Policy Instruments for a Sustainable Future

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Introduction

> One thing that really does worry a lot of us is the idea of a single aggregate tipping point for the earth as a whole – a shift to a state that may be much less amenable for human life. (Steffan, 2006)

> The chances of unexpected climate effects should not be underestimated, as clearly shown by the sudden and unpredicted development of the Antarctic ozone hole. (Crutzen, 2006)

> There is a mismatch between those [in the South] who may be vulnerable to climate change and those [in the North] who can afford to do anything about it. … [but] Insurance against catastrophes is thus an argument for [the North] doing something expensive about greenhouse gas emissions. (Schelling, 1992)

When the ozone hole appeared, a technological remedy was to hand – the substitution of chloroflurocarbons (CFCs) by hydrochloroflurocarbons (HCFCs) – which was implemented quickly by effective international agreement and regulatory enforcement imposed upon a willing industry. Nevertheless, ultra-violet (UV) radiation damage has persisted for many decades as a consequence of this 'surprise', which was due to a previously unknown effect of high altitude ice crystals in concentrating CFC's and accelerating their known capacity to destroy ozone.

At present we are hearing reports of surprise lakes of water detected underneath Antarctic ice sheets; in Al Gore's documentary *An Inconvenient Truth* we see surprise rivers of water disappearing down 'moulins' in the Greenland glaciers, and we hear of surprisingly high measured losses of ice from that vast island. Do these little surprises add up to precursor signals of a much more rapid collapse of Greenland's ice cover, and maybe the West Antarctic Ice Sheet too, than has previously been imagined possible?

We do not know the answer to that, but it is common sense rather than alarmism to consider what precautionary measures may be taken to make us better prepared to avoid such a situation should these fears, or fears regarding the imminence of other possible runaway climate processes, prove to be well founded. Sea level rises of 40 feet are a climatic catastrophe that must be avoided. That prospect points to the need to adopt an outcome-based approach – identifying what it is that policy must seek to prevent – to the notion of dangerous climate change, rather than relying on expert opinion as to a 'safe' level of greenhouse gases or 'safe' rate of change of average surface temperature (King, 2006). There can be no 'expert opinion' as to the behaviour of a non-linear dynamic system, such as earth's climate, removed to a state far different from any experience.[2]

This paper focuses on policy instruments designed to drive the preferential adoption of two technology types – involving carbon-conservative processing of the products of the land commercially as food, fibre and fuel (biofuel) – whilst, through tradability, generating the cash flow needed to finance the necessary capital investments. These are technologies for getting carbon dioxide (CO_2) out of the atmosphere, and technologies for stocking it (or carbonaceous material derived from atmospheric CO_2) somewhere other than in the atmosphere.

1 The author is grateful to Jonathan Boston, Mick Common and Paul Ormerod for their helpful comments. All responsibility for the views expressed rests with the author.

2 Of course, there have been levels of CO_2 of 500 ppm (parts per million) or more in the very distant past, but not imposed suddenly on a climate system adapted, over the last half million years, to between 180 and 300 ppm. We have extremely poor understanding of the dynamics of the climate system in such conditions, with some potentially crucial feedback mechanisms a matter for speculation rather than analysis.

Carbon neutrality for New Zealand

Article 3.3 of the Rio Climate Change Convention of 1992, where there are threats of serious or irreversible damage, calls on the parties to the convention to take cost-effective precautionary measures without delay on account of a lack of full scientific certainty. Unlike article 4.2(d) – from which hangs the process that began with the 1995 Berlin Mandate and ended with the 2001 Marrakesh Accords to the Kyoto Protocol – article 3.3 is a principle to which the parties are committed individually, and does not require the conference of parties to agree on what action to take collectively.

It has been shown that cost-effective precautionary action is, prima facie, possible through the world-wide adoption of two technology types (Read and Parshotam, 2007).[3] Neither of these types involves low emissions energy, and both are, through bio-energy systems yielding close substitutes for fossil fuels, fully compatible with the highly durable technologies of thermal power generation and locomotive internal combustion engines (whether reciprocating or gas turbine) (Smil, 2006). Thus, they do not shorten the useful life of most existing energy sector assets. But they do involve a change in investment behaviour, from investing in extracting fossil fuels to investing in land use improvements designed to co-produce biomass for bio-energy raw material, along with traditional products of the land.

For practical purposes,[4] the photosynthetic fixing of carbon in biomass is the basis for the only technology type that gets CO_2 out of the atmosphere. Thus, biosphere carbon stock management means improving and expanding the ways we use land so as to grow more plants and trees – potentially a big bonus for agriculture and forestry. Once fixed, the stocking of carbon elsewhere than in the atmosphere can be:

- pre-combustion: standing forest;
- post-combustion: CO2 capture and sequestration (CCS);
- partial combustion: pyrolysis to yield bio-oils plus stable carbon biochar that can be permanently stocked in the soil, raising fertility;
- nothing to do with combustion: wooden houses and other structures.

To clarify subsequent discussion, it is useful to note at this point that *tradable proportional obligations*, with the proportionality increasing over time, will emerge in this argument as the preferred policy instrument: for example, a tradable requirement on transport fuel sellers to include a rising proportion of sustainably produced biofuel in their product sales, and a tradable requirement on sellers of fuel for other uses, and on agricultural and other emitters of methane (CH_4) and nitrous oxide (N_2O), to offset a rising proportion of their emissions through carbon storage. 'Tradable' means that the obligation could be discharged by contracting it to a third party – Shell, for example, could contract its obligation to BP, Solid Energy to Meridian, or both to Weyerhaeuser Inc – thus securing the market efficiency that comes through the 'equi-marginal' principle (Kolstad, 2000).

It is obvious that a 100% obligation to use zero emissions technologies is, as regards its carbon cycle impacts, equivalent to a zero emissions cap. Assuming we have accurate forecasts of demand, there are, similarly, equivalent levels of proportional obligation for any less ambitious cap on emissions. However, the psychology is quite different. The emissions cap creates an accountants' paradise, setting one firm against another, and one country against another, in a punitive zero sum game, where the greater the burden on others, the less that is required of oneself. In contrast, a measure that imposes a required rate of take-up of policy-desirable technology types now, and which projects increasing take-up in the future, releases entrepreneurial energy to get ahead in the race for market share and competitive advantage with the new technologies.

In the competition between business-as-usual technologies and policy-desirable types of technology, the policy objective must be to squeeze out investments in the most undesirable technologies (such as, for

3 This paper proved controversial with reviewers for *Climatic Change*, and carries the comments of the latest reviewers, along with my rejoinders. The upshot of this was that I was invited to submit an editorial essay setting out the ideas involved in our Holistic Greenhouse Gas Management Strategy in a less rigorous framework than a formal article. This will be published in due course, along with invited commentaries from a variety of experts, on the lines of Paul Crutzen's editorial essay of August last year.

4 Keith and Ha-Duong (2003) have proposed washing CO_2 out of the atmosphere with amine solution in large structures looking like power station cooling towers. Per contra photosynthesis, this can be done in the middle of a desert and might be an important technology if there were a shortage of fertile land.

instance, the conversion of coal to gasoline).[5] This can be done by setting clear but flexible obligations for increasing adoption of the policy-desired technology types. Clarity comes from a commitment to use long-run flexibility to maintain the squeeze on undesirable technologies: the obligation is progressively raised so as to take up market expansion in excess of a dwindling policy-acceptable quantum of fossil fuel use.

As a small trading nation, New Zealand can, if appropriate, source its biofuel from overseas, as it does oil now. So, given the turnover of the vehicle fleet and the availability now of flexi-fuel vehicles, the biofuel proportion of New Zealand's fuel consumption could rise to nearly 100% by 2020. On cost grounds, offsets by other emitters could take the form of CCS (CO_2 capture and sequestration), if practicable – say, in the depleted Maui field – related to very low cost supplies of coal. But mostly, for a decade or so until land becomes scarce, offsetting would be by new forest plantations, maybe overseas. With a clear policy steer, it seems that 100% offset could also be achieved before 2030. Together, these would make New Zealand 'carbon neutral' and easily meet any conceivable post-2012 Kyoto commitment. Meeting the 2008–2012 commitment may also be feasible through such offsets, but would be difficult owing to a late start with appropriate policy.

Innovative investment

> ... the development and widespread adoption of new technologies can greatly ameliorate what, in the short run, sometimes appear to be overwhelming conflicts between economic well-being and environmental quality. (Kneese and Schultz, 1975)

The implication of Kneese and Schultz's remark above is that the behaviour that matters for policy success is investment behaviour that can embody the innovations that amount to policy-desirable technological change: for instance, CFC's are replaced by HCFC's, and acid rain is handled by flue gas desulphurisation, both by investing in new technology.

There are two interpretations of 'innovation'. It can mean the development and adoption of newly researched technologies by a pioneer firm, or it can mean the adoption of already developed, or partially developed, technologies by a follower firm that has previously relied on traditional technology. The first – what some would regard as true innovation – could be the design and development of a tidal flow generator and its installation and use in Cook Strait. Such innovation often leads to commercial failure, with follower firms learning from the pioneer's mistakes.

The second – what can be called imitative – innovation is innovative for the following firm even though it is not for the economy as a whole. Mostly the second, imitative innovation is what is meant in this paper, with investments in the widespread diffusion of policy-desirable technologies that are already quite well known and are low risk to the economy as a whole (and that likely result also in incremental technological progress, through learning by doing). Thus, the crucial questions for an effective response to the Kyoto commitment are about whether such imitative innovation becomes widespread, yielding a qualitative change in the stock of capital goods. Will households buy high efficiency light-bulbs? Will they insulate their ceilings and windows? Will they buy hybrid cars? Will there be a bus to catch? Will small- and medium-sized enterprises drive their machinery with efficient electric motors? Will they use diesel-powered delivery vans?

In relation to the threat of rapid or abrupt climate change, the questions are more specific, since the policy-priority technology types are more limited. Will the big oil firms invest in ethanol production, and in a gasohol distribution network with a high proportion of ethanol in the fuel? Will vehicle importers import flexi-fuel vehicles that can run on gasohol as easily as on gasoline? Will fuel suppliers cease drilling and excavating, and start tilling and cultivating for their raw materials?

Risk reduction for the firms involved can come from measures that give certainty about the type of investment that is needed and assurance that adopting policy-priority technology will not result in competitive disadvantage. That is what is achieved by the adoption of proportional tradable obligations. The required technology type is specified, and all competing firms

5 Even if the processing plant incorporates CCS (CO_2 capture and sequestration), any liquid fuel produced will lead to dispersed emissions of fossil fuel-derived CO_2 and continue the policy-adverse shifting of carbon stocks from deep underground into the atmosphere. This does not apply if it is a coal-to-hydrogen process, but a hydrogen-fuelled transportation system is decades off – too distant if the concern is threatened ACC (anthropogenic climate change).

have to comply, so that the pioneering risk of being first is removed.

Problems with a carbon price

Were it not for the burden of accumulated doctrine in environmental economics, that is all that would need to be said and this article would end here. But there is obviously some contradiction if it is possible to say, as Stern does:

> The first essential element of climate change policy is carbon pricing… . Putting
>
> an appropriate price on carbon ... means that people pay the full social cost of their action ...
>
> … But the presence of a wide range of other market failures and barriers mean that carbon pricing alone is not sufficient. Technology policy … is vital to bring forward the range of low-carbon and high efficiency technologies that will be needed to make deep emissions cuts. (Stern, 2006, p.308, introducing Part IV on policy responses for mitigation)

Of course, it is possible to treat Stern's first priority as mere rhetoric. Nobody knows what the full social cost of carbon is. But rhetoric usually serves a purpose and here it reflects the economists' gut instinct that, if we can get prices right, the market will, with help from Adam Smith's invisible hand, reach an equilibrium that is the best of all possible worlds (providing the question of income distribution has been settled equitably by a non-market process). Or, if it be an invisible foot, will at least do better than any alternative.

Addressing that instinct, it might first be remarked, to the wider public that is unfamiliar with the esoterica of modern economic theory, that the market paradigm, which hangs from the analysis of competitive general equilibrium (CGE) formalised by Arrow and Debreu (1954), is in tatters at a very fundamental level. CGE relies on complete futures and complete contingency markets (i.e. on known probability distributions of all possible outcomes at all future points in time, and on the existence of insurance markets where the cost of wrong commercial decisions can be offset against the profit from correct choices).

The work of Stiglitz (1994), summarised in the curiously titled 'Whither Socialism?', has revealed the informational infeasibility of this paradigm; the work of Simon (1997) on 'bounded rationality' reveals the impossibility of market agents making use of such information were it available; and empirical studies of consumer choice by Kahneman et al. (1991) reveal phenomena of loss aversion and status quo bias that are incompatible with the neo-classical axioms of consumer choice. So we have an invisible foot, and the question is, does it score goals? Can a price on carbon do better than the alternative advanced here?

Obviously a carbon price will do something, and we must first note what kind of thing the invisible foot can do well, and where it trips up. For this we can do no better than these words written before modern mathematical economics set off on its eventually fruitless long march in pursuit of Adam Smith's conjecture:

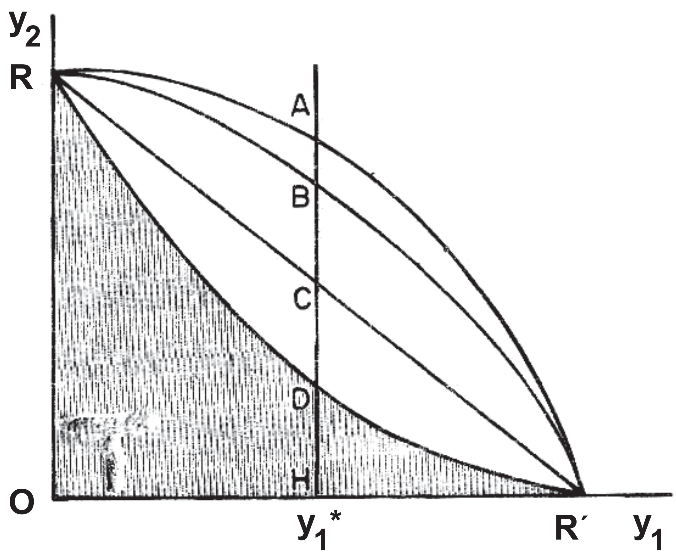
> Market prices, however, reflect the economic situation as it is and not as it will be. For this reason they are more useful for coordinating current decisions, which are immediately effective and guided by short term considerations, than they are for coordinating investment decisions. (Scitovsky, 1954)

So, in situations involving immediate outcomes, prices can do a good job: for instance, the recently-introduced congestion charge is highly effective in causing Londoners to catch a bus rather than drive into the city.[6] The complications of modern economic theory mean that the effect of a carbon tax on current decisions is hard to predict, but if it is not sufficient the tax can be increased to get the desired effect – as is the case in London where the congestion charge has gone up from its initial £5 to £8. With a price on carbon, maybe people will switch the lights off, tread lightly on the throttle, catch a bus and so on. Such good resolutions tend to wear off with time, unless reinforced by progressive price increases or continuing moral suasion through public education campaigns such as those EECA (the Energy Efficiency and Conservation Authority) mounts so well.

Precautionary action and carbon prices

However, in relation to climate change it is not these decisions that greatly matter, but the investment

6 I am grateful to Paul Ormerod for suggesting this example.



decisions discussed previously, and it is there that price signalling does the bad job noted by Scitovsky. Before turning to some practical considerations relating to the carbon price, however, and its relation to tradable proportional obligations, we must note a specific problem with carbon pricing in relation to the threat of abrupt or rapid climate change. Largely forgotten by policy makers, it is clearly apparent in the seminal text on applying CGE theory to environmental policy:

> If it is [a] sufficiently strong detrimental externality, … [it] must produce a non-convexity in the social production set. (Baumol and Oates, 1988, p.116)

The diagram, adapted from Baumol and Oates, illustrates the situation. The curve RAR´ is the convex production possibility frontier familiar to Econ 101 students. It is developed from the assumption of diminishing returns to scale in the production of two goods, y_1 and y_2 – say, consumption goods for this generation and consumption goods for future generations.[7] By doing without now and investing for the future, more is available to our descendants. At the simplest level of analysis, neglecting the difficulties of modern theory noted above, a point such as A is selected by market forces where the slope of the curve, equal to the discount factor,[8] represents the willingness of investors to forgo current consumption in order to profit from investment. The higher the discount factor – the greedier we are and the less we provide for the future – the steeper the slope and the further point A moves to the right and downwards, forcing future generations to suffer a lower level of consumption, y_2, since we have chosen a higher value of y_1.

Suppose we take RAR´ to represent a situation where today's consumption causes no environmental damage. However, if the already excessive stock of greenhouse gas is increased by current consumption, then future production is diminished by the impact of resulting climate change, and the production possibility frontier looks like RBR´. The invisible foot can still score well, providing that the externality enters the price system – for example, through a carbon tax – with the point where the slope equals the discount factor now somewhat to the left of y_1. Thus, market forces result in more 'doing without' by the present generation. This results in more investment to reduce environmental damage and/or compensate future generations. That is what Kyoto is all about.

If, however, the externality is sufficiently severe, the production possibility function falls to RCR´, a straight line that has constant slope and which therefore does not have a unique point where the slope equals the discount factor: the invisible foot shoots wide. Worse still is the environmental catastrophe pictured by RDR´, where the market will drive the system to either R or R´, scoring an own goal of starvation and extinction in either the first half or second half of the game. Given that future generations aren't fielding a team today, and that turkeys don't vote for Christmas, it is obvious what choice would be made. It is this that leads Baumol and Oates (1988, p.31) to conclude that the choice, as regards the level of mitigating activity, must then 'somehow be made collectively, rather than by automatic market processes'.

The heuristic argument employed here is no substitute for a formal dynamic analysis that takes account of uncertainty regarding the impact on future generations of investments made in the present; or of the possibility of alternative investments in sustainable technology,

7 This is to play a little fast and loose with the production possibility frontier concept, which is normally concerned with alternative goods produced in current time (or the timeless world of CGE). However, the Baumol and Oates example of soot from a power station smokestack causes production of electricity (y_1) to damage the productivity of a laundry (y_2) hanging out its washing to dry. Such unidirectional causality from y_1 to y_2 is consistent with the movement in time from this generation to future generations.

8 The discount factor = 1+r, where r is the discount rate or the risk-adjusted rate of interest.

rather than business-as-usual technology, retaining hope of the RAR′ world. Perrings (1987) moves beyond the comparative statics of Baumol and Oates to analyse the linked economy–environment system, with time playing an essential role, and concludes:

> It follows that a high discount rate that raises the current rate of exploitation of environmental resources will be associated with increasing disposals, increasing environmental damage, increasing uncertainty and consequent higher still discount rates in the future. (p.136)

Perrings shows that relying on markets to resolve environmental problems generates increasing uncertainty, progressive myopia and heightened risk – which we may judge an unacceptable risk in relation to the UNFCCC's (the United Nations Framework Convention on Climate Change's) article 3.3.

Keeping both baby and bath-water

However, the teaching of environmental economics has stuck with the static analysis of Baumol and Oates and has nothing to say on the crucial issue raised by Kneese and Schultz, i.e. how to stimulate investment in policy-desirable technological change.[9] That may not matter if climate change is the very long-term problem of gradual change envisaged by the architects of the Kyoto Protocol, and indeed by the IPCC (2001). But it does matter – traditional teaching is of no avail – if concerns regarding Steffan's tipping point prove to be well founded.

> A universal uniform carbon tax is not a solution I can imagine. … No greenhouse taxing agency is going to collect a trillion dollars per year in revenue. … Reduce the tax by an order of magnitude and it becomes imaginable, but then it becomes trivial as greenhouse policy. (Schelling, 1992)

The traditional teaching remembered by economic advisers within governments does not equip them to appreciate that, if the need is to step back from Steffan's brink, practicable levels for a carbon price may not drive the needed technological change fast enough. Policy makers must understand the strong theoretical grounds for believing that price mechanisms cannot succeed[10] where tradable proportional obligations can (hopefully, providing we are not already so far over the brink – given that time lags in the system prevent us seeing the consequences of our actions to date – that escape from a 40-foot rise in sea levels is already impossible).

But to abandon Kyoto is both unnecessary and undesirable. However poorly designed it may be in relation to tipping point concerns, it is the cement of international collective action on climate change, and a necessary framework for addressing the long-term concerns of article 4. So action under article 3.3 must be complementary to Kyoto and addressed to different concerns: e.g. addressing the threat of a tipping point. As regards policy measures, if Kyoto commitments are to be achieved through emissions permit trading, complementarity can be achieved by imposing the obligation as a condition of permit issue, as described elsewhere (Read, 2006). If the carbon tax proposal is revived, a similar result can be achieved by a tax relief mechanism, though with less certainty of effect, due to the problems with prices discussed above.

Practical aspects of tradable proportional obligations

Commercial behaviour

Schelling's order-of-magnitude reduction in carbon price is what results from the proportional obligation approach. Progressively raising the proportionality

9 Of course, research economists do better – *vide* section 6.5.3 in IPCC (2001). But, as for the textbooks, neither 'innovation' nor 'investment' feature in the index of Baumol and Oates (1988). Of eight texts drawn at random from the library shelves, three follow suit (Tietenberg, 2006; Gilpin, 1999; and Perman et al., 1999; four (Perrings, 1987; Common, 1988 and 1995; and Neary and van Wijnbergen, 1986) mention investment in the index, mainly from a macroeconomic perspective; and only one (Kolstad, 2000) mentions innovation/invention, though with no discussion of motivation for, or barriers to, investment in innovations beyond the conventional assumption that a carbon price (in the climate change context) would be more effective than regulation.

10 Conventional investment appraisal requires a cash flow estimate both for such investments and for investments in the next best (business-as-usual, say) alternative *over the decade or so life of the asset*. But all market players have is a history of the price for fossil fuels and a very short run of data on the price of carbon, the first highly volatile and the second different in different places and subject to policy makers' changing priorities. The European Carbon Exchange price for December 2007 settlement fell from ~16 euros a year ago to <2 euros in February 2007. The price for 2008 settlement was more stable but still fell from ~18 to ~14 euros per tonne CO_2 over the period. Yet it is the *difference* between these two highly uncertain future prices that would determine a conventional investment appraisal, uncertainty that leads to the use of a very high risk adjusted rate of interest for the investment appraisal and thus to a low elasticity of demand to invest in policy-desirable innovation, and hence to an apparent need for very high carbon prices.

involves incurring the financing costs of investing in an increasing proportion of policy-desirable innovative output. It means that the cost of funding investments in innovation is spread across the whole volume of sales, resulting, in the current context, in an order-of-magnitude smaller price on carbon than is arrived at by a static, CGE-based approach to the marginal cost of emissions reductions (i.e. the rhetorical 'full social cost').

This parallels commercial practice, where innovation is funded out of super-normal profit retained by successful firms whose products are sufficiently attractive for them to be priced at above production costs. The obligation requires all firms to retain more profit – i.e. to raise prices a little – in order to fund the additional cost of investments in the two policy-desired technology types relevant to tipping point threats. That such investments are likely to be low-cost, possibly even profitable, follows from the high prospective cost of 'peak oil' and the high value of co-producing timber with biomass energy raw material.

Equity

The rise in prices involved represents the carbon price induced by the proportional obligation. Such a carbon price is one that makes sense to the consumer and voter: it is passing on the costs of doing business in a policy-acceptable way. The consumer accepts price increases due to real costs without question, as has been the case with the yo-yoing price of petrol in the last year.[11] Such a small carbon price is preferable to the widely canvassed notion of exposing New Zealand to the world price of carbon, since energy taxes are highly regressive (Common, 1988); preferable, that is, until such time as proportional obligations come to be widely recognised as the preferred way of meeting Kyoto commitments, and the world price of carbon falls to its level in New Zealand.

Apart from domestic equity, there is the North-South equity issue raised in our initial quotation from Schelling (1992) – an inequity that is exacerbated, at least in the view of the South, by the historic responsibility of the North for most of the current excess stock of CO_2 in the atmosphere. Given the comparative advantage of the South in the land-based activities involved in the two policy-preferred technology types, growing biomass and terrestrial stocking of carbon, implementation of proportional obligations will result in substantial investment in, and technology transfer to, a large number of developing countries.

As discussed elsewhere (Read and Parshotam, 2007), this can provide the basis for sustainable rural development and economic growth led by exports of liquid biofuels. Since the agents for these direct foreign investments and technology transfers are private sector firms driven by tradable proportional obligations, the transfers involved are manifestly not a substitute for official (government to government) assistance, an issue of concern to the China and G77 group.

Earmarked taxes

This is one of several advantages (apart from equity aspects) enjoyed by proportional obligations (or the tax relief alternative mentioned above) relative to proposals for taxes, or to permit auction revenues that expose New Zealand to the international price of carbon as dummy for the unknown full social cost.

Among other things, such exposure extracts profits that could be used for financing policy-desirable investment. It has been suggested that this loss of private sector investment finance could be remedied by recycling the tax or auction revenue into a fund for policy-desirable investments (Ward, 2007). Quite apart from the capacity of the investment process to assimilate the very large cash flows involved in a carbon price set at the international level, and setting aside the traditional Treasury resistance to earmarking tax revenues, this procedure would involve public finance accountability, introducing unnecessary transactions costs and hampering the deployment of entrepreneurial initiative.

For instance, under public accountability, transactions would need to be transparent, with a level playing field between, say, one prospective owner of marginal land for energy plantations and another. But an entrepreneur, operating under a proportional obligation, could offer a high reward to the first landowner to take the plunge,

11 It is unimaginable that such price variation would have been accepted if it had arisen as a tax on road fuel varying at the month-to-month whim of the minister of finance – witness the European fuel tax protests of 2000–2001 (Mitchell and Dolun, 2001) and the 'fart tax' demonstrations in New Zealand.

and lower payments to follow-on landowners taking lower risks. Such discrimination, extracting surplus value and cutting costs, is natural to entrepreneurs but foreign to the use of taxpayers' money, which has to be seen to be fair.

Also, private sector entrepreneurship, operating under limited liability, can make mistakes and go broke, whereas publicly-funded programmes become embedded in permanent bureaucracies, with a tendency to throw good money after bad. So the design of a policy instrument, besides protecting the consumer from needless price increases, should also aim to channel cash flows through the private sector, as is the case with tradable proportional obligations.

Conclusion

In relation to avoiding the greatest dangers from climate change, the policy-preferred technology types are biotic fixation of CO_2 and various storages of carbon out of the atmosphere. Rising levels of tradable proportional obligations are an effective instrument for driving take-up of these technology types. An implicit carbon price finances a rising volume of policy-desirable innovation. This runs counter to common perceptions that market mechanisms can address serious damage risks, and that exposing New Zealand to the world price of carbon would be an effective approach. Future Kyoto commitments are easily met, providing a substantial proportion of the storages are consistent with the Kyoto Protocol's rules (e.g. afforestation). The carbon price that results might be quite small given the apparently long-term high cost of oil[12] and low cost of carbon storage in forest plantations. Certainly it will be smaller than the world price established under the cap and trade approach (unless other parties also adopt similar policies). In keeping the price of carbon quite low, domestic equity problems are substantially ameliorated, and problems in the internationally competitive at-risk sector are also substantially addressed.

12 With prices at 2006 levels, biofuels are commercially attractive. The policy concern that gives rise to a price on carbon is to ensure that biofuels are supplied sustainably, unlike current operations in Indonesia, where tropical forest is being burned down to make way for bio-diesel palm oil plantations; there is also concern over sustainability safeguards in the current discussions on US–Brazil biofuels trade (Kenfield, 2007).

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