Negotiating Greenhouse Abatement and the Theory of Public Goods

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Abstract

In this paper, the problem of negotiating an abatement agreement is approached from the perspective of the theory of public goods in a general equilibrium context. Such an approach has the appeal of simultaneously dealing with both equity and efficiency issues.

Three major difficulties in negotiating an agreement under such an approach are discussed. First, there is the problem of obtaining some measure of agreement about the welfare impacts of abatement on different economies. Second, there is the problem of obtaining agreement about the likely need to allocate side payments to address differential welfare impacts. Finally, in a partial abatement agreement, there is the problem of dealing with impacts on non-abating countries and the possible response of such countries. In a general equilibrium context, it is unlikely that there is a simple rule that could be used to approximate the appropriate public goods solution concept. Nevertheless, negotiations based on the use of indicator variables may provide a rough approximation.

General Abstract

In this paper, the problem of negotiating an abatement agreement is approached from the perspective of the theory of public goods in a general equilibrium context. Such an approach has the appeal of simultaneously dealing with both equity and efficiency issues. Under the appropriate equilibrium solution concepts, abatement costs are shared in proportion to the benefits of abatement. A number of points are illustrated by reference to results from the MEGABARE model which is a general equilibrium model of the world economy. Three major difficulties in negotiating an agreement under the proposed approach are discussed. First, there is the problem of obtaining some measure of agreement about the welfare impacts of abatement on different economies. Second, there is the problem of obtaining agreement about the likely need to allocate side payments to address differential welfare impacts. Finally, in a partial abatement agreement, there is the problem of dealing with impacts on non-abating countries and the possible response of such countries. In a general equilibrium context, it is unlikely that there is a simple rule that could be used to approximate the appropriate public goods solution concept. Nevertheless, negotiations based on the use of indicator variables may provide a rough approximation. The aim is to select a combination of indicator variables that will approximate the welfare impacts of abatement on different economies.

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1. Introduction

The initial qualified commitment of Annex 1 countries under the Framework Convention on Climate Change to stabilise emissions at 1990 levels showed little regard for economic considerations. Unilateral stabilisation could impose markedly different costs on different countries and is not a cost minimising approach to abatement. However, as negotiations have progressed and the problem has been increasingly studied, economic considerations have become more prominent. A number of countries now support differentiated targets to take account of the special economic circumstances of different economies and an emission trading scheme has been proposed in policy negotiations.

The problem of how countries should share the costs of abatement can be viewed as a problem of sharing the costs of production of a global *public good* (global abatement). There are some advantages in viewing the problem in this light now that economic considerations have become increasingly important in the negotiating process. Such a view brings to bear on the problem an extensive literature concerned with equilibrium concepts for economies with public and private goods and how such equilibria can be attained through self-interested ('incentive compatible') bargaining processes. The public goods solution concepts also simultaneously address both equity and efficiency issues.

In this paper the public goods interpretation of negotiating an abatement agreement is developed. A number of points are illustrated by reference to simulation results from the MEGABARE model which is a general equilibrium model of the global economy with both dynamic and comparative static versions[1].

2. The theory of public goods and abatement

The problem of cost sharing of global abatement is somewhat more complex than the standard cost sharing problem for public goods considered in the literature. In the case of abatement, the focus is on welfare at the country level in a general equilibrium model with international trade. The sum of changes in emissions in all countries produces the single public good of global abatement.

It is important to distinguish between the costs of abatement at the *consumption* and *production* levels. An identity between the vector of goods produced and consumed domestically will not hold if there is international trade. Furthermore, changes in the terms of trade as a result of abatement may alter the vector of imports that can be purchased by a given vector of exports. The costs of abatement at the

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[1] For documentation of the model see ABARE (1996) available at http://www.abare.gov.au.

production level may be defined as the reduction in profits for a representative firm in a given country from undertaking a given level of abatement (Montgomery, 1972). The costs of abatement at the consumption level will depend on changes in the equilibrium consumption (of private goods) and prices vectors. A convenient measure is equivalent variation for a representative consumer in a given country.

It is assumed that country welfare is measured at the level of the representative consumer. If utility is an increasing function of the level of global abatement, the change in welfare will depend on changes in the consumption of both global abatement and private goods.

In the standard cost sharing problem for public goods, the costs of producing the various public goods to be supplied are taken to be independent. In the case of global abatement, both the consumption and production costs of abatement in different countries will not be independent as a result of international trade effects. For example, if the equilibrium world price vector changes with the level of abatement in one country, both the production and consumption costs of achieving a given level of abatement in other countries may change. Prices of imported goods for final consumption and for use as intermediate inputs in production will change which will have further repercussions in a general equilibrium model. Thus, the costs for a given country of reducing emissions by a specified amount will depend on the level and distribution of abatement among other countries.

A further consequence of interdependence between economies is that in any partial abatement agreement, such as that proposed under the Berlin Mandate for Annex 1 countries[2], the welfare of non-abating countries will be affected by actions taken by abating countries. There will be both negative and positive welfare effects. Negative welfare effects will stem partly from reduced demand for commodities since abatement will reduce world income. Developing economies will also face higher prices for many emission intensive goods imported from Annex 1 countries as a result of higher production costs due to abatement. Positive welfare effects will follow from substitution effects as a consequence of *carbon leakage*[3]. Non-abating countries will also 'free-ride' on the benefits of abatement undertaken by the abating countries.

The possible response of non-abating countries to abatement action also assumes some importance. Of particular interest is the response by OPEC countries as discussed below.

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[2] Report of the Conference of the Parties on its First Session, Berlin, 28 March - 7 April 1995: Addendum: Part two: Action taken by the Conference of the Parties at its first session, (UN Document FCCC/CP/1995/7/Add.1, 6 June 1995).

[3] For a definition of 'carbon leakage' see ABARE-DFAT (1995, p.58).

In spite of these complications to the standard problem, it is possible to extend the analysis using the standard concepts. The two main equilibrium concepts developed in the literature for economies with public and private goods are the *Lindahl equilibrium* and the *ratio (or Kaneko) equilibrium* which has various generalisations with the generic term 'cost sharing equilibria'. The ratio equilibrium is a more general concept than the Lindahl equilibrium in the sense that it can hold under conditions such as increasing returns to scale where a Lindahl equilibrium may not exist. Both equilibria are Pareto efficient and coincide for convex economies with constant returns to scale.

Under a Lindahl equilibrium, the conditions for Pareto efficiency involve equality of the marginal rates of substitution between the public and private goods in consumption with the marginal rates of transformation in production. If abatement were implemented with a tradable quota scheme, such conditions would require equality between the willingness of a representative consumer to pay for an additional unit of abatement with the price of a permit which in turn would equal the marginal production cost of abatement. The difficulty is that if side payments between countries were not permitted, there may not exist any way of allocating a given abatement target across countries that could satisfy the above conditions and also equalise marginal abatement production costs across countries. A solution would be to allow different permit prices in different countries but this would not minimise the global costs of abatement.

A number of models dealing with the above points are considered by Chichilnisky, Heal and Starrett (1993). The relationship with other literature is somewhat obscured by the definition of marginal costs of abatement adopted but this can be reconciled by suitable redefinition. Chichilnisky, Heal and Starrett (1993) also discuss a tradable quota scheme implementing a Lindahl equilibrium where to increase emissions by a unit, a country would have to buy a quota from all participating countries possibly paying a different price to each country. If side payments between countries were prohibited, the initial allocation of quotas would have to satisfy the condition that no trade in quotas would occur.

The notion of a Lindahl equilibrium may have some appeal to those who believe that it may be impossible to negotiate an international abatement treaty involving side payments. A major difficulty is designing a bargaining process to implement a Lindahl equilibrium given the incentives to supply false information and 'free ride'. All of the bargaining processes proposed in the literature require side payments to force 'truthful revelation' (Varian, 1984).

In a ratio equilibrium, costs are shared in proportion to benefits. As noted above, it is identical to a Lindahl equilibrium for convex economies with constant returns to scale. If abatement is to be produced at minimum cost and perceived benefits and costs of abatement differ across countries, side

payments probably would be required to support a ratio equilibrium. If a tradable quota scheme is the policy instrument adopted, the initial allocation of quotas provides the mechanism to support the required pattern of side payments. The theory of a ratio equilibrium in an abatement context is developed by Welsch (1993) and its computation using the MEGABARE model is illustrated in Hanslow, Hinchy and Fisher (1996).

Bargaining processes to implement a ratio equilibrium will typically involve side payments. If the recent work of Tian (1994) is translated into an abatement context, each country would propose the share of total abatement costs to be borne by each country, the level of abatement it was willing to undertake and a proposed side payment (which could be either positive or negative indicating a willingness to induce others to undertake more abatement or compensation for the level of abatement proposed). With appropriate rules to weight the bids of different players, it is possible to design a bargaining process where the Nash equilibrium will implement the ratio equilibrium.

On the basis of this brief survey of the theory of public goods as applied to abatement the following major problems may be identified in negotiating a ratio equilibrium:

(i) the need to obtain some measure of agreement about (consumption and production) abatement costs in different countries and the possible interdependence of costs depending on the level and distribution of abatement;

(ii) the likely need to reach agreement on side payments and the possible impact of side payments; and

(iii) the issue of how to deal with impacts on non-abating countries.

The issue of obtaining some measure of agreement about the benefits of abatement across countries could be added to the list. However, given the level of uncertainty about such benefits, if only OECD countries are of concern, a rough approximation might be to assume a representative consumer in each OECD economy experiences identical utility from a given level of global abatement. To implement a ratio equilibrium where costs are to be shared in proportion to benefits, a necessary condition might be taken to be that the consumption loss to a representative consumer (say measured by equivalent variation) in each economy should be equalised.

If the concern is with abatement also involving non-OECD economies, differences in the marginal valuation of abatement between OECD and non-OECD economies becomes a relevant factor. Weitzman (1994) has tried to formalise the observation that such differences exist on all environmental

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issues with the notion that the environmental discount rate is a decreasing function of per person income.

The above three key negotiating factors are now discussed in more detail.

3. Abatement costs

In negotiating an international agreement, it will be necessary to obtain some measure of agreement about relative abatement costs in different countries. There are a number of models from which estimates of the costs of abatement can be derived but different models give different results. It is by no means a simple task to isolate the reasons for differences in these results. The problem is made even more difficult by the interdependence between abatement costs in different countries. Nevertheless, there is great interest in finding results that are robust across models.

The interdependence of abatement costs across countries stems from international trade and investment linkages. The limited evidence available indicates that in some cases allowing for international trade linkages can have a marked impact on the relative ranking of abatement costs across countries. For example, using the same basic model structure, marginal abatement production costs (as measured by the size of a carbon tax required to achieve a given reduction in emissions) were estimated to be markedly lower in Japan than Australia when international trade effects were suppressed (Hinchy, Hanslow and Fisher, 1994). However, when international trade effects were permitted and abatement occurred across OECD countries, marginal abatement costs in Japan were estimated to be almost double those in Australia (Hanslow, Hinchy and Fisher, 1996).

The major reason for the above result appears to be that as an importer of fossil fuels Japan faced significantly lower prices for imported fossil fuels when international trade and abatement occurred in exporting countries such as Australia. As a result of the lower price of fossil fuels, a significantly higher carbon tax was required to constrain the growth in emissions from Japan.

While the above example involving a change from no international trade effects to international trade effects represents an extreme case, it does highlight the mechanisms creating interdependence between abatement costs. A more policy relevant case that may assist negotiations would be to study systematically how abatement costs in different countries varied according to different allocations of a given level of total abatement across countries. Of particular interest would be the welfare effects associated with the 'threat point' for each country of refusing to join the abatement coalition. A non-

abating country would experience a change in welfare as a result of abatement by the remaining members in the coalition.

4. Side payments

If a ratio equilibrium is to be implemented and total abatement production costs minimised, side payments will almost certainly be required. In the case of an abatement agreement confined to OECD economies, differences in production and consumption abatement costs across economies create the major need for side payments. In a broader agreement, differences in the value placed on abatement across countries is also likely to add to the need for side payments.

There are a number of difficult issues involving side payments. Some maintain that any form of international abatement agreement involving side payments is impractical. Countries may be unwilling to enter into such agreements on the grounds of loss of national sovereignty. Nevertheless, it can be pointed out that there are examples of international treaties that have involved side payments (Barrett, 1992) although probably not on as extensive a scale as may be required for a widespread abatement agreement.

On the level of positive economics, it has been argued that extensive side payments will create major pressures on the world macroeconomic and international trade systems (McKibbin and Wilcoxen, 1997). In particular, it has been suggested that large side payments may create 'Dutch disease' problems for recipient countries with a contraction in traditional exports. Nevertheless, the basic issue is whether a country gains from side payments rather than whether its export pattern changes.

In terms of the pure theory of international trade, the impact of transfer payments is rather different from the effects of an increase in factor endowments (which would more accurately model the Dutch disease problem) (Dixit and Norman 1984). Conditions for the recipient country to lose from transfer payments as a result of terms of trade effects are rather restrictive. Moreover, the empirical evidence on 'Dutch disease' problems suggests that factors other than the growth of a new export industry may often be the major influence on a decline in traditional exports (Hutchison, 1994; Nowak, 1995). On the level of theory, the results of the standard Dutch disease model may be modified if allowance is made for intermediate usage of goods (Nowak, 1995) or unemployed factors (Bhaduri and Skarstein, 1996).

Numerous simulations have been undertaken with static and dynamic versions of the MEGABARE model of abatement schemes involving side payments (ABARE-DFAT, 1995; Hanslow, Hinchy and Fisher, 1996). Although the model does not include an extended macroeconomic module, it is based on

neoclassical assumptions and contains sufficient commodity and intersectoral linkage detail that potentially could give rise to 'Dutch disease'. The results do not suggest widespread 'Dutch disease' problems.

If the above difficulties with side payments are dismissed, there remains the problem of obtaining consensus among participating countries on the level and distribution of side payments. It might be expected from partial equilibrium modelling that countries with relatively high production costs of abatement would be willing to make side payments to induce greater abatement in countries with relatively low production costs of abatement (Hinchy, Hanslow and Fisher, 1994). However, in a general equilibrium setting with international trade, the problem appears somewhat more complex on the basis of the simulations reported in Hanslow, Hinchy and Fisher (1996). A country with high abatement production costs, suffering adverse international trade effects from abatement by other countries may actually require side payments from other countries in a ratio equilibrium.

The various possible difficulties associated with side payments might appear to create a preference for abatement agreements without side payments However, the efficiency gains from being able to negotiate an agreement with side payments may be substantial. In the case of an agreement involving only OECD economies, it has been found with various simulations of the dynamic and comparative static versions of the MEGABARE model that a ratio equilibrium where abatement production costs are minimised does not exist if side payments are prohibited (ABARE-DFAT, 1995; Hanslow, Hinchy and Fisher, 1996). In the absence of side payments, it may be possible to find a Lindahl equilibrium where marginal abatement production costs differ across countries. However, total abatement production costs would not be minimised and it may be just as difficult to negotiate such an agreement as one involving side payments. It would be necessary to agree on how abatement costs differed and were interrelated across economies to decide on the appropriate level of abatement for a given economy.

The case for an agreement involving side payments appears even more compelling when non-OECD economies are considered. It is difficult to see how most developing countries could be induced to participate in an abatement agreement without the offer of side payments given the low value they appear to place on abatement. Nevertheless, eventual abatement by developing countries appears essential if the growth in global emissions is to be controlled given their projected baseline growth in emissions (Brown, Feng, Kennedy and Fisher, 1997). Furthermore, abatement costs are widely estimated to be lower in most developing economies than developed economies. Global abatement costs would be lowered by extending abatement to developing economies. There is an economic

incentive for developed economies to compensate developing economies for abatement that they would otherwise undertake.

5. Impacts on non-abating economies

As mentioned above, the welfare of non-abating economies will be affected by actions of economies in an abatement coalition. In numerous simulations of the MEGABARE model where carbon leakage rates have varied from 10 to 35 per cent depending on the underlying assumptions, it has been found that many developing economies suffer a *direct* welfare loss in spite of carbon leakage. Such a welfare loss excludes any uncertain future environmental benefits such economies receive from the level of global abatement attained.

The OPEC economies are of crucial importance in terms of third-party impacts. In the MEGABARE simulations mentioned above, the OPEC economies are not modelled as a cartel involved in intertemporal maximisation of returns from a non-renewable resource. Work is underway to develop such a modelling capability. However, in a number of theoretical papers (Sinclair, 1992; Ulph and Ulph, 1994; Hoel and Kverndokk, 1996) it has been shown that if OPEC is modelled in such a framework, the potential OPEC response can significantly modify the optimal time path of a carbon tax (or whatever policy instrument is adopted) for OECD economies. The ability of OPEC to 'Granger cause' the world price of oil as reported by Güllen (1996) clearly could significantly undermine any attempts at abatement in OECD economies. Nevertheless, abatement by OECD economies may tend to create added incentives for OPEC economies to violate quota allocations and there is some question about the degree of cartel control that could be maintained under abatement.

The issue of carbon leakage is also of some significance since it undermines the impact of any abatement effort by OECD economies. While there may be incentives to attempt to counter carbon leakages through discriminatory trade policies, such policies would run counter to commitments by OECD economies to freer world trade.

Impacts on non-abating economies appear to be of sufficient importance that neither non-abating nor abating economies can afford to be indifferent to these impacts. The issue of 'compensation' for non-Annex 1 parties to the convention was raised at the climate negotiations in Bonn in March, 1997. Its importance in the negotiations is likely to be directly related to the size of the proposed emission reduction and therefore the magnitude and extent (in geographical terms) of the indirect effects on non-Annex 1 parties.

There would seem to be an incentive for abating economies to negotiate with many non-abating economies on a number of key issues. Indeed, ultimately the incentive would seem to be to find a basis on which to induce the non-abating economies to join the abatement coalition. However, extending the number of negotiating parties increases the complexity of negotiations.

6. Implications for negotiating abatement agreements

The concept of a ratio equilibrium is only one of many possible solution concepts for negotiating an abatement agreement. Nevertheless, the notion of sharing costs in proportion to benefits has some appeal in that it provides a Pareto efficient solution and simultaneously deals with the issue of equity. In the case of economies where it might be assumed that there is a reasonably similar valuation per person of the benefits of abatement, it can be approximated by the notion of equalising the consumption losses per person. The preceding discussion of the issues involved in negotiating an abatement agreement in a general equilibrium context has highlighted many difficult problems. While it may not be possible to deal with all of the refinements considered here in negotiating a workable agreement, it is useful to consider if there are any approximate guidelines that may assist negotiators.

Many possible rules involving a mixture of equity and efficiency considerations that would be simple to apply have been proposed for sharing abatement costs (ABARE-DFAT, 1995). There now seems to be some consensus that there is no such simple rule that would not disadvantage some country. The notion of sharing costs in proportion to benefits is a simple rule but it may not be simple to apply. None of the rules proposed in the literature appear to result in an allocation of costs that would approximate the ratio equilibrium based on the modelling results reported in ABARE-DFAT (1995).

The notion of using some weighting of indicator variables to suggest welfare impacts appears more promising. It is desirable that the indicator variables are not model dependent or at least are reasonably robust across models. Nevertheless, modelling results may assist in the choice of indicator variables. Decomposition analysis (Huff and Hertel, 1996) of the results of general equilibrium models may be a useful tool in the search for appropriate indicator variables. For example, it is possible to decompose welfare changes for a given country into internal and external influences. It would then be a matter of finding indicator variables that are reasonably well correlated with the internal and external influences.

The possibility of varying the weights on different indicator variables offers some flexibility in dealing with various possible future scenarios. For example, since emissions stemming from oil based products account for different proportions of total carbon dioxide emissions in different OECD economies, it would not be expected that the weights on indicator variables would be robust to widely different future

OPEC oil pricing strategies. Varying the weights on different indicator variables could also be a way of trying to reflect the country interdependence in abatement costs for different country allocations of a given total abatement target.

7. Conclusion

In this paper, the problem of negotiating an abatement agreement has been approached from the perspective of the theory of public goods in a general equilibrium context. Such an approach has the appeal of simultaneously dealing with equity and efficiency issues.

Three major difficulties in negotiating an agreement under such an approach were discussed. First, there is the problem of obtaining some measure of agreement about the welfare impacts of abatement on different economies. Second, there is the problem of obtaining agreement about the likely need to allocate side payments to address differential welfare impacts. Finally, in a partial abatement agreement, there is the problem of dealing with impacts on non-abating countries and the possible response of such countries.

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