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Report for the Working Group on CO_2 Policy, led by Tim Denne

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NEW ZEALAND CO_2 POLICY

There are three basic questions for New Zealand CO_2 policy.

a How much New Zealand should regulate CO_2 and the timing of regulation;
b Whether New Zealand should use a tax system, a tradeable permit market or direct regulation;
c How a tax or permit system should be designed.

This paper outlines very briefly most of the issues relevant to answering these questions and goes into more detail in a few areas where current analysis is less well developed.

1 HOW DOES NEW ZEALAND'S POLICY ON CLIMATE CHANGE RELATE TO INTERNATIONAL AGREEMENTS AND NEGOTIATIONS?

When a government is designing domestic environmental policy it takes into account the costs and benefits of the regulation and ideally equates marginal costs and benefits. In the case of CO_2 the benefits are harder to define because climate change is a global phenomena and hence our unilateral actions have little direct impact. We can have an impact, possibly out of proportion to our size, by setting an example for other countries, by innovating in our institutions and by encouraging the development of global cooperation as a whole. This impact will provide positive benefits for New Zealand to the extent that climate change is mitigated by international action.

2 WHY SHOULD WE USE AN ECONOMIC INSTRUMENT (I.E. PERMITS OR TAXES) FOR ADDRESSING CO_2 RATHER THAN DIRECT REGULATION?

There are major efficiency and equity advantages to using economic instruments where possible to reduce CO_2 emissions. The use of economic instruments does not preclude information programs where these are considered appropriate, or direct encouragement of particular technologies either by environmental NGOs or government if a facilitating role is appropriate. In some regulatory situations, economic instruments have disadvantages due to the nature of the pollutants. These disadvantages are not relevant in the case of CO_2.

A EFFICIENCY ADVANTAGES

The major advantage of an economic instrument is that it encourages experimentation by many firms and consumers in ways to reduce the use of CO_2 and rewards those who are able to find effective ways to do this. Not only do people innovate in terms of technology but they will find multiple financing sources, new contractual forms and new marketing approaches. Not only people who are concerned about the environment will be stimulated to

find effective solutions but also those who simply see the opportunity to make a profit or reduce costs. This innovation and experimentation is critical in an area where the changes required may have significant changes in many aspects of the economy and our lives. CO_2 use is involved in industry, residential use, transport, and forestry to name a few. It is extremely difficult for any one group to even conceive of the possible opportunities for effective, efficient abatement.

Under direct regulation firms and consumer only need to do what they are required. They have not incentive to offer new approaches and technologies which may require them to carry out more abatement even if it is optimal for society as a whole. Also, firms may not want to reveal their new technology to the bureaucracy because it may be revealed to their competitors and thus lose the firm a competitive advantage. Under an economic instrument they can profit from any ideas and initiatives rather than being penalized. They are able to sell any innovation to other firms to cover their costs of research and development, or simply expand their market share.

Markets are a mechanism for coordinating information and connecting those with ideas with those with capital and those who control investment decisions. A bureaucracy can carry out limited coordination functions but would be unable to deal with a large number of competing options.

The information required to choose optimal timing for investment for each firm or consumer is formidable. No government agency would ever have this information. Yet most responses to reduce CO_2 involve investment. If these investments are forced by direct regulation they will be required by all firms at a similar time and will almost certainly lead to inappropriate timing. No company will invest before it is required even if this is the most efficient action.

Everyone in the economy makes choices which affect the emissions of CO_2. If all these choices, such as deciding whether to drive children to school, had to be directly regulated the administrative costs, not to mention the infringements of personal liberty, would be phenomenal. An economic instrument alters the costs of these actions for all individuals and allows them to choose the most appropriate response.

Finally, even the most benevolent government will have tendencies to bias its choice of direct regulation in favor of actions it is familiar with, groups which are not politically sensitive and actions which will yield visible results in a time span which are politically favorable. These biases move regulation away from the efficient path and raise the costs of the outcomes.

B EQUITY ADVANTAGES

For reasons discussed above, direct regulation will tend to affect some groups which are easier to regulate more heavily than others. Economic instruments make the polluter pay directly. Individual and firms which use CO_2 bear the costs in proportion to how much they use.

C NO OPTIONS PRECLUDED

No form of response to reducing CO_2 emissions would be precluded by an economic instrument. Any energy efficiency measure, renewable technology etc. could be promoted by any group with the advantage that private companies with expertise in marketing and production and access to capital would have an incentive to cooperate to implement these approaches. If changes in institutions or laws were needed to facilitate these approaches,

perhaps by removing barriers, or information campaigns were considered valuable, these could be done in addition to the economic instrument and would complement it.

D POSSIBLE PROBLEMS WITH ECONOMIC INSTRUMENTS NOT RELEVANT

CO_2 is an unusually simple pollutant. It accumulates in the atmosphere and causes damage in relation to the total stock. Thus it does not matter where it is emitted or exactly when. There are no possibilities of spatial "hot spots" or high concentrations at particular points in time. These are two issues which frequently make design of an economic instrument more complex. CO_2 is extremely easy to monitor because of its very close relationship with fossil fuel use, forestry and cement manufacture and therefore there is no argument for controlling it indirectly by controlling the processes which use it rather than directly controlling the inputs of carbon. There is no significant time lag between the actions which cause the release of CO_2 and its appearance in the atmosphere so there is no concern that those we are regulating do not have complete control over the use of carbon. Thus none of the traditional arguments in favor of direct regulation are relevant in this particular case.

3 WHAT ARE FUNDAMENTAL / UNAVOIDABLE DIFFERENCES BETWEEN TAXES AND TRADEABLE PERMITS?

A COMPLEXITY;

A tradeable permit market may be slightly more complex to operate than a tax system. Permits are an unfamiliar regulatory approach so there will be a learning period. In contrast taxes are familiar and would operate through existing institutions. Permits must be defined in appropriate ways to allow flexibility across time both for investment and for changes in overall targets and to deal with possible manipulation of the market. The total number of permits must be reassessed when international targets change. However, taxes although simple in one time period must be adjusted for new information both on targets and on technology and must rise each year by the rate of interest to provide the optimal price path. This requires a level of ongoing decision making which in a permit market is unnecessary. These repeated adjustments lead to the risk of manipulation by interested parties and introduce uncertainty.

The operation of a tradeable permit market in this case is not as complex as people may expect. There are only a small number of importers and extractors of fossil fuels (under 20) who would need to be monitored. Good information already exists on their activities. The monitoring and registration of rights could be carried out with a spreadsheet program and one or two staff within an existing institution.

There would be additional complexity if sinks are included and carbon offset are allowed for new planting. Sinks cause increased complexity in a tax system or permit system of a similar magnitude. The major problem is registering all forestry land, certifying the creation of new sinks and monitoring the destruction of existing sinks.

B ENVIRONMENTAL VS. ECONOMIC RISK;

It is true that within one period where the tax rate or number of permits is fixed, a permit system provides environmental certainty whereas a tax rate limits the marginal cost of abatement thus providing more economic certainty. However, if permits are bankable so that the number used in one period is flexible the marginal cost will be smoothed over time. In addition, over time the number of permits can be adjusted if the economic costs are

considered too high and the tax rate can be adjusted to move closer to the desired level of abatement. Thus in a dynamic setting with appropriate flexibility in the use of permits over time and mechanisms for aggregate adjustments in taxes and permits the differences are probably not that great. They may however be perceived differently because of the different emphases they bring to negotiations.

C FLEXIBILITY IN DISTRIBUTION OF COSTS;

Both a tax system and a permit system lead to approximately the same abatement actions by the same individuals and the same incidence of costs. A permit system offers the flexibility to allocate permits to certain groups rather than auctioning all permits. These allocations are transfers of wealth and will not affect incentives. They are costly to government and the economy in the way that all government payments are because of the need to raise tax revenue to cover them.

D RISK OF STRATEGIC MANIPULATION BY BUSINESS;

There is no risk of economic strategic manipulation in a tax system. In a poorly operating permit market firms can potentially lower the price the government receives for auctioned permits or can raise the price of permits to increase the costs of a new entrant to the industry or a small competitor and thus increase monopoly power leading to welfare losses.

E POLICY FLEXIBILITY;

There is probably more policy flexibility in a tax system. The tax needs to be changed each year for the optimal path. Taxes are recognized as within the control of government not the legal system. Taxes are not seen as a property right. Changes in taxes affect all emitters roughly equally. In contrast tradeable permits do not need to be altered so frequently so there are fewer opportunities to change policy. In addition they are a legal property right for which vested interests will arise. However the degree to which property rights are fixed depends on how they are designed and the messages which are sent with their creation. If government makes it clear that these rights are temporary it is much easier to change them later and fight the interests who want to maintain them.

Policy flexibility is not always a good thing. To provide investment certainty the government wants to commit itself not to change the policy except in circumstances where there is a significant change in information or international policy. Investment certainty lowers costs of compliance. A tax system may therefore be more flexible but harder to maintain credibly. This is discussed in more detail in the next section.

F OPTIMAL INVESTMENT OVER TIME AND EXTERNAL OR DOMESTIC SHOCKS;

There are three major issues here. The first question is how each system affects choices by business on the timing of investment. The second question is how the risk of shocks is shared between business and government under different systems compared to how it would optimally be shared. Third, there is an issue of whether either system leads to incentives for business to behave strategically to alter policy over time away from the optimal path.

Optimal Timing of Investment

CO_2 is an accumulative pollutant. This means that from the environmental point of view it does not matter whether emissions occur this period or next. For economic efficiency, an extra unit of emissions should be abated this period if the marginal cost of doing so is less than the present value of the cost of doing so next period. For example, if the interest rate is 10% and it costs $11 to abate next period, abatement should be carried out until it costs $10 this period.

In a permit system where permits are issued for use in a particular year but are bankable, the price of permits will rise at the rate of interest as long as the rate of economic growth is higher than the rate of technological progress in abatement. (That is, if the current policy is not a binding constraint on firms' investment in abatement, i.e. it is expected to be harder to comply in the future.) Because firms will always abate until the marginal cost of abatement is equal to the permit price, this means that investment will be done optimally.

In a tax system, optimal investment could be achieved if the tax rate rises at the rate of interest to mimic the permit price. Government would need to commit to this path to give businesses certainty about the return to abatement investments.

If it is expected that abatement will be easier to achieve in the future (i.e. present targets are higher than they should be to achieve desired long term cumulative emission reductions) banking of permits will only be used to smooth short term fluctuations and reduce transaction costs for businesses. This path could occur if international agreements are expected to be reversed or major technological breakthroughs are expected. Both a tax and a permit system will be inefficient because the overall annual targets are inefficient. A tax chosen to yield the same level of abatement as a permit system in each given year will have the same efficiency effects although the tax may be less certain.

Risks and Risk Bearing

Optimal risk sharing is a balance between giving the risk to those with greatest control over it and ability to mitigate it, and reducing the risk faced by those who are risk averse. Government and large companies tend to be less risk averse than small companies and individuals. The risks arise from changes in international agreements, changes in technology, changes in domestic policy, short term economic fluctuations and learning about costs and institutions. The government has some control over international agreements, and significant control over changes in domestic policy. Businesses have some control over changes in technology, short term economic fluctuations and learning and the ability to change investment to respond to shocks to lessen their impact on costs.

How do taxes and permits distribute risks?

a External Negative Shock e.g.: increased stringency of national targets.

In a permit system as soon as information begins to arrive which suggests that this may occur the price of permits will rise in expectation of future reductions in permits. When the government changes domestic policy in line with the new international commitments there will be very little change in the permit price which will have already adjusted. Investment will optimally adjust to the new, higher price path. The government will either auction less permits in future periods or buy back permits which have already been issued. In either case they lose an equal amount of revenue. Those who hold permits (including the government) will receive a capital gain while those who need to buy permits will face higher prices. Thus risk is spread between the private sector and the government. Small firms could

choose to hold some permits to protect against rising prices but not all the permits they need so they do not make large losses with falling prices.

If permits were defined as proportions of total targets, business would bear all the cost of changes in the target level. This is inefficient because the government will not have incentives to choose its domestic response to the international target optimally.

If permits were fully issued in perpetuity, when the number of permits needed to be reduced, government would bear all the costs and business would be fully compensated. This would remove incentives on business to invest to lower marginal costs and hence permit prices before the government buy back. Thus business would not invest optimally when it first received information about the international changes.

Under a tax, the tax rate will need to rise and the government will receive more revenue and thus face no risk. Businesses will invest to reduce their emissions after the tax rise but not before. Thus the investment response will be inefficient. Business will bear the full costs of increased abatement.

b Unexpected Positive Technology Shock e.g.: New cheap renewable technology

Under a permit system, when a positive shock is anticipated the permit price will fall and businesses will defer investment in abatement. Permit holders will suffer a capital loss and those who need to buy permits will gain. Government will receive less revenue when it sells permits. Optimal incentives for technological innovation would require that innovating businesses can receive all the gain from the reduction in marginal costs the innovation causes. This is achieved when the innovating business holds no permits. The innovator has the best information about their innovation. When the innovator anticipates an innovation they will sell their permits before the information spreads and the price falls. They can also sell the innovation if they have intellectual property rights. Permit holders suffer capital losses which do not affect their incentives. The marginal cost of abatement falls for all firms.

Under a tax system the innovator initially receives gains by reduced taxes and then if they have intellectual property rights can sell the innovation and receive part of the other businesses' gains. The government receives less revenue, total abatement costs fall (assuming infra-marginal costs are the same or lower) and the level of CO_2 falls. Thus there is environmental over-compliance. Optimally the government would lower the tax by the amount the permit price would fall.

Strategic Incentives

Either the tax rate or the number of permits is set in a political process. For economic efficiency political uncertainty should be minimized. Policy flexibility is needed where the situation changes significantly but should be avoided otherwise. It is useful for government to be able to credibly commit itself to a future policy. There is an unavoidable tradeoff between investment certainty and political flexibility.

In a permit system, if future permits can be used in advance there is an incentive for businesses to over use permits initially and then legitimately claim that they are unable to continue production with the reduced number of permits which remain. This leads to strong pressure on the government to relax the target and issue more permits. The companies have not chosen an optimal emission path or an optimal investment path. This very strongly argues against being able to "borrow" permits from the future.

If there is no clear shock, there will be limited pressure to change the number of permits. Holders of existing permits will not want more to be issued because it lowers the value of their permits. It will certainly be difficult to reduce the number of permits without

good justification or full compensation. This makes a permit system relatively robust to political pressures.

When there is a shock, it may also be difficult to adjust the number of permits. This loss of policy flexibility is a cost. It could be minimized by clearly specifying the conditions under which numbers of permit can be changed and the process by which they will be changed, e.g.: whether government buys back permits or auctions less permits or devalues existing permits, how much advance warning they must give. The government could establish "triggers" which would lead to changes in policy. For example, new international agreements, a change in renewable energy costs of a given magnitude, a given increase in unemployment. These would limit the times when the policy could be changed and provide increased certainty to investors without preventing government from responding to major changes.

In a tax system, it is very difficult for the government to commit itself, and particularly future governments, to increasing the tax by the interest rate each period and for negative shocks. This may lead companies to expect lower future taxes if they think they can exert political pressure. This expectation will give them incentives not to invest appropriately in emissions reduction which may lead to a self fulfilling prophecy. All companies would prefer a lower tax so there is no countervailing economic pressure group which is equivalent to permit holders in a permit system. If companies are concerned about growing environmental pressure they may over invest.

Even if firms have no clear expectation about the direction in which taxes will deviate from the optimal path, the uncertainty will affect their investment decisions and lead to unnecessary efficiency losses. Thus a tax system is not robust because the tax must be changed each year which creates opportunities to change the system. This provides policy flexibility but also unnecessary uncertainty.

G TRANSPARENCY OF REGULATION.

This is a concept frequently referred to by business people. The argument is that firms respond the same prices effects of policies differently depending on how they are presented and hence perceived. Taxes and permits prices may be equal in economic theory but they enter accounting differently, are differently presented to boards of directors, involve different parts of the organization in response, and are perceived in one case as direct cost and the other as an asset to be managed. These differences may lead to differences in response.

4 DESIGN ISSUES COMMON TO TAXES AND PERMITS

A LEVEL OF REGULATION I.E. PRODUCER, WHOLESALE, RETAIL;

Any regulation should be imposed at a point where those whoa re regulated have the ability to control the pollutant. In the case of CO_2 any fossil fuel or other carbon source which is imported or extracted will ultimately release a fixed amount of CO_2 into the atmosphere. There are currently no economic equivalents to the "end of the pipe" technologies used for other pollutants. There is a lag in timing between the import of fuel and its combustion but this is not very large. The other issue in choosing the regulation is finding the level at which the costs of monitoring and administering the system both in terms of reporting costs for firms and costs to government are minimized. Regulation is simplest when it involves the smallest number of the most sophisticated players. Usually there is a tradeoff between this and the environmental outcome.

In the case of CO_2 it is clearly optimal to regulate at the highest point possible, that is, where carbon is imported or extracted. This achieves the environmental outcome at close to minimum cost, and minimizes administrative costs and complexity.

B WHAT IS REGULATED, I.E. ALL EMISSIONS OR ONLY MARGINAL;

For an economically efficient policy, equal incentives to abate must be provided at all margins. Any firm or individual considering an action which would increase or decrease emissions should take into account the effects of their action on CO_2 emissions. Firms which are considering closing down should recognize the CO_2 effects of all their emissions, not only those on the margin. Taxing or requiring permits for all emissions achieves this outcome and is also administratively simplest and most equitable.

C INCLUSION OF SINKS AS WELL AS EMISSIONS;

An efficient policy to address global warming would tax (permit) emissions and subsidize sinks of CO_2 as well as other greenhouse gases such as methane. Clearly adding sinks and other greenhouse gases increases the complexity of the system. There is a tradeoff between complexity and efficiency. There is no reason why the policy cannot be developed incrementally with new sinks and sources being added as their impact on efficiency becomes greater than their cost in terms of administration and complexity. Initially if we are considering a low level of regulation the additional economic benefits may not be justified given the increase in political and administrative difficulty. The policy chosen should however be designed in such a way that the extension of the system is facilitated.

D SEVERITY AND TIMING OF REGULATION;

Investment is always more efficient when there are less constraints on when it can be done. If the government plans to regulate it should make its policy clear and credible as early as possible to allow firms to make optimal timing decisions. Thus early regulation is preferable.

Because this is new regulation there will be a period of learning about optimal responses and about the regulation itself both from the point of view of firms and from the government's point of view. This argues for early implementation at a low level of severity in anticipation of more stringent regulation.

It is easier politically and economically to implement non-severe regulation. If regulation can be introduced at a time when it does not need to be strong, the opposition to it by vested interests is not as strong. It is therefore less likely that the policy will be distorted in response to these interests. This allows the government to maximize the equity of the policy and its efficiency.

Regulation on CO_2 should initially be fairly non-stringent because of the uncertainty surrounding global warming, because of the learning process we are involved in and because there are some economic costs from regulating a global public good much more stringently than our competitors. The stringency can be increased as we fine tune the program to deal with early implementation problems, as the private sector develops institutions and processes to efficiently respond, as new environmental information arrives, and as international cooperation grows.

E ENFORCEMENT;

This probably differs depending on the form of regulation. Legal advice would be appropriate here.

F INCIDENCE OF COSTS;

Who will pay the costs of CO_2 policy is not immediately apparent. There are three critical points to note here.

1 Who actually bears the cost is independent of who legally pays the tax or holds the permit.

2 The incidence of cost is exactly the same in a smoothly operating permit system as in a tax system if the permits are auctioned.

3 Taxes are borne by those who have inelastic demand for goods containing, or produced using, CO_2. That is those who are unable to reduce their use of carbon by substitution of an alternative, changes in technology or reduction in the carbon using activity.

1 Who actually bears the cost is independent of who legally pays the tax or holds the permit.

This is a standard result in public finance where markets operate smoothly. For example, suppose a wholesaler pays the tax. They are unable to reduce the amount of carbon in their fuel and they face competitive international markets in fossil fuels. They may pass on the full amount of the tax to their purchasers. If the purchaser is a business facing a competitive market with a fixed price, they are not able to raise their price to consumers who can buy the same good from other non-fossil fuel using suppliers at the old price, and the business will absorb the entire price rise on the fossil fuel they use.

Alternatively, suppose the business must pay the tax on every unit of fossil fuel they purchase. If they reduce their demand for fossil fuel it will not alter the price offered by the wholesaler though it will reduce their total tax burden. Similarly, they are unable to pass on a price rise to their consumers. Again they bear the full cost of the tax on each unit of fossil fuel they use.

If the consumer was required to pay the tax on the amount of carbon "embodied" in the product, and they face substitute products without carbon, they will only buy the product if the price is the same as before and therefore the business must again absorb the tax.

The business will of course reduce the amount of tax it must pay by reducing carbon use until the cost of reducing carbon emissions by one more unit is the same as the tax.

Figure 1.

2 The incidence of the tax is exactly the same in a smoothly operating permit system as in a tax system if the permits are auctioned.

If permits are auctioned, every time a wholesaler extracts or imports a unit of carbon (in fossil fuel or other sources), she must buy one permit. The price of this permit will be equal to the tax which would lead to the same level of total emissions. Thus paying for the permit is exactly equivalent to paying the tax and the conclusion from the previous section, that the incidence does not depend on who must buy the permits, holds.

If permits are not auctioned, once they are allocated their effect is still like a tax. If a business emits one more unit it either needs to buy a permit at the market price or it forgoes

the opportunity to sell a permit. Either way the unit of emissions costs them the same amount as the tax. Businesses will pass part of the cost on and / or increase abatement depending on their elasticity of supply and the elasticity of demand they face.

The allocation of permits by a system other than auctioning is simply a wealth transfer and has no effect on incentives to abate and hence no effect on efficiency. It would only be justified if there is a concentrated group which is of political concern (e.g.: poorer people, or older people) which we know will bear a high fraction of the costs and to which it is more feasible to allocate permits than to compensate in other ways. It makes no economic sense to allocate permits to wholesalers who can pass on the costs and hence pay little of the tax or permit cost. This is particularly true when many wholesalers are foreign owned.

3 Taxes are borne by those who have inelastic demand for the taxed good.

In a tax system (and hence equivalently a permit system) when a business or individual faces a higher price due to the tax they can reduce their demand for the good and / or pay a higher price. If they can reduce their demand significantly, if for example there are close substitutes, the seller of the good will be concerned about losing their market and will be unable to raise the price as much. For example, if an electricity company faces higher input costs due to a rise in the price of coal they could try to increase the price of electricity but this may encourage people to be more energy efficient or switch to gas for heating and cooking. Thus the electricity company may choose not to raise the price too much but may try both to cut down their use of coal and to absorb the input price rise in their profit.

The businesses and people who will bear the highest cost from a tax on carbon are those who are unable to reduce their energy demand and unable to change to a less carbon intensive fuel. If they are a business they will lose profits and may be forced to close down. Individuals will suffer lower living standards. It is extremely hard to identify who many of these people and businesses will be in the long run.

The costs of the CO_2 policy are both the costs of paying the tax and the real costs of abating use of carbon and products produced using carbon. The tax payments (or permit costs) are not a real cost to the economy because they are received by the government as revenue but they are real costs to firms. The incidence of tax also reveals the distribution of "deadweight losses" which are in this case the real costs of abatement. If an individual has chosen to reduce their emissions and thus reduce their demand for or supply of carbon it must have been cheaper for them than paying their share of the tax. Thus the cost of abatement is always lower than the individual's share of the tax. Thus those who bear the highest tax incidence are also those who bear the highest marginal abatement costs. Total cost shares will depend on who uses the most carbon because this determines the quantity of carbon on which they must pay their share of the tax. This is combined with their elasticity of demand for carbon which determines what their share of the tax is.

G REVENUE RAISED;

If the government can raise revenue while achieving an environmental goal it can reduce its need to raise revenue elsewhere. This revenue should be used to lower overall taxes, or for independently planned spending, depending on the government's fiscal priorities. It should certainly not be used to compensate the energy sector as this would decrease the efficiency of the regulation and lower the environmental benefit. It should also not be used to fund other environmental or even carbon policies which should be considered

on their own merits and funded out of general tax revenue. This form of revenue is no different to any other and should be treated as such.

5 DESIGN ISSUES SPECIFIC TO TRADEABLE PERMITS

A EFFECTS OF POSSIBLE COMPLEXITY OF PERMITS;

If permits are complex and not well understood various problems could arise and need some consideration. There would be speculation which in itself is not a problem but could lead to large losses to some groups which create equity concerns. For example, it seems that large fish processing companies effectively speculated on the value of ITQs and bought them from small fishers before the prices of quota rose to their current value.

Complex permits could also create transaction costs in trading if not all traders understand the permits and brokers do not develop to facilitate trading. If permits are so complex they are non-transparent it could create enforcement difficulties. Highly complex permits also raise administration costs.

There is probably a trade off between a theoretically perfectly designed permit system and the difficulty of implementing it. These difficulties should be borne in mind when designing the permit. If there are only a few sophisticated players required to hold permits the complexity is not such a constraint. Government will simply have to hire some sophisticated analysts to maintain and operate the system.

B MANAGEMENT OF ENVIRONMENTAL AND ECONOMIC RISK ARISING FROM ECONOMIC GROWTH AND FLUCTUATIONS, POLICY SHIFTS, INTERNATIONAL DEVELOPMENTS AND NEW SCIENCE;

Some of these issues have been discussed earlier. The fundamental issues of appropriate stringency of regulation in response to costs and benefits is not discussed in this paper and in my opinion will probably largely be learned incrementally and through experimentation.

C DISTRIBUTION OF PERMITS AND EFFECTS ON INCIDENCE OF COSTS;

This has been discussed earlier under common issues.

D TRANSACTION COSTS, EFFICIENCY AND INCIDENCE OF COSTS;

In a CO_2 market among importer and extractors, transaction costs will probably arise from five sources. Transaction costs are a problem because they mean some firms do not trade efficiently and thus overall costs are increased. They are a direct use of resources. They also may bias against some firms which are less able to trade and hence face higher costs of compliance.

There are costs of finding the market distribution of prices and then finding a partner. These can be minimized by creating an anonymous centralized trading mechanism where aggregate price (including the distribution of prices) and quantity information is periodically released and buyers are matched to sellers. The traders would have to have the confidence of the players. They would have to provide information on trading to the government (though not necessarily price information) for monitoring and enforcement purposes but this function would not need to be carried out by government. Large traders may prefer to negotiate directly when they have identified possible trading partners.

If there is concern about the validity of the rights being traded, transaction costs are created. This is unnecessary and can be avoided by accurate registration of rights in real time (i.e. as they are traded) so that buyers can check claims of ownership at low cost.

Negotiation costs between trading partners will depend on the liquidity of the market. If many players become involved in speculating on rights and creating rights (from forestry) the market will be liquid and a market price will emerge. If the market is illiquid, large trades will involve negotiation and bargaining which could be expensive. However, trades will tend to be repeated between the same partners and as trading patterns and prices become established, costs of negotiation will fall.

Trading of carbon permits may release confidential information about investment plans in the industry. If the market is liquid and anonymous, no information will be revealed except to government which would have to maintain strict confidentiality from both the private sector and other parts of government so that the information cannot be used to affect policy. If trading is observable publicly the release of information may restrict trading.

Another problem with publicly observable trades is that buying CO_2 rights and not being seen to be abating may have negative public relations effects for companies. This will lead to inefficient allocation of permits depending on who is exposed to public criticism but will not change the total allocation so has no environmental advantages.

E RISKS FROM, AND METHODS TO AVOID STRATEGIC BEHAVIOR;

Strategic Manipulation of Permit Markets

There are two possible forms of manipulation. A company can try to lower the price of permits to reduce their costs of compliance (CMM[1]) or the company can try to raise the costs to their competitors and hence exclude them or capture market share by raising the price of permits (EM[2]).

Why are we concerned about the price of permits being lowered?

If the government is auctioning permits it loses revenue and hence must raise more through distortionary taxation such as income taxation. Other firms which hold permits also lose. Marginal costs of abatement are not equalized because the firm lowering permit prices must over-abate to reduce its demand for permits and other firms will only abate until their marginal costs equal the new lower permit price. This means there is a higher cost to the economy as a whole. It also means that there is less of an incentive for the non-manipulating firms to innovate to reduce abatement costs so there is dynamic inefficiency.

Why are we concerned about the price of permits being raised?

Again marginal costs of abatement will not be equalized so that there is a higher overall cost of compliance. There will in this case be excessive incentives to innovate and invest. The government will gain revenue but at the expense of distortions and other firms will face higher abatement costs.

Most importantly, this form of manipulation can be used to monopolize a product market so the effects go beyond the CO_2 market. If a company is able to exclude its

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[1] Cost minimizing manipulation. Hahn, Robert W. (1984) "Market Power and Transferable Property Rights" Quarterly Journal of Economics pp. 753-765

[2] Exclusionary Manipulation. Misiolek, Walter S. and Harold W. Elder (1989) "Exclusionary Manipulation of Markets for Pollution Rights" Journal of Environmental Economics and Management 16 pp. 156-166

competitors the standard welfare losses, reduced innovation, lower quality and higher consumer prices will result.

How and under what circumstances can a firm lower the price of permits?

A firm can lower the price of permits in a static one period market (such as an auction) by reducing its demand for permits. It will only do this if the price reduction it causes is sufficient so that its total expenditures on permits fall by more than the increased abatement cost it incurs.

To be able to have a significant effect on price the firm (or firms) must make a up a considerable share of potential buyers. In addition, if there is no secondary trading of permits the extra abatement costs they incur must not be too large.

If permits are initially allocated by auction and major players can collude during the auction to reduce bids the government will receive little revenue. After the auction the firms could freely trade permits at their true price to achieve allocational efficiency. Every firm would gain from this because they would buy their initial permits at lower prices. The government (tax payer) clearly loses.

How and under what circumstances can a firm exclude its competitors from a product market?

Almost all users of CO_2 are broadly speaking competing in the same market, the market for energy. If there are only a few competitors and some are very large, one or a group of firms may be able to raise the price of permits in the market by under-selling or by over-buying relative to their true supply/demand.

If a new player wants to enter the market it needs to buy permits for all its emissions at these inflated prices. By distorting the market the manipulating firms are raising their own costs because they could abate more cheaply than the market price of permits, or because they have to buy permits at prices above their cost of abatement. However, they only bear these costs on marginal units if they are over-buying, and recognize that if they were to sell additional permits at the higher price the price would fall so the opportunity cost is not real. Thus the entering firm which must buy all its permits is more seriously affected and can be excluded at relatively low cost. The existing firm(s) could discourage entrants simply by the threat to raise permit prices. This is a credible threat and costs the existing firms nothing if they hold the permits. The benefits to the manipulating firm are the standard benefits to monopoly in a market, i.e. above normal profits. The size of these benefits depends on the elasticity of demand for the product, in this case fossil-fuel energy.

This form of manipulation requires that one firm, or a group of firms who are able to collude, holds enough permits that it is able to raise the price of permits. If there are other holders of permits who are price elastic they will sell their permits when the colluders withhold theirs and the strategy will be ineffective. It also requires that the possible entrant is sensitive to permit prices, i.e. that fossil fuel supply is a significant part of their cost.

How can strategic manipulation be avoided?

1 Broaden the base of who can hold permits. - not who surrenders them at period end.
2 Do not allow permits to become too concentrated. Trade commission? (No one company able to hold more than 20% of permits available for use in any one year?)

3 Auction some permits each year so existing firms never hold too high a percentage. If they have to buy a lot of permits in the auction it becomes expensive to push the price up.

4 Allow creation of forestry offsets to increase responsiveness of supply to changes in price due to reduced supply from existing holders.

5 Make permits bankable so there are more out there to sell - i.e. increase price responsiveness.

6 Make trading anonymous to make cartels difficult to sustain.

F METHODS TO SPECIFY AND ALLOCATE PERMITS TAKING INTO ACCOUNT INCIDENCE, STRATEGIC BEHAVIOR, REVENUE, RISK MANAGEMENT AND MARKET LIQUIDITY;

A Choice Variables in Distribution Design

(i) Permits defined for one use or in-perpetuity/eternal

By "one use" I mean that the permit is defined as the right to emit one tonne of carbon once. For example a permit might state "This permit gives the holder the right to emit one tonne of carbon after January 1999."

A permit in perpetuity gives the right to emit a flow of permits. For example the permit might state "The permit gives the holder the right to emit one tonne of carbon each year from the year 1999 to perpetuity.

(ii) Length of bankability of permits.

By "bankability" we mean that a permit dated January 1999 does not need to be used in January but could be saved (banked) and used in a later period. The government may want to define a limit on how long the permit can be banked. Thus the permit may be defined as "This permit gives the holder the right to emit one tonne of carbon after January 1999 and before January 2009."

(iii) Time of Auction of permits

If we use "one use" permits we have a series of permits dated for years out into the indefinite future. The later permits cannot be used for many years but could be sold in advance. One option would be to sell all permits with all dates immediately. Alternatively, the permits for each year could be sold at the time they can be used. I propose a mixed system where all current permits are sold, as well as a percentage of the permits from each future year with the percentage declining for more distant dates. Thus there would be annual auctions of a variety of different types of permit.

(iv) Method of selling permits

There are two basic methods for allocating permits. Giving them free or at a subsidized rate to specific groups or auctioning them. If they are auctioned there are a variety of different ways this could be done, tendering, English auction, Dutch auction, etc. The auction would be a multiple object repeated auction.

B Issues which need to be considered when choosing between options.

(i) Distribution of Costs

The incidence of the costs of regulation will be very widespread in the future and based on the social costs the individual incurs. Therefore there is no strong reason to compensate any given group. In particular there is no need to compensate the producers or importers of fossil fuels. If a given industry suffers and goes bankrupt they should certainly not be subsidized to keep operating. They are not economically efficient when the full costs of their activities are included. There may however be a case for transitional assistance and retraining of workers. If for social reasons there are groups toward which the government would like to direct resources to maintain their standards of living as energy prices rise, such

as the elderly, this can be done more effectively through increases in superannuation or improvements in health care and other services.

(ii) Market Power: - Concentration of Permit Holdings

(a) may distort permit prices leading to inefficiency

If there is a small group of buyers which dominates auctions, they may be able to collude to lower the price which the government receives. This reduces government revenue and thus requires higher distortionary taxes. This may also lead to temporary missallocation of the permits. If at any point a small group of players hold a large percentage of the permits available for a given time period they may collude to raise the price of permits which means that other players will not buy as many permits as they would at the true equilibrium price.

(b) may increase concentration in energy markets

If permit prices are artificially raised by collusion some players may be excluded from the market allowing the others to wield monopoly or oligopoly power with its resulting inefficiency. This would tend to raise consumer prices, reduce quality and reduce innovation in energy production. This distortion also has effects on the distribution of income because small entrants lose.

(c) Why do quota concentrate?

Quota could concentrate because as an asset they have certain risk/return characteristics which are more attractive to some players. In addition some players have better information about the value of permits which reduces their risk and makes them more likely to hold permits. Players which are involved in the energy market will be likely to place higher value on permits because of the "option value" they carry in an illiquid market. Permits provide the firm with security that they can emit CO_2 even if it is difficult to find a seller of permits. Therefore these firms may buy up a high percentage of the permits. If some players see the possibility to control the market they will be willing to pay more for permits because of the possible benefits they will gain from oligopoly or monopoly power in either the permit or energy markets. The concentration of permits was observed in the ITQ market with increased concentration in the industry as a whole.[3]

(iii) Liquidity of Market

(a) Why does liquidity matter?

Liquidity is important for the efficient operation of a market for many reasons. If a market is liquid there are many trades and prices are observed frequently. This gives good information on the value of carbon permits both to the government and to other possible users and/or purchasers of the permits. Improved information combined with the ability to buy and sell permits at any time at the market price makes it easier for companies to manage their risk and makes it possible for players to specialize in holding the permits and absorbing risk. If the market is not liquid, some players who would like to buy permits at the current price will not be able to and will be forced to reduce their economic activity. At the same time others will have too many rights which they will either not use at all or use without much economic gain. In a liquid market it is much less likely that we will face the difficulties arising from concentration. Any firm will be able to enter the energy market by buying permits and it will be difficult for existing players to maintain high prices when many units are traded by many players.

(b) What limits liquidity?

There are three main factors which would limit liquidity. First if the design of permits is complex or there are expensive administrative procedures which must be followed to have trades approved and make trades then players will only trade when they can make a significant gain. This will reduce trading and hence liquidity significantly. Second there may

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[3] The increased concentration in the fishing industry was also due to technology changes partly in response to the increase security of fish stocks. There is no counterpart to this effect in a carbon trading market.

be factors other than government procedures which make it difficult to trade. If there are no brokers and potential trading partners are in different industries people may find it difficult to find trading partners. If there is negative publicity associated with buying permits due to the environmental implications people may choose to limit their buying activity. If the trading of permits reveals business confidential information about the energy sector people may choose to restrict trade in order to avoid this release. Thus the ability to make anonymous trades may be valuable. Finally, if a small group is able to control the market they may restrict trades to raise prices or exclude competitors. If permits are relatively homogeneous the market will be "thicker", that is there will be many potential buyers and sellers of any particular type of permit, and if permits are infinitely divisible there is no restriction on how small a permit trade can be.

(iv) Maximize government revenue

This minimizes the need to raise revenue through distortionary taxation.

(a) Maximize number of potential bidders

If some people who could possibly be interested in buying permits and who value them highly do not know how to bid or find it difficult or costly to submit a bid, the price of the permits sold in auction will be lower. In addition game theory tells us that when there are more bidders it becomes less likely that bidders will bid lower than their true value, in the expectation of making a profit because there will be no one to outbid them. The effects of this depend on the auction form.

(b) Maximize value of permits - minimize restrictions and uncertainty

If there are limitations on when or how permits can be used the permits are less valuable to firms. Some restrictions are necessary to maintain the integrity of the system but each restriction should be evaluated to ensure that it is strictly necessary. Uncertainty increases the risk associated with holding a permit and makes it less valuable. Again some uncertainty is unavoidable and cannot be controlled by government. This risk should not necessarily be absorbed by government to raise prices because risk bearing has a real cost to the government as well as the private sector. However the government can create unnecessary uncertainty if it does not design the permits clearly and if it makes the value of those permits overly vulnerable to political changes.

(c) Increase information flows

Improving the liquidity and information flows in the market not only improves efficiency but in many cases it seems to raise the initial auctioned value of the rights. Lack of information reduces the number of bidders and creates tremendous uncertainty which appears to lower permit values (it could theoretically raise them). In the ITQ market permit values were initially very low and rose faster than the rate of interest as the market became established. Similarly many analysts argue that the permits being sold in the US SO_2 trading market are being sold well below what would be the equilibrium price. If the government is selling the rights it suffers from the low prices.

(v) Allocate risk appropriately between private and public sectors.

These issues are discussed in detail in section F on Risks and Risk Bearing.

(a) Investment certainty vs. government flexibility

(b) Private vs. public ability to respond to shocks and minimize shocks.

C Recommended Distribution Design

(i) Permits defined for one use

A permit in perpetuity is equivalent to an infinite set of permits for one use where each use is defined for a particular time period. The "in perpetuity" property right is more familiar but is a restrictive definition. In a normal property right situation the amount of property available is not subject to change so there is no reason not to allocate it completely. As discussed in section F, this is not the case with pollution permits the optimal total amount of which depend on changing perceptions of costs and benefits. It would be possible to define permits for several uses but would be more administratively complex than simply issuing several one use permits and thus having permits as homogeneous as possible. Homogeneity makes trading more efficient, reduces complexity and makes compliance easier to monitor. Each permit would need to be marked with a date before which it cannot be used. This would ensure that New Zealand is cumulatively in compliance up to any given date.

In addition, it is difficult to define bankability with an "in perpetuity" permit. With a normal property right it is not possible to use it twice in one period. e.g.: with land it is not possible to not farm in one period and use the same piece of land twice in the second period. In many environmental tradeable permit markets the timing of emissions is critical and bankability is not allowed. In this situation a permit in perpetuity can make sense because it is the right to emit a flow of emissions each year. In the carbon market we are concerned with the accumulation of emissions. A permit in perpetuity which was not used one year would have to be convertible into a permit to use those emissions in a later year. This becomes a "one use" permit system.

(ii) Bankability of 5 - 10 years with potential to change

Given the nature of carbon dioxide, its life time in the atmosphere and the timing of its effect on climate, ideally permits would be bankable for 100-200 years. However there are administrative and international political problems with this. If a large stock of banked permits builds up, New Zealand may not be able to comply with short term targets in later years. Although we must have overcomplied initially to create this situation this may not be the international or domestic perception. If in later years the international community decides on much more stringent targets, if New Zealand has many banked rights the government may find it necessary to buy back some rights at possibly significant cost.

The advantage of long allowances for bankability is that it allows businesses individually and the private sector as a whole to find the optimal path for emissions. However, given uncertainty and the relatively short horizons of most business, it is probably not necessary to make the bankability infinite to achieve most of the gains from intertemporal optimization. In actual markets most banking has been for the purpose of short run smoothing so that permits are banked for only 1 or two years at most. This is more a response to limited liquidity and short term individual shocks than an overall constraint on permits in the market. Banking of 5-10 years would probably be sufficient but will not over-constrain the government. When the market is actually operational, if there is too high (much more than rising at the rate of interest) a value on future rights relative to current rights this would be an indication that the limit on bankability is a real constraint and should be reconsidered.

(iii) Permits auctioned annually: remaining current permits and some for each future year out for about 25 years.

For example in 1999, or the end of 1998, all permits which are dated for use after January 1999 and before January 2009 would be auctioned. In addition 75% of the permits dated January 2000, 50% of those dated 2001, 25% of those dated 2002, 15% of those for 2003.....would also be auctioned. In the year 2000, the remaining 25% of permits for 2000 would be auctioned together with an additional 25% from 2001 etc. The percentages chosen

here are purely for illustration. The idea would be to have a sizable percentage of permits for each of the current year and immediate future years traded every year.

In a perfect market with perfect information all permits could be auctioned immediately. The government could invest the money gained and if it needed to buy back permits simply repurchase them with the return from the investment. However, given that markets are not perfect the government needs to take into account issues of market power, liquidity and maximizing government revenue. Market power can only arise if one small group gains control of most permits which are available for use in a given year. If not all permits are allocated in advance, the government can always counteract the market power by auctioning permits and thus making them available to new entrants. With annual auctions of all different types of permits (i.e. with different start and end dates) a minimum level of liquidity will be guaranteed in the market. Finally, gradual auctions will allow experience to develop in the private sector, so the uncertainty about permit values will decrease, probably allowing the government to sell them for higher values and make more revenue. This prevents private companies who have good information about the value of permits from making large speculative gains early in the market and buying many permits cheaply.

(iv) Method of selling permits

Get expert advice if this stage is reached. I am not an expert auction theorist. Game theorists such as John Riley (UCLA), Larry Ausubel(UMD), John MacMillan (UC-San Diego), Charles Plott (Caltech?) and others work on these issues at a theoretical level. The US telecommunications spectrum auctions used the most up to date theory and experimental evidence but this is a different form of auction so cannot be directly modeled on that. The SO_2 market is more similar and the US EPA are working toward improving the design of that auction. Timothy Cason at University of Southern California has done work specifically on the design of the SO_2 market. Again however, given that SO_2 is a non-accumulative pollutant and the market structure of the industry is different it may not be appropriate to use their auction form.

6 DESIGN ISSUES SPECIFIC TO TAXES

A ENVIRONMENTAL RISK MANAGEMENT UNDER TAX;

B CHOICE OF LEVEL OF TAX AND ADJUSTMENT OF TAX OVER TIME;

Choice of optimal tax is almost impossible. Given the accumulative nature of the tax we can try to define how much total emissions should be over time to achieve climate stabilization or slow change. However, we do not know the optimal path by which those emissions should occur. In a tradeable permit system with banking, businesses in the market will use all the information available to determine the future price path and their optimal responses to it. With no new information the price will rise at the rate of interest. As new information is received the price path will shift up or down automatically. It is not possible to determine the price path from current emissions and hence adjust the tax to achieve the target in the usual way with annual targets. We would not know we had the tax path wrong until well through the period for which total emissions were defined (maybe 15-20 years).

C INVESTMENT CERTAINTY UNDER TAX;

This is discussed earlier.