AARES 52nd Annual Conference, Canberra, 5-8 February 2008

Some Distributional Issues in Greenhouse Gas Policy Design

John Freebairn

The University of Melbourne

The paper argues from first principles and with supporting related empirical evidence that most of the final incidence of emissions taxes or tradable permits will fall on consumers of greenhouse gas intensive products. This distributional outcome supports an emissions reduction strategy of an emissions tax or auctioning the tradable permits, rather than gifting permits in a grandfather arrangement to current polluters as was done in Europe and has currency with proposals for Australia. Greenhouse gas emissions and climate change is a global pollution problem that gives rise to a prisoner's dilemma problem in which the global cooperative solution in undermined by individual countries free-riding. Some of the issues and challenges to be overcome to reach a cooperative global policy package are discussed, including the different interests and perspectives of developed and developing countries.

1. Introduction

The distribution of the benefits and costs of policy interventions to reduce greenhouse gas emissions are important to the design of politically acceptable policies. It is important to focus not on the initial or statutory incidence of taxes on emissions or the allocation of tradable permits, but rather on their economic incidence once market prices and quantities have responded to the changed incentives. Further, given the very long time frame for policy to reduce the stock of greenhouses gases, the focus should be on the long run economic effects. This paper argues that a high proportion of the economic costs of taxes or tradable permits to reduce greenhouse gas emissions will be passed forward to consumers, and as a consequence much contemporary policy discussion and lobbying to compensate producers is exaggerated. Understanding the distribution of the costs and benefits of policies to reduce greenhouse gases across different countries, and in particular between developed and developing countries, is important in designing a necessary global policy response.

Many aspects of the greenhouse gas policy debate will be taken as given in this paper so that it can focus on the distributional effects of taxes or tradable permits[1]. Although there remains controversy and uncertainty at the scientific level, there is a growing body of evidence that the build-up in the stock of greenhouse gases already is affecting climate, including warmer temperatures and more frequent severe weather events, that human activity, and particularly that associated with the burning of fossil fuels, is contributing, and that these adverse effects will increase and bring significant costs to future generations. The stock of greenhouse gases is a form of global pollution or externality under current industry structures and policies, and the flow of emissions at zero private cost is a significant market failure requiring policy intervention on a global stage. With the long lags between the costs of reducing the flow of greenhouse gases and the benefits of lower costs of adaptation to a smaller dose of climate change, issues of inter-generational comparisons and the choice of a discount rate cloud a benefit cost assessment of different policy intervention choices to reduce greenhouse gas emissions. Granted the uncertainty on both the science of climate change and the magnitudes of future economic costs, some policy action to restrict greenhouse gas emissions is argued by many at a minimum to be a good insurance policy investment. The favoured form of policy intervention to correct the market failure is a system of tradable permits, but with debate about whether the permits should be auctioned, allocated to current polluters (grandfathered), or allocated on some other formula basis. Many economists still push for a pollution or emissions tax. In practice, many in the political domain remain attracted to regulations and to subsidies for R&D to reduce dependence on greenhouse gas intensive products and production methods. The comparative economic incidence of the different options for distributing tradable greenhouse gas permits on consumers, producers and government, and on different countries, is the focus of this paper.

The first part of the paper considers a partial equilibrium model, either for the globe or for a particular economy, of a competitive industry greenhouse gas polluter to assess the distribution of the costs and benefits of a tradable permit system on producers, consumers and the polluted, and the aggregate efficiency gain, relative to a business as usual (BAU) scenario. The effects of non-competitive behaviour, a general equilibrium perspective, and some related quantitative evidence on the economic incidence of taxes is used to support and where necessary to qualify the simplified partial equilibrium competitive model assessment. The second part of the paper considers some of the distributional issues, challenges and opportunities to secure a global policy agreement which includes developing countries. A simple game theory model which builds on the earlier partial equilibrium model is employed. A final section brings together some key policy design messages.

2. A Competitive Partial Equilibrium Model

Consider for example the case of fossil fuel fired electricity or transport. Under BAU, producers consider the private costs of fuel and other materials, labour and capital, but not the external costs of pollution, including greenhouse gas emissions. Consumers consider the market price of electricity or transport costs, but again not the external costs of pollution. But, the flow of greenhouse gases from each and every country adds to the global stock of these gases, and in time this build-up of the stock induces climate change and adverse effects on future generations in the form, for example, of relocation of people and businesses, agriculture, the availability of water, greater damages to structures and the need to change construction guidelines, and the loss of biodiversity. These costs are world wide, although their relative magnitudes likely will vary from country to country. While some of these costs are likely to fall on the producers and consumers of electricity and transport services, they have much wider impacts.

For simplicity, initially assume a competitive industry so that the supply curve for the good good, electricity or transport, is given by a marginal private cost curve, and the demand curve is given by a marginal private benefit curve. Ignoring the complex issues of time and discount rates, the greenhouse gas pollution adds a marginal external cost. From a global society perspective, the marginal social cost is given by the sum of the marginal private cost and the marginal external cost. Clearly, the BAU solution, or the competitive market solution in which the external costs are ignored, results in too much production and consumption of electricity and transport, and too many greenhouse gases emissions, than is socially optimal.

A more formal representation of the foregoing arguments is presented in Figure 1. The horizontal axis shows quantities of the good good, Q_g, such as electricity and transport services, and the bad good, Q_b, greenhouse gases, and the vertical axis shows the price or cost per unit of good. Consider first the base case, or BAU outcome under a competitive market. With supply curve the marginal private cost, MPC, and demand the marginal private benefit, MPB, the market equilibrium and BAU solution is quantity Q_{BAU} and price P.

By contrast, the social optimum that recognises the external costs of greenhouse gas pollution would equate marginal social cost, MSC, equal to MPC plus the marginal external cost, MEC, with MPB. This would give a smaller level of production and consumption of both the good and bad goods at Q*, and a higher consumer market price of P^*_c and lower producer return of P^*_p. The social optimum can be achieved with a tax per unit emission of $P^*_c - P^*_p$, or with a system of tradable permits limited to OQ*. Note that the market price of the permits, or their opportunity return, will equal the emissions tax rate of $P^*_c - P^*_p$. Further, in a mature market this socially efficient outcome will occur whether the permits are auctioned or gifted, and then gifted to different identities under different criteria, with only minor differences due to differences in income effects associated with the different options for allocating the initial property rights.[2] From Figure 1 we can assess the re-distributional effects of a tradable permit scheme (or tax emission scheme) relative to the BAU base case scenario.

Consumers of the polluting electricity and transport products in all cases face a higher market price, P^*_c rather than P, and lose consumer surplus of area PP^*_cEC, equal to a transfer of PP^*_cEL plus ELC. Both the price increase and the consumer surplus loss are greater the less elastic is demand relative to supply. In the extreme case of a perfectly elastic supply associated with constant returns to scale production technology and infinitely elastic factor supplies to the industry, all of the emissions tax or scarcity value of tradable permits will be passed forward onto the consumers of the carbon intensive products as a higher price equal to the tax or market price of the tradable permit. Such a technology seems a close approximation for most of the manufacturing and service industries which generate greenhouse gas emissions, either directly or indirectly through purchased intermediate inputs.

The re-distributional effects on producers of tax and tradable permit policy interventions to reduce greenhouse gas emissions depend in part on the way in which the permits are allocated, and in part on the relative elasticities of supply and demand for the electricity, transport and other carbon intensive products. In all cases, producers face a lower net market return, P^*_p rather than P, and a lower producer surplus of P^*_pPCB, equal to a transfer of P^*_pPLB plus BLC. If the intervention is an emissions tax, or if the tradable permits are auctioned, and in both cases at a tax rate or fee of $P^*_pP^*_c$, government gains a transfer of revenue from producers and consumers of P^*_pPEB, and producers lose P^*_pPCB. However, at the other extreme, if the tradable permits are gifted to producers in a grandfather arrangement, producers make a net gain of PP^*_cEL less BLC. Further, if supply is close to perfectly elastic (for the reasons noted above), producers and their shareholder owners are large net winners and they benefit from the gift of the tradable permits times their market price. Clearly, if some of the permits are gifted and some are auctioned, as seems to be suggested by the Prime Ministerial Task Group on Emissions Trading (2007), the net outcome for producers, and for government, will lie between these two extreme scenario options.

An important result of the foregoing discussion is that the economic incidence of a tradable permit scheme is bound to be very different to the statutory or first round incidence. In particular, in the likely case of a highly elastic supply curve for the carbon intensive products, most of the cost of restraining the production of greenhouse gas emissions will be passed forward to consumers as higher product prices than otherwise. In this case, it is likely that political pressures for compensation for equity will come from households[3]. Compensation might be sought as higher wages than otherwise to maintain real incomes, with the associated threats to igniting a burst of inflation. Alternatively, the permits could be gifted to households who then on-sell them to business polluters, or households could be compensated for the price increases by providing compensating reductions in taxation and increases in social security rates. All options still change relative consumer prices and producer costs to encourage less use of carbon intensive products and production methods. The later option of compensating households via income tax reductions and increased social security payments require government revenues, and, in turn, this option places a premium on government choosing either an emissions tax or auctioning the permits to generate the offsetting revenue, rather than gifting permits to producers.

The reduction in the production of the greenhouse gas external product, Q_b, in shifting from the BAU output, Q_{BAU}, to the social optimum output, Q^*, in Figure 1 results in a reduction in pollution costs of BEFC. This gain is a type of public good (with properties of non-rival consumption and high costs of exclusion) spread across the globe rather than a gain to the members of a country which introduces the emissions tax or tradable permits. A particular country would gain only a share of BEFC, say α, with $0 \leq \alpha \leq 1$, and other countries free ride on the remaining share 1- α. In the case of a small country such as Australia which contributes about 1.4 per cent of global emissions the own country gain is very small.

Figure 1 can be used to evaluate the net gain for the globe and for particular countries. For the globe there is a net gain of EFC. The global net gain equals the reduction in the costs of adaptation to greenhouse gas induced climate change, BEFC, less the reduction in economic (producer and consumer) surplus from the reduced production and consumption of electricity and transport, BEC. Note that area $P^*_p P^*_c EB$ is redistributed between producers, consumers and government depending on the intervention policy instrument and on the relative elasticities of supply and demand. The net gain is the efficiency case for a global strategy to reduce, but not to eliminate, the production of greenhouse gases.

In the event that a particular country, or group of countries, introduce policies to reduce greenhouse gas emissions, but others continue with BAU, the innovating country or countries lose EBC and gain only α BEFC, with the other countries free riding with a gain of (1- α) BEFC. Note that the country or countries that in isolation introduce policies to reduce greenhouse gases may actually lose depending on the relative magnitudes of the aggregate economic surplus loss, the global benefits of the smaller externality cost, and the share of those benefits received by the policy initiator. By contrast, the free riding countries unambiguously gain. As will be shown later, these cross-country distributional effects are important considerations for the development of a global policy strategy to reduce greenhouse gas emissions.

3. Models with Market Power

In reality, because of the importance of economies of scale, product differentiation and other considerations, producers in particular industries may have market power and use this power in determining decisions. This section considers potential qualifications to the distributional effects of policy interventions to reduce greenhouse gas emissions reported in the preceding section for a competitive model if producers use their market power in setting prices and quantities, and in particular in changing price and quantity decisions in response to the additional production costs of an emissions tax or a tradable permit scheme.

While there are many different models of monopoly, oligopoly and monopolistic competition, they have some common properties which are germane to our questions. On the assumption that firms seek to maximise profits, they choose quantities and prices to equate marginal revenue, MR, with marginal private costs, MPC.

Assume initially that the firm demand curve has a constant elasticity of demand. A typical firm i has a MR_i function

$$MR_i = P_i (1 - 1/E_i) \qquad (1)$$

where, P_i is price on the firm's perceived demand curve, and E_i is the absolute value of the elasticity of demand perceived by the individual firm i taking into account such considerations as the quantity and price decision reactions of other firms in the industry. Note that profit maximising firms choose an output where demand is elastic, that is $E_i > 1$, so that $MR_i > 0$. Equating (1) to the firm marginal cost, MC_i, the firm sets price as a mark-up over marginal cost, with the mark-up given by $E_i/(E_i - 1) > 1$, at

$$P_i = (E_i/(E_i - 1)) MC_i \qquad (2)$$

Note from (2) that the competitive model of the previous section is a special case of (2), since as the perceived firm demand elasticity becomes more elastic, and in the extreme perfect competition case $E_i = \infty$, the mark-up approaches unity.

More generally, when the perceived firm level demand elasticity E_i is very large, the competitive model assessment of the distributional effects of market measures to reduce greenhouse gas emissions will provide a good approximation. In these cases $P \approx MC$, and the industry supply curve is also approximately the MPC shown in Figure 1. In the case of monopolies, often the price is regulated to be close to MC. In most cases of monopolistic competition there are many firms with fairly similar or close substitute product options. In the case of oligopoly industries, for Cournot (or quantity setting) firms the perceived firm elasticity of demand increases with the number of firms, and for Bertrand (or price setting) firms the price set approaches MC the closer are the firm product substitutes, and for perfect substitutes P = MC as under perfect competition. For many of the major greenhouse gas emitting industries, there are similar quality products, for example electricity is electricity, there is a large number of firms with differentiated products but where some of the different firm products are close substitutes, for example motor vehicles, or both, that suggests the competitive model results will be a reasonable approximation of the distributional effects of market based policy interventions to reduce greenhouse gas emissions.

Suppose instead that greenhouse gas emitting firms are able to, and in practice do, exercise market power and set prices according to (2), that is the perceived firm demand elasticity E_i is, say, 5 or less elastic. Then, BAU output, including of greenhouse gases, will be less than the competitive model, and the initial market price for the good goods will be above the competitive market price. More importantly, using (2) and assuming a constant marginal cost[4], the effect of a carbon tax or the opportunity cost of a tradable permit, T, to reduce greenhouse gas emissions on the consumer or market price P_c will be

$$dP_c/dT = E_i/(E_i - 1) > 1 \qquad (3)$$

That is, unlike the competitive model in which 100 per cent of the tax or permit price is passed forward to consumers, here more than 100 per cent of the additional cost is moved forward to consumers.

Now, rather than assuming as was done above that the firm demand curve has a constant elasticity at all price-quantity combinations, suppose instead that we assume a linear demand curve (with demand becoming more elastic at higher prices). In the special case of a monopoly, only a half of any marginal cost increase, including that associated with a greenhouse gas emission reduction policy, would be passed on to consumers. With a Cournot oligopoly the mark-up increases with the number of firms and approaches 100 per cent for many firms (Smale, et al., 2006). In the case of monopolistic competition, Ng (1986) shows that more than 100 per cent of any cost increase will be passed forward to consumers as higher prices. Here, the emissions tax or the opportunity cost of the tradable permit increases both the average and the marginal cost, and the reduction in firm numbers (because of the higher price and less aggregate industry demand), combines to reduce the slope of the firm demand curve at which the new higher equilibrium price, and lower firm output, is established.

In principle, we can point to a wide range of different models of firm conduct with the use of market power, to differences in the shape of the demand curve facing each firm, and to differences with the shape of firm cost curves. Different combinations result in less than 100 per cent, about 100 per cent and more than 100 per cent of the increased costs to firms of policy interventions to reduce greenhouse gas emissions been passed forward to consumers as higher prices. But, in most cases, with the monopoly with a linear demand curve being the main exception, a cost pass through of 100 per cent or more is the behavioural response. We now turn to some empirical evidence on the rate of pass through of higher taxes or tradable permit costs on greenhouse gas emissions on consumer prices for carbon intensive products.

4. Some Empirical Evidence

A study of the EU Emissions Trading Scheme by Sijm et al. (2006) estimated that for the German and Netherlands power industries between 60 and 100 per cent of the market price of the permits was passed forward to consumers as higher electricity prices. The cases of less than 100 per cent pass through were associated with situations where the additional cost reversed the low cost ranking of different production technologies, and in particular where the former higher cost gas fired units which are less carbon intensive than coal fired generators became the lower cost producer, and hence the marginal price setting option, under the additional emissions permit cost.

There are two related sets of empirical evidence for Australia which give insights into the likely economic incidence, and the distributional effects, of a tax on emissions or a tradable permit system to reduce greenhouse gas emissions. These are studies of tax incidence, and the experience of the GST package of reforms introduced in 2000.

Studies of the distributional effects of Australian indirect taxes, including the petroleum products excise which can be considered in part a selective carbon tax (and also in part a tax to fund road construction and maintenance and perhaps a tax on congestion) and on motor vehicles, assume 100 per cent pass through to the consumer for both the direct effects and the indirect effects through intermediary inputs. These include studies by ABS (2007), and by Warren and NATSEM (for example in Warren et al., 2005).

A related practical experience with several messages for the conduct of policy on emission taxes or tradable permits to reduce greenhouse gas emissions is the GST package of reforms introduced in 2000. The reform package involved using revenue from eight of the ten percentage points of the GST to replace other indirect taxes, including the wholesale sales tax and several state stamp duties, with revenue from the remaining two percentage points, plus some budget surplus, to fund lower income taxation and an increase in social security payment rates. The net incidence of the reform package of indirect taxes on product prices was modelled on the assumption of 100 per cent pass through to consumers, and the Australian Competition and Consumer Commission (ACCC) used these numbers with effect to monitor business pricing, and that is how the actual numbers evolved[5]. In the spirit of the competitive industry model of Figure 1, the ACCC modelling and monitoring of price changes assumed constant returns to scale production technology and competitive passing forward of net tax (and cost) changes. The actual numbers revealed corresponded almost one to one with the model estimates.

Another important message from the GST reform package is that it included a net increase in indirect taxes, much as would a carbon tax or tradable permit scheme as discussed in the previous section. This was projected to increase the overall CPI index, by about three per cent. Compensation of households (in fact over compensation because of the draw on additional budget funds), through a combination of lower income taxation and higher social security payments was argued by the Coalition government to avoid the need for any compensating wage increase, and for an increase in nominal interest rates. In practice, this is what happened. There was a one quarter blip in the CPI, with no flow-on effects to wages, interest rates and other macroeconomic variables (see, for example, The Treasury, 2003).

5. Some General Equilibrium Effects

So far the paper has focused on the partial equilibrium assessment of a single product, and with a key result that the introduction of an emissions tax or a system of tradable permits pushes up the consumer price and reduces the level of production and consumption of the greenhouse gas emitting product. In a multi-product or general equilibrium model assessment, consideration of the distributional effects of the policy initiatives should look also at the effects of changes in relative prices. In a multi-product and multiple production methods context, some products and production methods gain and others lose, whereas the partial equilibrium model focuses only on the losers.

For consumers, the relative prices of carbon extensive products will fall relative to the prices of carbon intensive products. Then, some of the reduction in consumption of electricity, transport and other carbon intensive products will be offset by increases in consumption, and in turn production, of such carbon extensive products as clothing, insulated buildings, public transport, and smaller and more fuel efficient vehicles and household appliances. Businesses similarly will redirect their choice of production methods to expand on the now relatively cheaper lower carbon intensive methods such as better designed and insulated buildings, renewable rather than fossil fuel based energy, and energy conservation measures. In a dynamic context, the changed relative prices provide larger incentives and rewards for a new set of innovations based on R&D and investment that economise on the now relatively more expensive carbon intensive products and production processes. Popp (2006) provides a compelling survey of studies showing a significant and quantitatively important response of induced business R&D and innovation towards energy efficiency and less carbon intensive production methods in response to higher energy prices.

From a general equilibrium perspective, market based policy interventions to reduce greenhouse gas emissions change the mix of production and consumption in what Schumpeter called “creative destruction” with a much smaller, and perhaps even indeterminate, net effect on aggregate employment, investment and output, but one with less greenhouse gas emissions.

6. A Global Policy Strategy

There are at least four sets of reasons why it is desirable, if not necessary, for global cooperation in developing a first best policy strategy to reduce greenhouse gas emissions, and here the distributional affects on different countries are important. First, the pollution externality is of a global nature, and the benefits of reduced pollution have classic public good characteristics. Second, this public good characteristic of the pollution reduction good means that there are incentives for individual countries to free ride with a likely non-cooperative game equilibrium of BAU and excessive global pollution relative to the global first best solution. Third, many of the carbon intensive industries are globally footloose. Restricting their activity level in one country induces migration off-shore of the pollution intensive industries, with the result of a very much smaller net reduction in the global stock of greenhouse gases. Fourth, cost-effectiveness in reducing global greenhouse gas emissions is favoured if tradable permits and credit offsets have an integrated global market in which to operate, rather than just a series of autarkic national markets. Given the obvious advantages of global cooperation, this section considers some of the distributional effects, and especially between developed and developing countries, that affect the barriers to, and the opportunities for, global cooperation.

Consider first a simple game theoretic model for two countries, or country groupings such as Developed countries, D, and Developing countries, Dev, with two possible individual country strategies of business as usual, BAU, and Invest in reducing greenhouse gas emissions, I. Table 1 sets out the game and with the pay-off matrix using the BAU-BAU strategy as the base case strategy with a net payoff for each country of zero. For simplicity, further assume the two sets of countries are similar, since this does not alter the points to be made. If both countries invest in reducing greenhouse gas emissions, each makes a positive gain, roughly area EFC of Figure 1, say +20 for each country for illustration. But, if one country chooses I while the other chooses BAU, the investor incurs the costs, roughly area BEC of Figure 1, and receives only a portion α of the reduction in the external costs of reduced climate change, area BEFC, and so makes a net loss, say, of – 20, and the business as usual player incurs no costs but free rides and receives 1 – α of the benefits of reduced global pollution for a net gain of, say, +30. Note that because the I-I strategy maximises global welfare, the I-BAU strategy mix provides a lower aggregate net gain, and in our illustration +10 versus +40.

From Table 1, the global cooperative strategy to maximise welfare involves both sets of countries investing in policies to reduce greenhouse gas emissions, the I-I strategy mix. However, for each individual country, their dominant strategy is to free ride, or to choose BAU, with a Nash equilibrium of BAU-BAU. This is no more than a variant of the text book Prisoners' Dilemma game.

The policy challenge becomes one of establishing a binding global agreement for the I-I strategy. This is an extremely difficult challenge[6]. Unlike national and regional pollution problems where there are national and regional governments with the power to coerce all players to accept the cooperative agreement, there is no such international government. Certainly international agreements, usually under the auspices of such bodies as the UN or the WTO, can be negotiated for such purposes. However, while some regard the Kyoto Protocol of 1997 to have made some progress for the specific case of greenhouse gas emissions, the fact that developing countries do not have binding agreements, that the US and Australia decided not to join[7], and that some of the signatory countries seem likely to exceed their targets, and with no effective sanctions, casts doubt on this approach as developed so far. At the heart of reaching a cooperative agreement is establishing a mutually agreed sense of fairness, or distributional equity, necessary to induce the majority of countries to sign-up, and then to meet commitments.

Different proposals for the initial allocation of tradable permits between developed and developing countries highlight the challenges to reaching a global consensus. With considerable merit, developing countries object to the option of grandfathering permit allocations to countries based on their current pollution levels, a strategy at the heart of the Kyoto Protocol and now of the European tradable permit scheme. Developing countries argue that the developed countries have been the principal contributors to the stock of greenhouse gases, this has been a key part of the industrialisation process over the past two centuries which lies behind the much higher per capita incomes of the developed countries, they, the developing countries, have legitimate equity claims to proceed with industrialisation to raise their own incomes, and therefore the developed countries should bear most of the cost of reducing the further build-up of global greenhouse stocks. Arguably, a fairer allocation of tradable permits would be one based on equal per capita allocations as argued, for example, by Parikh (2007). The developed countries look at this option, and its associated cost of buying permits from the developing countries, with much concern.

McKibbin (2007) presents another model with more generous quotas and tax rates over the next few decades for the developing countries but with convergence towards the developed country quotas and tax rates by the end of this century.

Suppose that for whatever reason(s), and as is beginning to be the case in practice, that developed countries choose to implement policies to reduce their own greenhouse gas emissions, That is, developed countries unilaterally choose the I strategy of Table 1. Given this choice, what are the minimum and maximum bribes developed countries would offer the developing countries to voluntarily also adopt the I strategy, and so achieve the global welfare maximising I-I outcome? In the first row of Table 1 we can evaluate the minimum subsidy or bribe that the Developing countries require to chose strategy I over BAU, and the maximum subsidy or bribe that the Developed countries would be willing to pay to have the Developing countries choose I over BAU without either set of countries being worse off than the I-BAU outcomes. Representing the benefit to country k, with k = D or Dev, for the choice of strategy i by D and strategy j by Dev, with i,j = I or BAU, as $G^k(i,j)$, so as not to be worse off, the minimum bribe required by the Developing countries, Bmin, is

$$Bmin = G^{Dev}(I, BAU) - G^{Dev}(I, I) \quad (4)$$

and the maximum bribe willing to be paid by the Developed countries, Bmax, is

$$Bmax = G^{D}(I, I) - G^{D}(I, BAU) \quad (5)$$

For the illustrative numerical payoffs in Table 1, Bmin = 10 and Bmax = 40. In general, using (4) and (5), together with the fact that the I-I strategy maximises global welfare, and therefore that the I-BAU strategy generates less global welfare, we can conclude that

$$Bmax > Bmin \quad (6)$$

This means that it is possible to reach a global Pareto agreement involving a subsidy from the Developed to the Developing countries, and that (4) and (5) set the bands for negotiating the subsidy level to the Developing countries to seek their agreement to invest in reducing greenhouse gas emissions.

In practice, the subsidy to gain acceptance by developing countries to participate in a global agreement could take several forms. Direct grants are the simplest and most transparent. Another option is in the initial country by country allocation of greenhouse gas emission permits to provide developing countries with surplus permits to current pollution (and in effect to move part way towards the per capita allocation idea). Until their economy and pollution output expands, the developing countries would gain from the sale of their surplus permits to developed countries, but a positive price for carbon signals the need for both producers and consumers in both sets of countries to reduce carbon use and consumption. The proposal by some developed countries for them to invest in R&D to reduce the costs of reducing greenhouse gas emissions, and then to share the results for free or at a subsidised rate with developing countries, for example as a key component of the AP6 proposals, will help, but it is unlikely to go far enough to win agreement from many developing countries.

7. Concluding Policy Implications

Most of the final or economic incidence of a system of emission taxes or tradable permits to reduce greenhouse gas emissions will be on consumers, and not producers. This follows from the high elasticity of long run supply of most products intensive in carbon, and it is supported by studies of the incidence of indirect taxes and the experience of the GST tax reform package of 2000. If we allow for the exercise of firm market power, even more than 100 per cent of the tax or permit price could be passed forward.

The passing forward of most to all of the cost of carbon taxes or tradable permits to consumers as higher prices has at least two key messages for the design of a tradable permits scheme. First, gifting the permits to producers, including under grandfathering principles, represents a redistribution of national income. A status quo equity system would auction the permits or turn to a tax on emissions system. Second, because of the price increase and associated increase in the cost of living, there is a compelling case for using the government revenues gained to compensate households via cuts in other taxes and increases in social security payments in an aggregate revenue neutral package to restore equity and to minimise the prospects of compensating wages and an impetus to inflation.

A complete picture of the distributional effects of policy interventions to reduce greenhouse gas emissions requires a general equilibrium model. These policy interventions change relative prices. While the production and consumption of carbon intensive products and the use of carbon intensive production methods decline, other products and production processes facing lower relative prices expand and in the process create new investment and employment opportunities.

In the global context there are incentives for individual countries to free ride and not to invest in policy actions to reduce greenhouse emissions and achieve a cooperative global social optimum. Developing countries with considerable merit argue that they should not bear much of the cost burden of reducing global greenhouse gas emissions, and in particular they object to a system of grandfather allocations of tradable permits of the Kyoto Protocol form. Clearly, global cooperation from the developing countries requires innovative options on an equitable distribution of global permits.

Interestingly, the paper shows that if developing countries choose to invest in policies to reduce their greenhouse emissions and the developing countries decline to participate, there is a sizeable win-win opportunity for the developed countries to subsidise or bribe the developing countries to join a cooperative global welfare maximising agreement.

References

ABS (2007), "Government Benefits, Taxes and Household Income 2003-04", Catalogue 6537.0.

Barrett, S. (2007), Why Cooperate? The Incentive to Supply Public Goods, Oxford, Oxford University Press.

Bovenberg, A., Goulder, L. and D. Gurney (2005), "Efficiency Costs of Meeting Industry-distributional Constraints Under Environmental Permits and Taxes", RAND Journal of Economics, 36(40, 951-971.

Carter, R. et al. (2006), "The Stern Review: A Dual Critique", World Economics, 7(4), 165-232.

Coase, R. (1960), "The Problem of Social Cost", Journal of Law and Economics, 3, 1-44.

Creedy, J. and C. Sleeman (2006), "Carbon Taxation, Prices and Welfare in New Zealand", Ecological Economics, 57(3), 333-345.

Dasgupta, P (2007), “Commentary: The Stern Review’s Economics of Climate Change”, National Institute Economic Review, 199, 4-7.
Dixon, P. and M. Rimmer (2000), “The Government/Democrats’ Package of Changes in Indirect Taxes”, Australian Journal of Agricultural and Resource Economics, 44(1), 147-158.
Intergovernmental Panel on Climate Change (2007), “Climate Change 2007: The Physical Science Basis”, Summary for Policymakers.
Jotzo, F. (2007), “Climate Policy: Where To and How?”, Agenda, 14(1), 17-34.
McKibbin, W. (2007), “From National to International Climate Change Policy”, The 2006 Sir Leslie Melville Lecture, Lowy Institute for International Policy, ANU, March.
Nordhaus, W. (2007), “The Stern Review on the Economics of Climate Change”, Journal of Economic Literature, forthcoming (September).
Parikh, J. (2007), “Climate Change and India: A Perspective from the Developing World”, Growth 59, Climate Change: Getting it Right, CEDA, Melbourne, 52-65.
Popp, D. (2006), “Innovation in Climate Policy Models: Implementing Lessons from the Economics of R&D”, Energy Economics, 28(5-6), 596-609.
Prime Ministerial Task Group on Emissions Trading (2007), Report of the Task Group on Emissions Trading, The Department of the Prime Minister and Cabinet, Canberra.
Ng, Y-K (1986), Mesoeconomics: A Microeconomic-Macroeconomic Approach, Wheatsheaf Books, Brighton, Sussex.
Sijm, J., Neuhoff, K. and Y. Chen (2006), “CO2 Cost Pass-through and Windfall Profits in the Power Sector”, Climate Policy, 6, 49-72.
Smale, R., Hartley, M., Hepburn, C., Ward, J. and M. Grubb (2006), “The Impact of CO2 Emissions Trading on Firm Profits and Market Prices”, Climate Change, 6, 31-48.
Stern, N. (2006), Stern Review: Report on the Economics of Climate Change, Cambridge University Press, Cambridge.
The Treasury (2003), “Preliminary Assessment of the New Tax System”, Economic Roundup, Autumn.
Toll, R. (2006), “The Stern Review of the Economics of Climate Change: A Comment”, Energy and Environment, 17(6), 977-981.

Warren, N., Harding, A., and Lloyd R. (2005) "GST and the Changing Incidence of Australian Taxes: 1994-95 to 2001-02", *eJournal of Tax Research*, 3(1): 114-145.

Weitzman, M. (2007), “The Stern Review of the Economics of Climate Change”, Journal of Economic Literature, forthcoming (September).

Figure 1: Partial Equilibrium Product Model

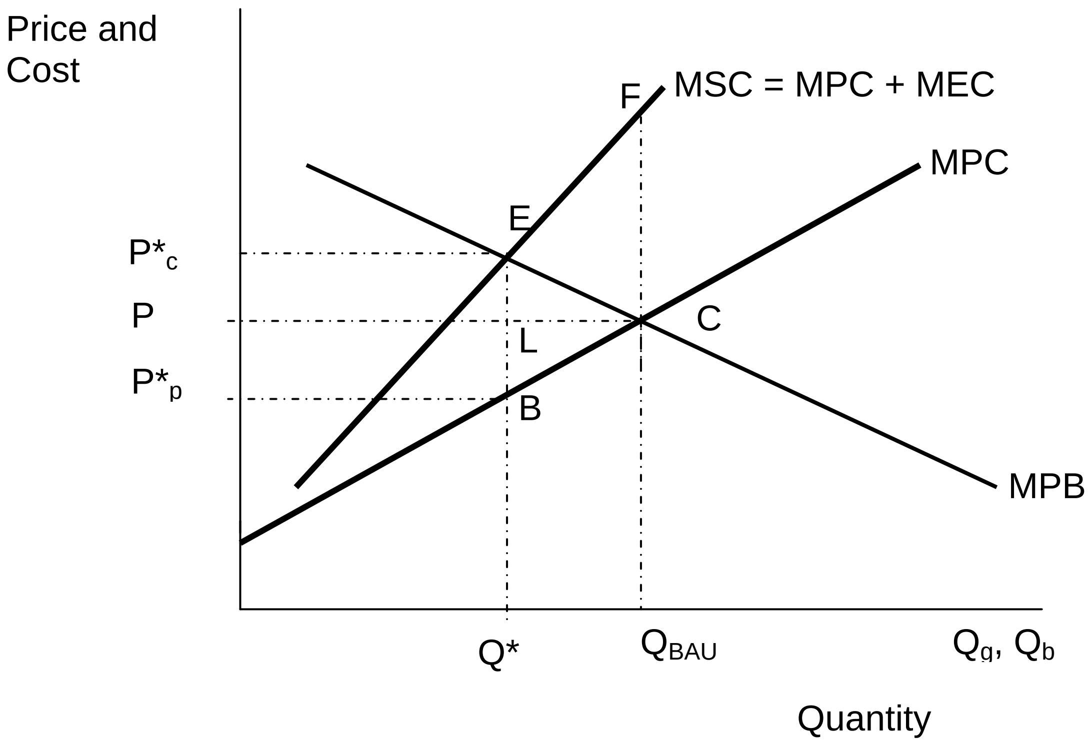

Table 1 A Simple Game Theory Model for Countries Choosing a Strategy for Greenhouse Emissions: Payoff Matrix

		Developing	Countries (Dev)
		Invest	BAU
Developed	Invest	G^D (I,I) =20 G^{Dev} (I,I) = 20	G^D (I,BAU) = -20 G^{Dev} (I,BAU) = 30
Countries (D)	BAU	G^D (BAU,I) = 30 G^{Dev} (BAU,I) = -20	G^D (BAU,BAU) = 0 G^{Dev} (BAU, BAU) = 0

[1] Some references include Jotzo (2007), International Panel on Climate Change (2007), Stern (2006). Critiques of the economics of climate change in Stern include Carter et al. (2006), Nordhaus (20070, Dasgupta (2007), Toll (2006) and Weitzman (2007).
[2] This result is an application of the Coase theorem, see for example Coase (1960).
[3] This effect is likely to be non-trivial. The Australian Greenhouse Office estimates Australian annual greenhouse emissions at about 550 million tonnes of CO_2-e. By way of illustration, if a half of these are subjected to a carbon tax or tradable permit system at a conservative low rate of $20 per tonne of CO_2-e, and all of this is passed forward to consumers, consumer outlays increase by $5.5 billion a year, or a little over one per cent of annual private consumption expenditure.
[4] An upward (or downward) sloping MC can be included in the model. In the case of an upward sloping MC curve, some of the tax burden will be bourn by the producer.
[5] Dixon and Rimmer (2000) provide a brief description of the application of the MONASH model used by the ACCC, with references to more details of this model, and also to the PRISMOD and MURPHY models which also were consulted.
[6] For a much broader and more comprehensive discussion of different experiences and options for achieving a global cooperative solution for a wide range of global public goods, including global peace, suppression of pandemics, CFCs and the ozone hole, as well as climate change mitigation, see, for example, Barrett (2007) and references therein.
[7] In December 2007 Australia changed policy and decided to sign onto the Kyoto Protocol.