marginal rates of abatement. There is some debate regarding whether this will prove to be true in practice. One argument is that Australia has more opportunities for introducing energy efficient technologies. Debating the likelihood or otherwise of this is beyond the scope of this report.

Russia has the benefit of being in credit for the first commitment period due to its hot air generated as a result of its wider industrial base declining since 1990. An implication of this may be that relative input costs increases brought about by climate change policies, such as energy and transport costs, are smaller in Russia than in New Zealand.

A third key competitor is Chile. Its forestry sector input costs will not be adversely impacted by climate change policies as it is a non-Annex 1 country. If the effect of climate change policies is to alter the international price of logs, then the fibre input costs of its domestic processors may be impacted. This, however, is contingent on whether changes in the price of fibre sold domestically is closely related to those available internationally.

2.2.5 CDM

The CDM is a flexibility mechanism allowing Annex 1 countries under a project basis to plant forests in non-Annex 1 countries. The objective is to promote emission reduction practices in developing countries and achieve lowest cost international outcomes by expanding the benefits of sinks, with the mechanism retrospective from the year 2000.

The CDM is significant from the perspective that if it is effective in raising new planting levels in non-Annex 1 countries, in the long run this will impact on the international supply and price of logs.

There are a number of issues that call into question just how effective the CDM will be in practice. One is how the additionality clause of Article 12 of the Protocol will be interpreted. One school of thought is that new plantings would have to be additional to projected plantings in order to qualify. Chile, for example, has ambitious new planting targets. Competing schools of thought are that an investor could argue a strong case that he would not have invested in new planting had it not been for the CDM, and that the sheer scale of new planting possible under the CDM suggests that it could well be significant. With regards to the latter, the outcome of negotiations to date is that the CDM will be capped at 1% of 1990 Annex 1 emissions. This is equivalent to around 262 million cubic metres of additional log supply.[2] Consequently, if only 10% of this target is planted (given the additionality tests), this equates to New Zealand's total harvest in 2005. All schools of thought have their merits. The purpose here is not to debate which school of thought is likely to be right or wrong. It is to examine how the CDM could impact under a number of assumptions.

[2] This estimate is based on radiata's 100t/C average carbon sequestration for a 25 year rotation forest and 550 tonnes average yield per hectare

3. ANALYTICAL FRAMEWORK

In the following three chapters we present and discuss the findings of our quantitative modelling of the effects of climate change policies on the returns from investing in forestry and wood processing in New Zealand relative to the returns that could be earned by countries that have no greenhouse gas emission targets to meet. We have chosen Chile as the comparator as it is at the same time a non-Annex 1 country and a significant competitor in overseas markets where both countries export their logs and processed wood products. The purpose of this chapter is to describe the models and the scenarios examined.

We have modelled the impact of climate change policies using financial models of:

- the New Zealand planted forest estate, in order to analyse the impacts on existing forests; and
- hypothetical wood processing plants, both in New Zealand and Chile, to analyse the changes in relative investment returns.

In all the models we have fed in the results of sub-routines that determine the impact of climate change policies on:

- carbon permit prices;
- energy costs;
- transport costs; and
- log prices.

3.1 Estate model

The function of the estate model is to analyse the impacts of climate change policies on existing forests.

As discussed in chapter 2, climate change policies will have different impacts depending on the timing of planting (pre or post 1990), whether the planting is new planting or restocking, and the timing of harvest (pre or post 2008).

If New Zealand were to sign the Kyoto Protocol tomorrow, the forest owner/manager has a limited range of things that he may do in order to maximise profits subject to the policies. He may:

- alter silvicultural practices, provided the trees are not too old; and
- bring forward or push out the timing of harvest, or not ever harvest the trees.

This will impact upon the quality and quantity of the wood supplied from New Zealand's forests, the time profile of the wood supply, and the returns earned. Rotation length and the net present value (NPV) of New Zealand's investment in trees over time are the output variables of the model that are reported in the next chapter.

3.2 Wood processing model

A prospective investor in a new wood processing facility will evaluate a range of financial and non-financial factors before deciding whether to invest and, if so, whether to invest in New Zealand or elsewhere. All other things being equal, climate change policies will alter the relative financial attractiveness of investing in all countries. Wood fibre costs may change for both Annex 1 countries and New Zealand. Energy costs and internal transport costs will increase in New Zealand. The purpose of our wood processing model is to analyse how the relative financial positions change. To do this, we consider and compare the range of internal rates or returns (IRRs) of four wood processing options, namely a:

- packaging lumber mill;
- laminated veneer lumber (LVL) mill;
- medium density fibreboard (MDF) mill; and
- pulp mill.

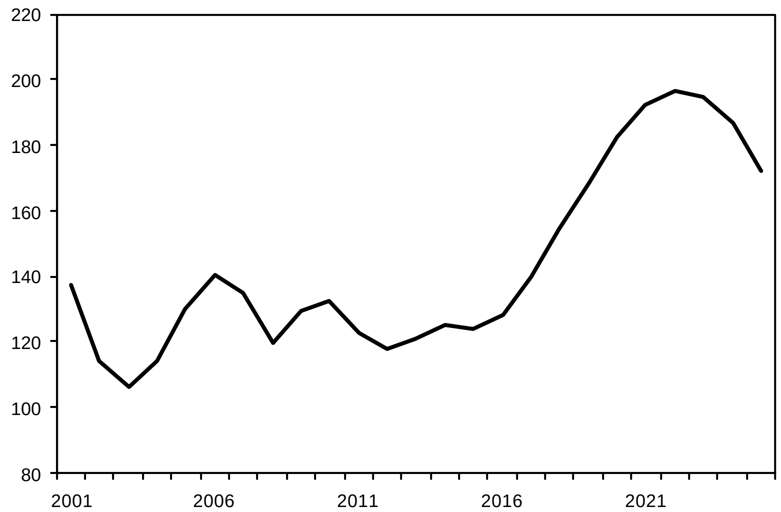
3.3 Business as usual assumptions

In the core models we assume that under business as usual:

- with the exception of log prices / fibre input costs, cost and revenue streams increase at the same rate as the generalised rate of inflation. Up until the current day we use consumer price index (CPI) actuals. From 2002 onwards we assume the CPI to increase by 2% each year; and
- nominal log prices pre 2025 follow the same price path as that modelled by RISI (refer Figure 4). From 2026 they are assumed to increase each year by the long run annual average percent change. Historically this has been 3%. The RISI forecasts suggest a 1% increase on average each year. We have, therefore, taken the middle path of 2%.

Figure 4 Nominal log price forecasts

Dollars per cubic metre



Source: RISI.

3.4 Sub-routines

Climate change policies will impact on:

- carbon permit prices; and, thereby
- energy costs;
- transport costs;
- log prices; and
- land prices.

Changes to these variables will alter the timing of harvest and returns to forestry for trees already in the ground and those about to be planted. They will also alter the input costs of wood processors and, thereby, decisions on where to locate future wood processing facilities. We feed changes in the first four variables into our core models discussed above. We ignore the effects of climate change policies on land prices, as there is considerable ambiguity around the direction of change in these prices given the variable effect of the policies on sectors that compete for use of the land.

3.4.1 Carbon permit prices

It is not possible to predict what prices will emerge in the future market for carbon permits when the likely size and dynamics of the market are still less than clear. The prices suggested in New Zealand and international literature range from US$10 per tonne of carbon to as high as US$400. With the United States out of the equation, so too is around 40% of the assumed demand for carbon credits. The supply-side impacts depend very much upon how much of Russia's considerable entitlements that it wishes to make available over time. These demand and supply considerations have influenced us to select carbon price scenarios towards the lower end of the scale.

The scenarios we examine are:

- no carbon permits , that is, business as usual;
- US$20 per tonne of carbon which, at an exchange rate of 0.42, is equivalent to NZ$48; and
- US$50 per tonne of carbon, which is equivalent to NZ$120.

3.4.2 Energy costs

The key energy source used to assist harvesting is diesel. As noted in the stage I report, forestry and logging is not a particularly energy intensive activity. The impact of climate change policies on these costs will, therefore, not be great. The energy consumed by wood processors, on the other hand, is more significant. Its primary source of energy is electricity.

Our calculations show that when the carbon permit price is:

- zero, there are no changes in energy prices other than those expected under business as usual;
- US$20 per tonne of carbon, the price of:
  - electricity prices will increase by 4.29% relative to business as usual,
  - diesel prices will increase by 4.64% relative to business as usual;
- US$50 per tonne of carbon, the price of:
  - electricity prices will increase by 10.73% relative to business as usual,
  - diesel prices will increase by 11.60% relative to business as usual.

Appendix D details how these price increases and those for the transport sector (below) were derived.

3.4.3 Transport costs

Transport costs in the forestry and logging sector are a function of how far the forest is from either domestic processors or export port. For wood processors they are a function of the distance to tertiary processors, domestic end users, or export port.

The fuel used most commonly by the heavy transport sector is diesel. Fuel contributes 17% to total transport prices.

When the carbon permit price is:

- zero, there are no changes in transport prices other than those expected under business as usual;
- US$20 per tonne of carbon, the price of transport will increase by 0.79% relative to business as usual;
- US$50 per tonne of carbon, the price of transport will increase by 1.97% relative to business as usual.

3.4.4 Log prices

In order to forecast log prices accurately we would need a detailed model that reflects the demand and supply situation for logs that compete in the end use markets overseas where New Zealand logs are sold (refer Appendix A). For the purpose of this report we have developed a sophisticated model of the New Zealand forest estate. In order to get a complete picture of log supply, we would need to do the same for each competitor country. We would also need to forecast the demand for logs in the countries where we sell our logs. To do so is possible in theory. Data constraints are , however, likely to make this a practical impossibility. This aside, the task would be time consuming and beyond the scope and timeframe of this project.

Instead, we present a series of price scenarios. Hence, financial models results are not forecasts, but rather case studies which allow different commercial options - when to plant, when to harvest, whether to re-stock - to be ranked depending on price expectations.

From our modelling of the log supply implications in New Zealand (refer next chapter), we know that if New Zealand signs the Kyoto Protocol tomorrow log supply will increase relative to business as usual in the short term until 2008, when climate change policies take effect. This is because forest owners / managers bring forward the harvest of their forests in order to avoid the liability of purchasing carbon permits to cover their emissions.

Post 2008 carbon permits are likely to encourage recently newly planted forests and future new forest plantings to be left in the ground longer, if not indefinitely. As the analysis in the next chapter shows, the higher the carbon permit price, the greater the incentive to delay harvest and to switch from rotational to permanent forestry.

The same dynamics would be experienced in all Annex 1 countries. However, rotational forestry would continue to be profitable in non-Annex 1 countries as no liability is incurred for harvesting trees and new plantings may still earn the forest grower credits under the CDM. The net effect in the period until 2008 is likely to be some downwards pressure on log prices as Annex 1 countries, such as New Zealand and Australia, try to sell more of there logs in shared markets, notably Korea and Japan (refer Appendix A for a discussion of the New Zealand log trade). After 2008, constrained supplies are likely to cause prices to increase. Non-Annex 1 competitors, such as Chile, may make up some of the demand gap. But as the gap is likely to persist, its ability to do so over the medium term will be constrained by its existing forest resource. The price effects of Chile's, Russia's and other countries logs coming on stream have already been factored into the price forecasts under business as usual.

A modifying influence on these dynamics is expectations. What happens in the short term prior to climate change policies coming into effect is partly driven by expectations about the future. Factors contributing to expectations include what the carbon permit price will be, the supply decisions of competing countries, and whether the CDM is likely to significantly impact on carbon permit prices and long term wood supplies.

Given these considerations and complexities, we have modelled three log price paths based on discussions with officials and industry, namely a:

- business as usual path;
- "best" case scenario: the anticipated and actual introduction of climate change policies will cause prices to fall by 1%relative to business as usual until 2007, and increase by 4% compared to business as usual from 2008; and
- "worst" case scenario: the anticipated and actual introduction of climate change policies will cause prices to fall by 5%relative to business as usual until 2007, and increase by 1% compared to business as usual from 2008.

Forecasting what will happen to log supply in the long term is fraught with difficulty as a number of considerations that will impact differently on prices, for instance:

- in future greenhouse gas commitment periods, developing countries may be included under the provisions of the Kyoto Protocol, thereby, contributing to the decline in log supplies from rotational forests and, as a consequence, applying an upwards pressure on log prices;
- if expectations are that developing countries, in particular Chile, are not subject to the Protocol's commitments in future periods, they may increase their new plantings now to address the demand gap. This will cause log prices to fall;
- if the United States eventually signs the Kyoto Protocol demand for carbon permits could increase by as much as 40%, this would have the effect of placing upwards pressure on these permit prices and increasing the attractiveness of leaving trees in the ground to maximise their value as a carbon sink. Log prices would rise;
- in the second and subsequent commitment periods the definition of what constitutes a carbon sink may be widened. If it is, then the supply of carbon permits will increase driving down permit prices, and the returns from delaying harvest of rotational forests and from permanent forestry. Log supply will increase and prices will fall.

The best and worst case scenarios represent two broad paradigms of how the log market may adjust to climate change policies. The "best" case scenario envisages a small negative effect in the pre-2008 period - a case where there will be only limited early logging to avoid the carbon tax - followed by sustained positive effect post-2008 as log supply declines due to permanent planting, and demand rises as other construction materials become less competitive.

The "worst" case paradigm assumes a sharper pre-2008 adjustment, and only a muted recovery.

3.4.5 Land prices

We have not modelled the impact of changes in the demand for and price of land given the ambiguity regarding the likely direction of change that will be observed as a result of climate change policies. The demand for land for forestry purposes will depend on which direction the incentives to plant and harvest trees lie. Forestry must also compete with alternative uses, such as sheep and dairying, for the land. The methane emitted by sheep and cattle is the primary source of greenhouse gases in New Zealand. Climate change policies could well have a range of differential impacts on the market for land depending on whether these sectors are included or excluded under the policies (refer NZIER 2001a). This dynamic will feedback and have an additional impact on the availability and price of land for forestry.

3.5 Scenarios

The figures on the pages that follow bring these models and sub routines together diagrammatically to illustrate the range of scenarios modelled in the following two chapters.

Figure 5 Estate model scenarios

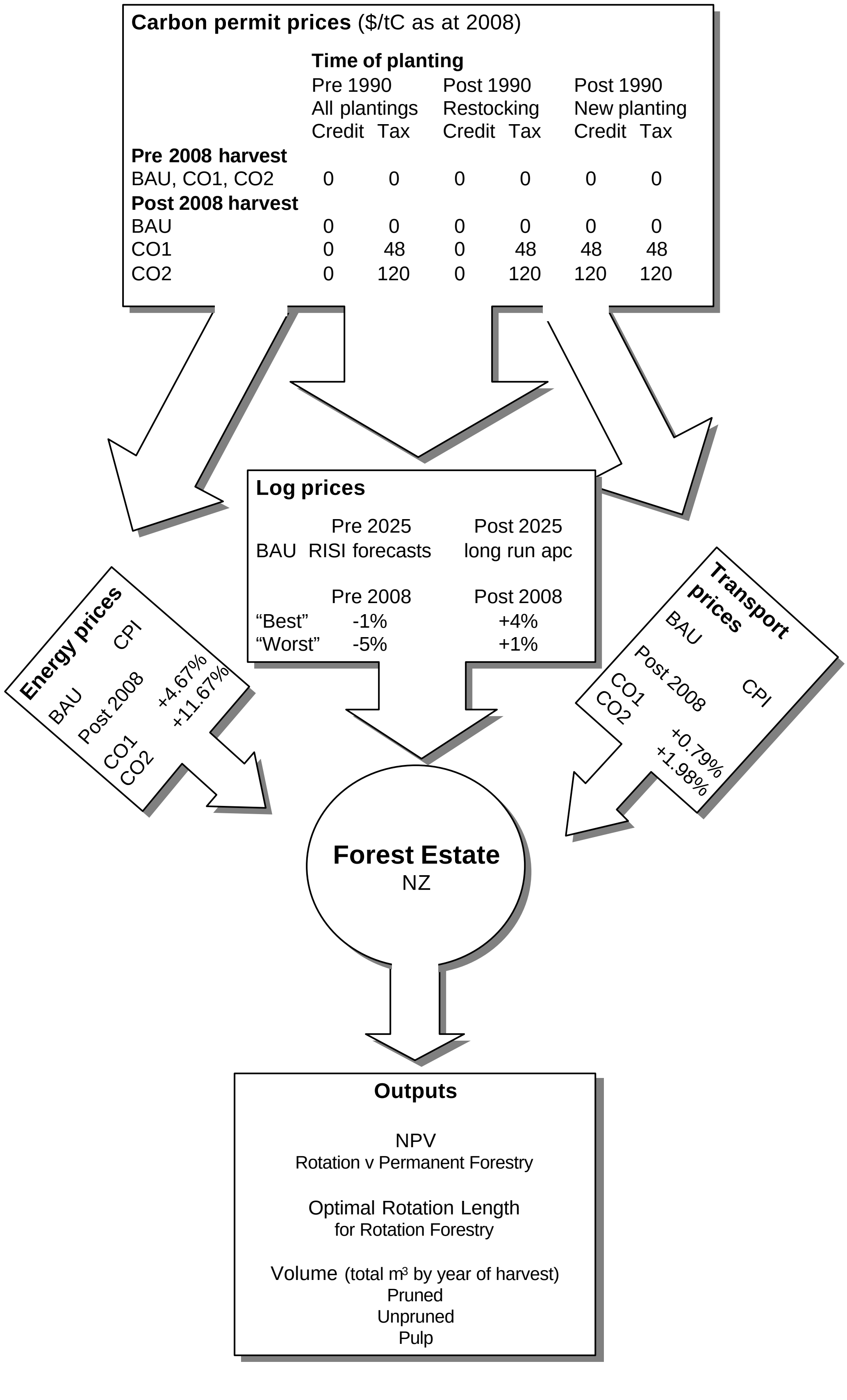
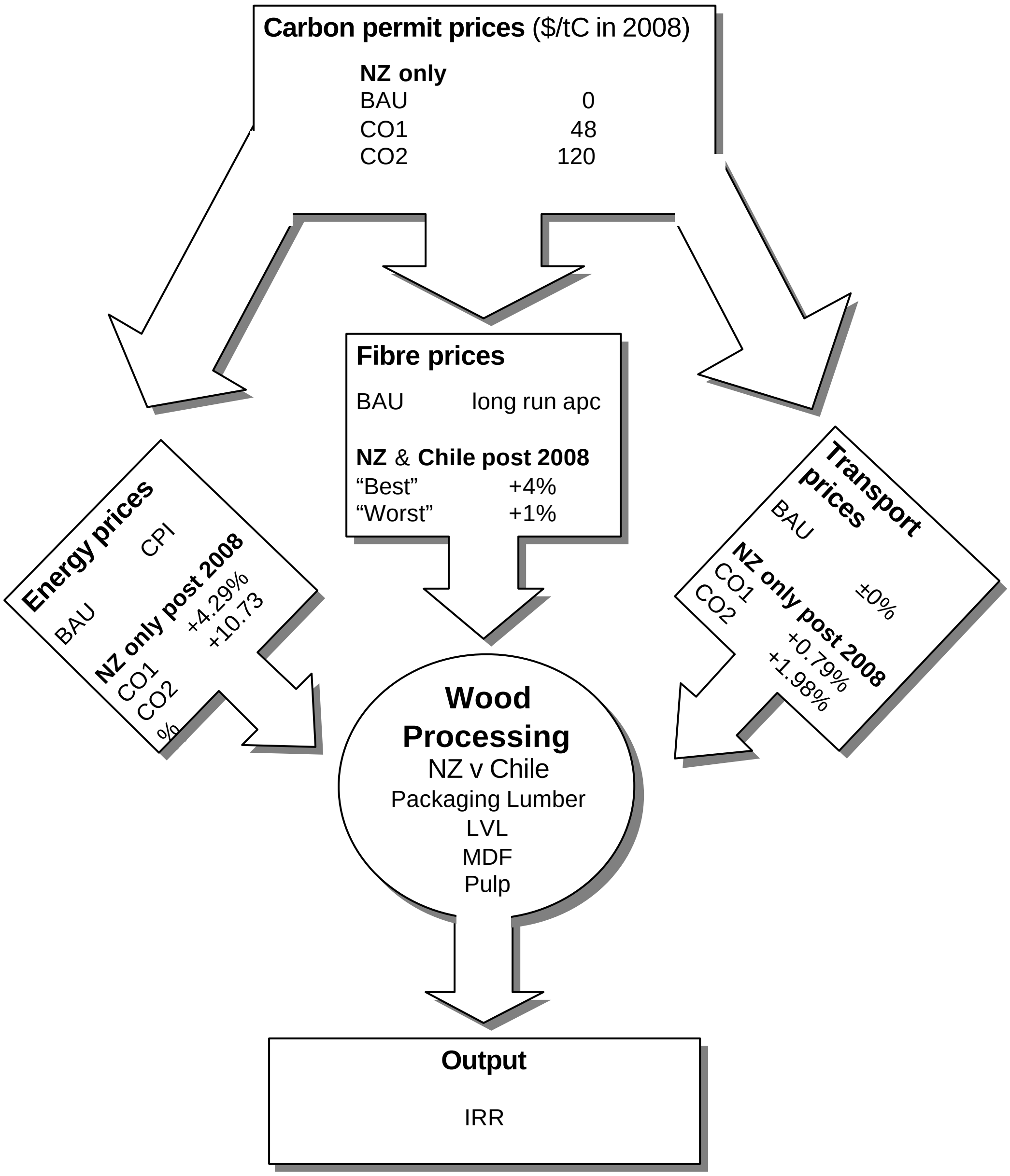


Figure 6 Wood processing model scenarios



4. IMPACTS ON THE CURRENT PLANTED FOREST ESTATE

This chapter addresses two questions:

- what would be the likely effects of climate change policies on wood supply in the future; and
- how will these policies affect the returns on forestry investment.

These questions are obviously inter-related, since changes in returns on forestry investment would have an important effect on land use changes. The current return on capital in forestry is around 4 – 6 percent, well below the typical weighted average cost of capital (WACC) of 8 to 11 percent. Hence, any further reductions in return may prompt exit from the industry.

In principle, there are two avenues of impact of climate change policies on wood supply:

- Foresters may choose to bring the logging of non-Kyoto forests forward before 2008 if they wish to change land use to avoid the tax on deforestation. This would create a short-term burst of supply, but will lead to a decline in future supply;
- Foresters may choose to keep Kyoto forests for permanent carbon sequestration rather than for logging. This would reduce future supply of wood fibre.

Below, we present the results from our modelling exercise on the rank ordering of the relative profitability of various forest management options. The models allow us to examine forest growers' likely responses to various log market and carbon market scenarios. The choices depend on when the trees were planted (pre or post 1990), when they are harvested (pre or post 2008), whether or not harvested areas have been restocked, and the carbon permit price. In the results that follow we make a distinction between two options: (a) no restocking (with an associated change in land use) and (b) restocking (which corresponds to no change in land use). Non-Kyoto forest owners also have the option of not restocking, but without changing land use i.e. leaving the land to revert back to forest. Due to time constraints, this option is not examined in any detail.

At the conclusion of the chapter, we discuss the implications of our model results for wood supply.

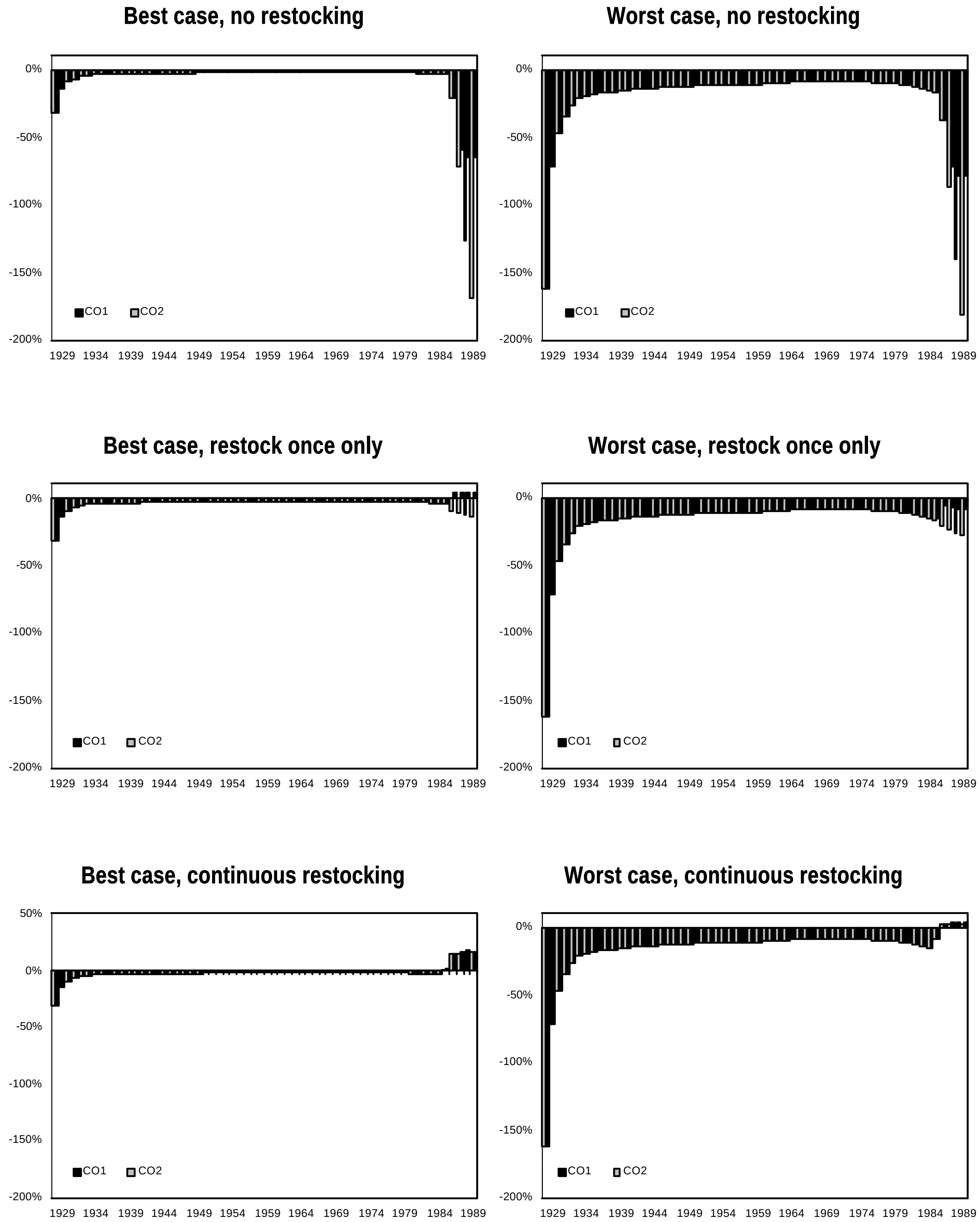
4.1 Pre 1990 plantings

Climate change policies have a detrimental impact on the profitability of trees that were planted in most of the years prior to 1990. Whether or not there are gains or losses in the planting years approaching 1990 depends on the carbon permit price, whether or not the trees are restocked, and, if so, whether they are restocked once only or continuously.

Table 7 (over) compares the change in the NPV earned with these policies against what would have been earned under business as usual.

Figure 7 Pre 1990: changes in NPV from BAU

Percentage change by year of planting



4.1.1 No restocking

For most of the period, the primary explanatory factor is prices. In anticipation of climate change policies taking effect, Annex 1 countries will bring forward the harvest of their trees, thereby, increasing log supply. The assumed fall in log prices causes the net present value of earnings to decline. The losses are greatest under the "worst" case scenario.

For trees planted in the years just prior to 1990, another dynamic comes into play. These trees, under business as usual, would have been left in the ground until they were 33 to 36 years old – well past the year 2008 when climate change policies take effect. Allowing for climate change policies to be anticipated causes the owners of these forests to log the trees early in order to avoid the liability of having to purchase carbon permits on harvest. This is most evident at the higher carbon price.

When the carbon price is $48 under both the "best" and "worst" case scenarios, trees that were planted in 1986, and would not have been harvested under business as usual until 2021, are now harvested in 2007, just prior to the introduction of climate change policies. The incentive to do this is the avoidance of the carbon emissions liability. The NPV of these trees is negatively impacted as the volume of logs yielded from these younger trees is considerably less. Trees planted between 1987 and 1989 continue to be harvested at 2021. The NPV of these trees is negatively impacted as forest owners are liable to pay for the total carbon that has accumulated in the trees up until their harvest.

At the higher carbon price of $120, again under both scenarios, all trees planted between 1986 and 1989 are harvested before 2008. The lower volume of logs yielded as a consequence explains the earnings reduction.

In today's dollars, the total loss for pre 1990 forests is estimated at between $698 million and $1.7 billion when the carbon price is $48, and between $1 billion and $2 billion at the higher carbon price of $120.

4.1.2 Restocking

When trees that are harvested and restocked, the losses are modified. The extent of modification depends on whether the trees are restocked once only or continuously. When trees are continuously restocked there is no cost in exiting the forestry market after 2007. However, continuous restocking ignores the fact that, if forest owners, at some time in the future, decide to exit the market, then at the time of harvest there will be an exit cost.[3] This means the net returns from switching to an alternative land use will be diminished because of the requirement to meet the carbon permit liability when exiting the forestry industry.

The "restock once only" option captures this exit cost by including in the NPV calculation the present value of the deforestation cost when evaluated at the end of the second rotation. In this case, the non-Kyoto forest owner restocks only for one additional rotation, and thereafter decides to exit the forestry market. Clearly the present value of this deforestation cost will diminish the longer the forest owners delays his decision to exit.

a) Restock once only

If they are restocked once only and land use changes after the second rotation then the losses are estimated at between $206 million and $1.3 billion when the carbon price is $48, and between $351 million and $1.4 billion at the higher carbon price of $120. The reduced ranges (compared to no restocking) are because payment of the effective carbon tax is delayed until the end of the next rotation period.

In the "best" case scenario, when the size of the tax is low, tress planted between 1987 and 1989 are rewarded for not altering their harvest dates by higher log prices for trees harvested in the post 2007 period. These trees earn a greater return than under business as usual as the increase in log prices is sufficient to offset the deferred deforestation cost. At the higher carbon permit price the rewards are insufficient to

[3] Exit cost is defined as the difference in the carbon permit liability payable on harvest when restocking versus not restocking. The exit cost for non-Kyoto forests reflects the cumulative carbon yield in the forest at harvest year. See Appendix C for a more complete discussion of this issue.

counterbalance the erosion of earnings attributable to the carbon liability incurred at the end of the second rotation.

Under the "worst" case scenario forest owners are always worse off as low log price increases post 2008 are not sufficient to compensate for the carbon liability, regardless of whether the carbon permit price is assumed to be high or low.

b) Continuous restocking

If they are continuously restocked, so that land use never changes out of forestry, then the losses are even further reduced. They are estimated at between $86 million and $1.1 billion when the carbon price is $48, and between $95 million and $1.1 billion at the higher carbon price of $120. The reduced ranges reflect the fact that no carbon liability is incurred. The losses are due entirely to the hypothesised log price reductions occurring before 2008.

Under both the "best" and "worst" case scenarios the owners of forests planted between 1985 and 1989 are better off due to the post 2007 log price increases. The gain in earnings is greatest under the "best" case scenario as log prices are assumed to increase by more relative to business as usual.

While continuous restocking acts to defer the deforestation tax and therefore reduces the financial losses for non-Kyoto forests, it is necessary to consider the poor current industry returns when evaluating whether this will be the likely response. Forestry returns are currently approximately half the industry's required return (or WACC). Given that the RISI log price forecast under BAU projects a long term nominal price increase of only 1.25% pa, unless the industry can substantially reduce its costs, it is unlikely that the industry will in the near future achieve WACC returns. On this basis, with climate change policy that will reduce profitability further, it is possible that non-Kyoto forests will not want to be locked into this underperformance and will seek to deforest before 2008.

4.2 Post 1990 plantings

Trees newly planted after 1990 become entitled each year to carbon permits equal to the value of the volume of carbon sequestered in that year. Forests planted prior to 1990 do not share the same entitlement. Nor do trees planted post 1990 when the purpose of planting is to restock previously harvested areas.

In chapter 2 we observed that most plantings since 1990 have been newly planted. For the purposes of analytical simplicity we have analysed here only the trees that have been newly planted since 1990. The consequence of this is that we are likely to be overstating the benefits. For post 1990 restocking we can expect that when carbon permit prices are high (and thereby the effective tax at harvest), log prices are low, and when harvested trees are not restocked the owners of these forests will be worse off. There is a potential for some gain in the opposite situation.

Figure 8 illustrates the impacts of climate change policies on the NPVs of forests newly planted post 1990 compared to what would have been earned under business as usual. The impacts differ depending on whether the forests are restocked or not or left in the ground as permanent cover.[4] Also relevant is the time of planting and the carbon permit price.

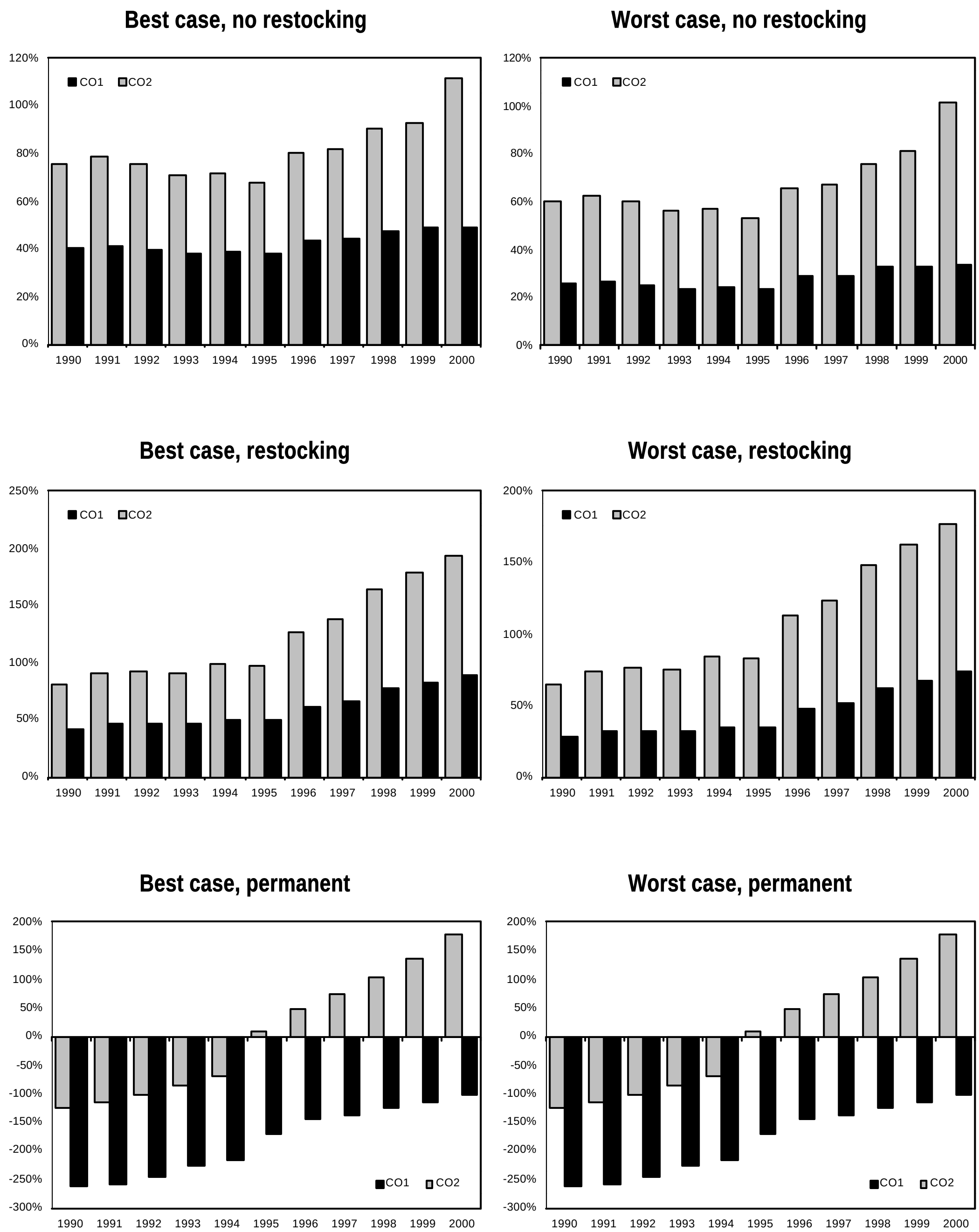
[4] When discussing the restocking option we make no distinction between restocking only once and continuous restocking. We assume that there is no exit cost for Kyoto forests after the first rotation (see Appendix C).

4.2.1 Rotational forests

Under the "best" and "worst" case scenarios, rotational forest owners are better off post 1990, regardless of whether or not restocking occurs. As one would expect the returns are larger the higher the carbon price post 2008, the higher the assumed log price increase, and when the trees have been restocked. Restocking allows forest owners the option of paying the lesser of the total carbon removed and the volume of credits received. In comparison, forests that are not restocked face a liability based on the volume of credits received since 2008.

Figure 8 Post 1990: changes in NPV from BAU – impact of carbon charges

Percentage change by year of planting



When restocking occurs, rotation lengths are largely unchanged compared to business as usual. Under the best case scenario, the gains when forests are restocked are estimated to be worth $1 billion when the carbon price is $48, and $2 billion at the higher carbon price of $120. The gains when no restocking occurs falls to $0.7 billion when the carbon price is $48, and to $1.4 billion at the higher carbon price of $120. These differences reflect the fact that restocked forests face a lower carbon charge at the time of harvest than forests which are not restocked.

4.2.2 Permanent forests

We have allowed for the possibility that if the value earned each year for carbon sequestered is high enough, this may be sufficient to entice a forest owner to leave his trees in the ground indefinitely.

Under the permanent forestry option the forest owner is assumed to avoid all silviculture costs not already occurred before 2001. Harvesting costs are also avoided since the trees are never harvested, although, like rotational forestry, permanent forestry is entitled to earn carbon credits from 2008.

On this basis, the point of differentiation between rotational and permanent forestry is the price of the carbon permit.

At low carbon permit prices, there is an erosion in earnings every year compared to what would have been possible under business as usual. There is no incentive to switch to permanent forestry. This is because the earnings from carbon sequestered are not sufficient to compensate for the loss of earnings from not harvesting the forest and realising a value for the logs. Under the best case scenario, the total loss is estimated to be worth $3 billion when the carbon price is $48.

At higher carbon permit prices, this loss making situation only holds until 1994. After that year the profitability of permanent forests improves relative to business as usual. Two dynamics underlie this turnaround; both are related to the age of the trees. The first is the same as what occurs under rotational forestry: because the trees are still young when they become entitled in 2008 to earn carbon permits for carbon sequestered, their carbon permit earning capacity is considerable. The second is that young trees provide the forest owner the flexibility to avoid silvicultural costs once he has decided to switch to a permanent regime. This luxury is not afforded to the owners of older trees to the same extent as those trees will have already incurred much of their silvicultural costs. The net effect is a total gain of $36 million.

4.2.3 No restocking, restocking and permanent forestry

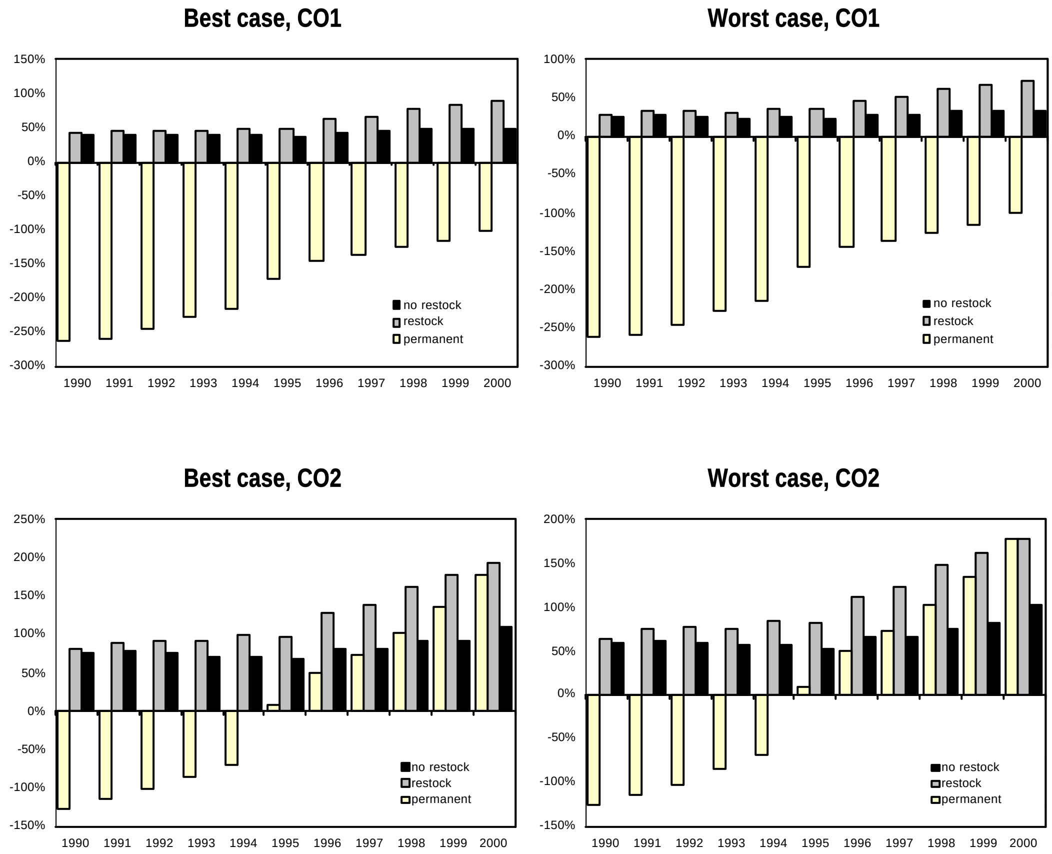
This leads us naturally on to thinking about which of the alternative regimes available to the forest owner is likely to be the most profitable – no restocking, restocking or permanent forestry? Figure 9 (over) suggests the answers.

In each of the scenarios examined, restocking is the best strategy to maximise earnings. The benefit of restocking over not restocking is that forest owners who restock pay the total carbon removed. This is less than the annual credits received, which is the liability faced by forest owners who choose not to restock.

At the low carbon credit price of $48 per tonne of carbon, permanent forestry is the least favourable strategy. The benefits of earning a return solely from the carbon sink capacity of the forests are not sufficient to compensate for the loss of earnings from not harvesting the logs.

Figure 9 Post 1990: changes in NPV from BAU – no restocking vs restocking vs permanent forestry

Percentage change by year of planting



At the higher price of $120 per tonne of carbon these dynamics reverse from 1995 onwards. The combination of young trees and high permit prices enables positive earnings from this point on. It is also possible to avoid much of their silvicultural costs. For trees recently planted, permanent forestry is a superior strategy to felling the trees after the first rotation and not restocking. However, restocking continues to be the best strategy.

4.3 Conclusions for wood supply

The key result from the above modelling is that climate change policies introduce considerable uncertainty into the behaviour of forest owners. The answers to the questions considered above (whether to bring logging forward, whether to restock, whether to keep Kyoto forests for carbon sequestration) are finely balanced. The preference order can switch easily with only minor changes in assumptions about:

- carbon prices;
- log prices;
- actual rules through which Kyoto is implemented; and
- preferred silvicultural regimes.

The direct changes in wood supply predicted by the model appear to be minor. Under the assumptions used in the exercise:

- The best strategy is to restock the non-Kyoto forests. When this occurs there is little variation in rotation lengths. There is little incentive to bring forward harvest dates to the first period as the carbon liability will not be incurred until a more distance future.
- The carbon permit prices are not high enough to encourage a switching to permanent forestry.

However, this apparent stability of results should be treated with great caution. First, the results are strongly influenced by the business as usual price forecast, which predicts a price spike prior to 2008. As a result, even under the business as usual scenario, the model indicates that it is optimal to increase the harvest before 2008 from the current 17 million cubic meters per annum to around 60 million cubic meters per annum. In reality, such an increase is unlikely without further depressing prices. Hence, rather than indicating the stability of supply, the model highlights the underlying uncertainty.

Second, the model does not compare forestry land use with the available alternatives. Restocking is ranked as the preferred option only compared to other forestry options. Since even with restocking, the return on non-Kyoto forestry declines compared to business as usual, the model indicates that switching in land use is likely to become a more attractive option. Hence, the model indicates that there is an increased risk of some of the pre-1990 estate being switched out of forestry prior to 2008.

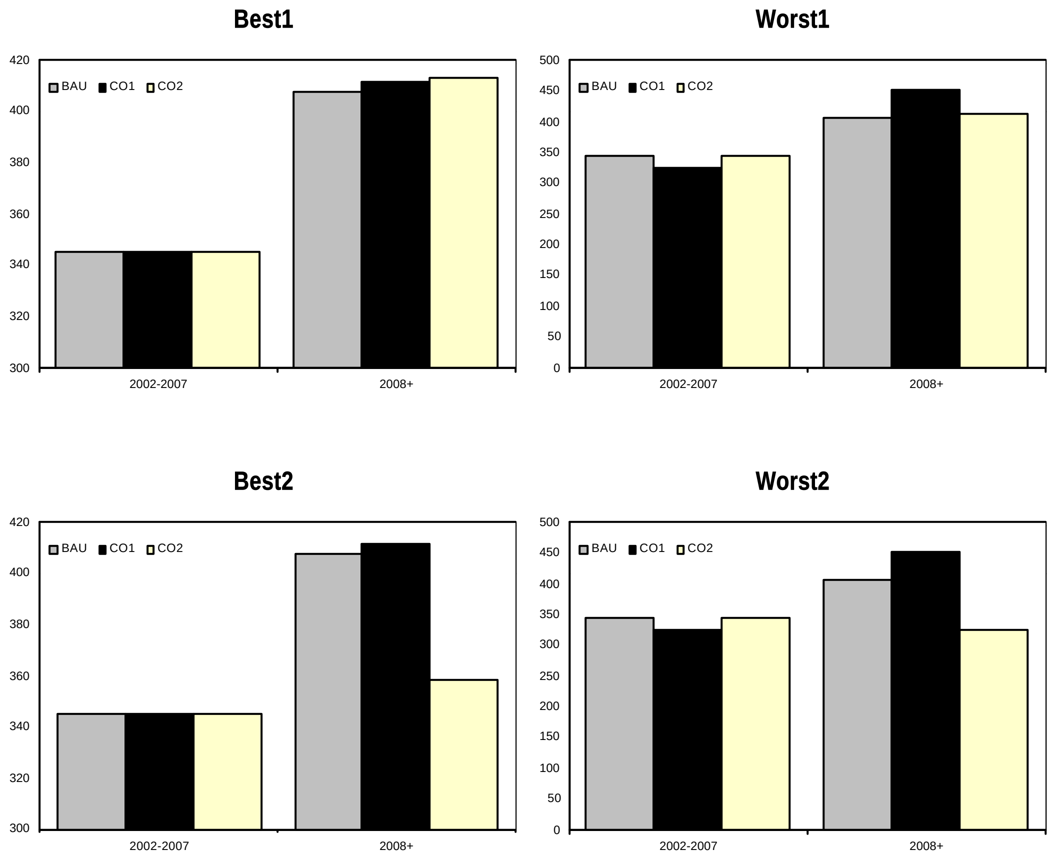
Finally, only very small changes in assumptions would rank permanent forestry as the preferred option for post 2008 forests. This suggests that uncertainty about future wood supply is considerable.

Figure 10 (over) illustrates the extent of this sensitivity. The top two charts show the wood supply when Kyoto forests, that restock, pay a carbon charge at harvest which is the lesser of the total carbon released (cumulative carbon less the residual carbon) and the carbon credits received between 2008 and harvest year. The bottom two charts show the wood supply when Kyoto forests, that restock, pay a carbon charge at harvest based on the carbon credits received. In the former case permanent forestry is never optimal. In the latter case, when the carbon charge is high, permanent forestry is optimal for forests planted after 1996, and consequently the wood supply from 2008 declines as forests are "locked up".

Overall, the model indicates that climate change policies increase the risks faced by wood processors whose long-term investments rely on New Zealand wood supply. For example, it is unlikely that any significant investment would occur to deal with a short term burst of pre-2008 supply. More generally, this added uncertainty is likely to increase the hurdle rate of return required by wood processing investors in New Zealand.

Figure 10 Variations in wood supply

Millions of cubic metres



5. IMPACTS ON WOOD PROCESSING

Growth in wood processing in New Zealand will depend on two factors:

- reliable growth in the supply of wood fibre; and
- New Zealand's relative competitiveness as a wood processing location.

The analysis in the previous chapter shows that climate change policies introduce an element of risk into the availability of wood supply in New Zealand. This risk is two-fold. First, pre-2008 logging to avoid the carbon liability on non-Kyoto forests may reduce the availability of wood post-2008. Second, for Kyoto forests, relatively small changes in assumptions about future log prices, future carbon prices, forestry management regimes and the actual implementation of specific climate change policies can lead to the cross-over from plantation forestry to permanent forestry.

Once such cross-over point is reached, wood processors would either face the risk of reduced supply, or would have to pay higher than international fibre prices in New Zealand to secure supply. This increase in risk is likely to raise the hurdle rate of return on wood processing investment in New Zealand. However, while the target rate of return would rise, the actual rate of return on New Zealand investments may decline due to the implementation of climate change policies.

The purpose of this chapter is to consider New Zealand's relative competitiveness (and attractiveness) as a wood processing location following the introduction of climate change policies. International comparisons of competitiveness are fraught with difficulty, and cannot be reduced simply to production costs. However, all other things being equal, changes in relative production costs provide a useful guide to the magnitude of the challenge New Zealand faces in order to remain a competitive location.

We start by comparing the existing gap in production between New Zealand and Chile, our key competitor. The current pattern of the New Zealand forestry industry - where we are substantially an unprocessed log exporter (refer Appendix A) - is explained by these production costs as well as all other relevant factors, such as the regulatory environment and so on. New Zealand has so far struggled to become a major international value-added wood processor. Keeping all other factors unchanged, the change in the relative production costs indicates how much more complex this task will become.

The operating environment in New Zealand under climate change policies alters due to changes in fibre, energy and transport input costs. The energy and transport cost increases could arguably be moderated through the introduction of energy savings technology and the use of renewable energy sources, such as biofuels. (These options are available and are currently being used by competitors such as Chile) However:

- technology improvements are available to all players internationally as the supply of infrastructure to wood processing is concentrated; and
- renewable sources of energy are generally high cost options. Their uptake would only become viable if carbon prices are high, and hence would still increase New Zealand's relative costs.

Overall, for the purposes of benchmarking the likely magnitude of impact, we consider it appropriate to examine the direct impact of carbon prices on the existing energy content of wood processing. Moreover, any increase in future energy efficiency may be offset by the shift to more value added – and largely more energy intensive – products.

By contrast with New Zealand, no changes in energy and transport costs will occur in Chile as a consequence of the introduction of climate change countries, as Chile is a non-Annex 1 country. However, as log prices are determined in the international market, changes to this input cost component will be felt in Chile, as well as in New Zealand.

The five wood processing investment options analysed are greenfield investments in mills to produce:

- packaging lumber;
- LVL;
- MDF;
- chemical pulp; and
- mechanical pulp.

The base data used to analyse all these options except the last is sourced from a recently completed Jaakko Poyry examination of "The Business Case for Investing in New Zealand Value-added Processing of Solid Wood and Other Wood Products" (Jaakko Poyry 2001a and 2001b).[5] The fourth option of a chemical pulp mill has been analysed by using input cost data from mills around the world (NLK 2000) and aggregating that data by country or region using output capacity weights. The fifth option of a mechanical mill uses industry data.

5.1 Costs and profitability

Given the uncertainties, we present the data from two perspectives: production costs and profitability of product delivered to a common market. Production costs in New Zealand and Chile exclude sea freight to specific markets. Cost comparisons at mill gate provide a broad basis for considering the issues facing a processor who may need to deliver to a variety of markets. For example, New Zealand has lower delivered costs than Chile in the Chinese market for MDF, but greater costs to the United States market as a consequence of the differences in sea freight due to distance. Moreover, comparisons are made more complicated due to different pricing structures, with the United States typically attracting a price premium in comparison to Asian markets. By excluding these factors, we focus on production cost issues and abstract from the difficulties which are, in any case, caused by New Zealand's relative distance from the more profitable developed country markets.

However, for the purpose of assessing relative profitability, we examine total costs (including sea freight) against prices for product delivered to a common overseas market. In this case, we choose the destinations such as China or Japan, where New Zealand and Chile currently compete. The detail of the data is contained in Appendix E. The results are discussed broadly below.

[5] This comparative study, which is being updated on a regular basis, was commissioned by Investment New Zealand to inform its wood processing investment attraction work with international companies and to benchmark the ongoing effectiveness of the Government's wood processing strategy initiative.

5.2 Packaging lumber

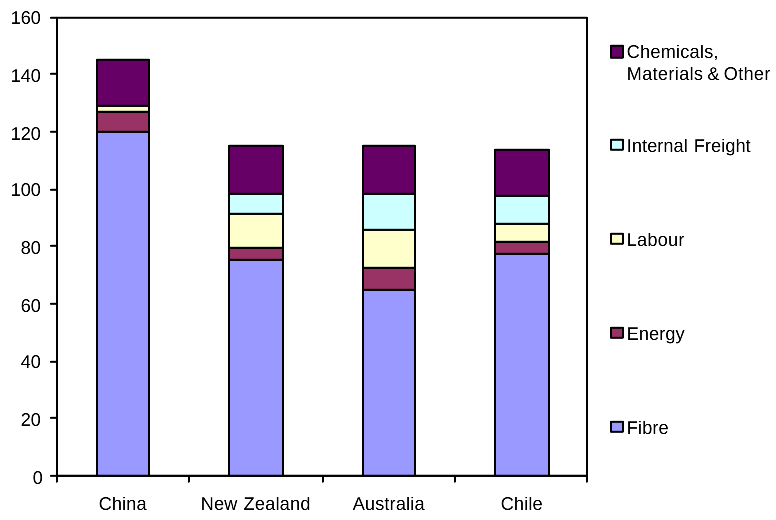
Packaging grade lumber is low grade sawn timber suited to low value end uses, such as packaging, pallets and cable drums. Within New Zealand, packaging lumber mainly produced by sawmills as a by-product of structural timber production This is because the returns on packaging lumber are generally low. While no major New Zealand mills currently exist to produce solely or even predominantly packaging grade lumber, some (such as, for example, Jakkoo Poyry) have argued that it is an option for the future, particularly given the trend towards felling trees at a younger age. Mills focused on producing packaging lumber exist in Chile and make a profitable return.

5.2.1 Cost competitiveness

There is not much difference in the total input costs faced by New Zealand producers of packaging grade lumber and that of its competitors in Australia and Chile. Low labour costs is the main source of Chile's cost advantage relative to the rest.

Figure 11 Packaging lumber

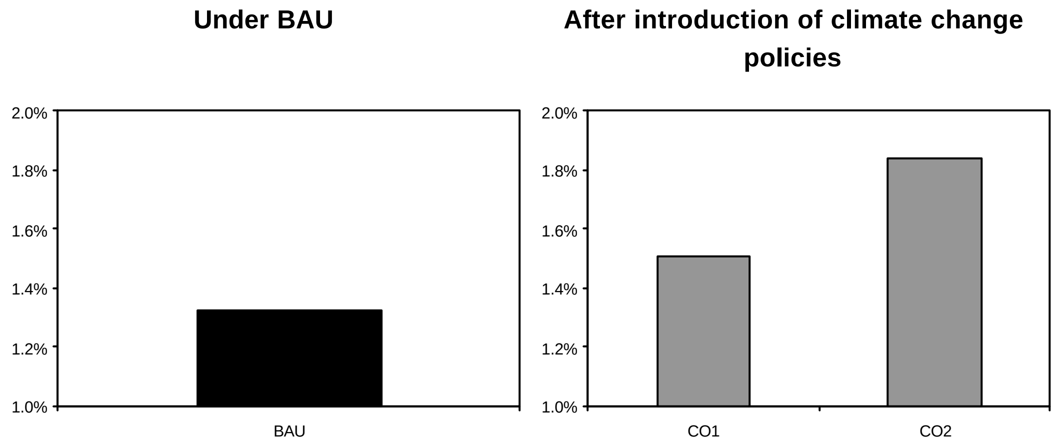
United States dollars per cubic metre, FOB



Source: Jaakko Poyry 2001a.

The effect of climate change policies is to increase the margin of difference between New Zealand and Chilean producers of packaging lumber.

Figure 12 Packaging: NZ cost competitiveness relative to Chile
Percentage differences



Note: Fibre prices are assumed to increase by 1% after the introduction of climate change policies. The case of a 4% increase is not examined here as it adds little to the analysis.

5.2.2 Profitability

Packaging lumber is a very price sensitive business. A fall in prices or increase in input costs of just a few dollars may be all that is required to turn a profitable enterprise into a loss making entity.

When packaging lumber is exported to China or Japan, New Zealand producers enjoy greater returns than their Chilean counterparts as relatively lower seas freight rates outweigh Chile's labour cost advantage. This does not change even with the introduction of climate change policies. However, if prices persist at their current low levels, climate change policies will cause such a significant reduction in expected returns that a prospective investor is no longer likely to regard a packaging lumber mill as a wise avenue for investment.

5.3 Laminated veneer lumber

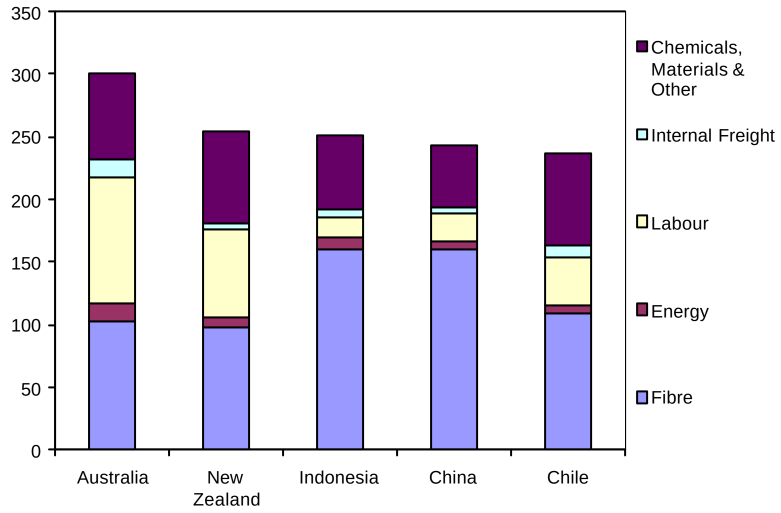
LVL is produced using high density logs. It is made by bonding sheets of veneer and laminating the surfaces. It is then cut into the dimensions demanded by end use markets.

There are currently only two producers of LVL in New Zealand – Juken Nissho and Carter Holt Harvey, who opened the doors to its mill in late 2000.

5.3.1 Cost competitiveness

A comparable situation exists between LVL producers. New Zealand producers share similar overall costs to their counterparts in Chile, Indonesia and China. As was the case for packaging lumber, Chile's cost competitiveness is explained by its low labour costs.

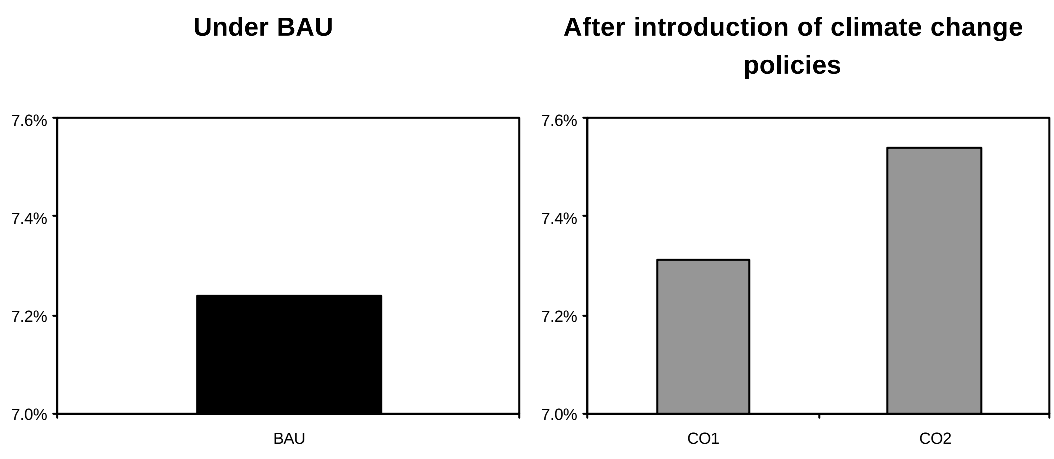
Figure 13 LVL costs
United States dollars per cubic metre, FOB



Source: Jaakko Poyry 2001a.

Climate change policies have the effect of increasing the cost differential between New Zealand LVL producers and their Chilean counterparts.

Figure 14 LVL: NZ cost competitiveness relative to Chile
Percentage differences



Note: Refer note under Figure 12.

5.3.2 Profitability

Marginally lower costs in Chile mean that an investment in a new LVL mill is likely to earn higher returns if located in that country relative to an equivalent investment in New Zealand. But only marginally so; under business as usual, a prospective investor is likely to be indifferent between investing in either country.

This indifference is not likely to be sustained under the influence of climate change policies. All other things being equal, the marginal investor will view Chile as the more positive prospect, given the widening of the gap between expected earnings.

5.4 Medium density fibreboard

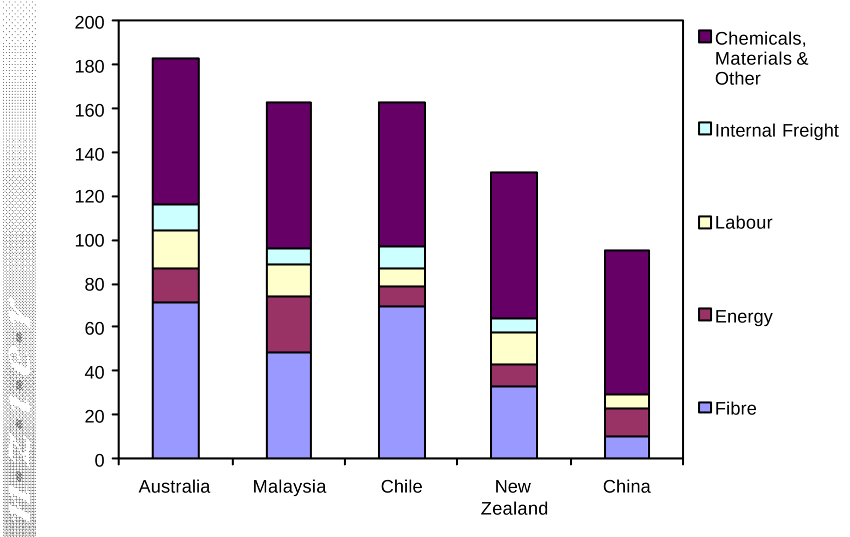
MDF is a value-added panel accepted world-wide for its uses within the furniture sectors, house construction and house remodelling. MDF is made by refining wood fibre, adding resin and pressing into panel form.

5.4.1 Cost competitiveness

The data suggests that New Zealand's costs are lower than those faced by its competitors from Chile, Malaysia, and Australia. China enjoys significantly lower costs than its overseas rivals due mainly to low fibre input costs. Industry sources, however, suggest that its fibre cost advantage is not as great as shown, nor New Zealand's advantage relative to Chile for the same input.

Figure 15 MDF costs

United States dollars per cubic metre, FOB

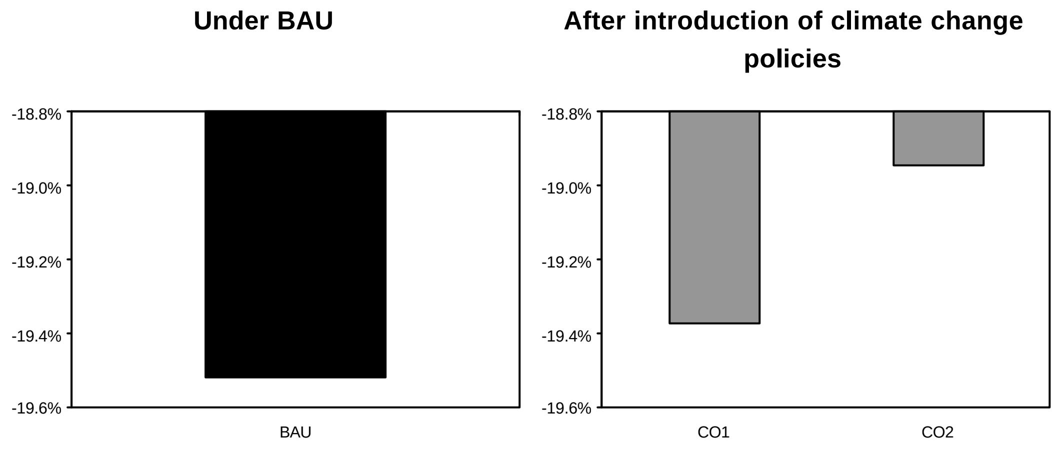


Source: Jaakko Poyry 2001a.

The increases in the costs of inputs affected by climate change policies – fibre, energy and freight –impact on the costs of New Zealand producers. There is some erosion in New Zealand's relative cost competitiveness compared to Chilean producers, but its advantage persists. This is partly due to New Zealand mills' success in keeping their energy costs down by burning their wastes to generate energy.

However, we should point out that our simplified cost model does not pick up is the fact that the prices paid for resin, which has a major oil based input, are likely to also increase as a result of climate change policies. As a consequence, the changes are likely to be greater than those illustrated.

Figure 16 MDF: NZ cost competitiveness relative to Chile
Percentage differences



Note: Refer note under Figure 12.

5.4.2 Profitability

The profitability of New Zealand's MDF product delivered to China is very similar to and even slightly higher than for Chilean product.

The effect of climate change policies is to upset New Zealand's position as the more profitable investment destination. The profits that could be earned in Chile are higher under every scenario examined.

5.5 Pulp

There are two main categories of pulp – mechanical and chemical. Chemical pulp is produced by "cooking" wood chips in a chemical solution at high temperatures. It is strong and well suited to the production of packaging paper. Chemical pulp can be bleached further for the production of higher quality paper products. Mechanical pulp is produced by physically separating wood fibres in an energy-intensive process. It is suitable for newsprint, tissues and other paper grades.

Here we analyse the impacts of climate change policies on both types of pulp. However, due only to the fact that comparative cost data is more readily available for chemical pulp, more space is dedicated to its discussion. Energy use in the production of chemical pulp is lower and heavily supplemented in New Zealand through co-generation techniques, utilising wood-based biofuels.

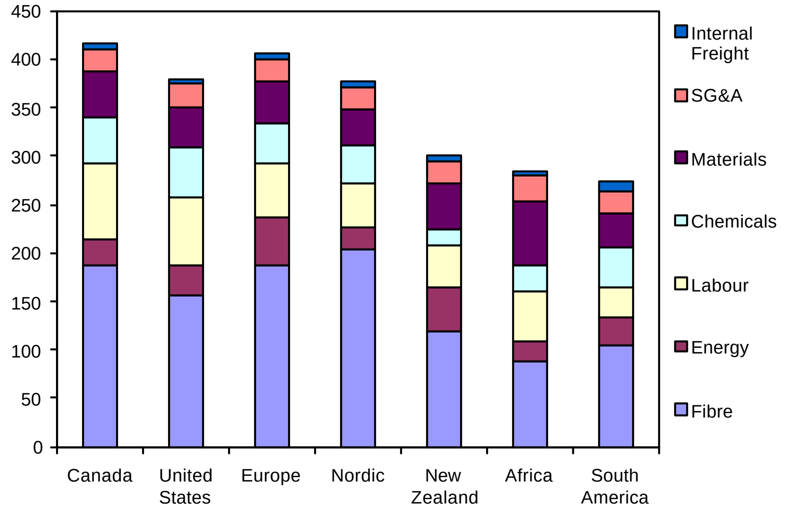
5.5.1 Cost competitiveness

a) Chemical pulp

The production of chemical pulp is a high cost activity. Lower fibre input costs gives Australia a cost advantage ahead of New Zealand. Higher labour costs mean that New Zealand producers are at a cost disadvantage relative to its South American competitors.

Figure 17 Chemical pulp costs

United States dollars per air dried metric tonne, FOB



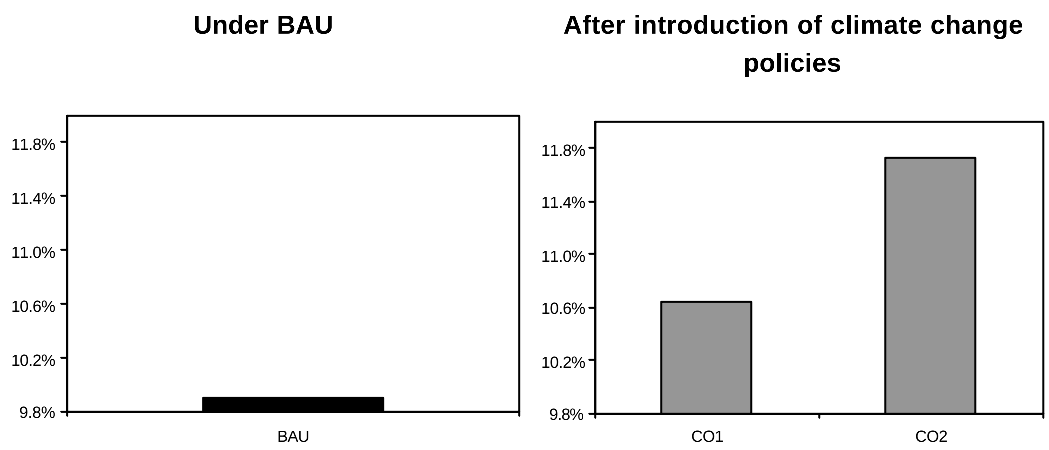
Notes: (1) Costs, other than internal transport costs, represent a capacity weighted average of all costs detailed in the source document.
(2) Internal transport costs have been approximated using Jaakko Poyry data.

Source: NLK 2000.

Increases in energy and freight costs add to the existing differential between New Zealand and Chilean producers.

Figure 18 Chemical pulp: NZ cost competitiveness relative to Chile

Percentage differences



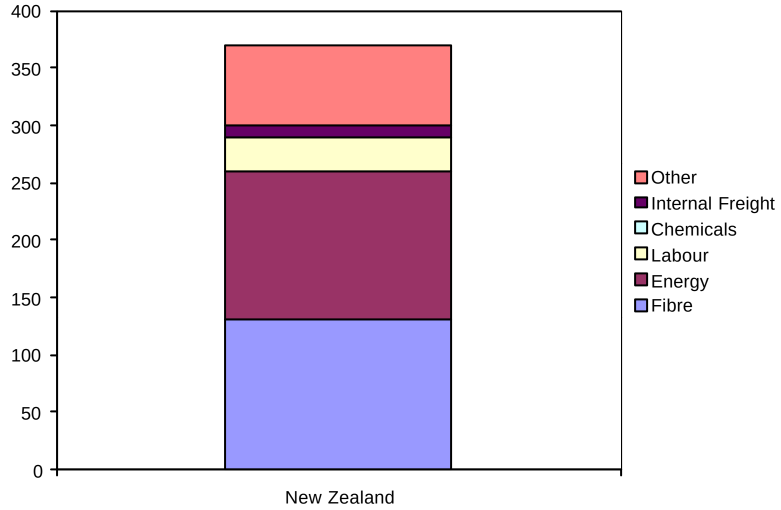
Note: Refer note under Figure 12.

b) Mechanical pulp

This is the process currently employed at five mills in New Zealand. These include market mechanical pulp, and pulp as a fibre furnish for newsprint, tissue and paper-board. As an input into mechanical pulp production, energy is on a level pegging with fibre costs and accounts for 35% of the total.

Figure 19 Mechanical pulp costs

United States dollars per air dried metric tonne, FOB

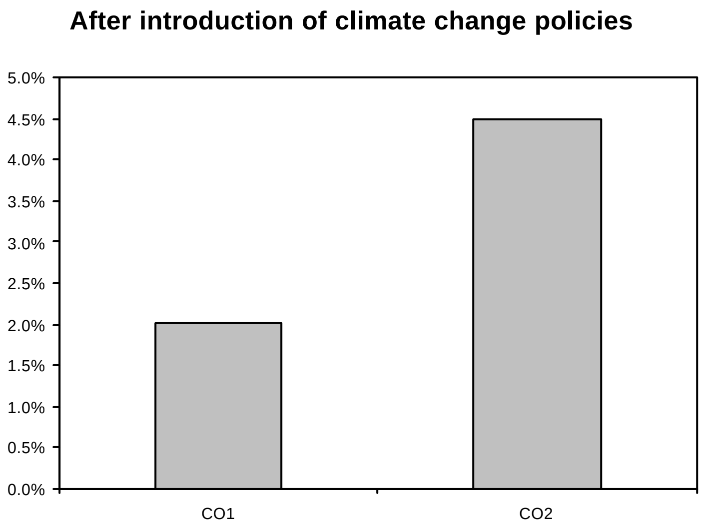


Source: Confidential industry source.

Relative to business as usual, the impact of climate change policies is to cause production costs to rise by between 2.0% and 4.5%. These are significant in the context of recently realised cost reductions which have been driven by the need to retain international competitiveness and move towards satisfactory profitability.

Figure 20 Mechanical pulp: New Zealand's cost competitiveness relative to BAU

Percentage differences



Note: Refer note under Figure 12.

5.5.2 Profitability

a) Chemical pulp

Of the two countries, under business as usual, Chile is the more profitable investment option. The effect of climate change policies is merely to exacerbate this difference, making it more likely that a prospective investor would view Chile in a more positive light than New Zealand. Modelled falls in profitability of between 3% and 8% are significant given unsatisfactory long run returns.

b) Mechanical pulp

Mechanical pulp production is not a highly profitable investment option, even in the absence of climate change policies. The effect of these policies is to reduce profitability by between 21% and 61%, exacerbating the unattractiveness of this investment option. While this is not a highly attractive investment opportunity on its own, it is expected that if New Zealand is undertake significant further processing of the forecast harvest that further mechanical pulp mills will be required. It is important to understand the integrated nature of the industry and that without a viable disposal source for the industry's residuals (thinning, chip & saw dust), returns for the processing options discussed above would be substantially lower. As indicated, from a competitive perspective, Chile is the preferred investment location for this activity.

5.6 Conclusion

Depending on the product the gaps between the internal rates of return on investments in New Zealand, compared to similar investments in Chile, widen after the introduction of climate change policies. The gap between the returns available to those who choose to invest in a chemical pulp plant in New Zealand, for example, is a quarter less than the returns available to the same investment in Chile. Combined with the likely increase in the hurdle rate of return on investment in New Zealand compared to Chile, the reductions in relative profitability is likely to reduce the probability of many processing investment taking place in New Zealand.

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New Zealand Forestry	www.forestrynz.govt.nz
New Zealand Climate Change Programme	www.climatechange.govt.nz
Statistics New Zealand	www.stats.govt.nz
United Nations Food and Agricultural Organisation	www.fao.org

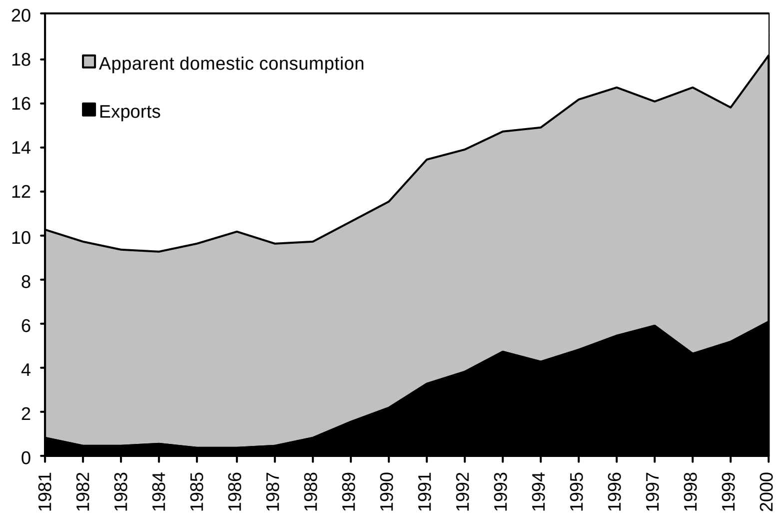
APPENDIX A: THE LOG TRADE

A.1 Markets

Currently, 34% of logs supplied from New Zealand's planted forests are exported. The remaining 66% is consumed as an intermediate input by domestic processors.

Figure 21 Log consumption

Millions of cubic metres



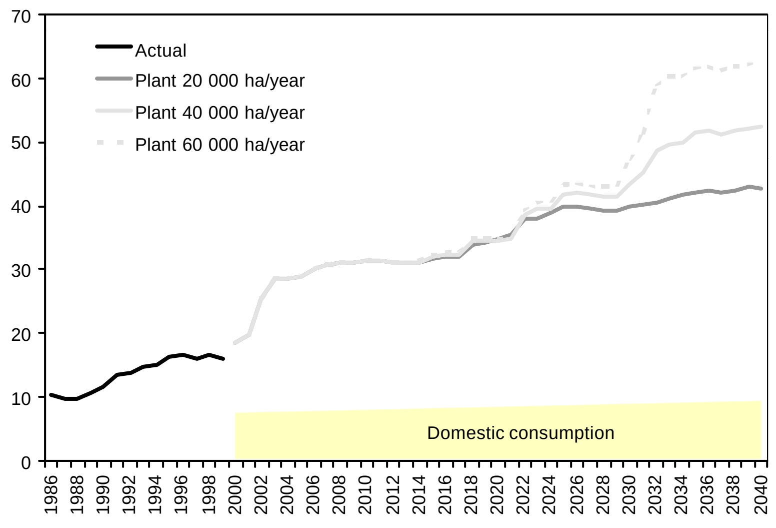
Notes: (1) Apparent consumption = roundwood removals + imports – exports.
(2) Roundwood removals are for March years.
(3) Trade data is for June years.

Source: MAF 2001.

Expectations of static demand mean that an increasing proportion of wood supplies will need to be sold overseas.

Figure 22 Projected production and consumption

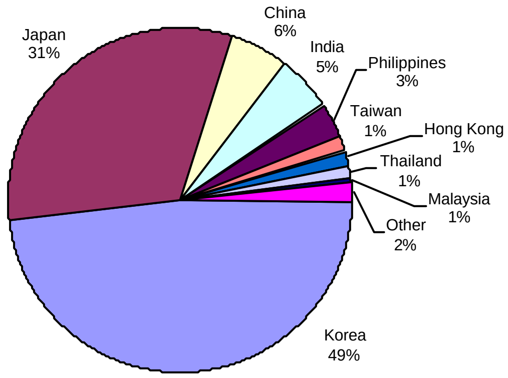
Millions of cubic metres



Source: NZ Forestry 2000.

Currently Asia dominates as a consumer of New Zealand's logs. Two Asian markets – Korea and Japan – account for 80% of the log trade.

Figure 23 Major international markets for New Zealand logs
By value

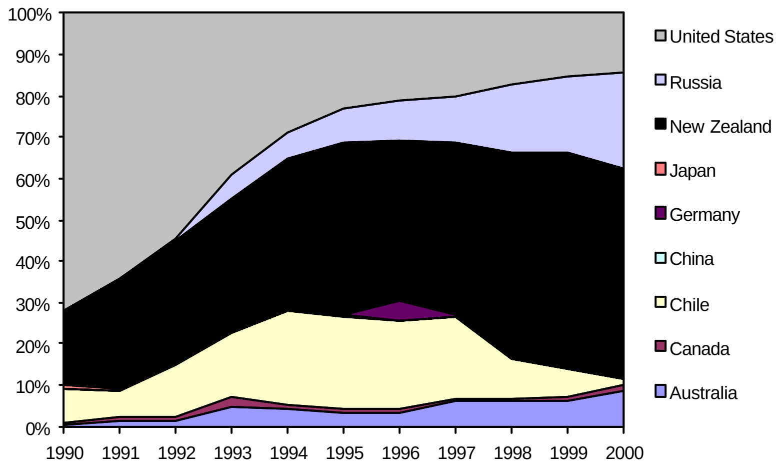


Source: MAF 2001.

A.1.1 Korea

Korea buys almost half of New Zealand logs sold overseas. New Zealand is the largest supplier of softwood logs to Korea; its accounts for just over half of the logs that enter Korea from aboard.

Figure 24 Korea: share of softwood log market
Percentage of value of imports by country of origin



2000	
New Zealand	51%
Russia	23%
United States	14%
Australia	8%
Chile	2%
Canada	2%

Source: Woodwide and WTA.

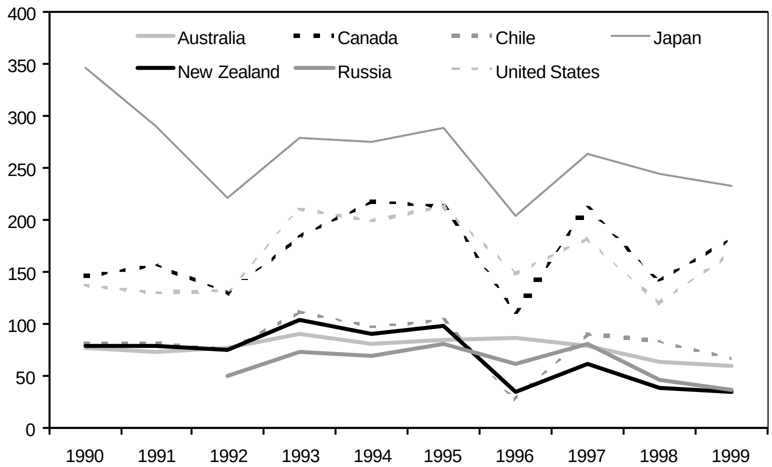
Korea is heavily dependent on imported logs because of its low self-sufficiency in log supply. Over the last decade, log imports to Korea have grown considerably as a consequence of its rapidly expanding construction sector.

New Zealand's radiata pine is accepted largely as a temporary construction material in construction sector. In recent years, radiata pine has also been used as a raw material for plywood manufacturing to substitute for the declining supply of tropical hardwood. However, in terms of the total volume of New Zealand's logs exported to Korea, the proportion used in plywood manufacturing is small. The main market for the domestically produced plywood is concrete shuttering (or boxing), another low end-use market.

In the Korean construction and plywood sectors our logs compete against radiata pine from Chile and Australia and larch from Russia. End users in these sectors will use these sources and species of logs interchangeably. This is reflected in how the price of the logs lie within a narrow band and track each other closely. Radiata pine logs from New Zealand does not compete with softwood logs from the United States, Canada and other softwood producing countries. The price paid per cubic metre of these logs is at least twice that which New Zealand receives.

Figure 25 Korea: softwood log prices by country

US dollars per cubic metre



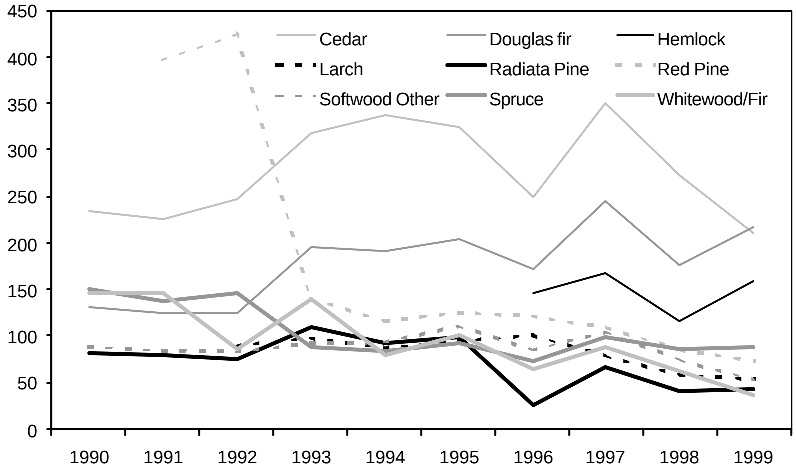
1999	
China	588
Japan	231
Canada	181
United States	168
Chile	67
Australia	60
Russia	36
New Zealand	35

Note: Woodwide obtains its data from the primary Korean sources. The quality of this data is not held in high regard.

Source: Woodwide

Figure 26 Korea: softwood log prices by species

US dollars per cubic metre



1999	
Douglas fir	217
Cedar	210
Hemlock	160
Spruce	88
Red Pine	72
Larch	53
Radiata Pine	43
Whitewood/Fir	35

Note: Woodwide obtains its data from the primary Korean sources. The quality of this data is not held in high regard.

Source: Woodwide

From an almost non-existent market share, with a 23% share of the market Russia now ranks as the second largest supplier of logs to Korea and is a serious competitor. Russia has grown its market share mainly through striking barter deals with Korean trading companies. Past practices had earned Russia the unenviable reputation as an unreliable supplier whose logs were of inconsistent quality. New Zealand suppliers, by way of contrast, are generally regarded as dependable, and whose quality of product can be relied upon. However, this has proved not to be a sustainable competitive advantage as quality improvements have caused a narrowing of the price differential between New Zealand and Russian logs.

Chile’s share of the Korean market has fallen as it has trimmed backed its involvement in the log trade to concentrate more on value adding processing. However, with increasing supplies coming on stream (refer below), Chile continues to represent a serious competitive threat.

Wood supply increases in Australia that are surplus to domestic requirements suggest that its market share of 8% has room to grow – a potential that Australia is not blind to (refer, for example, ANU 1999).

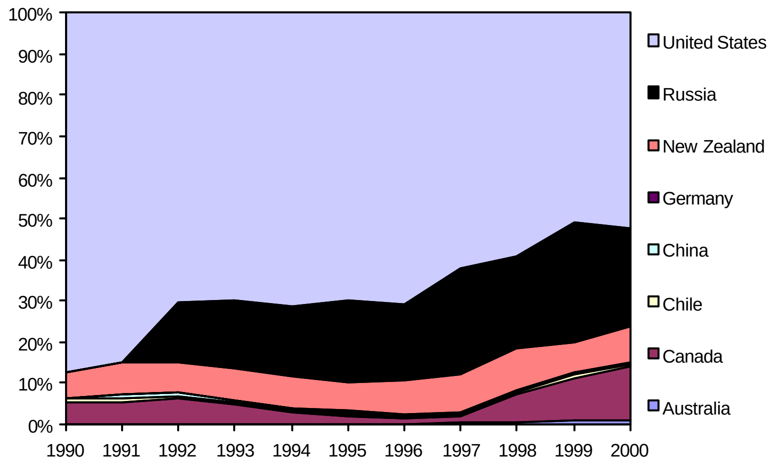
A.1.2 Japan

Japan is a large consumer of wood. Since the mid 1980s, a declining ability to supply its needs from domestic sources coupled with an appreciating yen, have seen imports increasingly relied upon to meet a growing domestic demand. In 1992 Japan became the largest single country importer of logs, consuming around 40% of the logs in the international trade. Until 1997 Japan was the largest importer logs from New Zealand. Today Japan accounts for a large 31% of logs that leave New Zealand’s shores.

From the perspective of Japanese log importers, however, New Zealand's share of this market has been steady over the last decade at between 7% and 10%.

Figure 27 Japan: share of softwood log market

Percentage of value of imports by country of origin



2000	
United States	52%
Russia	24%
Canada	13%
New Zealand	9%
Australia	1%
Chile	0%

Source: Woodwide and WTA.

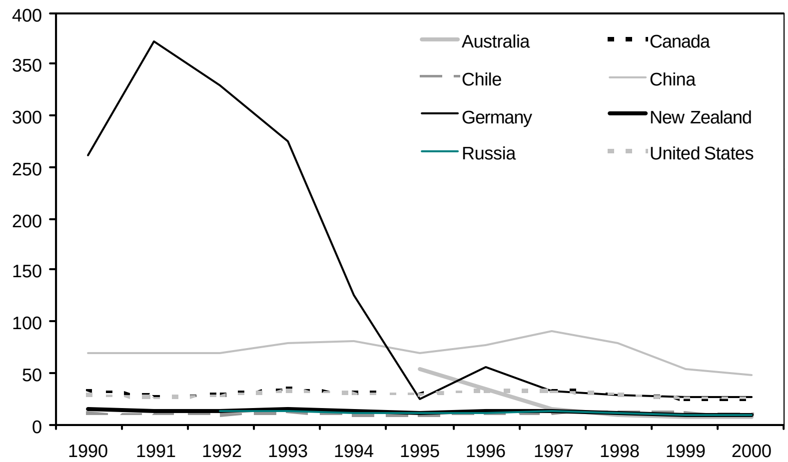
While most of the imported softwood logs in Japan are converted into lumber for the local construction industry, the majority of New Zealand logs end up in the low-value end uses such as packaging, pallets, cable drums and car cases.

Limited opportunity exists for greater use of New Zealand logs in other end uses. The biggest impediment is the enduring perception that radiata pine is of inferior quality to other softwood logs, such as those imported from Europe and North America. These logs command prices considerably in excess of those paid for radiata.

As was the case for Korea, the prices paid for New Zealand radiata pine are much the same as those paid for the small volumes of radiata pine imported from Australia and Chile, and the price paid per cubic metre of the considerable volumes of larch from Russia.

Figure 28 Japan: softwood log prices by country

Thousands of yen per cubic metre

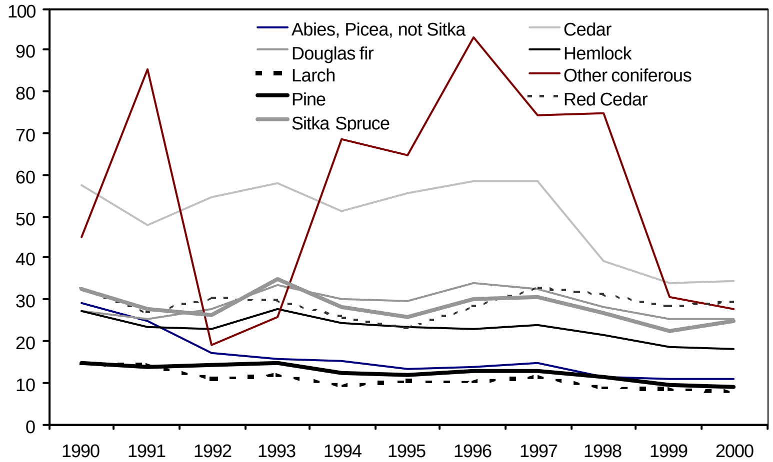


2000	
China	48
Germany	26
United States	26
Canada	23
Chile	10
Russia	9
New Zealand	8
Australia	8

Source: Woodwide.

Figure 29 Japan: softwood log prices by species

Thousands of yen per cubic metre



2000	
Cedar	34
Other coniferous	28
Red Cedar	29
Douglas fir	25
Sitka Spruce	25
Hemlock	18
Abies, Picea, not Sitka	11
Pine	9
Larch	8

Source: Woodwide.

A.2 Competitor Analysis

New Zealand's log exports to Korea, Japan and other major markets compete against logs from:

- Russia;
- Chile; and
- Australia

The following is a snapshot of the current supply situation and outlook for these regions and countries.

A.2.1 Russia

Russia is our biggest competitor in both the Korean and Japanese log markets, respectively accounting for 24% and 9% of total imports. The other market where we compete with Russia is China. As economic conditions in China continue to improve, expectations are that its demand for overseas sources of wood will increase.

Table 6 Russia's softwood log export trade

Country	Volume (000m³)	Share (%)
Japan	5500	28%
China	5500	28%
Finland	4000	20%
Sweden	2000	10%
Korea	1000	5%
Turkey	800	4%
Germany	600	3%
Others	600	3%
Total	**20,000**	

Notes: Shaded cells represent markets of significance to the New Zealand trade.

Source: USDA 2001.

Russia's forest harvest and export is concentrated in coniferous species. The number one coniferous species is larch, followed by pine. The logs are substitutes for New Zealand radiata pine in the end uses that shared overseas customers put both species of logs to.

As revealed in the previous discussion, Russia's presence in the markets where it competes against New Zealand has grown significantly in a short space of time and from very small beginnings. The potential to keep growing is huge as the majority of its extensive resource is largely untapped.

Russia is home to some 22% of the worlds timber resources. However it accounts for only 2% of the worlds forest products. An unfavourable investment climate, a lack of infrastructure and the slow process of forest sector restructuring has hindered the development of Russia's forestry potential. However, all this is beginning to change. More than a few foreign companies are investing in Russia's forestry potential; leasing of forest land and the auctioning of timber stands are occurring on a large scale; Russia is emerging as a market economy; harvesting technologies are improving; infrastructural investments are going ahead, and a weak currency has enhanced the competitiveness of Russia's log trade. These factors plus historical considerations have come together to make Russian logs extremely cost competitive in export markets.

All forestry resources belong to the Federal Government. The costs of forest establishment where incurred long ago. When deciding each year on the rates to charge firms for their rights to harvest trees, factors that are taken into consideration are locality, wood density, and quality. Silviculture costs are unlikely to enter into the equation. Russia has placed pressure on competing log exporters, including New Zealand, to keep prices down or otherwise risk losing market share.

Given present conditions, export markets represent the most profitable focus for Russia's forestry sector. European Russia and other regions located close to border areas are expected to increase their harvest.

Table 7 Outlook for Russia's product , and internal and external softwood log trade

Thousands of cubic metres

	2000	2001	2002
Production	64,000	66,000	68,000
Imports	0	0	0
Total supply	64,000	66,000	68,000
Exports	20,000	22,000	23,500
Domestic consumption	44,000	44,000	44,500
Total distribution	64,000	66,00	68,000

Source: USDA 2001.

Between 70% and 75% of Russia's wood available for harvest is classified as mature or over-mature. As a consequence, the natural mortality rate is high. One option that has been suggested for resolving the unbalanced age-classes and address the mortality is to increase harvest levels drastically over the next half century. In other words, the wood supplied from Russian forests and available for sale in export markets in the medium to long term could be huge. Russia is a serious competitors, not to be ignored.

A.2.2 Chile

Chile has had a persistent but not overwhelming presence in the Japanese log market. Its share of the Korean log market has gone from large to small in just the space of a few years, reflecting its increasing emphasis on onshore processing. The significant other country, where logs from Chile and New Zealand compete for market share, is India.

Table 8 Chile's softwood log export trade

Cubic metres in 1999

Country	Volume (000m^3)	Share (%)
Korea	340,523	69%
Japan	91,551	19%
Turkey	27,999	6%
India	27,904	6%
Morocco	2830	1%
Taiwan	52	0%
Total	**490,859**	

Notes: Shaded cells represent markets of significance to the New Zealand trade.

Source: USDA 2000b.

In 1999 logs represented only 2% of total forestry exports; softwood log exports accounted for 4% of the total softwood harvest. The short term outlook is that log exports will increase by 16% over a three year period.

Table 9 Outlook for Chile's product , and internal and external softwood log trade

Thousands of cubic metres

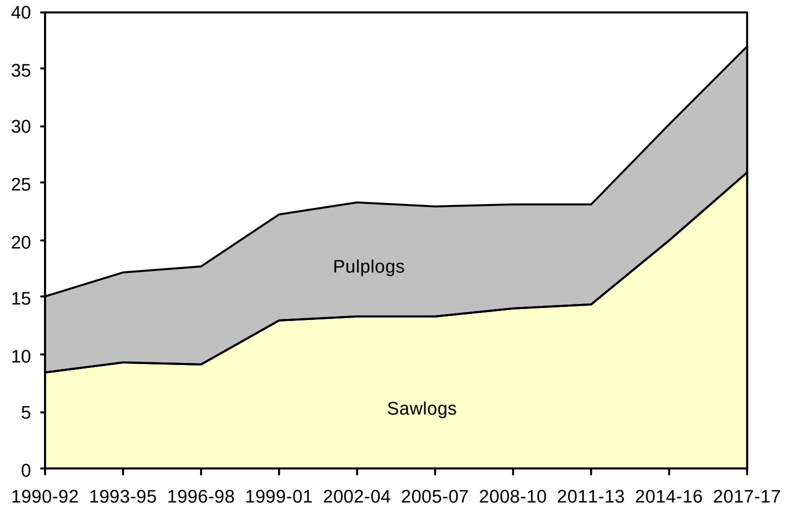
	1999	2000	2001
Production	11,434	12,500	13,700
Imports	0	0	0
Total supply	11,434	12,500	13,700
Exports	490	520	570
Domestic consumption	10,944	11,980	13,130
Total distribution	11,434	12,500	13,700

Source: USDA 2000b.

In the medium to long term, if domestic processing capacity does not keep pace with increases in the volume of wood coming on-stream, the log component of Chile's exports could become large again. Chile would represent a serious competitive threat to New Zealand. Figure 30 suggests that Chile's wood supply will increase by two thirds from current levels in the space of just a couple of decades.

Figure 30 Projections of wood supply in Chile

Millions of cubic metres.

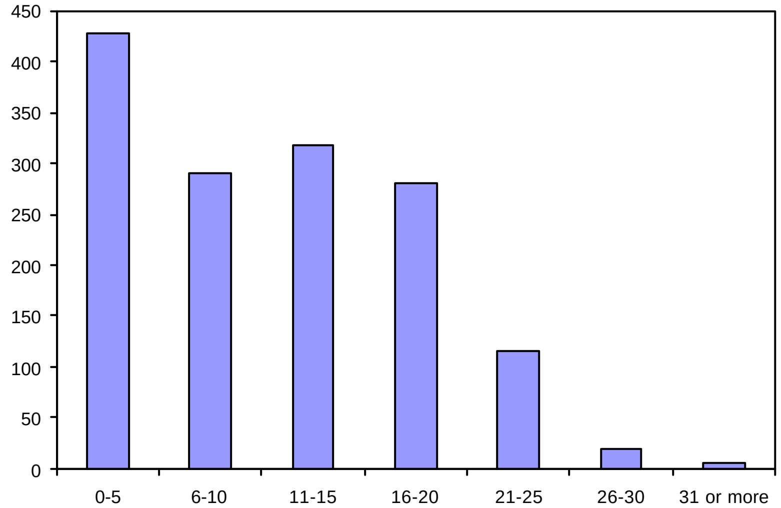


Source: INFOR.

The pace of increase is not likely to slow. The high rates of new plantings in recent years is reflected in an age-class distribution weighted heavily in the early years.

Figure 31 Age-class distribution of Chile's planted forests

Hectares in 1999



Source: USDA 2000b.

New planting has been encouraged by a forestry subsidy program. Decree Law (DL) 700 is directed at assisting small farmers. Planting costs are subsidised by as much as 90% for the first 15 hectares and at 75% thereafter. A subsidy of 15% of planting costs is available to larger scale farmers, when it is either severely eroded land or land suited only to reforestsation that is being planted. Special tax exemptions are also part of the programme.

The tax exemption, together with other considerations, suggests that Chile's current planted forest estate of 1.9 million hectares is likely to continue to expand, even in the absence of climate change policies. While currently the greater proportion (around two thirds) of the estate is planted in radiata pine, the make up of the future estate is likely to be more heavily weighted in eucalypts.

A.2.3 Australia

Australia is a small but not insignificant competitor in the Korean and Japanese markets for logs. Its softwood log exports, which currently represent 7% of its total softwood log supply, are expected to be fairly static over the immediate future.

Table 10 Outlook for Australia's product , and internal and external softwood log trade

Thousands of cubic metres

	1999	2000	2001
Production	10,760	10,812	11,122
Imports	1	1	1
Total supply	10,761	10,813	11,123
Exports	785	750	750
Domestic consumption	9,976	10,063	10,373
Total distribution	10,761	10,813	11,123

Source: USDA 2000a.

Longer term more and more of Australia's wood supply will need to find willing buyers offshore, as the volume surplus to domestic requirements increases.

As already mentioned, the potential for growing its presence in the Korean market is not lost on Australian log exporters. They have had some discussion with their New Zealand counterparts regarding joint strategies.

Australia's softwood harvest is sourced from its planted forest estate. In 1999 the total planted area was estimated at 1.3 million hectares. Just over 70% of this area comprises softwoods; primarily radiata pine.

While plantations represent less than one percent of Australia's total forest estate, they supply more than half the needs of the domestic industry. Virtually all future growth in log availability for internal use and export is expected to come from plantations (USDA 2000a). This trend has been given momentum by *Plantations for Australia: The 2020 Vision*, launched in 1997 by the Commonwealth government in conjunction with the state governments and forest industry. The goal is to triple the area in plantations by 2020 by removing institutional or market bases factors that inhibit plantation development. Achieving this goal would require around 80,000 hectares of new plantings each year. In 1999 Australia exceeded this threshold; in that year it newly planted 94,812 hectares. However, the majority (89%) of the trees were hardwoods, mainly eucalypts, and not softwoods.

Part of the explanation is the growing interest in eucalyptus plantations by the global forestry industry, including New Zealand and Chile. In New South Wales and Tasmania, at least, some of the explanation must lie in the early introduction of carbon emissions trading. As eucalypts are a fast growing species its rate of carbon sequestered in its early years is also considerable. New South Wales passed the world's first carbon rights legislation and other states are following closely behind.

A.3 Implications for modelling the effects of climate change policies

Points arising from the discussion above of significance to modelling the impacts of climate change policies on forest growing and harvesting include:

- New Zealand is a price taker in the handful of overseas markets where it sells its logs. Changes in its supplies will not impact on world prices.
- New Zealand does not compete against all exporters of softwood logs. It has a narrow range of competitors in the low value end uses to which its logs are currently put.
- Russia is a major competitive threat. The prices it receives for its logs need only cover extraction costs. Climate change policies are not likely to increase these costs as achieving its greenhouse gas emission targets will not prove difficult given the rapid progression it is making towards more carbon efficient technologies.
- While Chile does not currently have a major presence in the markets where we compete it could do as supplies from its forests increase. Chile is a non-Annex 1 country, so climate change policies will not add to the costs of harvesting its forests. But they may add to the benefits of planting new forests, through the operation of the CDM.
- Australia is an Annex 1 country. It is already gearing itself up for the new environment.

APPENDIX B: RATIFICATION & REDUCTION

(as at end August 2001)

B.1 Annex 1

Country	Signature	Ratification or Accession	Percentage of base year or period
Australia	29/04/98		108
Austria	29/04/98		92
Belgium	29/04/98		92
Bulgaria*	18/09/98		92
Canada	29/04/98		94
Croatia*	11/03/99		95
Czech Republic*	23/11/98		92
Denmark	29/04/98		92
Estonia	03/12/98		92
European Community	29/04/98		92
Finland	29/04/98		92
France	29/04/98		92
Germany	29/04/98		92
Greece	29/04/98		92
Hungary*	?	?	94
Iceland	?	?	110
Ireland	29/04/98		92
Italy	29/04/98		92
Japan	28/04/98		94
Latvia*	14/12/98		92
Liechtenstein	29/06/98		92
Lithuania*	21/09/98		92
Luxembourg	29/04/98		92
Monaco	29/04/98		92
Netherlands	29/04/98		92
New Zealand	22/05/98		100
Norway	29/04/98		101
Poland*	15/07/98		94
Portugal	29/04/98		92

Country	Signature	Ratification or Accession	Percentage of base year or period
Romania*	05/01/99	19/03/01	92
Russian Federation*	11/03/99		100
Slovakia*	26/02/99		92
Slovenia*	21/10/98		92
Spain	29/04/98		92
Sweden	29/04/98		92
Switzerland	16/03/98		92
Ukraine*	15/03/99		100
United Kingdom	29/04/98		92
United States of America	12/11/98		93
Total	**39/39**	**1/39**	

* Indicated economies in transition.

B.2 Non-Annex 1

Country	Signature	Ratification or Accession
Antigua and Barbuda	16/03/98	03/11/98
Argentina	16/03/98	
Azerbaijan	-	28/09/00
Bahamas	-	09/04/99
Barbados	-	07/08/00
Bolivia	09/07/98	30/11/99
Brazil	29/04/98	
Chile	17/06/98	
China	29/05/98	
Cook Islands	16/09/98	27/08/01
Costa Rica	27/04/98	
Cuba	15/03/99	
Cyprus	-	16/07/99
Ecuador	15/01/99	13/01/00
Egypt	15/03/99	
El Salvador	08/06/98	30/11/98
Equatorial Guinea	-	16/08/00

Country	Signature	Ratification or Accession
Fiji	17/09/98	17/09/98
Gambia	-	01/06/01
Georgia	-	16/06/99
Guatemala	10/07/98	05/10/99
Guinea	-	07/09/00
Honduras	25/02/99	19/07/00
Indonesia	13/07/98	
Israel	16/12/98	
Jamaica	-	28/06/99
Kazakhstan	12/03/99	
Kiribati	-	07/09/00
Lesotho	-	06/09/00
Malaysia	12/03/99	
Maldives	16/03/98	30/12/98
Mali	27/01/99	
Malta	17/04/98	
Marshall Islands	17/03/98	
Mauritius	-	09/05/01
Mexico	09/06/98	07/09/00
Micronesia (Federal States of)	17/03/98	21/06/99
Mongolia	-	15/12/99
Nauru	-	16/08/01
Nicaragua	07/07/98	18/11/99
Niger	23/10/98	
Niue	08/12/98	06/05/99
Palau	-	10/12/99
Panama	08/06/98	05/03/99
Papua New Guinea	02/03/99	
Paraguay	25/08/98	27/08/99
Peru	13/11/98	
Philippines	15/04/98	
Republic of Korea	25/09/98	
Saint Lucia	16/03/98	
Saint Vincent and the Grenadines	19/03/98	

Country	Signature	Ratification or Accession
Samoa	16/03/98	27/11/00
Senegal	-	20/07/01
Seychelles	20/03/98	
Solomon Islands	29/09/98	
Thailand	02/02/99	
Trinidad and Tobago	07/01/99	28/01/99
Turkmenistan	28/09/98	11/01/99
Tuvalu	16/11/98	16/11/98
Uruguay	29/07/98	05/02/01
Vanuatu	-	17/07/01
Vietnam	03/12/98	03/12/98
Uzbekistan	20/11/98	12/10/99
Zambia	05/08/98	
Total	**47/64**	**38/64**

APPENDIX C: EXIT COST FOR KYOTO AND NON-KYOTO FORESTS

Table 5 in the main body of the report indicates that, for trees harvested after 2007, the value of the carbon (or deforestation) charge will reflect whether the forest owner chooses to restock or not to restock. This is true for both Kyoto and non-Kyoto forests. Where the carbon charge for the not restocking option is higher, then there is a cost in exiting the forestry market. This exit cost is measured by the difference in the carbon permit liability payable on harvest when choosing to restock versus not to restock.

C.1 Non-Kyoto forests

With non-Kyoto forests there is clearly an exit cost. If the decision is taken to restock there is no carbon charge, while if the decision is taken not to restock then the carbon charge reflects the cumulative carbon in the forest at harvest time. The exit cost, in this instance, is the cumulative carbon yield. That there is an exit cost is undisputable, the issue is whether, or if, this cost will ever be incurred.

To take this further, assume that the non-Kyoto forest owner only restocks for one additional rotation. A rotational forester will therefore be concerned with maximising the returns of the existing non-Kyoto forest (in the first rotation), and maximising the returns of the land in the next (second) rotation.

Consider the decision to restock. Under the restocking option the forest owner will, in the first rotation, earn a return from their forest that is equivalent to the NPV earned under business as usual (BAU).[6] Denote this as NPV_rot1.

In the next period the forest is restocked, the tress are eventually harvested and at that point the decision is taken not to restock i.e. the forest owner exits the industry. The return earned on this restocked land, denoted as NPV_rot2, incorporates the deforestation charge. This means that NPV_rot2 can be separated into two components:

- the NPV from the restocked forest, excluding the deforestation tax (denote this as NPV_rot2′); and
- the value of the deforestation tax paid on the restocked forest at the time of harvest, discounted back to the beginning of the restocking period (denote this tax as t).

Thus the net returns to the land owner over these two rotation periods is:

NPV_rot1 + present value of (NPV_rot2′ – t) (1)

Which is also equivalent to:

NPV_rot1 + present value of (NPV_rot2) (2)

[6] This is true other than for changes in return bought about by modifications to log prices resulting from the climate policy.

Now consider the decision not to restock. The return from the forest owner in this instance is NPV_exit, which incorporates the value of the deforestation charge. NPV_exit we can be separated into two components:

- the NPV from the non-Kyoto forest, excluding the deforestation tax (this is equivalent to NPV_rot1); and
- the value of the deforestation tax paid on the forest at the time of harvest, discounted back to when the non-Kyoto forest was planted (this is denoted by t').

In the next period, the land is converted to some alternative use (say dairying), which earns a return of NPV_dairy. Thus the net returns to the land owner over the two rotation periods is:

$$(NPV\_rot1 - t') + \text{present value of } (NPV\_dairy) \quad (3)$$

Which is also equivalent to:

$$(NPV\_exit) + \text{present value of } (NPV\_dairy) \quad (4)$$

Pulling this together, if a forest owner was trying to evaluate whether to exit today, or at the end of the next rotation, they would need to compare the net returns from restocking versus not restocking:

$$(NPV\_rot1 + PV(NPV\_rot2' - t)) - (NPV\_rot1 - t' + PV(NPV\_dairy)) \quad (5)$$

This simplifies to:

$$PV(NPV\_rot2' - NPV\_dairy) - PV(t) + t' \quad (6)$$

The point should be made that t and t' are not equivalent. Firstly, t is evaluated in the second rotation, which means that it is valued using different carbon prices than was used to evaluated t' (in the first rotation). So t may be higher because of price inflation.

Secondly, t' and t relate to different rotations (first and second), so they may have potentially different optimal rotation lengths and therefore different cumulative carbon yield tied up in the forest at the time of harvest. The second rotation is also likely to have a higher yield curve.

Although t may be higher than t' because of stronger price inflation, a longer rotation length or a higher yield curve, in practice it is likely that $PV(t) < t'$ because of discounting. This implies that $-PV(t) + t'$ will be positive i.e. the returns to the restocking option are higher than the returns to no restocking option by the amount $t' - PV(t)$.

The returns to stocking versus not stocking also depends on the returns to rotational forestry versus the returns to dairy. Restocking will always be preferred if NPV_rot2 ≥ NPV_dairy. The only time restocking may not be preferred is when NPV_rot2 < NPV_dairy. In this case, not restocking will be preferred if the difference in NPV between restocking and dairying is large enough to offset the difference between $t' - PV(t)$. The forest owner will choose the no restock option if the higher returns to dairy (relative to forestry) are sufficient to compensate them for bringing the exit costs on early.

Finally, if the assumption of zero differential returns between forestry and dairying holds true indefinitely, as the number of periods increases PV(t) will approach zero and the NPV for the restocking option will:

- approximate the NPV for BAU, and
- relative to the no restocking option, be better off by the amount t'.

If it cannot be assumed that rotational forestry will indefinitely provide returns that match the returns to the alternative land use, at some future point there may well be some switching and therefore the occurrence of exit costs, thus making non-Kyoto forests unambiguously worse off compared with BAU.

In the main part of this report we compare the no restocking scenario against two alternatives: continuous restocking and restocking only once. Continuous restocking means that the forest owner never exits the forestry market, and so returns are only affected by log price changes resulting from the climate change policy. This equates to NPV_rot1. The restocking once only scenario captures the situation where the forest owner chooses to exit the forestry market after one further rotation. In this case the NPV for the restocking once only option incorporates the present value of the deforestation cost evaluated at the end of the second rotation i.e. PV(t). The implication is that the NPV for restocking once only will be < the NPV for continuous restocking, but > the NPV for no restocking.

C.2 Kyoto forests

Based on the climate policy rules outlined in Table 5, Kyoto forests also face an exit cost. If the decision is taken to restock the carbon charge reflects the lesser of the total carbon released (the cumulative carbon less the residual carbon) and the carbon credits received between 2008 and harvest year. If the decision is taken not to restock, then the carbon charge reflects the carbon credits received since 2008. The exit cost is the difference between the total carbon released and the total carbon credits received up to harvest year. Clearly an exit cost will be incurred when the forest owner chooses not to restock and will be avoided when they choose to restock.

In the main part of this report we illustrate only one restocking option. This assumes that forest owners restock continuously, and so avoid paying the exit cost. It turns out that, in our modelling of Kyoto forests, if the forest owner exists after one further rotation, the exit cost goes to zero. This reflects the way in which we have modelled the residual carbon and the credits received by the forest owner in subsequent rotations.

In the Estate model the residual carbon is measured by the carbon remaining in the slash, stumps and roots after harvest. This residual carbon is evaluated by the carbon yield in the first period of the second rotation yield curve for a typical forest. (The second rotation yield curve has been calculated assuming that the forest in the first rotation is harvested at a rotation length of 28 years). For forests that are initially restocked, the restocked trees are then eventually harvested but not restocked, it has been assumed that the credits received in these later rotations do not include the residual carbon. This has been done on the basis that restocked forests have already received the benefit of the residual carbon at the end of the first rotation. The implication is that the total carbon released at the end of subsequent rotations will equal the total credits received, meaning that there is no exit cost.[7]

[7] In point of fact, this is only true for tress restocked after 2007.

This result also partly reflects our measure of residual carbon. We have used the residual carbon from a single yield curve, which assumes a given rotation length (28 years) in the first rotation. If the rotation length from the first rotation is < 28 years, then our measure of residual carbon may be too high and the total carbon released too low (and vice-versa). It seems likely that the residual carbon from the second rotation will vary according to the rotation length of the first rotation, which therefore creates uncertainty about the carbon charge faced by Kyoto forests and thus their optimal NPVs. This uncertainty cannot be removed without modelling more accurately the residual carbon.

For the purpose of elucidating this problem, section 4.3 illustrates the wood supply implications when Kyoto forests, that are restocked, are assumed to pay a carbon charge at harvest based on the credits received since 2008. This specification significantly alters wood supply, as forests planted after 1996 now move to permanent forestry.

APPENDIX D: CALCULATING ENERGY AND TRANSPORT COST CHANGES

Table 11 Electricity cost increases

	Gas	Coal
$/tC/MWh	0.16	0.372
Share electricity generation	24.7%	2.6%
	0.040	0.010
Weighted ave $/tC/MWh	0.049	
$/tC/GWh	49.192	
Energy component electricty price/GWh	40,000	
Transmission component electricity price/GWh	15,000	
Total price electricity/GWH (incldg GST)	55,000	
When $/tC = ...	**48**	**120**
$increase/GWh = …	2361.216	5903.04
New enery component electricity price/GWh	42,361	45,903
New total electricity price/GWh	57,361	60,903
%increase/GWh = ...	**4.29%**	**10.73%**

Table 12 Diesel and transport cost increases

When $/tC=$48

	Conversion factors		
tCO2/PJ		CO2	68,000
	21	CH4	273
	310	N2O	930
		Total CO2 equivalents	69,203
tC/PJ	3.6666667		18873.55
tC/t diesel	21,747		0.8679
tC/l diesel	1,217		0.0007
Total price change per litre diesel	48		0.03423
Current price per litre diesel (incldg GST)			0.73325
Implied price increase			**4.67%**
Implied increase in cost of transport	0.17		**0.79%**

When $/tC=$120

	Conversion factors		
tCO2/PJ		CO2	68,000
	21	CH4	273
	310	N2O	930
		Total CO2 equivalents	69,203
tC/PJ	3.6666667		18873.55
tC/t diesel	21,747		0.8679
tC/l diesel	1,217		0.0007
Total price change per litre diesel	120		0.085575
Current price per litre diesel (incldg GST)			0.73325
Implied price increase			**11.67%**
Implied increase in cost of transport	0.17		**1.98%**

APPENDIX E: RELATIVE WOOD PROCESSING PROFITABILITY

Table 13 Packaging lumber to China/Japan: profitability analysis

Assumptions

Investment	US$18 million	
Mill life	15 years	
Mill output capacity	200,000m^3	
Fibre recovery	NZ: 40%	Chile: 40%
Input costs	As illustrated in Figure 11	
Total delivered cost	NZ: US$144/m^3	Chile: US$154/m^3
Market price	US$155/m^3	

Profitability

	New Zealand					Chile		
	BAU	CO1		CO2		BAU		
Fibre costs		+1%	+4%	+1%	+4%		+1%	+4%
IRR (%)	11.75	10.28	6.87	9.68	6.23	-5.48	NA	NA

Note: m^3 - cubic metres.
Sources: Jaakko Poyry 2001a and 2001b; NZIER.

Table 14 LVL to Japan: profitability analysis

Assumptions

Investment	US$54 million	
Mill life	15 years	
Mill output capacity	80,000m^3	
Fibre recovery	NZ: 46%	Chile:46%
Input costs	As illustrated in Figure 13	
Total delivered cost	NZ: US$285/m^3	Chile: US$277/m^3
Market prices	US$420/ m3	

Profitability

	New Zealand					Chile		
	BAU	CO1		CO2		BAU		
Fibre costs		+1%	+4%	+1%	+4%		+1%	+4%
IRR (%)	21.09	20.86	20.36	20.76	20.26	22.43	22.25	21.70

Note: m^3 - cubic metres.
Sources: Jaakko Poyry 2001a and 2001b; NZIER.

Table 15 MDF to China: profitability analysis

Assumptions

Investment	US$45 million	
Mill life	15 years	
Mill output capacity	150,000m^3	
Fibre recovery	NZ: 60%	Chile: 61%
Input costs	As illustrated in Figure 15	
Total delivered cost	NZ: US$159/$m^3$	Chile: US$159/$m^3$
Market prices	US$200/$m^3$	

Profitability

	New Zealand					Chile		
	BAU	CO1		CO2		BAU		
Fibre costs		+1%	+4%	+1%	+4%		+1%	+4%
IRR (%)	13.57	13.24	12.83	12.95	12.54	13.45	13.34	13.01

Note: m^3 - cubic metres.
Sources: Jaakko Poyry 2001a and 2001b; NZIER.

Table 16 Chemical pulp: profitability analysis

Assumptions

Investment	US$420 million	
Mill life	20 years	
Mill output capacity	300,000 ADMT	
Input costs	As illustrated in Figure 17	
Total delivered cost	NZ: US$347/ADMT	Chile: US$324/ADMT
Market prices	US$492/ADMT	

Profitability

	New Zealand					Chile		
	BAU	CO1		CO2		BAU		
Fibre costs		+1%	+4%	+1%	+4%		+1%	+4%
IRR (%)	10.88	10.60	10.28	10.34	10.01	12.89	12.80	12.53

Note: ADMT - air dried metric tonne.
Sources: NLK 2000; NZIER.

Table 17 Mechanical pulp: profitability analysis

Assumptions

Investment	US$168 million
Mill life	20 years
Mill output capacity	220,000 ADMT
Input costs	As illustrated in Figure 19.
Total delivered cost	NZ: US$370/ADMT
Market prices	US$422/ADMT

Profitability

	New Zealand				
	BAU	CO1		CO2	
Fibre costs		+1%	+4%	+1%	+4%
IRR (%)	6.22	4.91	4.16	3.24	2.44

Note: ADMT - air dried metric tonne.
Sources: Industry sources; NZIER.