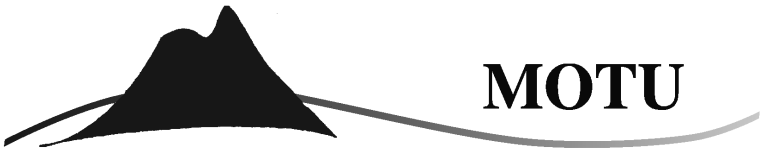

Ecological Tax Reform

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Report prepared for the Ministry of Environment

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Executive Summary

Where used effectively, ecological taxes have the potential to make appropriate environmental decisions an automatic part of every economic decision. They are flexible to different needs and changing conditions. They induce people to use their own information and ideas about how to reduce pollution most effectively. At the same time they raise revenue that can replace distortionary taxation on income and capital. They are a valuable part of the environmental regulation toolbox and although they are not appropriate for addressing all environmental problems they are probably currently underutilised and worthy of more investigation.

An active academic literature has explored the possibility that eco-taxes are not only good for the environment but might also improve the tax system. The conclusion is emerging that because of 'tax interactions' this latter result is only true where the existing tax system is grossly distorted and eco-taxes provide an opportunity for much needed reform. Despite this, raising revenue where there are no additional distortions from doing so is certainly good. For example, if we use regulation to cost-effectively reduce pollution we will create the same distortions whatever approach we use. We should therefore use an approach that raises revenue. Eco-taxes should however only be used where the environmental benefits alone justify the regulation.

Two under-appreciated facts about the costs of regulation are first that industries do not bear costs, individuals do. All costs are ultimately passed on to either workers, the owners of capital or consumers. Second, new investors in a regulated industry, who enter after regulation is imposed, never bear costs. Any compensation to the owners of capital for a new regulatory program (payments to firms go to the owners not the workers) should go only to those who own capital at the time the regulation is created.

With eco-taxes the distributional effects are more transparent than with other forms of regulation but the costs to individuals are actually lower on average. All efficient regulation has the same underlying distributional effects and the same tax interactions. To be efficient every decision must face the full cost of the pollution it creates; that is, the marginal cost of polluting must be the same. The ultimate distributional effect depends not only on these marginal prices but also on any lump sum compensation included in the program. Inefficient regulation has higher total cost and in the short run imposes higher costs on some groups while reducing the costs to others. In the long run consumers bear all costs so they just face more total cost distributed in broadly similar ways.

In this report we analyse the likely distributional effects in New Zealand of one specific eco-tax, the tax on petrol. Simple empirical analysis suggests that a petrol tax would have slightly regressive impacts but might affect middle-income people most. This result, while based on limited analysis, is consistent with more detailed international studies.

Internationally many economic instruments are used for environmental protection. These include eco-taxes but also a range of other similar instruments all of which

internalise environmental effects in decision making and many of which can raise revenue. Other instruments include tradable permits, insurance surcharges, deposit-refund systems, and even information and labelling programs.

Many notable environmental successes have been achieved, particularly in the United States, through the use of economic instruments and particularly tradable permits. They not only have had positive environmental effects at relatively low economic cost, but also have had positive effects on innovation and adoption of new technology. Europe tends to use taxes more and their effects have not been so heavily analysed.

Despite much talk about eco-taxes however, they are not used to their full potential. The predominant form of environmental regulation still involves direct control through technology standards and non-tradeable permits. Many countries use low-level charges that don't directly have environmental effects. They create environmental benefits only through the use of revenue. These charges don't generally have significant revenue raising benefits either. Climate regulation may change that in OECD countries. Most countries are currently engaged in serious discussions about the use of either carbon taxes or tradable permit systems.

In New Zealand we have a history with some use of economic instruments and we have legislation that allows more use. At a national level one appropriate use is for greenhouse gas regulation. National level economic instruments could also be used to help protect biodiversity (though subsidies rather than taxes may be needed) and to reduce the risk of ecological accidents. More opportunities exist at the local level and some are already well exploited such as solid waste policies by many councils. Water management, toxic waste disposal, local air pollution, and agricultural run off are all areas that might benefit from more consideration of eco-tax type approaches. Even though many of these approaches are inherently local and can probably be carried out under the existing Resource Management Act provisions, central government may have a role in providing advice, helping councils to share experience, and, if necessary, encouraging harmonisation of regulations across regions.

1 Introduction

New Zealand is beginning to face more acute local environmental problems such as water supply, sewage treatment, local air and water pollution and land-fill issues as well as taking on international obligations relating to climate and biodiversity. We need to reconsider which are the most effective and efficient instruments for environmental management. At the same time, many countries are considering and implementing 'economic instruments' which include ecological taxes. These instruments have the double benefits of being effective and relatively non-intrusive regulatory instruments as well as providing government revenue that can help meet the demands for cuts in traditional taxes on income and capital.

Defined purely, an ecological tax is a regulatory instrument that increases the cost to actors of an activity in a way related to the cost of the extra environmental damage caused by that activity. Sometimes these taxes are referred to as 'pigouvian taxes'; they correct the 'externality' caused by the lack of a market for the environmental good that is being consumed. Any good that is free will be over-consumed.

For example, if every litre of chemical waste from a pulp and paper plant released into a river creates social costs of $100 from loss of fishing and aesthetic damage, an ecological tax might impose a levy of $100 per litre of waste produced by the plant. If the firm can reduce its waste at a lower cost than $100 it will do so until the point where reducing waste is more costly than paying the tax. At this point society is adequately compensated for the environmental harm and it is more socially efficient to allow the pollution and use the tax resources elsewhere. An ecological tax may be set lower than the level of social cost; this will still create social benefits but will not achieve the socially optimal level of pollution.

Eco-taxes are one form of 'economic instrument' for environmental protection. All economic instruments work through prices. Stavins (2000) categorises economic instruments for environmental protection in the following way.

1. Pollution taxes and pollution charges
    - effluent charges
    - deposit refund systems
    - user charges (funds used for earmarked purposes)
    - sales taxes and tax differentiation
    - insurance premium surcharges
2. Tradable Permit systems
3. Market barrier reductions
    - market creation
    - liability rules
    - information programs
4. Reduced government subsidies for environmentally damaging activities

The first category includes eco-taxes but the others have similar effects by operating solely through prices and markets. Different pollutants might best be treated in

different ways depending on the pollutant and the existing regulatory and market structure. For example, making firms liable for the costs of accidents that have adverse environmental impacts is equivalent to a tax on the pollution but operates through a different instrument and institution. If environmentally damaging government subsidies already exist, removing them will have environmental and revenue advantages just as an eco-tax does but we do not usually think of these as eco-taxes. In addition to Stavins' list, government subsidies can be used to encourage environmentally favourable activities. These have some of the benefits of using the price mechanism to use decentralised information about how best to control environmental damage but have high costs because of the need to raise revenue to implement them; in contrast eco-taxes provide beneficial revenue sources.

This paper provides background analysis of the potential role for ecological taxes addressing both their advantages and limitations. We discuss the revenue raising implications of the taxes as well as their environmental effectiveness. We discuss some of the international experience with eco-taxes both in terms of their political aspects as well as practical issues in implementation. While they have been extremely successful in some instances, in other key instances they have failed to be implemented. We also discuss both distributional effects of eco-taxes and give some empirical evidence on the likely effects of one key potential eco-tax, a tax on gasoline. Finally we discuss current New Zealand use of eco-taxes and consider where opportunities may exist for usefully extending their application.

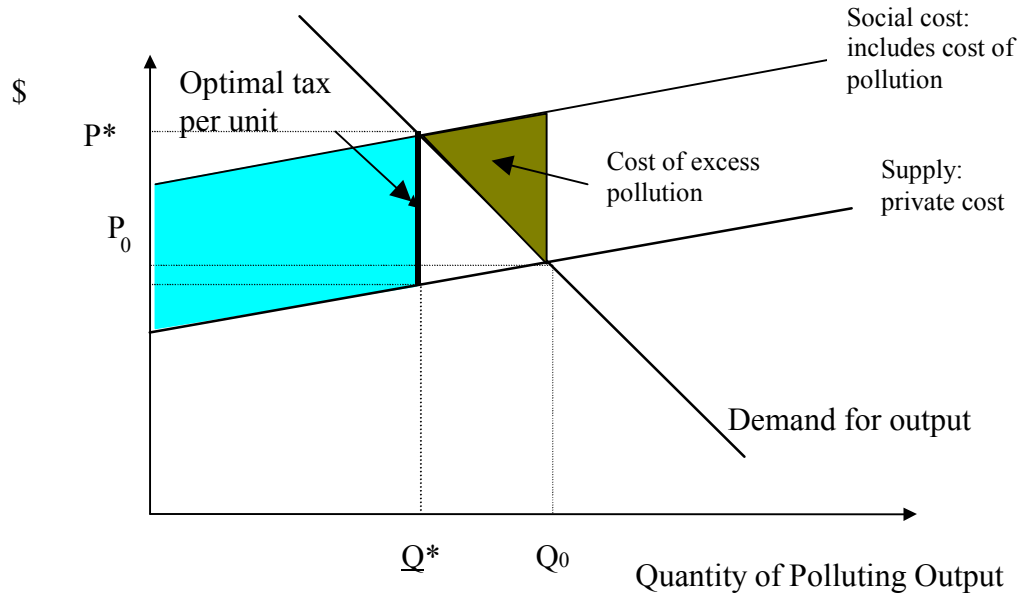
2 The Theory of Ecological Tax Reform

Ecological taxes are pigouvian taxes aimed at addressing an externality that causes inefficiency in the form of too much pollution. Those who create pollution do not take account of the social cost they impose. If a tax is set appropriately, at the level where the marginal cost of reducing the pollution is equal to the marginal environmental benefit, it will equalise marginal costs of abatement across all actors and can achieve the environmental goal of reduced pollution at least cost.

Figure 1 shows an example of how an eco-tax operates. The lower upward sloping line is the normal marginal cost curve or supply curve. Suppose each unit of output creates a constant level of environmental damage equal to the vertical difference between the lines. The social cost of every unit of output is higher than the private cost by this fixed amount. With no regulation the level of output will be inefficiently high from a social point of view at Q_0. The dark shaded area represents the excessive social cost from pollution. If the tax is set equal to the marginal damage from the pollution, people will only consume the output when they value it so much that they are willing to compensate society for the damage they cause. The cost of the pollution will be the lightly shaded area but this is outweighed by the value the consumer gets (represented by the demand curve – how much they are willing to pay). The overall level of output will be lower, Q^*. A lower eco-tax than the optimal tax will lead to some social gain – in fact the gains are largest initially.

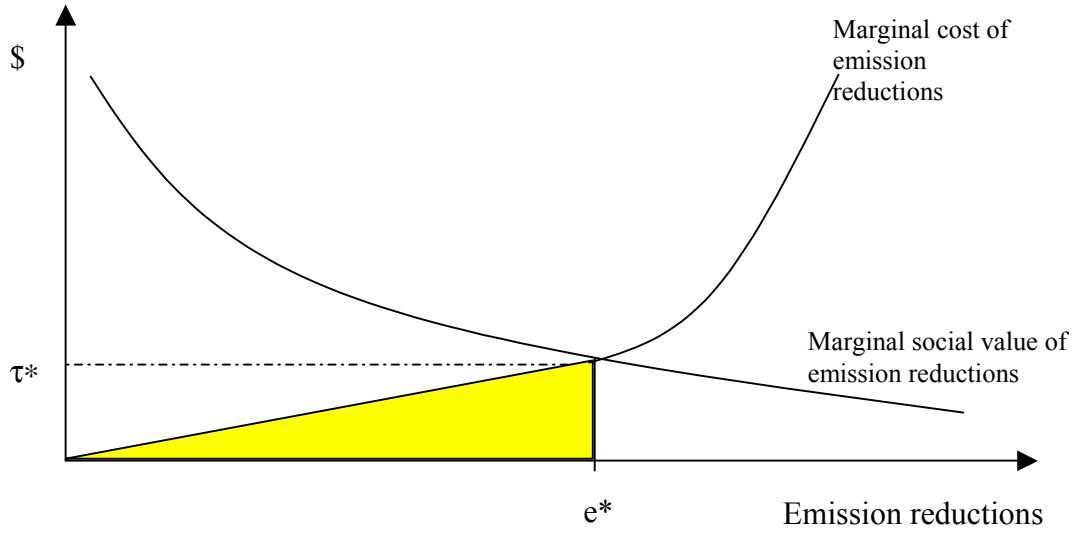
In this example the tax leads consumers to buy less of the output that creates pollution.

Figure 1 **Optimal ecological tax**



The tax might also lead the manufacturer to reduce the amount of pollution per unit or invest in research to reduce future pollution. If the costs of emissions reductions includes the loss of consumer and producer surplus from reduced output as well as the cost of reducing emissions per unit of output, the overall effect of the tax can be shown in Figure 2. As emissions are reduced, the additional social benefit from further reductions decreases while the costs of reducing rises are cheaper options are exhausted. The optimal tax equalises the marginal cost and value of reductions.

Figure 2 **Costs and benefits of abatement**



This is the simple story. In real applications a number of complications arise that can make ecological taxes less appealing or potentially more appealing.

Ecological taxes play two roles. They create incentives to reduce environmental damage or enhance environmental benefits and they raise revenue. In this section we will consider first their tax implications, whether their interactions with the existing tax system raise or lower the real costs of ecological tax reform. Then we will consider their environmental role and how they fit within a suite of possible environmental regulations.

Are Ecological Taxes Good Taxes? The Double Dividend Debate

Because eco-taxes raise revenue and change prices they have implications for the tax system. Relative to other environmental regulations, that achieve the same goals but do not raise revenue, eco-taxes have positive effects through the 'revenue recycling' effect. Thus the total social cost of ecological taxes is lower than that of other non-revenue raising regulations.

Revenue Recycling Effect

Taxes on labour income and on capital cause inefficient distortions in behaviour. For example, with no taxes, wages will be equal to the marginal productivity of the worker (simplistic but roughly true). Each person will work until the value of the extra amount they produce is equal to the extra cost to them of working – their marginal utility of lost leisure. With a labour tax, this decision is distorted because they are paid only a percentage of the value they produce and thus will stop work sooner or choose not to participate in the labour force at all. This is socially inefficient because the social benefit of their work is unchanged, some benefit simply goes to the government through taxes.

Ballard, Shoven and Whalley (1985) estimate that each additional $1.00 of government revenue, raised through distortionary taxation, costs society $1.30.[2] If we can gain revenue with no additional distortion, by using eco-taxes rather than other non-revenue raising forms of regulation, we can achieve significant efficiency gains. The revenue raised could be used to cut other taxes or reduce government debt. If labour or capital taxes can be lowered while maintaining overall tax revenue, the economy as a whole would benefit. In the case of carbon taxes in the US, using the revenue from carbon regulation to cut other taxes is estimated to reduce the cost of the regulation by two thirds.[3]

One concern commonly expressed by private sector actors is that government will not use the revenue well.[4] If revenue is used poorly, the potential benefits of revenue recycling are squandered. There is no revenue recycling benefit if the revenue is neither used to reduce

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2 Recent work by Feldstein suggests that the cost may be even higher.

3 Parry, Williams and Goulder (1998) estimate that, the cost of reducing emissions by 10 % would be more than three times higher under grandfathered allowances than under a tax, or equivalently an auctioned permit system.

4 One criticism of the efficient revenue raising argument is that government spending is not exogenous. Raising revenue through auctions may not lead to equivalent tax cuts. Preliminary work by Becker and Mulligan (1997) suggests that more efficient tax systems are associated with larger governments. If this is the case, the efficiency gain from auction revenue will depend on the actual size of the tax cuts and what is done with the additional government spending.

the cost of existing taxation nor used for expenditures that have social benefits that outweigh the costs.

If regulation is going to be imposed and one available form will raise revenue while another, equally cost-effective, will not, the revenue raising instrument will be more efficient.

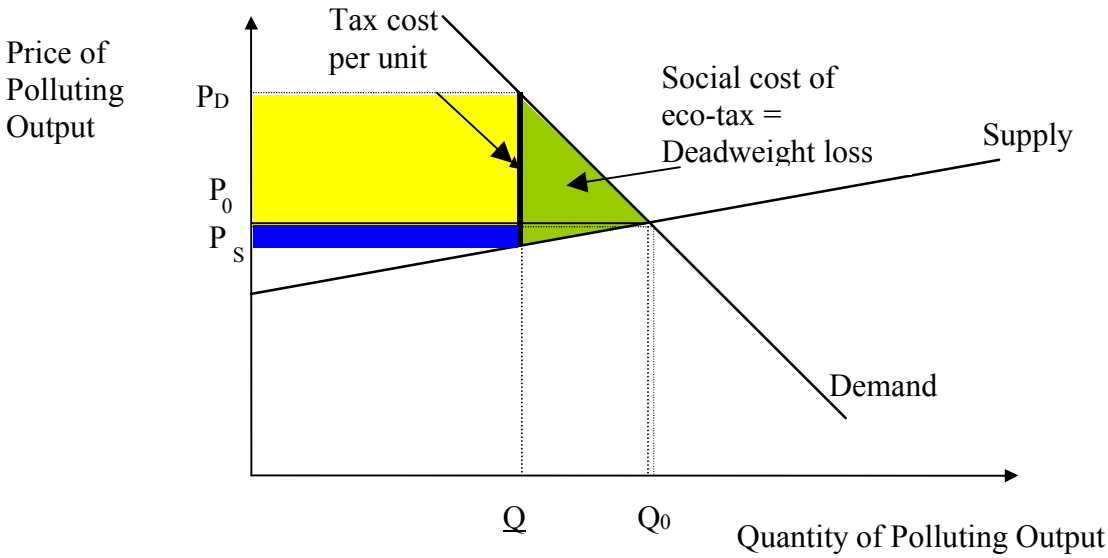
Direct Costs of Ecological Taxes

Eco-taxes lead to environmental gains and have benefits for the efficiency of revenue raising; they also create economic cost. Figure 3 shows how an eco-tax raises the price of a good that uses a polluting input by the tax cost per unit. It reduces the quantity from Q_0 to $\underline{Q}$. This figure assumes that the good is sold directly from the producers of the goods to the final consumers. P_0 is the original unregulated price, P_D is the price consumers pay after regulation and P_S is the price sellers receive. The difference, P_D- P_S is the tax per unit. The direct social cost of the regulation is equal to the deadweight loss. This is the loss of consumer and producer welfare from reduced consumption. The shaded area in Figure 2 shows the total cost including the direct cost of abatement. If the level of regulation is efficiently set, the deadweight loss will be lower than the social benefits from the environmental gain. In fact the marginal environmental gain should be equal to the level of the tax.

The eco-tax achieves the outcome by simply pricing the environmental damage in the same way that other inputs to production are priced thus inducing efficient use of this input. The cost created by this is the lowest possible cost of achieving the environmental gain (if there are no problems with people having information about abatement opportunities or access to capital to implement them). Any other regulatory program will have at least as great a cost on average (though some goods may face higher costs and others much lower) in order to induce the same reduction in emissions. The costs may be differently distributed between deadweight loss, and costs to producers and consumers. Even if the marginal cost to society is the same, the average cost may be much higher.

The tax revenue (tax cost × Q) is collected by the government. This revenue could be used to offset a cut in income or corporate taxes or GST or to reduce government debt. All of these would create efficiency gains. Some could be used to further equity goals as discussed below.

Figure 3 **Direct Cost of Ecological Taxes – no tax interactions**



In a simple world, if the environmental gains outweigh the direct costs the regulation is a good one. If the regulation is able to raise revenue the costs fall and a higher level of regulation can be justified. However, regulations also change other prices and can have indirect effects that could raise costs.

Tax Interactions

Because of interactions with existing taxes, regulations could have higher costs than are immediately apparent (Bovenberg and de Mooij 1994). For example, because environmental regulation raises the cost of some consumer goods it reduces the return to labour because workers can buy less with their income. It inefficiently reduces their incentive to work. It exacerbates the existing distortion from the labour tax. This distortion is not constant but rises rapidly with the level of the tax. If labour taxes are high the efficiency cost of an eco-tax, which is effectively a labour tax increase, could be very high on the margin. Similarly, if the regulation raises the cost of capital it will reduce the return to certain sorts of investment and could have a high efficiency cost. An increase in any input price exacerbates existing distortions; the key difference with an input price rise caused by environmental taxes is that the government controls these price increases. The government can take the interactions into account when designing policy. Interactions with the tax system can affect the cost of regulation so should also have effects on the decision about the level of regulation.

These tax interactions will occur regardless of the form of regulation. The larger the effect on the cost of consumption or capital, the greater the distortion in the tax system. More efficient regulations have a smaller tax interaction.

Double Dividend?

In the extreme, some people have argued that eco-taxes could be beneficial even if they are not environmentally justifiable – i.e. they have negative cost because they improve the tax system. This can only occur if the taxes are recycled and shift the tax burden from the overtaxed input to a relatively undertaxed input. eg: if labour taxes are very high and Europe relative to capital taxes, an eco-tax package that shifts taxation from labour to capital could improve efficiency.

The "double dividend" argument is that not only are environmental goals achieved in a tax or tradeable permit system, but the tax system is also made more efficient through revenue recycling so that the overall cost of the policy is negative and eco-taxes should be used irrespective of environmental gain. This is a very strong claim. For the tax system to be made more effective the gains from revenue recycling must outweigh both the costs of abatement and the 'tax interaction' effect.[5]

How large are tax interactions?

Tax interactions are only really critical where the anticipated tax is large.

Tax interactions will be greater when the existing tax system has high levels of taxes or is biased toward the same basic factor, labour or capital, that the eco-tax also affects. A tax on energy may strongly affect the costs of capital in the agricultural manufacturing sector. If this sector is considered to be overtaxed, the energy tax will increase this burden. In contrast, in Europe labour taxes (both direct and through labour regulations) are generally considered to be high and some research suggests that eco-taxes which impact more on capital could create a double dividend when the revenue is used to reduce labour taxes and hence lower unemployment and increase work effort. If eco-taxes raise the cost of consumption, the increased regulatory cost from the tax interaction would be very high in Europe, but the gains from cutting labour taxes using the eco-tax revenue would also be very high.

Tax interactions will be greater if the 'pollutant' is a substitute for leisure rather than a complement. If a rise in petrol prices makes people want to work less because of increased commuting costs (rather than making leisure less attractive because long road trips are more expensive), a petrol tax will exacerbate the labour tax. If a tax on marginal water use in Auckland makes gardening less attractive it might reduce the distortionary effect of the labour tax by making leisure less attractive.

Parry, Williams and Goulder's (1998) results suggest that the interaction effects in the case of US climate change regulation are so serious, that unless the benefit of reductions is greater than $18 per ton, a non-revenue raising form of regulation would not yield any net social benefits. Research strongly suggests that US carbon regulation will not generate a double dividend.

In New Zealand, if we think that overall tax rates are not particularly high, our taxes are relatively balanced across factors and we are thinking of introducing relatively

[5] Bossello, Carraro and Galeotti (1998) and Bovenberg and Goulder(2000) provide surveys of analytical and numerical studies of this issue. Goulder and Parry (2000) provide a useful simple summary.

modest eco-taxes, the tax interactions are not likely to be too severe.[6] This means that the social cost of the eco-tax is more or less the direct cost of pollution abatement as our normal intuition suggests. If these things are true about current New Zealand taxes however, there also will not be large gains to the efficiency of the tax system from eco-taxes so they should not be over-used in the expectation of improving the tax system.

Tax interactions suggest that although eco-taxes may be good environmental regulation they are not a panacea for problems in the tax system and should be used only where the environmental benefits justify them. The size of the tax interactions depend on the 'pollutant' taxed and the nature of the overall tax system. If we are going to regulate, the existence of tax interactions should not mean that we do not use taxes (or raise revenue through auctioning permits). Where possible, if the regulation is going to occur, designing it to generate revenue and reducing other taxes is always economically beneficial.

When are Ecological Taxes the Best Instruments for Environmental Regulation?

A government needs to consider a range of objectives when designing new environmental regulations.[7] These are summarised in Table 1.

Table 1 Government concerns in the design of environmental regulation

Environmental Effectiveness
- Short run
  Is the pollutant uniformly distributed and/or persistent/accumulative?
- Long run – effects on investment and technology change

Limitations on government capability and resources
- Ability to monitor particular pollutants

Efficiency
- Static efficiency
- Dynamic efficiency

Flexibility – ability of regulation to respond to changing circumstances

Distributional effects
- Political feasibility
- Winners and losers relative to status quo
- Vertical and horizontal equity

Existing regulatory structure
- Fixed costs of creating new monitoring regimes or legal frameworks,
- new regulations will interact with existing ones,
- existing regulations may be substitutes,
- or compliments-e.g. address non-price barriers

Ancillary benefits

Cultural approaches to regulation

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6 NZ taxes are lower and more balanced than those in Europe but higher than those in the US.

7 Stavins and Whitehead (1992) discuss these in more detail.

Opportunity to raise more revenue
Attitudes toward certainty of compliance

- Different perceptions of their certainty

Environmental effectiveness

The environmental effectiveness of an ecological tax depends very much on the nature of the pollutant involved: its spatial distribution and its persistence. Taxes work best for pollutants that are 'uniformly distributed' and cumulative or where the marginal damages from pollution do not rise rapidly with the level of short run emissions.

A key feature of the pollutant is whether it is 'uniformly distributed' over space. When a pollutant is uniformly distributed, the source of the pollution does not matter. The pollution mixes uniformly in the atmosphere or water or all ends up in one place regardless of where it originates. This is true for greenhouse gas emissions, ozone depleting chemicals and to a certain extent for solid waste or sewage (within a city it may all go to the same landfill or sewage treatment plant so the specific household that produces it is environmentally irrelevant). In contrast, it is certainly not true for street level air pollution or water pollution in small streams or near particular beaches, or loss of habitat of a specific species. A tax does not differentiate between sources of pollution so this uniformity is essential for its effectiveness.

The extent to which the pollution persists is also important. A 'cumulative' pollutant where the damage occurs through the stock of the pollution rather than the current flow may be more concerning in the long run; however it offers more flexibility over time because the exact timing of the emissions does not matter. Greenhouse gas emissions have cumulative effects, as do toxic wastes and deforestation while air pollution, household sewage and noise pollution are not strongly cumulative. A tax does not yield a fixed level of environmental quality in a given period, its effect depends on people's behaviour and cannot be accurately predicted in advance. With a tax the emissions level could change over time in ways that do not reflect only changes in the current efficient level of pollution. This may have economic advantages if current emissions are a small share of the ambient pollution level.[8] However, it could be severely damaging if the pollutant is not persistent and emissions are closely related to ambient pollution.

Tradeable permit systems, like taxes, work best for uniformly distributed pollutants because they do not control pollution at each source separately. They also work well for non-cumulative pollutants however because they can cap emissions in each period with certainty.[9] For cumulative pollutants, taxes and permits with banking are very similar.

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[8] From the economic point of view, the lack of certainty in the quantity of emissions can be an advantage if the reason emissions rose was that the cost of reducing emissions in that period was much higher than expected when the tax was set (Weitzman, 1974).

[9] In a tradeable permit system a high level of cost in a particular period would lead firms to want to draw down banked reserves of permits if they exist.

Long term environmental effectiveness

The choice of instrument may also have longer term effects on environmental effectiveness through the way instruments affect government and regulators' interests and their political economy. A regulation that creates definite environmental improvements but at high cost may not be sustainable or may not be able to be used to create increased environmental benefits because those who bear the costs may strongly oppose them. In the US, great environmental strides were made in the 1970s with command and control regulation. Dead lakes such as Erie slowly regained life and air pollution reduced markedly in cities such as Los Angeles. These gains slowed in the 1980s when the costs of regulation became very high relative to the perception of additional gains achieved. At this point the US began to explore different, lower cost approaches to regulation.

Some forms of regulation create vested interests either in the bureaucracy or the private sector which can make them difficult to alter in the future. Intensive regulation programs that create many jobs in a regulatory agency will be protected by bureaucrats. Programs that provide implicit subsidies to business (such as 'voluntary programs', research and development subsidies or grandparented permit programs) will be protected by business even if a new approach offers more social gains. On the other hand permit programs where permits are allocated in advance (either by auction or grandparenting) create a constituency to maintain and possibly intensify the environmental program.

Limitations on government capability and resources

Governments need to implement regulations and frequently face limitations on capability and resources. Governments often prefer regulations that are less administratively demanding.[10] To create an ecological tax the government needs to define how emissions will be measured. To enforce the program it must be easily able to measure the unit taxed. If emissions can be directly monitored (the US Acid Rain program does this for SO_2) or a perfect proxy exists (fossil fuel combusted is a near perfect proxy for CO_2 in the absence of commercially feasible sequestration options) the taxable units should be defined as quantities of emissions or the proxy. This is best. If emissions cannot be monitored directly and no perfect proxy exists, the regulator may be forced to use an imperfect proxy.[11] This means that the private entity will not have perfect incentives to reduce emissions because some efficient actions will not affect their measured emissions. For example a loose proxy for agricultural methane would be the number of sheep, cows, pigs etc. A better proxy would also take into account the breed and the feed used (free range, corn fed…). If the proxies that can be monitored at reasonable cost are too poor, a non-economic instrument may be preferred.

[10] In some situations the opposite is true. If the bureaucracy is a powerful interest in itself it may seek forms of regulation that increase their discretionary power and require that government builds and sustains large bureaucracies. Bureaucrats often oppose market-based instruments because they become limited to a monitoring role.

[11] For discussion of the use of imperfect proxies see Fullerton and Metcalfe (1996).

Sometimes governments choose to regulate activities that are very loose proxies for emissions. For example, to reduce pollutants from fossil fuel, governments may require a certain percentage of electric power to be generated from renewable sources. They may allow this requirement to be traded among electric utilities so that utilities with the best renewable opportunities produce all the renewable electricity for the industry. This will not lead to efficient pollution abatement even though trading occurs because trading is in a loose proxy, not in emissions. For taxes on items that generate waste, taxes often do not take into account the method of disposal and may be quite crude proxies for the environmental damage caused. For example, hazardous waste disposed of in purpose-designed secure sites causes significantly less damage than that dumped in an ordinary landfill in barrels.

Second, the government needs to define the point of regulation, that is, which legal entities will be required to pay a tax to match measured emissions. Ideally this will be chosen to cover as wide a range of measured emissions as possible while minimizing the number of entities regulated. 'Downstream' regulation (usually used to mean regulation at point where fuel is consumed) simply imposes higher costs and has no distributional, short run efficiency or innovation advantages unless artificial restrictions are placed elsewhere in the program. If the pollutant cannot be directly monitored through a relatively small number of actors at any point, ecological taxes (or permits) will be costly to implement and other regulations may be preferred.

Efficiency of Regulation: Short run and long run

Economic analysis emphasizes the efficiency of regulation.[12] Is the regulation set at an appropriate level to balance the costs and benefits of the environmental protection? This is primarily a question about the appropriate intensity of regulation and is not specific to eco-taxes. Hence we do not discuss these issues here. If the form of regulation reduces the cost of controlling pollution, however, the optimal level of regulation will be higher. When used in appropriate situations, eco-taxes can control pollution more cheaply.

Will the regulation achieve government's objectives at least cost to the economy? Taxes create static cost-effectiveness - providing incentives for different actors to reveal and act upon their private information about static costs of abatement. Ecological taxes can equalize the marginal costs of abatement across all regulated entities without government needing any knowledge about abatement options. Each actor chooses between reducing pollution a little further or paying a little more tax. They will use their own information about the costs of reducing pollution to make the best decision for themselves. If the tax is set correctly this is also the best decision for society. Taxes create price signals that are passed forward and backward through the economy to all entities that affect the creation of emissions through their consumption or production behaviour.

[12] Here we are really considering cost-effectiveness because the actual environmental goals are given by the international agreement and may or may not be efficiently set.

Dynamic efficiency – providing efficient incentives for research and development and adoption of new technologies - is also critical.[13] In theory, ecological taxes that are expected to persist will lead to efficient research and development, adoption and investment decisions. If they are not expected to persist, if private actors have high discount rates or if there are concerns with the protection of intellectual property, the level of investment may be too low and government involvement in subsidising or even providing direction for R&D may be justified. This is discussed further under attitudes toward certainty.

Flexibility

A regulation that is flexible in response to changes in technology, tastes and resource use reduces the need for government to change the policy as conditions change. Flexibility improves efficiency over time and also minimizes disruption to regulated entities. Ecological taxes allow flexibility in response by private actors. If the tax rates can be adjusted easily, they also allow flexibility in the stringency of regulation. A downside to this flexibility is that private actors may anticipate changes in the rate and behave strategically to avoid or induce changes.

Attitudes toward certainty

Different policies offer different levels of certainty. In the short run, a properly monitored and enforced tradable allowance market offers complete certainty on emissions levels. In contrast a tax or policies that control technology or product standards have highly uncertain effects on emissions.

In the long run, the effect of a tax or tradable allowance system on R&D and adoption of new technology depends on firms' expectations about the continuity and future stringency of the system. If future regulation is highly uncertain, firms may choose short-run approaches to compliance. This may not lead to long-term non-compliance but, by making future costs higher, could make governments unwilling to impose stringent regulations. A government may want to have policies that will reinforce the certainty of future regulation to enhance long-run efficiency. The government can try to commit to maintaining the regulation even under successive governments by choosing abatement options that have high fixed costs up front but then lead to low future costs. A policy that directly subsidizes R&D or requires adoption of a new technology guarantees a certain level of investment that will lower future costs. More investment and R&D is not necessarily efficient, however, and the type of investment and R&D induced may not be efficient so this could raise costs significantly.

Not only may policies differ in terms of their actual level of certainty, people also have different perceptions of their certainty. Many people who are unaccustomed to economic approaches are deeply sceptical of the idea that simple price changes with no coercion will lead to significant long-term changes in behaviour. Empirical

[13] For a discussion of the dynamic efficiency of different instruments see Fischer, Parry and Pizer (1998).

evidence suggests that responses to price signals are significant but cannot say if they are efficient.[14]

Cultural differences

In different cultures and for different problems people have different attitudes to the use of price instruments for achieving environmental goals. Some people find it morally abhorrent that polluters can 'buy their way out of' regulations aimed at reducing pollution.[15] At the same time, some people feel that they have a right to certain goods for free and on principle are strongly opposed to paying for them. Key examples are water and roads that people feel they own or have already paid for. These attitudes can change but may be significant barriers to implementation.

Political Economy

To enact regulations, governments need to have sufficient support. Thus the interests of particular powerful lobbies may influence the form of regulation. These groups could be generally powerful or could be critical to forming a coalition on a particular issue.[16] Distributional / political concerns also could lead governments to subsidize particular sectors through the regulation to increase their international 'competitiveness'. Related but not identical, governments are generally concerned about the distributional effects of policies and particularly about 'winners and losers'. This concern could be for political feasibility reasons or for deeper equity reasons. We discuss the distributional effects of ecological taxation in more detail below.

Existing regulatory structure

Another major element that affects government's choice of regulation is its existing regulatory structure. Some of this is related to the fixed costs of creating new monitoring regimes or legal frameworks. Existing ones can be adapted to new tasks. It may be efficient to build on existing structures that have been tested and accepted and that are well understood. This is one potential advantage of ecological taxes if they can operate through the tax system or existing charging systems.

New regulations will interact with existing ones in other areas, either as complements or substitutes. For example, New Zealand already regulates energy extensively; this may affect greenhouse-gas policy. Energy-related policies are aimed at issues such as local pollution issues and energy security. Some existing policies, such as information programs, address non-price barriers to energy efficiency and would be directly complementary to market-based GHG regulation. Other policies will still be relevant and will be substitutes to greenhouse policy. For example, partly because of past concerns about energy security in New Zealand (as well as local jobs) we already have significant hydropower, which lowers our emissions.

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[14] See Newell et al (1999) and Kerr and Newell (2000).

[15] Kelman (1981) discusses early perceptions of the use of economic instruments in the US.

[16] For discussion of the political economy of the US Acid Rain program see Joskow and Schmalensee (1999).

Ancillary Benefits

New environmental policies may have ancillary benefits. For example, policies aimed at mitigating climate change could also alleviate problems such as local air pollution, deforestation or traffic congestion. If a new policy can be altered slightly to take account of these benefits the overall efficiency of the regulation can be improved even though the costs of regulating the pollutant of primary concern may be higher. In another example, if we introduced road charging in Auckland in response to congestion problems this would also have implications for local air pollution and greenhouse gas emissions.

Summary

At their best, ecological taxes and other economic instruments provide strong incentives for static and dynamic efficiency throughout the economy. They are extremely flexible instruments that respond easily to changes in economic and technological conditions. Taxes and allowances can often use existing monitoring systems and taxes can use the existing tax administration. Both require little knowledge of abatement by government. Ecological taxes, however, are only appropriate for certain types of pollution (e.g., uniformly distributed) and where the emissions can be monitored with a reasonable level of accuracy and comprehensiveness without undue administrative cost. Ecological taxation is not a solution to all environmental problems.

Non Economic Instruments

In many situations eco-taxes or other economic instruments are not appropriate or only partially address environmental problems. They may be replaced by or complemented with other regulatory instruments. This paper focuses on eco-taxes so does not discuss these other instruments in any detail. Here we simply list their key roles. A full analysis of whether an eco-tax is an appropriate regulation and whether it should be used alone requires full consideration of the alternative and complementary instruments.

Non-economic instruments such as technology standards, emissions standards, information programs and permitting programs (eg: Resource Management Act) have four potential roles. First, they can address efficiency where there are non-price barriers to abatement such as information problems or public goods. These instruments are often complementary to economic instruments. Second, they can fill regulatory gaps where monitoring needs do not allow the use of economic instruments. Alternatively, for some pollutants, even it they can be monitored and are uniformly distributed there may be so few sources that it is not worth designing general regulation that covers them. Third, non-economic instruments can fill a political need by creating a perception of dynamic efficiency; they can force investment and adoption of pollution reducing technology although this may in reality not be efficient or effective. Fourth, they can deal with distributional issues in a flexible, non-transparent way; they allow deals with politically powerful groups that

might otherwise not be acceptable. They make the price increases, that are inevitable with effective regulation, less transparent and hence more politically acceptable.

3 The Political Economy of Ecological Tax Reform

Economic Motivations for ecological tax reform

As discussed earlier, some people believe that the 'revenue recycling' benefits would make it worth raising eco-taxes even beyond the level required for domestic compliance. If labour taxes are highly distorting relative to carbon taxes, eco-taxes taxes might be not simply good environmental policy policy but also good revenue policy. Countries may choose to over-regulate (i.e. beyond the level that cost benefit analysis would suggest is an efficient level of environmental protection) in order to raise more government revenue. For this to be efficient, a substantial 'double dividend' must exist. The existence of a double dividend is empirically very uncertain. US evidence suggests there is not one in the US but European evidence is more varied.[17] In any case, if a double dividend exists because of gross distortions in labour or capital markets either through taxes or regulation, directly reforming taxation and regulation would be more efficient.

Ecological taxes can provide a platform for initiating a broader reform of the tax system and create political support for changes to labour and capital taxation that otherwise would not be possible. Ecological taxes are often seen as socially favourable and morally difficult to oppose and could be used as a lever to remove damaging complexities in the existing tax system or to raise taxes on currently relatively undertaxed groups. General tax cuts or even changes to the tax system may not be acceptable but in the context of ecological tax reform they may be possible.

Political Motivations for ecological tax reform

Others may simply want to raise tax levels overall in order to expand other government programs and this is another way to do it. Europeans certainly have seen carbon taxes as a possibility for 'eco-tax' reform. While this is presented as replacing existing taxes with environmentally motivated taxes, business is concerned that the new taxes will simply raise the tax burden. Politicians may see eco-taxes as more politically acceptable ways to fund new spending initiatives. Finally, new taxes could raise compliance costs for the private sector even if they are offset with reductions in existing taxes.

On the other hand, in some cases eco-taxes have been unsuccessful precisely because of their role as taxes. In the US a carbon tax is unlikely to be implemented and in Europe the EU-wide carbon tax proposal failed partly because of industry opposition. Where there are carbon taxes in Europe, heavy industry is almost invariably exempt. Eco-taxes may have social benefits relative to regulation that does not raise revenue but they do change the distribution of costs to the detriment of the owners of polluting

[17] For the US see Parry et al (1998). For general discussions see Bovenberg (1997) and de Mooij (1998).

businesses. Insistence on the use of a tax instrument could lead to much less efficient and effective environmental policy because of the exemptions that are created or an inability to regulate at all. Where industry lobbying is strong, a permit system that allows at least short-term grandparenting may be more feasible and ultimately effective.

4 Recent International Experience with Ecological Taxes

Use of eco-taxes and similar instruments

Use of eco-taxes is widespread but generally does not have a large environmental impact. Command and control generally still dominates. The most direct ecotaxes in current use are *effluent charges* which are in widespread use in Western and Eastern Europe. These are applied to a range of pollutants including CO, CO_2, SO_2, BOD, NO_x, TSS, N, P, landfill and hazardous waste. Although they are heavily used in Eastern Europe they are generally set at very low rates so they may be though of more as revenue raising instruments than instruments for environmental protection.

One problem that arises with pollutant taxes on land fill items such as refrigerators, car batteries or tires is that the tax may be an incentive for illegal disposal. It would be almost impossible to tax the disposal of beverage containers since they can be mixed in with other household rubbish. For items of this sort *deposit refund systems* are widely used to avoid these problems. They are also used for autos, chemical containers, plastic bags and fluorescent lightbulbs.

User charges are also applied to a range of items at the point of production. The revenues from these charges are used to fund environmental programs so they are not necessarily expected to have direct behavioural effects. User charges include fuel taxes, but also charges for disposing of landfill and hazardous waste, and taxes on batteries, beverage containers, manure, batteries, tires, nuclear power, and fertilizer. The benefits from user charges largely depend on how the revenue is spent rather than how it is raised.

Insurance premium taxes are primarily used to address the risk of oil and chemical pollution and are used to fund clean up in cases where the liable party cannot be found or cannot be made to pay the full cost. These are used in Belgium, Finland and the US. They have behavioural effects only if premiums reflect the firm's previous history of polluting or level of precaution. Generally the linkage is weak.

Sales taxes are imposed on gasoline in most Western European Countries. The revenue is applied to the general budget. Leaded gasoline is generally taxed more heavily than unleaded. Diesel is generally untaxed. Many European countries also have significant taxes on new cars. China imposes a very low tax on both fuels and on vehicles. The effect of gasoline taxes on gasoline usage is highly contentious. The short run elasticity of use is generally believed to be low, that is people do not reduce the amount they drive much when gasoline prices rise. The long run response of car design, consumer purchase choices and locational choices may be much higher. Taxes are also applied directly on vehicles or registration. A tax on new cars may

actually be counter-productive in terms of air pollution which is mostly caused by older vehicles. However most rules discriminate by fuel efficiency or engine size which may have some beneficial effect.

Differentiated taxes are used in many European countries and the United States to encourage public transport and more environmentally friendly fuels (US). Income tax rebates and accelerated depreciation are used to encourage environmentally friendly investments in several European countries, the US, Latin American countries and Japan. Australia uses them to discourage land degradation and encourage water conservation and environmental impact studies.

Tradable permits are used widely in the United States for leaded gasoline, water quality, ozone depleting substances, NO_x, SO_2, and other air pollutants. Canada, the EU and Singapore also used tradeable permits to phase down ozone depleting substance use. In Chile the tradable permit market for total particulates was unsuccessful because of inadequate enforcement (see p. 21).

Information programs are used in Australia, the EU, the US, Canada and Japan to encourage and facilitate energy efficiency and generally positive attitudes to the environment. The US also has specific information programs for toxics and hazardous chemicals. Chemical use and toxic waste production by companies is public information. While information programs do not provide a price incentive for environmental protection they may reinforce existing price incentives such as the effects of energy taxes.

The Significance of Tax Shifts in the Context of Wider Tax Reforms.

Despite much talk about eco-taxes, they are currently relatively insignificant in terms of both their role in environmental regulation and as revenue. Most environmental regulation is still command and control, and regulations based on price instruments generally either involve grandfathered permits or the funds are earmarked for specific environmental programs rather than general revenue. Fuel taxes are the only exception to this. They raise considerable revenue in Europe (which is also the region most seriously considering raising them). Developing countries are often quite heavily dependent on excise taxes (such as on imported fuels) for revenue but not for environmental reasons.

Successful use of Eco-taxes and similar economic instruments

Most empirical analysis of environmental regulation has been done in the US. Empirical evidence suggests that eco-taxes can be successful at creating environmental benefits. Deposit-refund systems have significant behavioural effects in terms of assuring careful disposal or recycling where appropriate (Sigman, 1995). Some empirical evidence shows that hazardous waste taxes alter the overall production of hazardous waste as well as altering the method of disposal. Tradeable permit programs such as the lead phasedown and the Acid Rain program have been associated with dramatic reductions in pollutants (Stavins, 1998 and Hahn and Hester, 1989).

The economic gains from emissions trading (similar to those that would be achieved through eco-taxes) have been estimated relative to command and control approaches and range from $250m annually from lead banking and around $1bn per year for the Acid Rain program to around $5-12bn from the lifetime of the EPA emissions trading program.

Some evidence also supports the theoretical expectation that price signals created through economic instruments such as eco-taxes will lead to increased innovation (Newell, Stavins and Jaffe, 2000) and faster adoption of environmental technology (Kerr and Newell, 2000).

Lessons from Unsuccessful Use of Economic Instruments

Several lessons have arisen through experience with economic instruments. The first is that they always require close monitoring of emissions to be successful. Taxes or tradeable permit markets are not a substitute for a stringent compliance program. In fact they require direct monitoring of pollutant use or emissions, or engineering modelling of expected emissions which may be much more complex than monitoring technology standards. One case where insufficient monitoring led to a failed market was the total suspended particulates market in Chile where grossly inadequate enforcement meant there were few trades, and it is unclear that the market had any environmental impact. The lead phasedown market in the United States initially suffered from severe registry maintenance problems that created political concern though the effects on both the market and the level of environmental gain were ultimately minimal. The success of the Acid Rain program is closely linked to the continuous emissions monitors and the stringent penalties. These have led to perfect compliance to date.

The second lesson is that the rules for defining pollutants must be simple, transparent and non-ambiguous. This has been a key issue in tradeable permit markets where uncertainty and complexity create high transactions costs that cripple markets but probably also arises in tax programs.

Third, for environmental impact, the program must cover a wide range of pollution sources and the measured output that is regulated should closely relate to the pollutant of ultimate concern. Many eco-taxes in Europe, particularly carbon taxes, are crippled by the fact that they exclude the industrial sector that is a major source of emissions and may have low cost abatement opportunities. Eco-taxes are most valuable where there is a large enough number of sources with variable abatement costs to both justify the creation of a general program and make efficient command-and-control regulation very difficult.

Fourth, to have noticeable environmental effect the tax needs to be at a significant level. Many ‘environmental taxes’ are really charges that have no environmental impact but are simply means for more acceptable revenue raising. This may be particularly true in Eastern Europe. These charges may raise money that can be spent

on the environment but these programs do not have the advantages of eco-taxes for identifying abatement opportunities that only the private sector can identify.

Fifth, although 'hot spots' and 'hot times' have not been large problems in practice, eco-taxes and other economic instruments are not necessarily effective instruments (or at least cannot be used without additional regulations) when these problems are likely. If the location or timing of emissions is critical and is ignored the environmental effects of the regulation may be less favourable and those who face the high ambient levels of pollution may create political pressure against the program. This arose in the early years of the Acid Rain program where people in some states tried to stop their electric utilities buying permits (which implies higher local emissions). In the end this was a problem of perception not reality as ambient SO_2 levels have fallen everywhere.

5 The distributional impacts of ecological taxes

Theory of Distribution Incidence

The distributional effects of ecological taxes arise through changes in prices for intermediate and consumer goods and returns to factors such as labour and physical capital. As long as regulation is efficient, the price and return effects are the same regardless of the form of regulation. An inefficient regulation may lower the cost to some groups but at the cost of raising it more to others.

Three aspects of the distribution of costs of carbon regulation are important because of concerns about equity, political feasibility or both. The extent to which "the polluter pays" is important for equity reasons, and from the point of view of environmental groups.[18] The way that costs are distributed across the income distribution, and the effects on particularly vulnerable groups, have clear equity impacts. The costs borne by specific, powerful interest groups are critical for political feasibility.

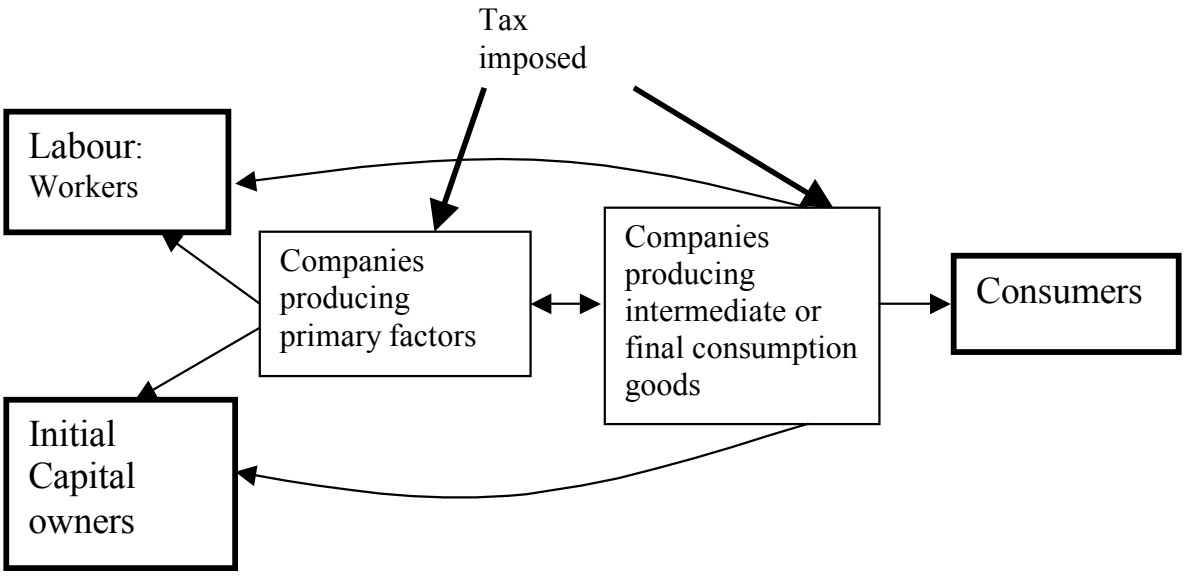
Theory of cost incidence

Three groups ultimately bear costs: consumers, workers (owners of human capital), and capital owners, especially current owners of physical capital such as thermal power stations and industrial boilers and energy-inefficient buildings. Consumers suffer loss of consumer surplus, workers suffer a fall in income, and capital owners suffer a fall in the value of their capital. Who bears costs does not depend on the legal form of the regulation, only on its effects on prices. In particular, after an initial period of price adjustment, cost bearing does not depend on who is legally required to actually pay the tax. The distributional effects are the same if a petrol tax is imposed on fuel importers and refineries or on petrol stations as they sell to consumers. The flow of price effects is illustrated in Figure 4.

[18] In the case of carbon, "polluter pays" may be inappropriately judgmental in tone. However the logical replacement "user pays" has the same equity implications.

At every point in the economy, economic actors can pass changes in price due to regulation forward to consumers, and backward to suppliers of factors of inputs.[19] When an ecological tax is instituted, production of primary factors associated with the polluting output leads to a tax liability that essentially raises the cost of these primary factors. For example, coal is a primary factor that is involved in local air pollution and production of greenhouse gases. If the rise in cost does not lead to an equivalent rise in the output price, the producers of the factors lose.[20] The change in output price depends on the relative elasticities or responsiveness of supply and demand.

Figure 4 **Flow of tax from point of regulation (companies) to final cost bearers (workers, capital owners and consumers)**



The 'elasticity' of domestic supply or responsiveness of the supply of products with a change in price may depend partly on producers' access to international markets. If the product can be imported without having to pay the cost, supply is almost infinitely elastic and the domestic output price will not rise. If domestic producers cannot absorb the higher cost they will simply be replaced with imports: eg. manufacturing imports from Indonesia. If the product cannot be imported or imports face the same tax then domestic prices will rise. The latter is likely to the case with a tax on crude or refined oil products. The long run supply elasticity of primary factors will be higher than the short run, because producers can alter exploration and development behaviour. If coal becomes less valuable, new mines will not be developed and the supply of coal will gradually shrink. The costs borne by domestic primary factor producers will be greater in the short run than the long run and will be greater if they face unregulated foreign competition.

[19] Prices of substitutes and complements to factors, inputs and outputs will also be affected through cross elasticities. Some factors and consumers may benefit from rising returns or falling prices.

[20] As with a tax on land rent (Feldstein (1977)), not all the tax is borne by fossil fuel reserve owners even though in the short run they can do nothing to change their behavior.

The elasticity of demand depends partly on all the possible ways that downstream producers and consumers can reduce their use of the good. In the same way that primary factor producers pass part of the cost forward with an increase in primary factor prices, some can be passed backward through reductions in factor returns, to factors used in the production of polluting goods, such as coal miners' labour. The rise in the output price and hence reduced demand for output will lead to reduced demand for the factors used to produce the good. In particular labour that is specific to production of polluting goods or polluting industries will face falling wages and fewer jobs. Existing capital that is used to produce the good will become less valuable. The effect on coal miners' wages depends on the elasticity of demand for coal miners, and their elasticity of labour supply to mining. In the short run at least, coal miners may be geographically and occupationally immobile, so may face significant wage reductions and unemployment.

The cost incidence also depends on the industrial structure.[21] If the industry is competitive, the price rise will fully offset the increased cost. For example, recent dramatic rises in petrol and diesel prices will have to passed on by truckers who have very small profit margins. In contrast, if oil companies really have monopoly power they will not fully reflect international crude oil price changes in local prices. In a monopoly, if supply is inelastic, producers will tend to bear the cost. [22]

We can identify similar effects throughout the economy. As each producer faces a cost increase they pass some on to their customers, as increased prices, and some back to their workers. In general, part of the cost increase can also be passed backward to owners of capital. If capital is specific to a particular industry, its supply is inelastic in the short run. The return to its use will fall, leading to a fall in its value. Inefficient coal fired power stations and industrial boilers are examples of immobile capital that would fall in value with taxes on carbon. The current owners of these assets will face losses. Some forms of relatively carbon-efficient capital, such as gas fired, nuclear or hydro plants will rise in value.

A particularly important point is that 'industries' do not bear costs. The owners of existing assets in industries that face new taxes will bear costs because their existing or 'stranded' assets are less valuable. These owners may be shareholders if the firms are public. The share price will tend to fall after the tax is announced or introduced. In this case the costs are spread over a wide range of people. New shareholders will not be affected.

The owners of new firms that enter the industry after the tax is imposed do not bear any costs. New firms do not have any stranded assets so do not face costs from regulation if the industry is competitive. They only enter if they expect to make profits and will take the environmental regulation into account as an additional cost.

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[21] Atkinson and Stiglitz (1980)

[22] If supply is elastic, the price rise will depend on the shape of the demand curve, the price could rise by more than the tax leading to a negative incidence on producers. $MR = p(1-1/.D)$ where MR is marginal revenue, p is the price and . D is the price elasticity of demand. With a constant elasticity demand curve, MC as marginal cost and tax = τ , $MR = MC+\tau$ so $dp/d\tau = (1/(1-1/.D))$ which is greater than one for a monopolist.

The costs to owners of firms from environmental regulation relate to their investments before the regulation was imposed not to their ongoing activities.

Ultimately the price changes reach the final consumer of fossil fuel or any good produced using fossil fuel. How much of the cost consumers bear depends on the elasticity of demand for fuels and goods containing carbon, relative to the elasticity of supply. Individual cost bearing depends also on how much of the good they consume. In the short run, consumer demand for fuel may be relatively inelastic, because they can only respond by reducing usage. In the longer run, they can invest in new heating systems, cars, houses, and appliances that allow them to switch fuels and increase energy efficiency. In the long run there are no 'stranded assets' because they would be obsolete and no 'stranded workers' with the wrong skills or in the wrong place. Consumers bear all long run costs.

Figure 5 Price and Quantity Effects from Ecological Taxation

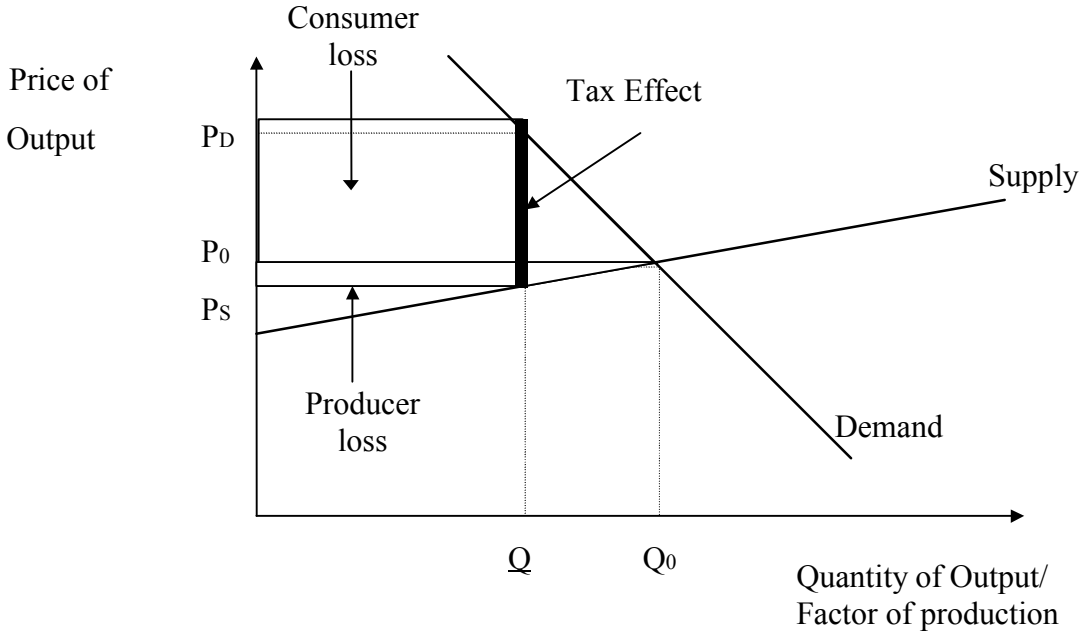


Figure 6 illustrates the losses to consumers and producers (passed on to factors). In this simple example we assume that the pollution is directly embodied in the output or use of a factor and ignore the potential for reductions per unit of output/factor.[23] These measures would also raise the cost of output and are fully reflected in Figure 2. In this illustration the buyer has relatively inelastic demand and hence bears most of the price rise. We could draw similar figures for specific labour markets, specific intermediate product markets and physical capital markets.

In summary, the relative changes in prices (including wages and dividends) in response to the regulation depend on relative elasticities of supply and demand for crude fossil fuels, specific types of capital and labour, and consumer goods. The

[23] We could think of this as the level of pollution per unit output after all efficient measures to reduce pollution have been taken.

overall cost to the economy of a given pollution target will fall with higher elasticities. The costs to specific individuals depend on these price changes, their ownership of different types of physical and human capital, and their consumption patterns. In the long run consumers bear all costs.

Empirical Evidence on the Incidence of Ecological Taxes.

Most empirical evidence on tax incidence for environmental regulation comes from simulation models rather than studies of actual programs. Tietenberg 1985 offers a good summary of evidence. Incidence is very program specific. One key point he makes is that it is important to consider the distribution of benefits as well as that of costs.

Empirical evidence on the incidence of carbon regulation

A variety of empirical studies shed light on the incidence of carbon regulation. All current models assume that the tax is fully passed through to consumers. Thus they implicitly assume perfectly elastic supply of factors, or equivalently full factor mobility. Poterba (1990) considers the relative expenditure shares directly devoted to energy across the expenditure distribution. Casler and Rafiqui (1993) use a similar methodology for direct expenditures. They also use an input-output framework to estimate indirect incidence through the purchase of goods produced using energy. Dowlatabadi, Kopp and Tschang (1994) consider only direct effects but allow for partial equilibrium responses to energy prices. Jorgenson, Slesnick and Wilcoxen (1992) use a general equilibrium model to consider the lifetime incidence of carbon taxes through all possible channels.

The different models have several consistent qualitative results. All agree that the impact of the tax would be relatively, but not dramatically, regressive.[24] The indirect effects tend to reduce the regressivity. Consumer incidence varies significantly by region within the United States. The Midwest bears the highest costs; the Pacific States bear the lowest. This is dependent on climate and energy sources. Other results are less clear. Casler and Rafiqui find that rural households are harder hit, and the young less affected. Jorgenson et al. find the opposite. Jorgenson et al. find that large households are more affected.

None of these models can say anything about loss of capital income and therefore loss of capital value. To do this, a model needs to identify the elasticity of capital in specific industries and the owners of capital. The models currently can say nothing about the effects of carbon regulation on labour markets. Also the models all assume perfectly competitive pricing, which may not be appropriate in some of the key industries. Goulder et al (2000) estimate that existing capital bears around 10% of the present value of all future discounted costs from carbon regulation.

[24] As Poterba (1990) points out, for consumers in the lowest expenditure quintiles who are receiving transfers, an automatic partial compensation mechanism exists through the indexation of transfers. This compensation is not captured in measures of regressivity.

Because people are relatively immobile in the short run and because employment effects are regionally concentrated, the regional effects on employment and consumption may exacerbate each other to create short-run macroeconomic effects on local economies. In contrast the wide dispersion of owners and the high mobility of financial capital imply that the regional effects on capital value are unlikely to have local macroeconomic effects.

Identifying the cost distribution is a non-trivial exercise. It seems likely that costs will be slightly regressive across consumers, will reduce the income of shareholders in parts of the energy sector (especially coal producers and users), and will have impacts on immobile workers in the coal sector. Clearly more research is needed to clarify these relative effects on individuals.

New Zealand empirical evidence related to the distributional effects of carbon regulation.

In this section we consider one possible ecological tax, a carbon tax on petrol, and its likely distributional implications. This is not because we consider this to be the sole optimal tax on carbon but because petrol is an important part of NZ carbon emissions and it is relatively easy to assess the incidence of a petrol tax. A carbon permit system that comprehensively covered petrol-fuelled transport would have the same distributional effects. A broader based carbon tax that included other fuels as well as cement and aluminium production would lower these costs by improving the overall efficiency of regulation. Broader based regulation is also less likely to create artificial differences in costs among competing producers simply based on the fuel or technology they use.

The costs of a petrol tax will fall almost completely on consumers because New Zealand has a relatively competitive market for petrol. (If the market were non-competitive, oil company owners/shareholders would bear part of the cost of the tax). The distribution of costs will depend on the level of demand by different people (dependent on their lifestyle, preferences and income) and the prices they face. Some of the tax on petrol will be paid by businesses using transport. If they are in competitive markets they pass these costs on through the price of the goods they sell. A full analysis would consider both the direct incidence on consumers through petrol purchases and the indirect incidence through purchase of consumer goods that involve significant transport costs. Here we consider only the direct incidence.

Data

The data used come from the 1998 Household Expenditure Survey produced by Statistics New Zealand. The raw data are separately provided on disk. The first files 'Hhpetrolexpenses.xls', 'Household characteristics by household type.xls' and 'Household characteristics by income group.xls' provide household expenditure on petrol and total expenditure by household income deciles and household types scaled up to represent the population as a whole. The figures for the total number of households are for the weighted population. The second file 'Purchaser Profile Petrol 1998.xls' considers individual expenditures and breaks down average expenditure by

a variety of individual characteristics, income, age, gender, marital status, ethnic group, highest qualification, occupation, employment status, labour force status and region. We also use general information on the characteristics of household types and income groups.

Total cost of carbon tax to average consumer

If we assume that there are $7x10^{-4}$ tonnes of carbon per litre of petrol and the price of petrol is around 85c per litre with no carbon tax, then a carbon tax of $10.00 per tonne will raise the price by 1c per litre or a little over 1%.[25] $50 per ton implies a 3c price rise and $100 a 7c or 8% price rise.

Distribution by Income

Our analysis starts with the simplest ways to show the distributional relationship and then explores the implications of problems in measurement of critical variables and the effects of unobservable personal characteristics for measuring the distributional impact. We show that the distributional impacts may not be as straightforward as they first appear.

All the following analysis assumes that consumer expenditure on petrol is not affected by a rise in petrol price. This is quite a reasonable assumption for small short-run price changes. In the short run people do not change their vehicles, move house or job or change habits and hence tend to have very small responses to changes in petrol price. In the long run, poorer people could either be more responsive to the price change because it is a greater percentage of their income or possibly less responsive if they travel only for essential purposes and have no alternative modes available.

Table 2 shows the average adult's weekly expenditure on petrol by income group. Figure 6 shows the same thing for household expenditure by household income deciles. Both indicate that expenditure on petrol rises with income. Higher income individuals and households will pay more petrol tax than lower income individuals and households.

Table 2 Petrol Expenditure by Income Group

Annual Gross Income	Distribution of Adult Population	Average Weekly Expenditure per Adult ($)
Under $5000	349,400	6.23
$5,000-9,999	287,200	8.40
$10,000-12,499	180,700	7.75
$12,500-14,999	173,400	8.75
$15,000-19,999	241,400	11.16
$20,000-24,999	228,900	11.79

[25] '21 cents per litre of petrol is equivalent to $300 per tonne of carbon.' Ministry for the Environment (1997). This implies 0.21/300 = 7x10-4 tonnes of carbon per litre of petrol.

$25,000-29,999	192,200	13.37
$30,000-39,999	270,200	13.43
$40,000-49,999	155,400	13.44
$50,000 or over	245,100	13.54
Total	**2,324,100**	**10.55**

Figure 6 Weekly expenditure ($) as a function of household income ($ per week)

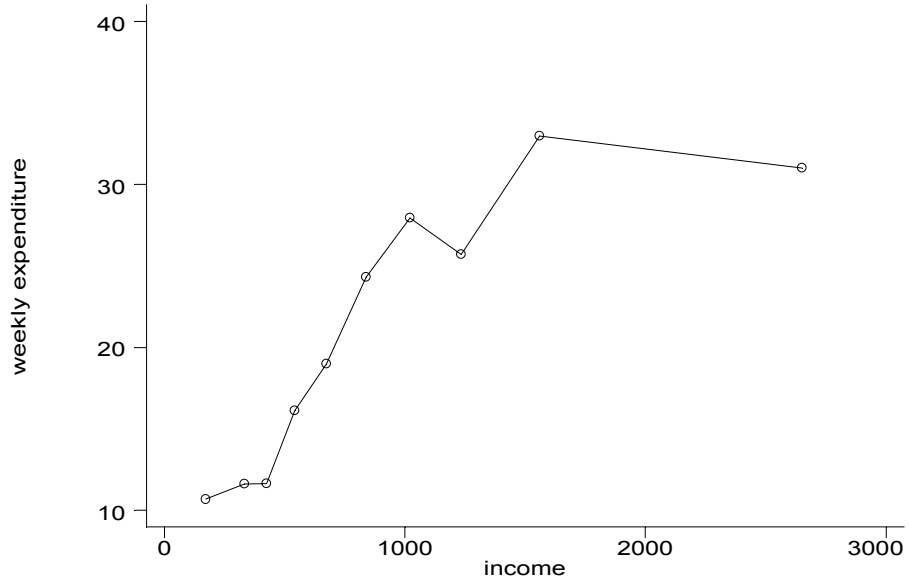
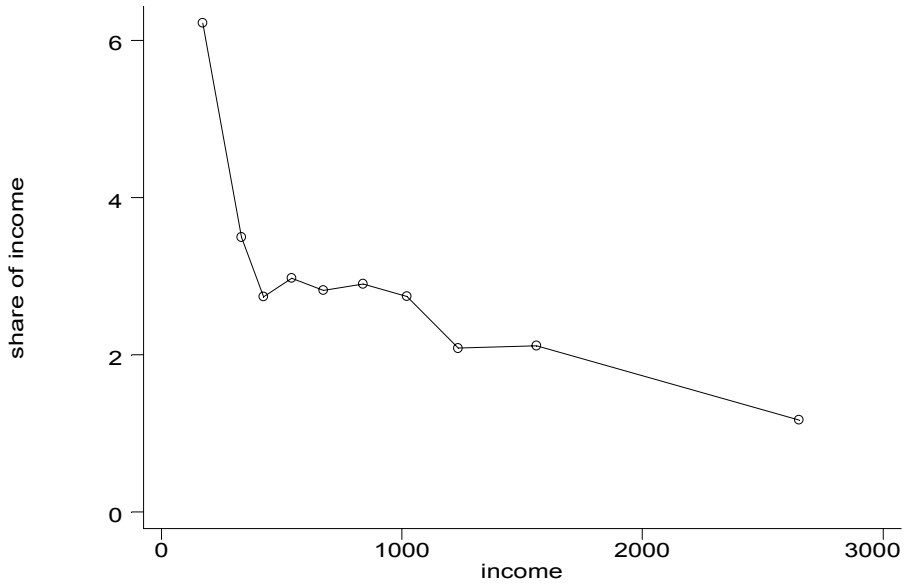


Figure 7 shows the share of income that households in different income deciles spend on petrol. Higher income households spend more on petrol but less as a percentage of income. This suggests that petrol taxes are regressive. Excluding the lowest decile, which is strongly influenced by self-employed people who tend to underreport income, the slope is still downward but not dramatic.

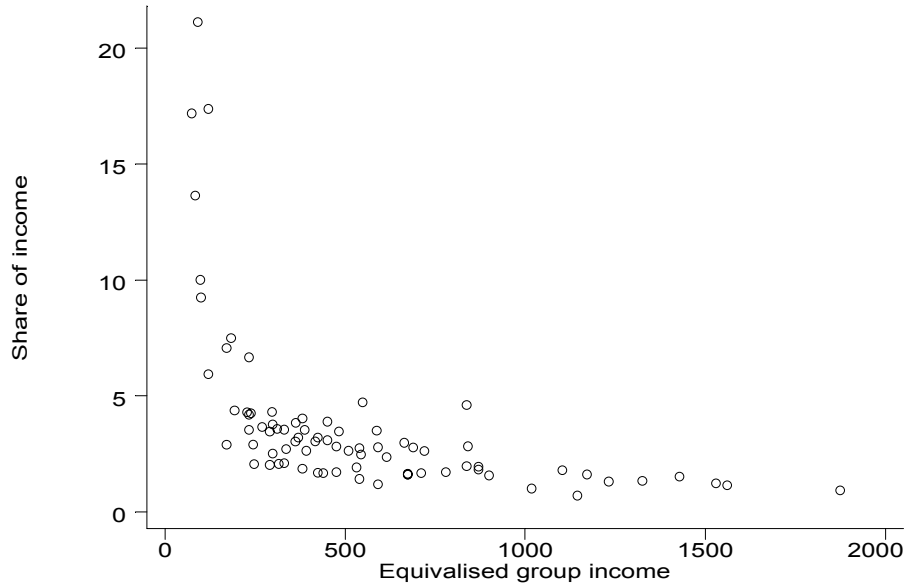
Figure 7 % Share of income spent on petrol as a function of income



These household data do not differentiate between households of different sizes. If small households consume more petrol per person and also tend to be lower income because they contain fewer earners, the regressive relationship will be driven partly by household size and will not really be a relationship between the overall economic welfare of each household member and their expenditure on petrol.

Equivalised income is generated by taking average income for each decile and then for each household type adjusting it for the number of people in the household. We use the Luxembourg square root approach; we divide the household income by the square of the number of the people in the household (Atkinson et al 1995). A simple alternative would be to simply divide by the number of people but our approach takes account of the economies of scale that larger households experience. plots 'equivalised income' against petrol expenditure as a share of income. If anything this seems to exacerbate the regressivity of the tax.

Figure 8 % Share of income spent on petrol as a function of 'equivalised' group income



In a regression aimed at explaining the difference across income groups in the share of income spent on petrol, Table 3 (columns (1) and (2), the coefficient on equivalised income is more negative than the coefficient on income. Again, either excluding the very lowest income groups in the graph or including a quadratic term in the regression (column (3) Table 3) suggests a much less regressive relationship over most of the income range. The relationship is steeply downward at low incomes but flattens out at higher income levels.

Table 3 Expenditure on petrol as a share of income by income group

	(1)	(2)	(3)
Income	-0.0013** (0.0004)		
Equivalised income		-0.002*** (0.0005)	-0.007*** (0.002)
Equivalised income squared			2.74e-06*** (9.66e-07)
Constant	4.19*** (0.5)	4.38*** (0.00)	5.8*** (0.62)
R-squared	56%	21%	29%
N	10	79	79

Note: Standard errors are in parentheses; *=significant at 10%, ** = at 5%, *** = at 1%

There are however problems with the use of household income as an indicator of welfare and hence equity. Households may have lower incomes because of a life-cycle stage. Students often have very low incomes but don't necessarily have deprived living conditions. Older people may earn very little but have significant capital to spend. Alternatively people who are self employed may take their income in invisible ways such as capital gains. Incomes can also fluctuate, especially for self-employed people, so that they may have low income one year but be generally well off. Poterba (1990) suggests that expenditure may be a more relevant measure of welfare because it represents 'permanent income'. People who spend a lot relative to their income generally do so because they have high savings or expect higher incomes in the future.

Figure 11 plots petrol expenditure as a share of expenditure of each income decile against income.[26] The regressivity we observed in petrol expenditure as a share of income is no longer obvious against expenditure. We appear to see a pattern where the expenditure share rises in the middle deciles and then falls again. The regressions in Table 4 columns (1) and (2) confirm this. With only equivalised income in the regression the relationship is actually progressive. Richer people spend a larger percentage of their total expenditure on petrol. When we include a quadratic term (equivalised income squared) the data suggest that the expenditure share initially rises with income but then falls. This 'inverted U' relationship is consistent with international studies. We find the same thing with total expenditure as a proxy for 'permanent income' in Table 4 columns (3) and (4).

There are many shortcomings of our current analysis but it suggests that New Zealand would have similar distributional effects to other countries. Carbon taxes may be mildly regressive in their effect through petrol expenditures but it may be the middle-income people who bear the greatest cost relative to their total current and permanent income.

These regressions exclude many factors that will influence households' petrol expenditures such as age, distance to services and employment, occupation, and personal preferences. Even within an income group expenditure will vary significantly. Even if the tax is slightly regressive, the variance in cost bearing across individuals of similar incomes is much greater than the variance between income groups.

Figure 9 Share of expenditure on petrol as a function of income

[26] We would ideally plot against expenditure deciles but these data were not easily available.

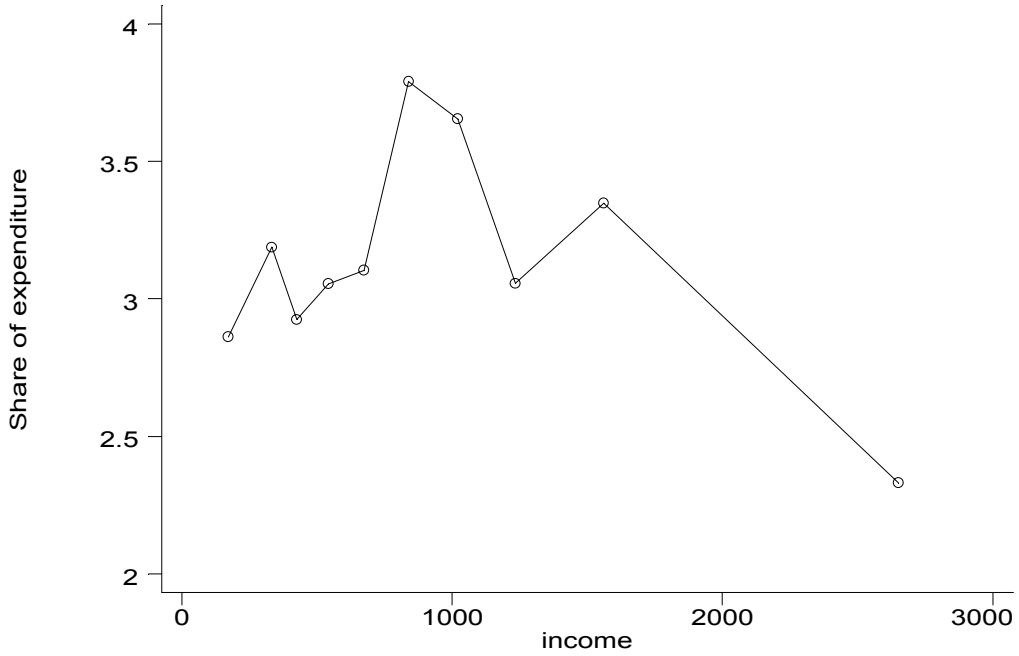


Table 4 Dependent variable: petrol share of expenditure

	(1)	(2)	(3)	(4)
Equivalised income	0.0034 (0.0035)	0.011 (0.012)		
Equivalised income squared		-4.36e-06 (6.62e-06)		
Total expenditure			0.007 (0.004)	0.045*** (0.015)
Total expenditure squared				-0.00002*** (8.69e-06)
Constant	0.372 (2.50)	-1.92 (4.29)	-2.28 (3.17)	-14.86*** (5.62)
R-squared	0.01	0.02	0.03	0.12
N	77	77	77	77

Note: Standard errors are in parentheses; *=significant at 10%, ** = at 5%, *** = at 1%

Distribution by other individual characteristics

The following data are taken from the Statistics New Zealand 'purchaser profile' that uses data collected from individual fortnightly diaries. The data reflect the characteristics of the individual but do not control for the household they live in.

The following tables consider different aspects of the incidence of a carbon tax. Table 5 shows a lifecycle pattern of petrol consumption. Petrol consumption is low among teenagers, increases during the 20-40 range and peaks between 40 and 50. Older

people then use less petrol. Thus on an age basis, working age people during their prime earning years bear most of the cost.

Table 5 Petrol Expenditures by Age Group

Age Group	Distribution of Adult Population		Average Weekly Expenditure per Adult
	Number	%	$
15-19	196,100	8.4	5.25
20-29	397,400	17.1	10.98
30-39	517,300	22.3	12.52
40-49	429,400	18.5	13.14
50-59	327,200	14.1	11.12
60-64	131,000	5.6	8.16
65 or over	325,600	14.0	7.02
Total	**2,324,100**	**100.0**	**10.55**

Table 6 shows that expenditure is relatively equal across different ethnic groups. European/Pakeha is somewhat higher and NZ Maori somewhat lower. These differences are probably largely explained by income differences.

Table 6 Petrol Expenditure by Ethnicity

Ethnicity	Distribution of Adult Population		Average Weekly Expenditure per Adult
	Number	%	$
European / Pakeha	1,913,000	82.3	10.73
New Zealand Maori	216,700	9.3	9.26
Pacific Island	80,400	3.5	10.16
Other	113,900	4.9	10.23
Total	**2,324,100**	**100.0**	**10.55**

By qualification the pattern is relatively predictable). Those who are more qualified, and hence probably earn more income, spend more on petrol and hence will bear more of the burden of a carbon tax.

Table 7 Petrol Expenditure and Educational Qualifications

Highest Qualification	Distribution of Adult Population		Average Weekly Expenditure per Adult
	Number	%	$
Not applicable (aged over 65)	325,600	14.0	7.02
No formal qualification	536,000	23.1	9.27
School Certificate	355,700	15.3	10.89
UE, Bursary, Scholarship	279,500	12.0	11.58
Vocational or Trade certificate	445,800	19.2	11.89
Bachelor's degree, Diploma	230,500	9.9	13.14
Post-graduate qualification	80,000	3.4	12.96
Part degree or other qualification	46,800	2.0	12.98
Not specified	24,300	1.0	7.21
Total	**2,324,100**	**100.0**	**10.55**

In terms of occupation, Table 8 shows that 'Trades workers' spend a high level on petrol. This is unlikely to be fully explainable by income differences. It may reflect high levels of self-employment in this group and hence may reflect business travel rather than true consumption travel. Over time, the business-related travel costs are likely to be passed on to customers but in the very short run trades people could face some hardship.

Table 8 Petrol Expenditure by Occupation

Occupation	Distribution of Adult Population		Average Weekly Expenditure per Adult
	Number	%	$
Legislators/Administrators/ Managers	211,000	9.1	10.89
Professionals	207,900	8.9	15.36
Technicians & associate professionals	153,800	6.6	13.37
Clerks	170,000	7.3	12.17
Service & Sales workers; Armed Forces	218,800	9.4	11.79
Agricultural & fishery workers	126,900	5.5	9.01
Trades workers	136,600	5.9	14.19
Plant-machine operators, assemblers	123,800	5.3	12.68
Elementary occupations and other workers	89,500	3.9	11.64
Not actively engaged	885,700	38.1	7.47
Total	**2,324,100**	**100.0**	**10.55**

As Table 9 and Table 10 show, wage and salary earners and particularly full time workers use the most petrol. Those running households also spend quite high amounts on petrol. Those who are unemployed spend less but more than students or retired people. This could be a mixture of the effects of lower income, age and the effects of having less need to commute.

Table 9 Petrol Expenditure and Employment Status

Employment Status	Distribution of Adult Population		Average Weekly Expenditure per Adult
	Number	%	$
Retired	384,600	16.5	6.77
Full-time student	145,900	6.3	5.64
Running own household	498,700	21.5	10.72
Self-employed	193,100	8.3	10.67
Wage or salary earner	919,300	39.6	13.21
Other	182,400	7.8	8.39
Total	**2,324,100**	**100.0**	**10.55**

Table 10 Petrol Expenditure and Labour Force Status

Labour Force Status	Distribution of Adult Population		Average Weekly Expenditure per Adult
	Number	%	$
Full-time (over 30 hours per week)	1,116,600	48.0	12.73
Part-time (Less than 30 hours per week)	321,800	13.8	11.44
Unemployed, actively seeking work	94,800	4.1	8.98
Retired	365,000	15.7	6.44
Studying	130,400	5.6	5.61
Running household	226,500	9.7	9.56
Other	69,000	3.0	7.47
Total	**2,324,100**	**100.0**	**10.55**

Limited regional information is available in the Household Expenditure Survey. The only pattern that seems strong here is that people in the Auckland region drive more.

This could relate either to higher incomes or longer commuting times. Unfortunately a rural/urban breakdown was not readily available.

Table 11 Petrol Expenditures by Region

Region	Distribution of Adult Population		Average Weekly Expenditure per Adult
	Number	%	$
Northland, Waikato, Bay of Plenty, Hawkes Bay	565,500	24.3	10.45
Auckland	629,200	27.1	12.53
Taranaki, Manawatu-Wanganui, Wellington	521,200	22.4	9.59
All South Island	608,200	26.2	9.40
New Zealand	**2,324,100**	**100.0**	**10.55**

A brief examination of the indirect effects.

The analysis above looks at the distribution of spending on petrol and hence a significant part of the incidence of a carbon tax on consumers. However, although domestic transport makes up around 80% of liquid fuel emissions, they made up only around 25% of total CO_2 emissions in 1990.[27] In the long run consumers will bear all the costs of carbon taxes. The part that they do not bear directly through higher petrol and other fossil fuel prices they will bear through the increased costs of goods they purchase. Previous analysis (Casler and Rafiqui, 1993) suggests that these indirect effects reduce the regressivity of fuel taxes.

Initial effects of a carbon tax on non-consumer groups

A carbon tax is not simply a tax on petrol and through its effects on the value of physical and human capital will affect groups other than consumers. It is likely to considerably reduce the value of CoalCorp with associated adverse effects on its owners (the taxpayer). NZ Steel is also likely to reduce in value with higher energy prices. Workers in the Huntly area or those specialised in steel production will face either lower wages or the need to find a new career. In the short run there may be effects on the communities where energy workers are a significant part of the workforce. Owners and workers in other companies with large energy-intensive industrial processes will suffer some loss of capital or fall in wages. These effects will tend to happen in a lump-sum way and will not affect new workers or firms who will make decisions with the regulation in mind. The earlier the intention of the regulation

[27] Greenhouse Gas Emissions from New Zealand Energy Sources 1990 – 1994. Ministry of Commerce.

is made clear the lower these costs will be because current investments will not be made inappropriately.

Effects of eco-taxes on competitiveness of New Zealand producers

The competitiveness of companies competing in international markets depends primarily on their costs of production relative to their competitors. Regulation can raise the cost of production. If it only applies to products produced domestically domestic companies are at a disadvantage. How great this disadvantage is depends on the real cost of the regulation, on how flexible imports are in replacing domestic production and on how sensitive NZ companies' abilities to export is to price.

On the positive side, revenue raising instruments such as eco-taxes impose higher average costs on production of goods that involve pollutants but by lowering taxes they may raise the overall efficiency and hence competitiveness of other NZ firms. When an environmental regulation is very significant (as greenhouse gas regulation could be) they could even have macroeconomic effects.

If environmental regulations raise the productivity of workers or increase New Zealand's attractiveness for skilled workers they could actually increase our competitiveness. Environmental regulation is usually a small part of the overall determination of competitiveness. Competitiveness does not need to be considered for regulations that have relatively small effects on cost but may be an issue for some specific industries and some regulations. In general more efficient regulation will have less effect on producers. Regulation that is matched by our trading partners will have less effect.

Evidence from GHG regulation

If our competitors face similar regulation to New Zealand producers any effects of regulation will be significantly ameliorated. Domestic companies may face a fall in the value of their existing fixed capital but output and jobs may be relatively unaffected. International trading is one way to ensure that all countries face similar marginal costs. In the case of greenhouse gas regulation, with no emissions trading – i.e. no regulation in developing countries- Bernstein et al. (1999) suggest that China's output of energy intensive products will rise 1.94% under Kyoto and South East Asia's by 4.69% while Europe's will fall by 0.17%, Japan's by 1.06% and the US by 7.87%. In contrast, with global trading, China's output falls by 0.57%, South East Asia's rises by only 0.07% and Europe, Japan and the US output rises 0.44%, 0.18% and falls 0.59% respectively.[28] Global trading of emissions and hence global equalisation of marginal regulatory intensity almost totally removes the effect of Kyoto on energy intensive production patterns. The key for maintaining production levels in each country is equalising the marginal effect across countries not the total cost of the regulation.

[28] These results are from one specific model and thus have a high degree of uncertainty but other work is supportive of the overall effects.

Even without regulation in developing countries, the extent of displacement of production is a matter of empirical debate.[29] The extent of displacement will clearly depend on the stringency of the Kyoto Protocol and the resulting rise in marginal cost of energy use. If Kyoto has a small effect on costs, it will have a small displacement effect. Annex I countries such as New Zealand have other advantages in production that may offset much of the disadvantage due to carbon prices.

As another example of empirical results, Tulpulé et al. (1999) suggest that leakage/displacement will be low. Their model suggests small changes in iron and steel output in Annex I countries as a result of leakage of production to developing countries.[30] For example US production is predicted to fall 9.3% with leakage and 8.2% without. Japanese production is expected to fall 12.5% with leakage and 11.6% without. These changes have infinitesimal effects on GDP. In the same volume, Bernstein et al. (1999) suggest that leakage could be around 18% of Annex I reductions, i.e. for every 100 units reduced in Annex I, non-Annex I countries could increase emissions by 18 units. Some of this leakage would be a result of lower fuel prices. The rest can be attributed to shifts in production of energy intensive products.

More generally, empirical evidence seems to suggest that production location decisions are mostly driven by other factors such as the quality of the local labour force, infrastructure such as transportation and local amenities and political stability (for a survey see Jaffe, Peterson, Portney, and Stavins (1995)). Studies generally find no identifiable effect from differences in environmental regulation. If eco-taxes are a more efficient form of regulation for a particular problem they will have even smaller effects on competitiveness than alternative regulatory forms.

6 Ecological taxes in New Zealand

New Zealand has a somewhat different set of ecological issues from most countries. Our major problems are not regional air pollution or generalised water contamination. Air and water problems are more local in nature. We do however face more serious issues of agricultural pollution of surface and ground water and habitat protection and are behind other OECD countries in some areas of regulation. In this section we first summarise the relatively sparse current use of ecological taxes, and economic instruments more generally, in New Zealand. Then we discuss the opportunities for potential uses and some of the issues involved in implementing NZ eco-taxes.

Previous uses of ecological taxes in New Zealand

Various different types of economic instruments with environmental benefits are, or have been, employed in New Zealand. These include charges for activities which cause pollution or the consumption of a limited resource, tradable permits which enable the efficient use of a capped substance or resource, and incentives for the adoption of new technologies with environmental benefits. Examples of programmes

[29] These issues are analyzed in detail in 'The Costs of the Kyoto Protocol, A Multi-Model Evaluation' ed. John Weyant, 1999 Special Issue, *The Energy Journal,* International Association for Energy Economics.

[30] Tulpulé et al. (1999), p. 278.

in these different categories are listed below. Some economic policies do not easily fit into these categories, but still provide a benefit, and these are also listed.

Charges

1 Waste disposal, and recycling

Across NZ Territorial Authorities implement a variety of programmes to encourage a reduction in waste, and increased use of recycling (Ministry for the Environment, 1997 p. 3-37; Ministry for the Environment, 2000). In the case of household waste this is typically achieved using user-pays kerbside collection programmes, in combination with free separate collection of recyclables, e.g. Wellington City Council charges $1.10 per rubbish bag, with recyclables collected for free (Wellington City Council, 2000a).

2 Water supply and disposal

The Rating Powers Act 1988 empowers TLAs to 'rate' for water supply to consumers using either a fixed annual charge (s 19), or a flow-based charge (s 26). For example: Wellington City Council offers residents the choice of a fixed annual charge, or a charge based on the actual water used as measured by a water meter; in the year 2000 there were over 1200 residents who had chosen to have their water metered (Wellington City Council, 2000b). Christchurch City Council charge based on metered consumption of water supplied to properties other than private residential properties (Christchurch City Council Financial Plan and Programme, 2000a, p.15). A discussion of the issues facing urban water systems in NZ, and the powers available to local government can be found in the report: Ageing Pipes and Murky Waters – Urban water systems issues for the 21st century (Parliamentary Commissioner for the Environment, 2000).

3 Financial contributions and performance bonds in land use consent procedures

The Resource Management Act 1991 section 108 allows Territorial Authorities, and in some circumstances Regional Authorities, to require a financial contribution or a performance bond as a condition for a resource consent. The extent and consistency with which these powers have been used across the country are difficult to determine.

4 Leaded petrol phase out

In New Zealand regular grade petrol has been lead free since 1987, and super grade petrol has been lead free since 1996 (Bird and Moncrieff, 1997 section 3.2.4.1). During the phase-out process a price differential existed between equivalent grades of leaded and unleaded petrol (Ministry for the Environment, 1997 p. 6-35). The purpose of this differential was to encourage motorists to convert their cars to use unleaded petrol, thereby reducing the problem of lead pollution in the atmosphere.

5 Petrol excise duty

Petrol is currently subject to a general excise tax, at the level of 34.3 cents per litre in 2000/2001 (Treasury, 2001). Although this is viewed as a source of revenue it also has an impact on the level of consumption. Some of this revenue is used to subsidise public transport.

Tradable permits

1 Permits for Ozone Depleting Substances

As part of the process for the phase-out (between 1996 and 2015) of certain Ozone Depleting Substances, namely CFCs and HCFCs, a system exists for the temporary or permanent transfer of permits between users of these chemicals (Ministry of Commerce, 1999). The permit system has been effective in its environmental aim of reducing NZ consumption of ozone depleting substances (NIWA, 2000). While trade in permanent transfer of permits has been relatively light, the practise of trading in temporary transfers is widespread (NZIER, 1998). A report on the effectiveness of the ozone permitting system has been prepared by NZIER on behalf of the Ministry of Commerce (NZIER, 1998). The report concludes that 'there is nothing seriously wrong with the ozone permitting system. In almost all cases, everyone who wants a particular HCFC is able to obtain all that they need ...' (we acknowledge the Ministry of Economic Development for making this report available to us). However, following the implementation of the second stepped reduction in the NZ phase out programme on 1 January 2000, the Ministry of Economic Development noted that particular difficulties in some areas of industry were becoming more apparent. The combined effect of the reduced entitlements and the NZ phase out programme being ahead of Montreal Protocol requirements (and the related development of some alternatives) did result in shortages in some sectors that could not entirely be met from trade/transfers (Collier, 2001).

2 NZ Fisheries quota system

A Quota Management System (QMS) was introduced in 1986 in order to conserve fish stocks in NZ waters, and to increase economic efficiency in the fishing industry. Total Allowable Commercial Catch (TACC) levels are chosen to ensure that catch levels are sustainable in the long run, and to restore fish stocks where they have become depleted. The process of determining the TACC is conducted by the Ministry of Fisheries using research into fish stocks and their productivity, the process also includes consultation with representatives from the commercial fishing industry and other interest groups (Ministry of Fisheries, 2000). An Individual Transferable Quota (ITQ) is the right to catch a specified proportion of the TACC per year, firms owning ITQ may also sell or lease their quota. One of the benefits of the ITQ system is to increase the confidence that quota owners have in their ability to access fish stocks in future, and this allows better long-term planning (Clement and Associates Limited, 1997). Since the introduction of the QMS economic performance in the fishing industry has improved (Batstone and Sharp, 1999). The environmental benefits are harder to judge, but the evidence suggests that fish stocks are generally in better shape (Annala, 1996). The management costs of the programme are now paid for by the fishing industry itself (Clement and Associates Limited, 1997). Some problems arose with the fiscal cost of changing quota in the early years when quota were defined in tons rather than shares of TACCs. Other problems have arisen with bycatch and enforcement continues to be a challenge for some species.

Incentives to encourage the use of new technology

1 Christchurch Clean Air and Energy Efficiency Programme

The Canterbury City Council Helping Hand Programme (Christchurch City Council, 2000b) makes available to ratepayers grants of $500 to close off open fires and coal burners, and replace them with approved replacement heaters. The council also provides discounts on the costs of certain kinds of insulation. The motivation for this programme is the problem of poor air quality in Canterbury caused substantially by smoke from domestic fireplaces.

2 Subsidies for cars to convert to LPG or CNG

Liquefied Petroleum Gas and Compressed Natural Gas are alternatives fuels to petrol in car engines. The use of these fuels produces lower levels of exhaust emission pollution, particularly in older vehicles. Use of natural gas as a fuel was promoted in the 1980s as a response to increases in oil prices, and involved a subsidy to encourage conversion of cars (Bird and Moncrieff, 1997 Section 4.4). This subsidy has now been removed, and consequently the current rate of conversion is low.

3 Energy Efficiency and Conservation authority

The Energy Efficiency and Conservation Authority (EECA) makes available information to encourage and assist improvements in energy efficiency, and in some situations it also provides financial assistance to facilitate the introduction of energy efficient technology. Examples of financial assistance include: grants which are available to encourage organisations to undertake energy audits to identify areas where energy saving improvements are possible (EECA, 2001a), and loans to public bodies for projects to achieve energy cost savings (EECA, 2001b). The original motivation behind the EECA was to reduce energy use, but as most energy production has negative environmental consequences (eg CO_2 from fossil fuel combustion) environmental benefits may also be achieved.

4 Queen Elizabeth II National Trust

The Queen Elizabeth II National Trust generally pays 50% of the landowner's costs for erecting animal proof fencing when a new covenant to protect land in natural habitat is made. This helps to protect the land from invasion by species of animals that would be detrimental to the environment (Queen Elizabeth II National Trust, 2000).

Other

1 Rates relief for private properties managed for public benefit

The Rating Powers Act (1988) allows Territorial authorities to charge reduced rates for private properties managed for public benefit. The extent and consistency with which these powers have been used across the country are difficult to determine.

2 Subsidies for public transport

Traditionally public transport in New Zealand has been subsidised with the intention of increasing the mobility of sectors of the population with limited access to private transport. However it is increasingly being seen as an area in which environmental benefits can be obtained (Ministry of Transport, 1999 p. 11-12) due to factors such as

reduced road congestion and air pollution. As such it is likely that future funding for public transport will be aimed at achieving these benefits.

3 Removal of agricultural subsidies

New Zealand's removal of agricultural subsidies in 1985 led to widescale abandonment of marginal land and reduced land degradation (Ministry for the Environment, 1997 p. 8-33, 8-84).

Opportunities for New Zealand

Possible environmental issues for which eco-taxes or similar instruments would be worth considering further are roughly divided into two categories, national issues and local issues, based on the extent of effects of the pollutant. This division probably determines also the level of government that should design and implement the taxes given the structure of the Resource Management Act. Even where issues and effects are local however, there may be a role for central government in advising on design and providing some harmonisation across regions if necessary.[31]

Local government already has the legal authority to use economic instruments as discussed above. Most already use environmental charges and some use regulations akin to an eco-tax through rubbish and water policies. Use of eco-taxes on a larger scale where the revenue raised is used for general purposes and is a significant share of total revenue might raise new issues however. The tax benefits of eco-taxes relative to property based taxation, which is local government's current tax base, has not been studied.

Here we discuss some areas where eco-taxes could be considered. It is by no means a comprehensive list but may spark ideas. We are not advocating their use in these instances but suggest that they may be areas worthy of further study.

National Level opportunities for eco-taxes

1 Greenhouse gas regulation

The most obvious use for eco taxes (or better still auctioned tradable permits) is for the control of greenhouse gases. These are uniformly mixed and decay slowly so meet the environmental criteria for good candidates for economic instruments discussed in Section 3: uniformity of distribution and persistence/accumulation. They come from a very wide range of sources and can be controlled in many different behavioural and technological ways that a government could never imitate. CO_2 emissions are easily monitorable (by proxy) while methane, nitrous oxides and land use sinks are more difficult to monitor so may not be so easily incorporated. An economic instrument may not be the sole method of meeting our international climate commitments but most economists agree they should be a key element of the mitigation strategy.

[31] These issues are discussed in detail in Kerr, Claridge and Milicich (1998).

2 Require insurance against ecological accidents

This is done internationally for oil and chemical companies. It could also be used as one part of the regulation of toxic waste transport. Premia should depend on preventative actions and past history of accidents. The transport of these products implies that their risks have national consequences. The premia could either be used to create a fund for clean up and reparation or could simply be general revenue. This would only be part of any regulation of ecological risks from transport. Where the transport is in international waters many regulations already apply.

3 Biodiversity protection

This is a national and even international issue and requires coordinated national response.[32] Distributional issues are important here because the location of the habitat does not necessarily relate to those who most value its protection. If the benefits are national, cost bearing should also be national. This may be a case where subsidies are more appropriate than taxes. Subsidies have equivalent environmental effects but clearly different distributional impacts and opposite revenue raising impacts. It is hard to justify a tax on those who simply happen to have biodiversity on their land. For example one could require landowners to pay for the right to develop land if it had valuable habitat or offset the development by protecting equivalent habitat elsewhere. This happens in the US under the Endangered Species Act where landowners with endangered species on their land are forbidden to develop it. Such a tax can also create perverse incentives to destroy the biodiversity before it is found.

Subsidies could pay for habitat protection as in our existing National and Regional Parks but also on private land. Payments could also be made for pest control. One possibility could be the old bounty system for possums or ferrets. This might need to be fine tuned to focus effort in high priority areas, avoid perverse incentives to 'farm' possums and possibly encourage hunters to completely clear areas rather than reduce density in wide areas.

INFORMATION PROGRAMS

A relatively low-cost way to improve consumers' and businesses' responses to energy prices is to simply make them more aware of the value of energy efficiency. Compulsory labelling or free provision of information where it is believed that economic gains can be achieved from more efficiency even without eco-taxes can be effective. Some of this already occurs through EECA but it may be worth enhancing.

Another role of information programs is to mobilise public opinion where they are affected by environmental problems that may be invisible. In the US, the Toxic Release Inventory forces firms to publicise their level of toxic chemical use and waste production. Similarly, the US 'right to know' legislation allows citizens to find out about the environmental dangers they are exposed to and take legal or political action. We may effectively have this for new projects through the Resource Management Act but the information may not be readily available for existing plants.

[32] The issue of appropriate protection for kiwi, as an example of biodiversity is discussed in Claridge and Kerr (1998).

Local level opportunities

1 Local Air Pollution

Some of these opportunities have been widely discussed in the context of road reform.

a Congestion taxes

b Public transport subsidisation that relates more directly to environmental impact.

2 Water pricing

This could replace water restrictions in areas with shortages and may avoid the need to take more water out of rivers thus causing damage to river ecosystems.

3 Performance bonds for care and clean up

eg: mining sites, run off from subdivision development

4 Toxic waste disposal and waste incineration

Many local councils already use economic incentives for solid waste. This could be extended to complement the use of permits and technology control for toxic wastes and to influence the form of solid waste disposal (e.g. landfill vs. incineration).

5 Agricultural pesticides and run off

Agricultural pollution (non-point source) is an internationally increasing problem. Some countries tax fertilizers. Others directly monitor manure and field management and have economic incentives relating to the likely run off. Given that it is often difficult to measure and hence tax run off, an alternative approach is to provide incentives to plant along waterways and hence reduce the impact of runoff. Alternatively, planting could be expected with a tax levied for those who opt not to plant.

7 Summary

Where used effectively, ecological taxes have the potential to make appropriate environmental decisions an automatic part of every economic decision. They are flexible to different needs and changing conditions. They induce people to use their own information and ideas about how to reduce pollution most effectively. At the same time they raise revenue that can replace distortionary taxation on income and capital. They are a valuable part of the environmental regulation toolbox and although they are not appropriate for addressing all environmental problems they are probably currently underutilised and worthy of more investigation.

An active academic literature has explored the possibility that eco-taxes are not only good for the environment but might also improve the tax system. The conclusion is emerging that because of 'tax interactions' this latter result is only true where the existing tax system is grossly distorted and eco-taxes provide an opportunity for much needed reform. Despite this, raising revenue where there are no additional distortions from doing so is certainly good. For example, if we use regulation to cost-effectively reduce pollution we will create the same distortions whatever approach we use. We

should therefore use an approach that raises revenue. Eco-taxes should however only be used where the environmental benefits alone justify the regulation.

Two under-appreciated facts about the costs of regulation are first that industries do not bear costs, individuals do. All costs are ultimately passed on to either workers, the owners of capital or consumers. Second, new investors in a regulated industry, who enter after regulation is imposed, never bear costs. Any compensation to the owners of capital for a new regulatory program (payments to firms go to the owners not the workers) should go only to those who own capital at the time the regulation is created.

With eco-taxes the distributional effects are more transparent than with other forms of regulation but the costs to individuals are actually lower on average. All efficient regulation has the same underlying distributional effects and the same tax interactions. To be efficient every decision must face the full cost of the pollution it creates; that is, the marginal cost of polluting must be the same. The ultimate distributional effect depends not only on these marginal prices but also on any lump sum compensation included in the program. Inefficient regulation has higher total cost and in the short run imposes higher costs on some groups while reducing the costs to others. In the long run consumers bear all costs so they just face more total cost distributed in broadly similar ways.

In this report we have analysed the likely distributional effects in New Zealand of one specific eco-tax, the tax on petrol. Simple empirical analysis suggests that a petrol tax would have slightly regressive impacts but might affect middle-income people most. This result, while based on limited analysis, is consistent with more detailed international studies.

Internationally many economic instruments are used for environmental protection. These include eco-taxes but also a range of other similar instruments all of which internalise environmental effects in decision making and many of which can raise revenue. Other instruments include tradable permits, insurance surcharges, deposit-refund systems, and even information and labelling programs.

Many notable environmental successes have been achieved, particularly in the United States, through the use of economic instruments and particularly tradable permits. They not only have had positive environmental effects at relatively low economic cost, but also have had positive effects on innovation and adoption of new technology. Europe tends to use taxes more and their effects have not been so heavily analysed.

Despite much talk about eco-taxes however, they are not used to their full potential. The predominant form of environmental regulation still involves direct control through technology standards and non-tradeable permits. Many countries use low-level charges that don't directly have environmental effects. They create environmental benefits only through the use of revenue. These charges don't generally have significant revenue raising benefits either. Climate regulation may change that in OECD countries. Most countries are currently engaged in serious discussions about the use of either carbon taxes or tradable permit systems.

In New Zealand we have a history with some use of economic instruments and we have legislation that allows more use. At a national level one appropriate use is for greenhouse gas regulation. National level economic instruments could also be used to help protect biodiversity (though subsidies rather than taxes may be needed) and to reduce the risk of ecological accidents. More opportunities exist at the local level and some are already well exploited such as solid waste policies by many councils. Water management, toxic waste disposal, local air pollution, and agricultural run off are all areas that might benefit from more consideration of eco-tax type approaches. Even though many of these approaches are inherently local and can probably be carried out under the existing Resource Management Act provisions, central government may have a role in providing advice, helping councils to share experience, and, if necessary, encouraging harmonisation of regulations across regions.

A number of potential areas exist for greater use of ecological taxes (and similar instruments) in New Zealand. They have the benefit of being flexible and efficient when used appropriately. By raising revenue they can reduce tax distortions elsewhere in the economy. Eco-taxes are a valuable component of the regulatory tool-box but will never be the overwhelming form of regulation. We have not however reached their full potential and should explore them further.

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