Chapter 26
A Global Carbon Market and the Allocation of Emission Rights

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26.1 Introduction

The paving of the way for a new climate agreement has turned out to be extremely challenging. The negotiators struggle to make the required emissions reductions binding under international law and to agree on burden-sharing amongst nations. Despite the fact that the G8 (Major Economics Forum 2009) as well as the Copenhagen Accord (UNFCCC 2010) refer to the 2°C target, the current pledges of the nations would lead to a temperature increase of more than 3°C by 2100 (Rogelj et al. 2010) and even in the most optimistic scenario a considerable gap of 5 $GtCO_2e$ would remain (UNEP 2011). A reasonable climate policy architecture thus needs to (1) specify a binding overall carbon budget that is in line with the 2°C target, (2) decide on the regional allocation of this budget and (3) create the institutional framework for a global carbon market.

Given that the 2°C target implies that a certain budget of emissions may continue to be emitted (see Chap. 13), it is debated how these emission rights could be allocated among the nations (e.g. WBGU 2009; den Elzen and Höhne 2010; Chakravarty et al. 2009). The national emission reduction commitments (e.g. the pledges in the Copenhagen Accord, 2009) and possible allocation rules of an emission budget play a major role in international negotiations. The idea prevails that these allocations will determine the distribution of the burden of climate protection. Here we emphasise the importance of an international emission trading scheme (ETS). We also

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analyse a number of allocation schemes and their influence on regional mitigation costs based on an intertemporal general equilibrium model. Major differences can be discerned between the schemes pursuing the "allocation of emission rights" versus those based on "allocation of reduction efforts". The allocation rule however, accounts for only one part of the overall mitigation cost: the full assessment of these costs is much more complex depending also on technological progress and the effect on trade of the devaluation of fossil resources under restricted emissions. We evaluate the ethical presumptions and their implications on the assessment of the different allocation schemes in terms of justice. We also discuss the institutional requirements for a global cap and trade system.

26.2 Establishing an International Emissions Trading Scheme

A price for the emissions of carbon dioxide (CO_2) has to be developed to reflect the limitations of the atmospheric reservoir and its remaining ability to absorb carbon deposited whilst keeping the temperature below the 2°C goal (see Fig. 13.1). A market price for CO_2 emissions can be introduced in two different ways: either by introducing a tax regime with national CO_2 taxes, or by implementing a global ETS where emission rights are allocated amongst the nations and can be traded between countries. From the perspective of economic theory, taxes and emissions trading are equivalent in a world without uncertainty; it has been assumed that the effectiveness of taxes and quantity instruments will not differ from each other if the climate damages and/or costs of mitigation are known. However, when there is uncertainty over damages and costs it can be shown that the instruments are no longer equivalent.

Such a model was originally formulated by Weitzmann (1974) as a "flow problem" in which the damages are related to the annual rather than the cumulative emissions. This frame of reference developed by Weitzman (1974) has subsequently been regarded as inadequate for the climate problem which is considered a "stock pollutant" problem whereby the damages are determined by cumulative emissions, i.e. by the stock deposited in the atmosphere. It can, however, be shown that the basic statements of the Weitzman model are valid for a "stock problem". Newell and Pizer (2003) demonstrated that under certain assumptions a tax is advantageous in the short-term; in the long-term, however, emission trading as a quantity instrument is preferable. The reason for this is that in the long-term the damage function will, due to the accumulation of emissions, become steeper than the costs of emission mitigation which simply depend on the flow of emissions. Given the condition of a long-term "steep" damage function, the advantage of quantity control was evident in the original Weitzman model. In the light of the results, a tax solution should take preference in the short-term, but emissions trading is the better option in the long-term.

It is, however, questionable that the selected model framework is suitable for the climate problem: the social planner or a well-intentioned government plays against "nature", as the future climate damages and/or mitigation costs are uncertain. Thus, the crucial problem of the economy of climate change is not examined.

As shown in Chap. 13, substantial levels of fossil fuels have to remain untouched if climate policy is to be taken seriously. For a climate policy to harmonise with a global carbon budget, the CO_2 tax would need to rise over time in accordance with the modified Hotelling rule (Edenhofer and Kalkuhl 2009). But how will the suppliers of coal, oil and gas react? They are likely to accelerate the extraction of their resource, running the risk that the global carbon budget will be exceeded despite a rising CO_2 price (see also the discussion about the “Green Paradox” in Sinn 2008 and Edenhofer and Kalkuhl 2009). A CO_2 tax is therefore not an effective instrument because it is rational for the resource owners to bring forward the extraction of fossil resources: they will expect future profits to be substantially reduced. This incentive does not exist for an emissions trading scheme since a budget of emission rights is determined *a priori*. The budget approach in combination with a global ETS thus has the potential to cut the Gordian knot of climate policy.

26.3 Distributional Aspects of Climate Policy

In this section we will concentrate on the distributional effects of a global cap and trade emissions trading scheme and evaluate different burden sharing regimes in terms of their level of global equity. It becomes clear that when CO_2 emissions are to be strictly limited, mitigation is not only a technical issue but becomes a distributional question: how are emission allowances allocated among nations? What is fair burden-sharing and what is acceptable to all players? On the global level it can be shown that the costs for climate protection are moderate (Stern 2007; Edenhofer et al. 2006, 2010), but on the regional level the assessments are weaker and vary much more in their conclusions (e.g. den Elzen et al. 2008). Three factors must be considered: (i) the allocation rule which determines the mitigation costs, (ii) the national mitigation costs and potentials for climate-friendly technologies and (iii) the global reallocation of resource rents resulting in the devaluation of fossil resource stocks that will particularly affect the oil and gas exporting countries. Understanding the contribution of each of these three factors is crucial for achieving an international commitment to climate change mitigation. It is of utmost importance to show, on the one hand, that mitigation is technically feasible (see Chap. 13) and, on the other hand, to give policy makers a robust assessment of the regional mitigation costs. The magnitude of these three effects can only be determined using model calculations. Here we present results of such an analysis, calculated using the REMIND-R model (Leimbach et al. 2010a, b) and refer to results published in Lüken et al. (2011).

26.3.1 The REMIND Model

REMIND-R consists of a macro-economic model coupled to an energy system model with a hard link. It is disaggregated into 11 World regions. The macro-economic module has a representation of long-term economic growth in an intertemporal optimisation framework in the tradition of Ramsey (1928) and runs in a social planner mode. This type of growth model is widely used for integrated assessments of mitigation policies in a long-term perspective. The energy system module consists of a detailed technology based structure. Exhaustible energy carriers are modelled by endogenous extraction and price formation (Hotelling 1931). A detailed representation of low-carbon technologies (including endogenous learning-by-doing) is the core of this module. REMIND-R allows the representation of trade by an exchange of ownership, which is fundamental for the determination of associated rents and effects on regional consumption. The model runs in a cost-effectiveness mode. Crucial assumptions within the modelling framework are that perfect foresight of the social planner is assumed and no strategic behaviour of actors is considered (Pareto optimum). This implies that the actual emissions of each region are independent of the allocation scheme and the allocated emission permits, i.e. the model allows the separability of equity and efficiency (Manne and Stephan 2005).

In the scenarios discussed here, a global cap and trade system is utilised, with an immediate start of global mitigation action and setup of an international carbon market from 2010 onwards. The time horizon considered for all simulations presented here is 2005–2100. In the following scenarios, a global budget of 905 $GtCO_2$ from 2010 to 2100 is assumed as a binding global emission cap, leading to a ~60% probability of achieving the 2°C target. The allocation of emission rights are distributed among the 11 World regions according to different allocation schemes that are described in the following sections.

26.3.2 Allocation of Emission Rights

As argued above, the distribution of emission allowances is one of three effects influencing the global reallocation of resource rents. How to distribute the initial emission allowances is heavily debated in international negotiations. As the trading of permits generates extra regional costs or revenues (den Elzen and Lucas 2005; Leimbach et al. 2010b; Rose et al. 1998) it is understandable that the allocation of permits amongst nations be subject to different perceptions of fairness. Here we analyse different allocation schemes and evaluate them against the ethical criteria presented in Part II.

Often the difference between allocation schemes is discussed with respect to the categories "allocation-based" or "outcome-based" (Rose et al. 1998); allocation scheme either focuses on the initial permit allocation of emission rights (before trading) or on the outcome (in monetary terms) of such an initial allocation. We introduce here a second category distinguishing "allocation of *emission rights*" versus "allocation of *reduction effort*". Regimes that allocate emission rights are, for example:

- *per capita*: allocation of emission rights in proportion to population, as for example, proposed by the German Advisory Council on Global Change (WBGU 2009), based on an immediate allocation from 2010 onwards;

- *per GDP*: allocation of emission rights in proportion to a region's share in global GDP; so-called Vattenfall proposal, based on an immediate allocation from 2010 onwards;
- *C&C*: contraction and convergence where the regional shares of global emissions rights converge linearly from status quo (2005 emissions) to equal-per-capita in 2050 (e.g. Meyer 2000);
- *C&C-hist*: contraction and convergence as described above but additionally the historic emissions since 1990 are taken into account: countries that emitted more (less) than the global average per capita emissions in the period 1990–2005 have to reduce (may increase) their allocation allowances by this amount in the period 2010–2100.
- *CDC*: allocation of emission rights according to "common but differentiated convergence", see Höhne et al. (2006), where industrialised countries have to reduce their emissions immediately and more stringently in comparison with C&C, whereas least developed countries may continue to emit up to a certain threshold. The threshold is defined as 20% above the global average per-capita emissions. When a region emits less than this, then the business as usual (BAU) emission path is followed. Once this threshold is crossed, per-capita allocations converge within 40 years to the level of the industrialised countries. In contrast to the other approaches, the emission paths for the different regions are prescribed exogenously to match a global emission profile compatible with the assumed global budget of 905 $GtCO_2$.

Beside these allocation schemes that distribute the "cake" of emissions (blue colours in Fig. 26.1) there are also proposals that aim to allocate the global mitigation reduction effort ("burden") of the mitigation challenge, i.e. they define a rule for distributing the reductions required relative to the baseline level. In contrast to the above mentioned allocation schemes, the allocation of the burden could result in some countries being assigned negative emissions, i.e. that they would have to buy additional emission permits from other countries even if they completely decarbonised their domestic energy system. The most prominent proposal of this kind is the Greenhouse Development Rights Framework (Baer et al. 2007). This distributes the global mitigation effort in terms of historic responsibility and economic capacity. Our analysis shows that this approach can substantially alter the distributional effect of climate policy. The investigated burden allocation regimes are (in red colours in Fig. 26.1):

- *GDR (static)*: Greenhouse Development Rights (Baer et al. 2007). The allocation of emission reduction commitments based on the *Responsibility and Capacity Index* (RCI), a composite index based on historic responsibility and economic capacity. The historic responsibility is quantified in terms of the cumulative emissions from 1990 to 2005. The capacity represents the level of individual income in excess of a pre-defined per-capita development threshold. Thus the allocation depends on the income distribution within nations. The higher the historic responsibility and the higher the capacity, the higher is the aggregated responsibility-capacity index (RCI). The static form of the GDR framework

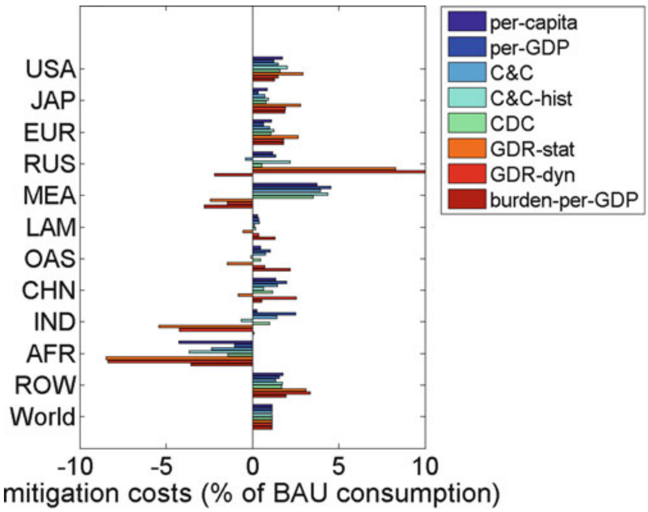

Fig. 26.1 Mitigation costs resulting from different allocation schemes. Mitigation costs are measured in terms of consumption losses relative to business-as-usual (*BAU*) aggregated over time (2010–2100) at a discount rate of 3%. *Blue colours* indicate allocation schemes, where the emission rights are distributed; *red colours* those where the reduction efforts are distributed. Regions: *USA*, *JAP* (Japan), *EUR* (Europe), *RUS* (Russia), *MEA* (Middle East), *LAM* (Latin America), *OAS* (Other Asia), *CHN* (China), *IND* (India), *AFR* (Africa), *ROW* (Rest of the World) (Source: Own figure)

means that for each time interval, the global mitigation burden in terms of the difference between the baseline emissions and the emissions in the climate stabilisation scenario is distributed in proportion to the 2005 value of the responsibility-capacity index. The allocation for a region thus equals its baseline emissions minus the region's share of the global mitigation gap. Parameters for the RCI are taken from Baer et al. (2007). For matching the regions in REMIND, a representative country is chosen for each region.

- *GDR (dynamic)*: Distribution of the global mitigation gap according to the RCI Index, albeit with dynamic adjustment of the capacity component to account for the fact that GDP and therefore capacity in the regions, changes over time (see second edition of the GDR framework, Baer et al. 2008). In order to demonstrate the effect of dynamical adjustments, we calculate a time-dependant RCI by scaling the RCI with the regional GDP growth rates. For each time-interval, the reduction relative to the baseline is then distributed in proportion to the time-dependant RCI.
- *Burden per GDP*: Distribution of the global mitigation gap according to share of GDP. The approach is similar to the GDR-approach, but the burden is allocated, not according to the RCI index, but according the regional share of GDP in each year. This leads to higher reduction efforts for those who have a higher GDP and therefore a higher capacity.

26.3.3 Effect on Regional Mitigation Costs

The global mitigation costs remain unaffected by the different allocation schemes (see Fig. 26.1) as the model allows the separation of equity and efficiency. But the different allocations schemes have a major impact on the regional distribution of mitigation costs. It is noticeable that a major differences in regional costs can be traced back to the difference between the schemes allocating emission *rights* (in blue tones) and those allocating emission reduction *effort* (in red tones).

The REMIND model projects that among the first group of allocations that distributes the emission allowances (*per capita, per GDP, C&C, CDC*), the industrialised countries (USA, Japan, Europe) face consumption losses that are within 1–2% of the baseline and close to the world average. This is due to the fact that these countries have economies that are not so carbon-intensive, so the cost of emissions reduction, compared to the overall economic output is small. Exporters of fossil resources, however, suffer the highest consumption losses (primarily the Middle East). It is interesting to note that some fossil fuel exporters can avoid a reduction in income. Russia, for example, is required to reduce its gas exports but can benefit from using the technology of Carbon Capture and Sequestration (CCS) in combination with biomass energy to extract CO_2 emissions from the atmosphere and generate "negative emissions" (see Chap. 13). Countries in transition, such as China or regions such as Latin America report losses below global average. Africa, however, benefits considerably from climate policy due to the sale of emission rights. Africa is the only region exhibiting appreciable welfare gains from the global mitigation policy for all effort sharing allocation schemes. Consumption gains are highest for the per capita allocation scheme. It is not surprising that industrialised countries benefit from an allocation based on GDP, whereas countries in transition such as China or India, or least developed countries, such as those in Africa, would benefit from a *per capita* allocation scheme.

This picture changes substantially for some regions when the reduction effort allocation schemes are considered. In the default *GDR* scenario net sellers of emission rights benefit substantially from an "allocation of reduction efforts" scheme: it gives rise to substantial welfare gains for Africa, India and the Middle East. The high-income industrialised countries (USA, Europe, Japan) are characterised by high historic emissions and per-capita GDP, thus their allocations are substantially smaller than in the *C&C, CDC* and *per-GDP* scenarios. In fact, as demonstrated by the calculations in Baer et al. (2007), the static application of the *GDR*-framework results in negative emissions for the USA, UK and Germany as early as 2020–2025, i.e. these countries would be obliged to purchases emission rights even in the hypothetical case of a complete elimination of domestic greenhouse gas emissions. In absolute terms, the mitigation costs borne by the USA and the EU exceed the global total average (Fig. 26.1). Not surprisingly, this allocation scheme would result in the highest mitigation costs of all schemes considered here for the high-income industrialised countries.

The *dynamic GDR* framework results in a considerable increase of mitigation costs, over those of the static case, for fast-growing economies such as China, India and Russia. For high-income industrialised countries by contrast, the aggregated relative welfare losses decrease to a level that is only moderately higher than the global average.

An additional calculation shows that the allocation of the mitigation effort according to *burden per GDP*, results in a similar picture as the *GDR* approach. This lets us conclude that the main difference between the *GDR* and the traditional approaches is not so much due to the different index that is used for the allocation, but the difference between allocating the emission *rights* in contrast to the *reduction burden*.

To quantify the contribution of the other two effects besides the endowment of emission permits, we apply an economic decomposition method that separates regional consumption losses into domestic and trade-related components (for details of the method see Lüken et al. 2011). For this analysis we use the *C&C* allocation scheme in a fully functioning carbon market. Other measures, such as the Clean Development Mechanism (CDM), are not considered.

In REMIND, a macroeconomic budget equation balances the production output Y with net exports of the aggregate good X_G, consumption C, investment into the macroeconomic capital stock I, and energy system costs G_{ESM} in all regions r and for all time intervals t:

$$Y(t,r) - X_G(t,r) = C(t,r) + I(t,r) + G_{ESM}(t,r)$$

Climate policy constraints affect consumption along two lines. On the one hand, costs for the domestic energy system G_{ESM} and investments into the macroeconomic capital stock I are modified. On the other hand, redirected trade flows result in a changed contribution of good trade X_G in the macroeconomic budget. Consequently, by considering differences between scenarios with and without climate policy, consumption losses can be traced back to domestic and trade-related contributions.

The domestic effect consists of changes in production (GDP), macroeconomic investments, energy investments and fuel costs. Reductions in economic output (i.e. production or GDP losses) constitute the major contribution to the overall consumption losses (compare light red bar on the left with dark red bar on the right for each region in Fig. 26.2). Reduced macroeconomic growth (GDP loss) accompanies lower investment into the macroeconomic capital stock (green bar), thereby partly counterbalancing the production loss and thus exceeding the consumption loss in most regions. In the energy system, a shift from fossil fuel-intense technologies towards capital-intensive low-carbon technologies leads to positive contributions from saved fuel costs (light blue bar) and negative contributions from increased investment costs in the energy system (dark blue bar). The contribution of energy trade in oil, gas, coal and uranium to consumption loss is low compared to domestic effects for all regions, except for coal trade for RUS.

In contrast to the permit trade effect, the domestic effect and the energy trade effect remain the same for all allocation schemes. So the strength of the three effects can be evaluated when combining the brown bar of consumption losses in Fig. 26.2 with the range of these losses given by the different allocation schemes in Fig. 26.1.

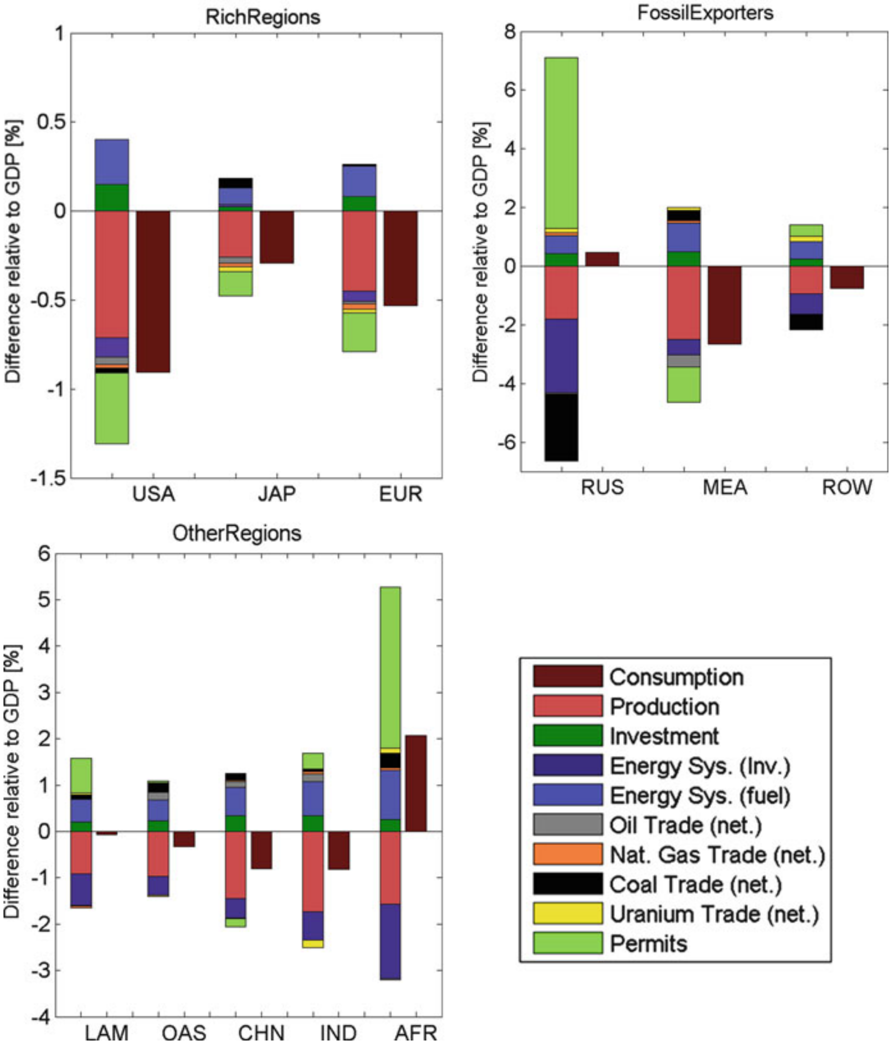

Fig. 26.2 Decomposition of cumulative consumption losses for the different regions in % of GDP aggregated for 2010–2100. *Negative values* indicate losses or additional investments, *positive values* indicate savings or gains. Note the different scales. For each region the *brown bar* on the right shows the consumption difference, and the *stacked bar* left to it shows the components. The decomposition is shown for a C&C allocation scheme. For other allocation schemes only the consumption losses (*right brown bar*) change according to Fig. 26.1 and the permit trade effect (*green bar*). All other components remain the same for all allocation schemes. Regions: *USA*, *JAP* (Japan), *EUR* (Europe), *RUS* (Russia), *MEA* (Middle East), *LAM* (Latin America), *OAS* (Other Asia), *CHN* (China), *IND* (India), *AFR* (Africa), *ROW* (Rest of the World) (Source: Own figure)

In summary it can be concluded that for industrialised countries the differences of mitigation costs due to different allocation schemes (at least for those allocating the emission allowances) are lower than one would expect, as the allocation rule is only one of three factors determining the mitigation costs (besides the domestic effect and the trade effects). This aspect could lead to some leeway in international negotiations. On the other hand, the distributional impacts for developing countries and least developed countries are enormous. Moreover, the differences between individual regions are large: whereas USA, Europe and Japan have to face costs for every allocation scheme, Africa could generate large revenues from an ETS. The latter probably holds in a cap & trade system but not for a continuation of the CDM scheme.

Above all, Luderer et al. (2011) show that the uncertainties in regional mitigation costs between model outcomes are significant. Models with low technical flexibility show a stronger influence of the allocation rules than those with high technological flexibility. This is due to higher carbon prices, which result in higher monetary transfers associated with the international carbon market. A crucial conclusion can be drawn from this: the higher the technological flexibility the lower the climate rents created resulting in fewer conflicts over allocation schemes.

A further reason for the uncertainty about the regional costs is that the (model) assumptions differ widely about how easily economies can be decarbonised and the extent to which technical potential exists for the individual technologies. In order to reduce this uncertainty, the governments should ensure that an international expert group will be commissioned to estimate costs. The international work on such issues will create mutual trust and a common basis for speedy negotiations.

26.4 Ethical Evaluation of Allocation Schemes

According to the model results, the various possible allocation rules do not differ in their globally aggregated costs, but differ greatly in their impact on regional and national abatement costs. This fact raises fundamental normative questions. The dispute in political debates and international negotiations about allocation schemes is primarily about different views of "justice", "equity" or "fairness" (see Sect. 7.1). UNFCCC 1992, Art. 3.1, also refers to "equity" and "common but differentiated responsibilities and respective capabilities", but without defining these concepts. Because of the normative nature of permit allocation, the issue has also been widely discussed within political philosophy and ethics, (e.g. Baer and Athanasiou 2007; Caney 2009; Gardiner 2004; Meyer and Roser 2010; and Rose et al. 1998). In the following sections, this normative-ethical question will be discussed, particularly in the light of the triangle concept of justice evolved in Part II, with its three dimensions of basic needs fulfilment, sufficient opportunities and fair procedures.

Thus, what can be regarded as a just rule for allocation of tradable emissions allowances among nations? If one does not regard exclusively procedural aspects as ethically relevant, an important preliminary decision is whether the allocation of emission permits is regarded more as (i) an instrument to solve general problems e.g. of global injustice such as poverty and extreme inequality ("complete perspective" of allocative justice), or (ii) an "isolated" problem of justice, sometimes also called "local justice", dealing solely with climate justice.

From our point of view, a specific permit allocation is not an ethical end in itself, but merely one instrument among others for realising ethical claims. Therefore, both the complete and the isolated perspective can be ethically acceptable. However, there are some essential ethical preconditions for this view, so a closer look at some prevalent proposals for allocations and their often implicit ethical assumptions is helpful.

26.4.1 The Isolated Perspective

Although most proposals for allocation schemes are mixed regarding the ethical principles involved, different categories of allocation rules can be distinguished systematically with regard to their predominant underlying principle of justice. There are three prevalent types of allocation schemes within the political discourse that adopt a more isolated view, namely, (A) equality, (B) compensation of historical emissions, and (C) grandfathering.

GROUP (A): Equality

Probably the most high profile proposal of all is equal *per capita* allocation of emission rights (e.g. Agarwal and Narain 1991; WBGU 2009), which can be viewed in the tradition of liberal equality. It belongs to the isolated view of the allocative problem, because it is only concerned with equality in respect to emission rights, rather than other forms of wealth, goods, resources etc. Variations of this isolated idea of distributive equality are *C&C*, and most proposals that include historical emissions for reasons of distributive justice, such as *C&C hist*. They differ from the *per capita* proposal only in some temporal aspects of equal per capita emission rights (e.g. within each year, or within a life-span, or after some years of transition period, or equal average per capita emission rights within an entire nation since the beginning of industrialisation). Common to all allocations of group (A) is the idea of equal opportunities.

Despite its intuitive appeal, some critique on this kind of allocation could be made (cf. Caney 2009): More general critique on allocations of group (A) centres on liberal equality (e.g. by sufficiency-oriented theories, see Chap. 7). But even if one favours liberal equality and the isolated view, it is not clear why we aim for equality of emission rights because bearing emission rights as a resource endowment or as a property right cannot be ethically regarded as an end in itself (see Sect. 7.2 and Sen 1997). Why not aim for equality of some kind of benefits from emission rights, e.g. in terms of GDP or utility, or opportunities such as access to energy, or equality of benefits from emissions during a life-span (see Sect. 7.4)? However, it is very difficult to definitely identify benefits and opportunities from emission rights, particularly from past emissions, or to implement concepts such as "during a life-span". Furthermore, it is hard to determine "equal access to energy" within the framework of an ETS, without at the same time rewarding the maintenance, or even provision, of undesirable incentives for creating high carbon intensity in the energy sector. A focus on equality of benefits from emissions in terms of GDP could even feed higher energy intensity in addition to higher carbon intensity. Note that such side effects and incentive structures have to be considered for every proposal for allocating emission allowances.

From our perspective of justice (see Chap. 7), the most important aspect within an isolated view of permit allocation is not the focus on equal benefits in terms of GDP or equal access to energy. Rather, emission permits are extremely, though not equally important resources for every society, insofar as they are required for fulfilling basic needs and for creating crucial economic opportunities for everyone (see Sect. 7.2). Thus, one could argue for a *per capita* allocation, although the claim to equality in this case would be a mere means to roughly provide these claimed goods for everyone. Since it is very hard to practically determine regional differences, an equal allocation of emission permits among all regions seems a fairly good approximation. For these reasons, *per capita* (or similar proposals) could serve as a just allocation as outlined in Part II, if one accepts the isolated view. In addition, it leads to the positive side effect of gains for some poorer countries, which can support their development.

GROUP (B): Compensating Historical Emissions

C&C hist, the "Brazilian Proposal" (UNFCCC 1997; La Rovere et al. 2002) or the approach of "cumulative emissions per capita" from 1900 onwards (Ding et al. 2009) seem to be based on the idea of compensation or retribution of wrongdoings rather than on ideas of distributive justice: they incorporate past emissions with regard to the damages they cause, or benefits from past emissions as immoral "free-riding" (see Sect. 7.4). The ethical reasons for not taking past emissions into account in this way have already been presented in Sect. 7.4.

GROUP (C): Grandfathering

The principle of grandfathering, which is considerably in vogue in industrialised countries, is implied in *per GDP* allocation, but weaker in *CDC* and *C&C*. It does not meet with the approval of the triangle of justice, since its mere focus on property rights and on keeping the status quo does not accord with the claims of the three dimensions of justice, particularly in regard to eradication of poverty. Caney (2009) states that no moral or political philosopher defends the principle of grandfathering.

The only ethically acceptable reason for a *transition* period from status quo to equal *per capita* allocation could be the protection of socio-economic systems in industrialised countries in order to secure basic needs fulfilment and sufficient opportunities. To achieve this, 2020 as convergence year should be adequate. Thus, if *C&C* for example, with its component of grandfathering, was pursued the year of convergence should be much earlier than 2050.

26.4.2 The Complete Perspective

GDR, as was explained above, takes into account historical emissions, but also to a large extent the capacity, or "ability to pay", of nations. With this, *GDR* seems to take a complete perspective, along with some other allocation proposals such as the *burden per GDP* rule. *GDR* uses emission permit allocation to target much more general global distributive problems. Within the international climate change negotiations the discussion of the *GDR* approach helped to draw more attention to poverty and global inequality of wealth as problems of global injustice. However, if capacity is taken as a criterion in this approach, it should not be reduced to a mere economic value, but should also include, for example, technological potentials and governance aspects (Winkler et al. 2007).

Although we have not analysed "outcome-based" (Rose et al. 1998) proposals, they are another interesting alternative among the complete view allocations. Their advantage in comparison with "allocation-based" (Rose et al. 1998) approaches (e.g. based on the criterion of economic capacity such as *GDR*) is that they more precisely target a certain redistribution: they focus on the outcome of an allocation scheme *after* permit trade, taking into account all three factors of regional abatement costs explained above. However, major uncertainties are associated with these model-based expected outcomes.

Note that generally the suitability of the "complete perspective" allocation to solve more general problems of global injustice is decisively restricted. This is because by allocating emission permits, only the distribution of monetary wealth in terms of GDP can be changed directly and this only to a limited extent. Other important aspects of justice such as governance and procedural issues, access to processes or the distribution of other important economic goods or ecosystem services cannot be targeted directly by a permit allocation. If one nonetheless adopts a "complete view", both allocation-based and outcome-based proposals can be regarded as just from our point of view. That is as long as they aim to redistribute global wealth in order to support the realisation of moral rights according to the three dimensions of justice (see Sect. 7.2). This would obviously require redistribution in favour of poor countries. If outcome-based allocation schemes are politically preferred, it may be helpful to take into consideration the different outcome patterns of "burden-sharing" on the one hand and of "allocation of rights" on the other hand.

26.4.3 Isolated Versus Complete Perspective

What is now the "right" perspective? Caney (2009) argues for a total view, whereas Posner and Weisbach (2010) argue for an isolated view, mainly because of political-practical reasons. We consider both the isolated perspective, if it is a *per capita* or a similar allocation, and the complete perspective, if it aims at a just global redistribution, as ethically acceptable. But the shortcomings and ethical conditions of both perspectives as pointed out above should be borne in mind. A further important ethical condition in each case is the *overall* bundle of political measures and instruments in terms of justice or injustice. This concerns the related procedures as well as the overall outcome (distribution of wealth) and other aspects: if one adopts the isolated view, it is absolutely ethically demanded that other political instruments and measures, at least, fully provide basic needs fulfilment and sufficient opportunities for everyone within fair procedures (see Chap. 7). On the other hand, if a complete view is preferred, the interplay of the chosen allocation with other political measures has to be considered.

Beside these few permit allocations, which are considered as just, some other allocation rules can also be seen as just under two conditions: first, they have been decided in a fully fair procedure, and second, the overall bundle of political measures and instruments and their results is in line with the claims of justice (see Chap. 7). However, these two ethical conditions might be hard to meet for most other proposals.

On the practical-political level, an advantage of *per capita* as an isolated view allocation is that the principle is simple, transparent and supported by intuition. This is distinct from much more complex allocations pursuing the complete perspective. In addition, permit allocation should not be overloaded by claiming a complete view, because many governments of wealthier countries are reluctant to pursue ambitious climate mitigation, let alone pave the way for a global redistribution. While *per capita* or similar group (A) proposals constitute the minimum of fairness that is acceptable for most Southern countries, they would prefer type (B) or "complete perspective" allocations. However these proposals are rejected by Western countries, for example the USA, because of the relatively high expected costs compared to those of group (C) allocations (Posner and Weisbach 2010).

Fortunately, there is an important leeway within the difficult political negotiations due to (i) the fact that some of the allocation rules do not differ much in terms of outcome (see Fig. 26.1), (ii) our assumption that more than one allocation rule could be regarded as just, under certain conditions, dependent on the overall bundle of measures, and (iii) the possibility of reducing potential conflict by technological innovation and technology transfer, which would reduce mitigation costs.

26.5 Institutional Requirements for a Global ETS

If the carbon budget is managed by a fiduciary institution, a clear signal will be given to the markets that no emission in excess of the budget will be issued. A global system of regional and national climate central banks should undertake the task to ensure an economically efficient compliance with the carbon budget. For this purpose, an institution which acts as a climate bank needs to issue emission rights in such a way that the firms themselves can decide when they will reduce emissions and which technologies they will use. Depending on the economic situation, the central climate banks can limit or extend the temporal flexibility by issuing certificates.

Such a system cannot be implemented overnight. But an important question is if there is still enough time to achieve an international agreement, on an incremental basis for example by linking regional emission trading markets (Flachsland et al. 2008). Model calculations show that the costs could increase by half if a global agreement was deferred to from 2010 to 2020 (Luderer et al. 2011). In the event of a further delay, the 2°C target might not even be achieved.

The emissions trading scheme could have the potential to be an instrument to contribute to justice (as argued in Part II) in two ways. Firstly, the global cap of emissions can be regulated efficiently and effectively by restricting emissions rights to ensure the target of 2°C is achieved (see Chap. 12). Secondly, a global ETS allows a fair burden-sharing of the mitigation effort and with it the chance to decrease global injustice. If poorer countries receive more emission rights than they need for themselves, they can sell the unutilised emission rights and create a climate rent. Such a global reallocation of rents (from fossil fuel owners to owners of emission rights, see Chap. 13) has to be accompanied by regulations to ensure the rents from emission trading are invested in sustainable development for the poorest rather than personal enrichment of the elite.

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