Distributive Justice in International Environmental Policy: Axiomatic Foundation and Exemplary Formulation

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ABSTRACT

Proceeding on a limited number of general, widely accepted equity criteria, we develop a proposal for distributing common resources. In particular, the proposed fair division mechanism is individually rational, envy-free, Pareto-efficient and satisfies the stand alone test, which follows as a minimum requirement from the resource and population monotonicity criteria. Applied to international climate policy, the thrust of this proposal is that the South should initially be fully compensated for the greenhouse gas abatement measures it is to undertake as a result of efficiency considerations.

KEYWORDS

Fair division, equity, common resources, climate change

1. THE PROBLEM

Questions of international distributive justice are certainly not new. We need only think of the demand made by the developing countries in the 1970s for a New International Economic Order (NIEO), which aimed at a more equitable

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distribution of the benefits derived from the international division of labour. Demands were at that time raised for improved chances for exports to the industrialised countries, stepped-up financial and technology transfers, and a larger share in the decision-making processes in international institutions, above all in the World Bank and the International Monetary Fund. Even though these demands have remained largely unanswered, there are, at the outset of the 21st century, a number of highly topical reasons why the issue of international distributive justice is again attracting attention. Many of these reasons are bound up with the phenomenon of 'globalisation'.

In general, the emotional and geographic distance between individuals is regarded as an essential criterion for the acceptance of social inequality: the closer to us someone is, the more we know of another person, the more willing we are to contribute to his or her well-being. If, therefore, the world does in fact grow closer together – via a variety of processes such as more rapid means of transportation, the Internet, the networking of economic relations, or even through experiences made on vacation trips – then the question of international distributive justice is, for this reason alone, likely to grow in significance. The integration process within the European Union is a good example of this: it was accompanied by a sharp increase of transfer payments between the individual European countries. Besides, the motive need not necessarily be a moral one, one geared to the welfare of the other. And so one argument frequently advanced for international transfers is that it is better to help people 'where they are' than to have to care for them as refugees.

On the other hand, globalisation is placing new demands on the sphere of politics which will prove impossible to meet at the national level alone and which therefore call for co-ordinated action on the part of the individual countries. Formally, the relevant policy fields can be conceived as 'global public goods' or 'global commons' – as goods from the use of which no one can be excluded outright (Sandler 1997). Since these goods may also benefit agents who have not contributed to providing them, individual agents have an incentive to go along as 'free riders'. Without effective institutional framework conditions, this would lead to a systematic undersupply of such public goods. The funding of international institutions extending from blue-helmet missions and macroeconomic stabilisation programmes, to the management of global environmental goods provides examples of this. They generally pose the question as to the 'equity' of the manner in which the costs and benefits of international policy measures are distributed.

In what follows we shall concentrate on criteria for an equitable distribution of transboundary common resources. Relevant examples at the global level include particularly the climate system and biodiversity, but also such things as telecommunications (see Kaul et al. 1999). Examples at the regional level would include the use of the water of transboundary rivers and the exploitation of migratory fish stocks.

However, in the following we shall restrict ourselves to international climate policy as an example. Now that the anthropogenic influence on the global climate system is a matter disputed by the few only (see Helm and Schellnhuber 1998), the political debate turns chiefly on the allocation of the emission rights for the greenhouse gases responsible for climate change. In the 1997 Kyoto Protocol 38 industrialised countries agreed on initial, so somewhat modest, reduction targets of 5.2 percent on average for six greenhouse gases (Simonis 1999). Over the medium to long term, however, substantially more far-reaching efforts, as well as participation of the developing countries, will be on the agenda if the world's climate system is to be effectively stabilised (IPCC 1996).

It should be mentioned that by concentrating exclusively on justice regarding efforts to limit polluting emissions, we abstract from other important ethical aspects, in particular the negative impacts of environmental pollution and associated risks. Our intention is not to deny the importance of justice in coping with those impacts, but we assume that they, and other issues, can be treated separately from the fair division of emission reductions and associated costs.

2. LOCAL VERSUS GLOBAL EQUITY

At the start of the search for an equitable distribution of common resources the first question is what information on the agents involved should be taken into consideration. A simple example may serve to illustrate this point:

Two persons walking down the sidewalk at the same time find a hundred-pound note. Most of us would no doubt find it fair if each of the two finders were to receive half of the money found. But if we now introduce the additional information that one of the two finders is poor while the other is rich, then our judgment would be apt to take on a different hue. Many of us would now probably find it more fair for the poorer of the finders to be given all of the money found, or at least the greater share of it.

In the first variant of this story the distribution of the money found is viewed *independently* of the distribution of any other goods, while the second variant takes this factor into account. There are many reasons to regard the latter perspective as the more appropriate one. Yet even in this case it can make sense in analytical terms to keep these things apart. After all, the only reason why we accord all of the money found to the poor person is the simple fact of his poverty – and this has nothing to do with the money found. Our motivation is thus no longer the equitable distribution of a common resource (the find) but the realisation of an income transfer for which the money found is to be used, even though the former would be justified without the latter.

If, in what follows, we start out by looking into the equitable distribution of transboundary common resources independently of existing worldwide income disparities, this in no way implies that we regard the latter as negligible. Indeed,

there are very good reasons to argue in favour of using the distribution of transboundary resources and/or global resources as an instrument to effect international income transfers (Simonis 1996). But the question is then a different one: the issue in this case would no longer be the equitable division of a common resource; it would instead be a means to achieve further-reaching, overriding distribution goals.

The question of such overriding distribution goals is, to be sure, even more difficult to answer at the level of international politics than it is at the level of the nation state. John Rawls (1999), for instance, has argued that it is above all nation states themselves that are responsible for the welfare of their citizens. By comparison, he goes on to note, the international community has more a supportive function; its task is to secure a setting in which national societies can develop positively (Beitz 1999). For Rawls, however, this also includes a substantial stepup of international transfers to disadvantaged countries (see also Rawls 1971).

As a means of separating the conceptual problems of a 'global welfare policy' from the question of the equitable distribution of a common resource, we conceive the latter as a 'local' equity problem (Young 1994). We here proceed in two steps. We start out by discussing the equitable distribution of the *initial endowment* with rights of use to a common resource. In the previous example, this refers to the question of who is entitled to what share of the find. Suppose that we have settled this question, but instead of a hundred-pound note the find now consists of a bundle of heterogeneous goods. If the agents' tastes for these goods differ, there will usually exist reallocations of the initial entitlements which make all agents better off. In the second step we will therefore develop criteria for a just *exchange* of the initial endowment with user rights.

In the debate on climate change the second point in particular has thus far attracted hardly any attention. Reflections on equity have for the most part been restricted to the question of the initial endowment with emission rights, while the subsequent exchange of these rights – and hence also the distribution of the ensuing efficiency gains – is to be governed by the market. However, *a priori* there is no reason to expect the market to allocate those efficiency gains in an equitable way.

3. EQUITABLE DISTRIBUTION OF THE INITIAL ENDOWMENT WITH USER RIGHTS

Let us start out with the question of the equitable distribution of the initial endowment with the entitlements to a common resource. With the above example in mind, there is not much to debate here: what, if not the same per capita endowment, could be regarded as equitable if we neglect all superordinate information such as different welfare levels etc.? After all, Aristotle, in his 'formal principle of justice', demanded that equals be treated equally.

Still, there are at least two arguments that are advanced against an equal per capita allocation. First, it is sometimes argued that the continued use of a common resource gives rise to a certain claim to retention of the status quo. Second, some authors claim that the allocation of emission rights should be geared to the 'needs' reflected in the current emission levels of the countries concerned (see the contributions in Tóth 1999).

To ground the first variant one might adduce John Locke's theory of the initial appropriation of unowned goods as well as the contemporary philosopher Robert Nozick, who builds on Locke's ideas and is regarded as an important representative of the so-called libertarians. According to Nozick (1974), an allocation can be regarded as just only when (i) the initial acquisition of the holdings and (ii) the exchange of these holdings have been conducted in a just manner (not, for instance, by means of theft) and (iii) prior violations of these principles have been corrected (for instance by means of compensation). In dealing with the question of the original appropriation Nozick has recourse to Locke (1632 – 1704), who wrote at a time in which the New World was regarded as a huge unowned area.

In his *Two Treatises of Civil Government* (1690) Locke writes that nature was, in principle, given equally by God to all men to be worked and appropriated by them. In its original state nature is thus said to be common property. In contrast, man, with all his capabilities, 'owns himself'. This is why his labour and, in the end, everything created by it is his property. By mixing his labour with nature man wrests it from its state as common property, gaining property rights to it which exclude others from their use. It is in and through this line of argument that Locke provides a theoretical foundation for the materialistic and strictly individualistic thinking and practice of economic liberalism (see Schwan 1993).

To be sure, Locke added to his theory of natural rights the proviso that 'enough, and as good', must be left in common for others – the so-called 'Lockean Proviso'. As long as, for instance, there is enough fertile farmland for all, this proviso is not unduly restrictive. But as far as climate change and other global environmental issues are concerned, the problem is precisely that nature's capacity to absorb pollutant emissions is *not* sufficient. Therefore, Locke's theory of natural rights and the approaches building on it can hardly be cited to back an allocation of emission rights in international climate policy that is geared to the status quo.[1]

The demand that the allocation of emission rights be geared to needs as reflected in current emission levels is based on even weaker grounds. True, Ronald Dworkin (1981), for instance, called for deviation from an egalitarian endowment with resources whenever the latter serves to offset natural inequalities – i.e., for instance, to compensate for differences in aptitudes. Unlike in the case of climatic conditions or natural resources, however, it can hardly be argued that the industrialised countries have 'inherited' their high levels of pollutant emissions. They are, instead, a result of their own production and consumption decisions.[2]

In the international climate-policy debate an equal per capita distribution of emission rights is in fact the most commonly voiced proposal (IPCC 1996: 106). In an earlier draft of the United Nations Framework Convention on Climate Change this was even explicitly specified as a goal, before then being replaced by the toned-down provisions of Article 3(1). According to this article, protection of the climate system is to be sought by the signatories '... on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities'.

But even though the acceptance of an approach entailing equal per capita rights does leave room for further discussion: it must, for instance, be decided whether the term initial entitlements refers to *gross* emissions or *net* emissions, which would mean taking into account countries' different biotic sink capacities (due to the specific forest and soil conditions). Nor have we addressed the problem of accounting for historical emissions which impair nature's present and future absorptive capacity. As a general guideline, however, we can note that the initial endowment with user rights to a common resource should follow the principle of an equal per capita allocation.

4. CRITERIA FOR AN EQUITABLE EXCHANGE OF THE INITIAL ENDOWMENT WITH USER RIGHTS

The second step of our analysis is now concerned with the criteria for an equitable *exchange* of the initial endowment with user rights. The point of departure here is that the interest individual agents have in using a common resource will differ considerably. When compensation payments are possible, this opens up the way to redistributions of the initial endowment from which all agents benefit.

In economic theory an allocation is termed Pareto-efficient when there exists no reallocation of the goods by which at least one agent is made better off while no agent is made worse off. Accordingly, the Pareto-criterion advocates only those reallocations which are to no one's detriment, and for this reason it is sometimes also referred to as the criterion of *unanimity*. This is enough to make it clear that the Pareto-criterion is nothing more than a lowest common denominator, the only undisputed normative argument on which the economic profession has been able to concur.

What implications follow from the Pareto-criterion for the fair division of common property resources? In international climate politics, essentially there is a single good to be distributed, namely emission rights for greenhouse gases. At the same time, we assume that those rights can be transferred in exchange for monetary compensation payments among countries.[3] In such situations, the Pareto-criterion implies that emission rights should be directed to their most efficient usage, while accompanying compensatory payments should make sure that no agent is made worse off due to this reallocation.

To see this, imagine that every country is entitled to an equal per capita share of emission rights, but that marginal abatement costs of reducing emissions to this level, i.e. the costs for the last avoided unit of greenhouse gases, differ across countries. Such a situation can not be Pareto-efficient because a country with *low* marginal abatement costs could transfer emission rights to a country with *high* marginal abatement costs. If this is accompanied by monetary transfer payments in the opposite direction which lie in between the two countries' marginal abatement costs, we would have a Pareto-improvement: both countries are better off than in the original situation. Accordingly, the Pareto-criterion implies that the marginal abatement costs are the same in all countries. This is a far-reaching outcome in that it defines the global allocation of emissions.

The best-known instrument suited to reaching a Pareto-efficient allocation is to be seen in competitive markets.[4] A common proposal is therefore to allocate initial emission rights according to some equity principle, and then trade them on international permit markets to achieve Pareto-efficiency (e.g. Cline 1992). In this case, the extent of monetary transfer payments is governed by the market.

Yet, Pareto-efficiency is not the primary aim of our analysis; it merely serves the purpose of keeping as large as possible the pie to be equitably distributed. We must therefore ask whether the market also equitably distributes the gains resulting from a utilisation that is regarded as more efficient than the initial endowment. In this respect, the Pareto-criterion has little to say, because for given emission levels any allocation of monetary payments is efficient: we can not give one agent more money without taking it away from someone else.

In what follows we shall present four analytical criteria relevant for this issue. Though they differ considerably, they are nevertheless based on the overarching idea that the use of a common resource should exhibit a certain degree of solidarity. In principle this is also true of Pareto-efficiency, for it implies the obligation on my part to support others, at least in cases which entail no costs for me.

4.1. The criterion of envy-freeness

The best-known criterion of equity in economic theory is that of envy-freeness – and this goes so far that equity is sometimes defined as lack of envy plus efficiency (Varian 1974). When equal claims are made on a common resource, a distribution is regarded as *envy-free* when every agent experiences his own share as at least as valuable as that of any other agent; that is to say, when no one feels the need to exchange his share for another person's.

One essential aspect of this criterion – and for the ones that follow as well – consists in the fact that it can get along without any comparisons of interpersonal utility, which are naturally disputable. The criterion demands no propositions on whether one person needs a good more urgently than another person, it simply

asks whether one person would prefer his own bundle of goods to that of someone else.

However, in many cases the number of envy-free distributions may be rather large. This also holds true for the distribution of emission rights and concomitant compensation payments in international climate policy, at least when the distribution problem is restricted to two major agents, North and South. There are a number of different possible allocations in which the North would compensate the South for its greater share of emission rights by providing it with monetary compensation, and would do so without one of the two parties preferring the emission rights and compensation payments of the other.

4.2. The criterion of individual rationality

The criterion of individual rationality states that all agents should be guaranteed at least the utility deriving from the usage of their entitlements to a common resource. Other names for this criterion are *fair-share guaranteed* and *acceptability* in that as a rule no one would consent to a reallocation if this would entail being made worse off than one would be with a guaranteed minimum share.[5]

Applied to the climate change problem, the criterion of individual rationality requires that those countries which, in an efficient allocation, are given fewer emission rights than their fair share be fully compensated for any abatement costs accruing to them in this connection. Conversely, those countries which, in an efficient allocation, are given more emission rights than their fair share should not have to pay compensations higher than the abatement costs which they save due to the additional emission rights conceded to them. This is to say: no agent should lose on the way from the original to the efficient allocation.

4.3. The criterion of resource and population monotonicity

The criterion of resource and population monotonicity defines limits on how the utility of the individual agents will respond to a change of the size of a common resource or the number of the agents that have a just claim to it. For the case in which a common resource grows in size, e.g. the atmosphere's absorptive capacity for greenhouse gases turns out to be bigger than expected, *resource monotonicity* demands that every agent should be at least just as well off as from the fair division of the smaller resource (Roemer 1986).

This criterion is one of great relevance for international climate policy. Estimates of the atmosphere's capacity to absorb pollutant emissions are still uncertain and have to be regularly adapted to the latest state of scientific knowledge. In addition, long-term environmental and reduction goals are as a rule approached on a step-by-step basis, as is the case in the Kyoto Protocol. In both cases the size of the common resource to be allocated is altered, and this should effect all agents involved in the same direction.

The criterion of *population monotonicity* requires that when the number of persons or states with a just claim to a common resource increases, no agent should be better off than he was beforehand (Chichilnisky and Thomson 1987). Just as in the case of resource monotonicity, this criterion is based on the ethical argument that common ownership entails a minimum degree of solidarity, namely that everyone should contribute to satisfy the legitimate claims of newcomers.

4.4. The stand-alone criterion

The term stand-alone utility refers to an agent's utility when he is able to utilise the entire resource on his own (Moulin 1992). This can be derived as the upper bound of the utility level that an individual agent should obtain from the fair division of a *common* resource. Let us assume that there is only one agent. This agent would *per definitionem* receive his stand-alone utility. Now, the criterion of population monotonicity requires that this agent's utility should not increase when the number of agents (persons or states) with legitimate claims to the common resource increases. Consequently, he must not obtain more than his stand-alone utility, as was to be shown. Operating on the criterion of resource monotonicity we arrive at the same result (Helm 2000).

While the criterion of individual rationality defines a *lower* bound for the level of compensation payments, the stand-alone criterion thus establishes an *upper* bound. Applied to international climate policy, it requires that no country should receive compensation payments higher than the abatement costs it would save with the quantity of global emission rights.

Formulated more generally, the stand-alone criterion implies that no agent should benefit from the atmosphere's limited capacity to absorb pollutant emissions. Moulin (1992: 1333) justifies this by arguing that 'fair division conveys the idea of no subsidisation: The presence of other agents who are willing to pay higher monetary transfers than me for consuming the resources should not turn to my advantage'. This arguments appears particularly convincing when a greater willingness to pay is more a duty to confine a problem affecting all agents, like climate change.

5. A PROPOSAL FOR THE FAIR DIVISION OF COMMON RESOURCES

Building on an equitable initial allocation of the rights of use to a common resource (here, the climate system's absorptive capacity for greenhouse gases), we have defined the following 'minimum standards' for the exchange of these rights:

- One should exhaust the potential for reallocations that make someone better off without making anyone else worse off (*Pareto-efficiency*).

- Every agent should (weakly) prefer his own share of the common resource and compensatory payments to the share of any other agent (*envy-freeness*).
- No agent should be made worse off by the redistribution of the initial endowment than he was beforehand (*individual rationality*).
- No agent should be made better off than he would be if he were able to use the whole resource on his own (*stand-alone criterion*, derived from resource and population monotonicity).

Taken for itself, none of these criteria appears especially restrictive. That is why we have termed them 'minimum standards' – they constitute, as it were, a lowest common denominator that can be used to approach the difficult problem of distributive justice. The problem is thus to be sought less in the contentious nature of the individual criteria *per se* than in their combination.

On the one hand, we frequently find no solution that simultaneously meets all the criteria so that one or more of them would have to be abandoned in favor of others. On the other hand, there may also be a great number of allocations that meet all four criteria. However, at least in cases of relatively simple fair division problems referring to a homogeneous good and permitting compensation payments, the four criteria set out above complement each other harmoniously, making it possible to derive concrete policy recommendations from them. This also goes for the allocation of emission rights in international climate policy – and in particular for the politically highly complex issue of North-South distributive justice.

As long as the South's emissions are relatively low, the South would not have to undertake any major abatement efforts to restrict them to the level of the emission rights to which it is entitled. The criterion of individual rationality thus guarantees the South a utility level that corresponds to the level that would be realised without any abatement efforts. On the other hand, the stand-alone criterion implies that no agent should be made better off than he would be on an emission trajectory without any abatement efforts of his own.

The lower bound defined by the criterion of individual rationality for the South's utility level thus coincides with the upper bound defined by the stand-alone-criterion. This leads to a clear-cut outcome: *The North would have to offset all of the South's abatement costs; but, conversely, the South would not be justified in demanding any additional transfers and would have to consent to the reduction measures required for reasons of efficiency.*

This solution is, furthermore, envy-free in that neither the South nor the North would prefer the other's emission rights and compensation payments. What is somewhat more difficult is the question of the mode of distribution within the North, or generally of those countries whose emissions exceed their initial endowment with emission rights.

Here it would make sense as a point of departure to let the reallocation of initial entitlements be governed by competitive markets, which will then

determine the pattern of monetary transfers as well. It is well-known that this mechanism not only ensures efficiency, but also fulfils the equity criteria of individual rationality and envy-freeness (e.g., Young 1994). Due to the (initially) highly pronounced differences in the per capita emissions of the North and the South, however, the market-driven allocation would violate the stand-alone criterion if applied to this group.

Therefore a mode of distribution seems most plausible in which all countries are assured the minimum resulting from competitive allocation and stand-alone utility. This so-called 'WESA mechanism' (WESA = Walrasian mechanism with the stand-alone utility as an upper bound) meets all of the criteria of equity set out at the beginning of this section.[6]

If the initial endowment with emission rights is made in accordance with the principle of an *equal per capita distribution* and if the subsequent exchange of the initial endowment is conducted on the basis of the WESA mechanism, we come up with a clear-cut final allocation of the emissions and the concomitant compensation payments for each of the countries involved (see Helm 2000).

We can then ask how the initial endowment would have to be distributed if we are to arrive at this desired final distribution in the course of a subsequent reallocation via competitive markets (Walrasian mechanism). Figure 1 depicts the difference between the initial endowment with emission rights implementing the WESA mechanism and an equal per capita distribution.

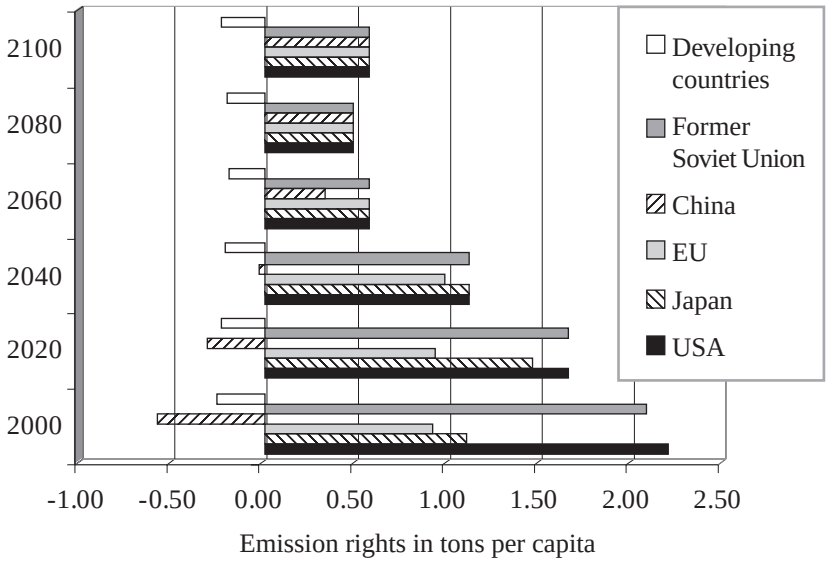

FIGURE 1. Implementation of the WESA mechanism. *Source:* Authors' calculations, based on Pareto-optimal path in the RICE model of Nordhaus/Yang (1996).

Initially the developing countries would be given less, the industrialised countries more than an equal per capita share of emission rights; since, however, the greenhouse-gas emissions of the developing countries are marked by high growth rates, this difference will diminish over the course of time.

Figure 1 thus illustrates not only the importance of subjecting to equity criteria both the distribution of the initial endowment with emission rights and their subsequent exchange. It also shows the similarity of the outcome thus obtained with William R. Cline's formula, according to which the endowment with emission rights should initially be geared to current emission levels and then converge over the medium to long term into an equal per capita distribution (Cline 1992).[7]

6. CONCLUSIONS

We started out by arguing that questions of international distributive justice will gain significance over the further course of globalisation. However, propositions based on equity-related considerations often run up against pronounced scepticism. Two of the most frequently heard objections are: 'Equity is merely a word that hypocritical people use to cloak self-interest', and: 'Equity is so hopelessly subjective that it cannot be analysed scientifically' (Young 1994: xi).

But the situation is not quite as bleak as all that. Proceeding on a limited number of general, widely accepted equity criteria, the present article develops a proposal for distributing common resources and applies it to the particularly urgent example of international climate policy. The thrust of this proposal is that the South should initially be fully compensated for the greenhouse gas abatement measures it is obliged to undertake as a result of efficiency considerations.

This finding in many ways resembles the arrangements in place in the international regime for the protection of the ozone layer (Montreal Protocol), which has generally been praised for its fairness (Benedick 1998); countries with low CFC emissions have been fully compensated for their additional abatement costs (Biermann 1998).

In analytical terms we have pursued a 'bottom-up approach' in the present article: equity criteria were applied to the initial allocation of rights of use to a common resource (here, the climate system) and their subsequent exchange, instead of to the final distribution as such. One essential virtue of this method is that it makes it possible to view individual allocation problems independently of the superordinate level of the global distribution of welfare. But it is important never to lose sight of this limitation of the information drawn upon to deal with a distribution problem. Indeed, in many cases it is possible that while the mode of distribution of a common resource meets the criteria discussed here, it may nevertheless intensify global welfare disparities which are regarded as highly unjust. Our distribution-related proposal for international climate policy is,

however, not affected by this proviso, for according to it, it will initially be the rich industrialised countries that are required to assume the costs of reducing greenhouse-gas emissions.

NOTES

We are grateful to three anonymous referees for their valuable comments.

[1] Nozick (1974) later softened his version of the 'Lockean Proviso'. His criterion for the just appropriation of property rights is that it should make no one worse off than he would be without the appropriation. Obviously an allocation of emission rights on the basis of the status quo would violate this criterion.

[2] One of the referees argued that the people of any given generation to a significant extent inherited their dependence on pollution-generating activities. However, do we really have to produce and use energy intensive cars, for example, only because our parents have done so?

[3] Formally, we assume that preferences can be represented by a quasilinear utility function.

[4] According to the First Theorem of Welfare Economics a competitive equilibrium always is Pareto-efficient.

[5] The criterion of individual rationality is in no way equivalent to Pareto-efficiency. For instance, an allocation that gives all to one agent may be Pareto-efficient, though not individually rational.

[6] Formally, the WESA mechanism provides that every agent obtains the emission rights in the competitive allocation, e_i, and compensation payments, m_i, in accordance with the following rule:

$$m_i(e_i^*) = \min\left\{ u_i(\omega) - u_i(e_i^*),\ (\omega_i - e_i^*)p^* + \frac{\sum_{i \in A}\left[(\omega_i - e_i^*)p^* - (u_i(\omega) - u_i(e_i^*))\right]}{|N \setminus A|} \right\}$$

where p^* indicates the market price for emission rights, ω_i initial entitlements, $u_i(\omega)$ the stand alone utility, N the number of agents, $A = \{i \in N: m_i(e_i^*) = u_i(\omega) - u_i(e_i^*)\}$ and $|N\setminus A|$ is the cardinality of the set N\A. Accordingly, the WESA mechanism allocates the common resource in keeping with the efficiency criterion and in determining the compensation payments distinguishes between two groups: (i) members of set A receive compensation that brings them to the exact level of their stand-alone utility, and (ii) members of set N\A receive (or pay) their compensations as in the market-driven outcome, and are given an equal per capita share of the difference between the compensation payments that members of set A would receive at a market equilibrium and the compensation payments that they need to reach their stand-alone utility (see Helm 2000).

[7] If e is the global emission target, then, using the Cline formula, we come up with emission target e_i for the individual countries as a weighted sum from their share of historical emissions h_i/h, the world social product y_i/y, and the world population p_i/p, where w_h, w_y and w_p designate the weighting of these three indicators, which may be changed over time:

$$e_i = e\left(w_h\left(\frac{h_i}{h}\right) + w_y\left(\frac{y_i}{y}\right) + w_p\left(\frac{p_i}{p}\right)\right)$$

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