

INTERNATIONAL KYOTO MECHANISMS AND EQUITY

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Abstract

International Kyoto mechanisms are especially designed to reach worldwide emissions reduction targets globally. The main intention behind the idea of emissions abatement attainment by Kyoto mechanisms is to make emissions cut opportunities more flexible and to allow the trade of emissions permits (ET) and the investment transfer from industrialized to less developed countries or regions in transition (CDM or JI) instead of or additional to emission abatement by domestic policy strategies. Within climate change negotiations, all Kyoto mechanisms are discussed controversially, one important discussion point is directed on equity. Particularly, active discussion and literature concentrate on the opportunity to compensate most vulnerable regions by reliable countries. Kemfert and Tol (2001) demonstrate that the consideration of equity by burden sharing have substantial impacts on the optimal global emissions control path.

This paper investigates which economic effects are induced by Kyoto mechanisms and focuses especially on the equity implications of world emissions trading schemes. Different options of permit allocation within the world regions and revenue distribution due to equity rules and its impacts on world economic relations are compared and evaluated. Due to the Kant and Rawls criteria, all regions share the fate of the region affected worst by climate change, Varian's non envy implies an equalization between costs and benefits of all world regions. Model calculations by a world general equilibrium model WAGEM include different equity criteria incorporating the initial permit allocation and the revenue distribution in order to evaluate global economic effects. The polluter pays principle is included through the compensation of vulnerable regions by the responsibilities. Model results demonstrate that these equity criteria does not imply as fundamental consequences to world economies as other more influential allocation and redistribution criteria like per capita measurements. Whereas international Kyoto mechanisms support negative implications due to trade spill over effects also to less developed regions, model results demonstrate that equity compensation and allocation methods can alleviate these effects.

Key words: Kyoto mechanisms, equity, CGE analysis

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I. Introduction

Industrialised countries agreed on a joint proposal to cut emissions globally by national and international measures and policy strategies. Besides national or domestic policy measures to reduce emissions drastically international so called flexible mechanisms allow for a more accommodating approach of emissions abatement. Countries could invest in energy saving or emissions abatement technologies in countries in transition or less developed countries so that emissions will be reduced due to this new technology. Both opportunities are summarized as Joint Implementation (JI) or Clean development mechanisms (CDM). Furthermore, countries can trade their emissions permits depending on the initial allocation of its emissions permits.

Within this context, following two aspects arise to be most relevant: a. should the emissions trading opportunities be limited to industrialized countries or should it be opened to all world regions, especially less developed countries? b. Independently of how many nations will be involved in the international emissions trading scheme, how should the initial allocation of permits be ruled? The Kyoto protocol is fairly clear in both of these aspects: the emissions trading scheme should be limited to the industrialized countries (Annex I/B) and the initial allocation is ruled by the reduction level or the negotiated assigned amounts (AA) of the industrialized regions within the commitment period, respectively. But, if less developed countries or especially countries in transition will progress rapidly and reach the same evolution standard as the industrialized countries, emissions diminution will become relevant for these countries. Additionally, assuming that developing countries continue with business -as -usual with increasing economies and therefore emissions, these countries will pass the industrialised countries soon, as the *International Energy Outlook 1999* projected. In view of the fact that countries in transition will grow fast and reach the same standard as industrialized countries in the near future, emissions will increase due to an intensification of energy consumption. New energy savings technologies could help not to expand energy consumption as with the current standard of technologies which is imposed by JI or CDM. But, emissions trading will become relevant if these countries face binding emissions reduction targets. If not only responsible nations should take care of climate change, the most powerful argument is that climate change is a global problem which requires a global solution, that means developing and countries in transition should participate in an overall agreement. The next argument why developing regions should participate is that of so called carbon leakage. That means countries without binding reduction targets could function as new location for energy intensive industrial production resulting in higher emissions, called

carbon leakage. Furthermore, a reduction of energy consumption causes a decline of the world energy prices which on the other hand encourages the energy demand in developing regions. In order to avoid the negative effects of all previously described arguments for developing regions the best solution out of it is to open the emissions trading market to all world regions, that means to developed *and* developing countries.

Because of this argument and also because of the equity reason each emissions trading scheme should be distended to include all nations. As a result of that and again because of equity criteria the initial allocation of emissions permits are crucial in order to share the burden not only of climate damages but also the prevention costs of emissions reduction to diminish the climate damages. This paper investigates different international burden sharing rules and focuses especially on equity of burden sharing. Particularly, an emissions trading scheme is analysed under different permit allocation rules and its impacts on world economies are compared. As in many analysis, emissions trading between Annex I regions or between Annex I and non Annex I regions is not treated as JI or CDM because emissions trading is neither project based nor does it necessarily influence energy efficiency as it is the case with CDM and JI.

The implications of different emissions trading schemes, i.e. different allocation rules are contrasted against the Kyoto solution. Furthermore, diverse revenue redistribution of permit selling due to equity criteria are assessed in view of their economic implications. Part II of this paper concentrates on the different burden sharing rules and equity considerations, part III investigates the applied model runs by a world general equilibrium model WAGEM in terms of its equity impacts, part IV of this paper evaluates this model results, part V concludes.

II. Burden Sharing and Equity

Equity as an argument in general policy negotiations serves not always as a primary discussion factor, but in climate change negotiations equity plays a crucial role (see IPCC (1996)). Because countries welfare differ substantially between all regions, an international agreement will not base on economic efficiencies alone but also depends on voluntary compliance influenced by equitable burden sharing. Developing countries demand not without good reason that equity should be considered more deeply within the climate change negotiations before they will be willing to agree on any commitments. Different equity criteria are discussed in the literature: following Rose and Stevens (1998) and Rose (1998) equity criteria can be classified into allocation based, outcome based or process based.

Allocation based equity refers to the option to the *sovereignty* criteria where the emissions cutback is equal in all nations, the *egalitarian* criteria indicates an emissions allowance in proportion to population and the *ability to pay* criteria equalizes the abatement costs over all nations. Outcome based criteria can be classified in to *horizontal* and *vertical equity*, first signifying equal net welfare changes across nations, vertical equity means that welfare gains should vary inversely with economic welfare (GDP). The *compensation* criteria refers to the *Polluter Pays Principle* that no nation should be made worse off, that means nations facing welfare burden should be compensated. Process based equity represents the *Rawls Maximum* principle where the welfare of the worst off nation should be maximized, the *Consensus* criteria signifies that the international negotiation process is fair, where parts of the *Kant* principle is involved to choose the abatement level that everyone would like to others to undertake. Market justice specifies a fair market, in the case of permit trading would that mean that the permit allocation is regulated by the highest bidder.

Equity plays a crucial role in analysing the optimal allocation of emissions permits: following Grubb (1995) emissions permits should be distributed due to an equal per capita allocation (see also Grubb (1989), Bertram (1992), Epstein and Gupta (1990)) and an allocation related to the status quo. That is, emissions entitlements are restricted to current emissions. Whereas the emissions permits allocation due to the population is influenced mainly by ethical arguments (see Ott and Sachs (2000)), the second discussion of per capita allocation concentrates on the equal historical or stock entitlements, that means that everyone should have the same right to identical emissions, regardless of country or generation (see Fujii (1990), Gosh (1993) and Meyer (1995)). Hybrid approaches of equity combining both egalitarian and status quo principles are proposed by Grubb and Sebenius (1992), Shue (1993) or Welsch (1993). Bohm and Larsen (1994) elaborated that an initial allocation of permits due to an equalization of net costs per GDP in the short run and per capita in the long run can be characterized as a fair distribution which could increase the attractiveness of joining a negotiation agreement. Larsen and Shah (Larsen and Shah (1994)) analysed an emissions trading system based on a “acceptable” permit allocation in terms of a Pareto improvement that no country, developed or developing, should be made worse off as a result. Barrett, Grubb et al. (1992) investigated different permit allocations determined and influenced by self interest (egoistic) or the Kantian imperative (altruistic) approach. Rose and Stevens (1993) examined diverse equity criteria by reaching a 20 % reduction target. Kemfert and Tol (2001) demonstrate that the consideration of equity by burden sharing have substantial impacts on the optimal global emissions control path.

Implications of an implementation of flexible or Kyoto mechanisms are analysed by diverse authors, the restriction of emissions trading and the initial allocation of emissions permits and the redistribution of revenues were and are discussed controversially within climate negotiations and scientists. Mc Kibbin and Wilcoxon (1999) investigated the impacts of diverse emissions trading schemes, Bernstein, Montgomery et al. (1999) studied the restrictions of an emissions trading schemes with the global MS MRT model. Most analysis of the impacts by the Kyoto protocol found that the allowance of international Kyoto mechanisms reduces the global and national costs of abatement significantly, an overview gives Weyant and Hill (1999) and Edmonds, Scott et al. (1999). Kemfert (2000) and Babiker, Reilly et al. (2000) found that the implementation of the Kyoto protocol induce negative impacts to the developed and developing countries. A more pragmatic way of interpreting equity as an equitable, international distribution of the burden by emissions reductions is drawn by Buonanno, Carraro et al. (2000) and Bosello and Roson (2000). Two different permit allocation rules based on per capita measurements are analysed in Böhringer and Welsch (1999).

On the European level, the European Commission presented in 2000 its green paper to implement an emissions trading scheme in Europe, Ellerman (2000) gives an overview of approaches by national emissions trading in Europe, concrete implementation rules summarise Tietenberg, Grubb et al. (1999).

This paper intends to analyse the world economic impacts by emissions reduction measures by taking into account diverse equity criteria. Mainly, the above mentioned literature focus on the investigation of stylised methods and models of emissions trading options based on equity constraints or world models study the implications of the Kyoto protocol which stresses only marginally on equity concerns. This paper studies the world economic implication of different permit trading schemes focused on the developing countries by a world general equilibrium model WAGEM. In previous analysis we found that the implementation of the Kyoto protocol and an emissions trading scheme will induce negative economic implications to developed and developing countries. Negative economic impacts occur because developed countries face binding targets and have to take domestic action or trade permits in order to meet its individual reduction target. Developing countries suffer primarily because of increasing energy prices and negative trade spill over effects (see Kemfert (2000)). Including less developed countries within a global emissions trading scheme let global and national welfare augment significantly (Manne and Richels (1999)).

This paper incorporates equity interests by implementing diverse emissions trading schemes where the initial allocation of permits is distributed due to the *Egalitarian*, the *Ability to Pay*, the

Sovereignty and *Compensation* criteria and compared against an Annex I trading scheme (Kyoto). The main intention lies on the assessment of the welfare implication by an emissions reduction on developed and developing countries and if equity compensation and allocation approaches can alleviate negative impacts on less developed countries.

III. Model runs and results

In order to assess and evaluate the economic implications of emissions abatement policies by equity criteria assorted permit trading schemes of different initial permit allocation and revenue distribution are simulated by a world general equilibrium model WAGEM (Kemfert (2000)). WAGEM is an intertemporal computable general equilibrium and multi regional trade model for the global economy. It considers 11 world regions that are linked through bilateral sectoral trade flows based on GTAP data of 1995. For each region, a representative agent maximises lifetime utility from consumption. This determines the level of savings. Firms choose investment in order to make the most of the present value of their companies. In each region, production of the non-energy macro good is captured by an aggregate production function. The production function characterises technology through transformation possibilities on the output side and substitution possibilities on the input side. In each region, a representative household chooses to allocate lifetime income across consumption in different time periods in order to maximise lifetime utility. In each period, households face the choice between current consumption and future consumption, which can be purchased via savings. The trade-off between current consumption and savings is given by a constant intertemporal elasticity of substitution. Producers invest as long as the marginal return on investment equals the marginal cost of capital formation. The rates of return are determined by a uniform and endogenous world interest rate such that the marginal productivity of a unit of investment and a unit of consumption is equalised within and across countries. Domestic and imported varieties for the non-energy good for all buyers in the domestic market are treated as imperfect substitutes by a CES Armington aggregation function, with a constant elasticity of substitution. Due to the initial allocation of emissions permits, permits can be traded by countries that are allowed to trade, the revenue is redistributed lump sum to the selling nation.

First, we simulate the Kyoto emissions reduction targets as our baseline and primary comparison case, i.e. the quantitative results contain committed emission reduction levels for Annex I countries due to the Kyoto protocol mitigating greenhouse gas emissions by 5.2 % below 1990 level

within the commitment period 2008 to 2012. The global emissions baseline pathway is assumed to start from 6 to 11 billion tons of carbon in 2030 which is roughly consistent with the carbon emissions projections of the IPCC reference case of medium economic growth. All parameter selections orientate on general assumptions made for preceding simulations aligned with previous model calculations. The so called Business as Usual (BAU) scenario covers the world development without any additional reduction options. The BAU scenario is used to underline the equity effects of diverse initial allocation of emissions permits, the base case contains the Kyoto emissions reduction targets. In order to highlight the effects of different permit allocation schemes due to diverse equity criteria, a second baseline scenario is defined including a 25 percent emissions reductions target of all Annex I countries by 2010. We assume that all nations that face a binding reduction target not only within the commitment period sketched within the Kyoto protocol (2008-2012) but also after it, that means that we assume a so called “Kyoto or reduction forever” scenario. The Annex I nations can choose whether they will abate emissions by domestic actions (e.g. emission taxes, command and control measures, voluntary agreements) or by Annex I emissions trading. We expect that trade will not be restricted, for model calculations focusing on economic impacts by emissions trading constraints and different assumptions about baseline emissions pathways see Kemfert (2000).

Second, definition of the equity scenarios is outlined as described in part II of this paper as a mixture of different equity criteria. That means, we include developing regions into the emissions trading scheme either by allocating permits to them or by fixing reduction targets (“targets with trading”). A. due to the *egalitarian* criteria, the initial allocation of permits is ruled by an equal distribution of emission per capita and emissions per GDP endowment as a mean value of 2010 emission per capita entitlements. B. The initial allocation of permits (permit allocation PA) is distributed by the population and GDP share within the first commitment period of 2008. C. In order to include more equity criteria described in the previous part of the paper, further scenarios base on the assumption of revenue redistribution from Annex I to non Annex I countries including elements of different equity criteria: regarding to *egalitarian*, *ability to pay* and *Rawls Maximum* as the redistribution of gains to poorer nations, it is assumed that the revenue of permit trade is redistributed to non Annex I countries. Here, we distinguish also between a Kyoto emissions reduction target and a 25 percentage abatement level. Equity defined by *Kantian* or *Sovereign* criteria as each nation selecting the abatement level as large as the reductions level it would like others to undertake, i.e. all nations have the same right to pollute and gets the same amount of initial permits (“targets with trading”). The first equity criteria is also known as Contraction and Convergence (C&C) principle

signifying that everyone has the right to emit an equal amount of pollution. The *Compensation* criteria cover the above already described idea to compensate most vulnerable regions by the responsibilities, that means the *polluter pays principle*.

Following table summarises all simulated scenarios:

	Initial allocation of permits		Revenue redistribution	
			Kyoto, 5 % abate.	Kyoto, 25 % abate.
Base	BAU /Kyoto	BAU / Kyoto	Base case I	Base case II
Egalitarian	Equal PA E/Cap	PA per Cap	Per Cap I	Per Cap II
Ability to pay	Equal PA E /GDP	PA per GDP	Per GDP I	Per GDP II
Sovereign			Kant I	Kant II
Compensation			PPP I	PPP II

Table 1: Scenario definition

The extent of influence and impacts on national welfare by implementation of the Kyoto mechanisms in terms of real income effects is measured in HEW: Hicksian equivalent which exhibits a not surprising increase of international and national welfare. Not surprising, because we are calculating all effects by a general equilibrium model which leads to an intensification of global welfare by the allowance of global permit trade (Pareto improvement), but not necessarily to an increase of national and regional welfare. However, in our studies we find that the allowance of Annex I permit trade initiates an advancement of national welfare as well (see Table 2).

	Region	Trade / no trade	Change
JPN	Japan	0,13	++
CHN	China	0,04	+
USA	USA	0,11	++
SSA	Sub Saharan Africa	0,06	+
ROW	Rest of the World	0,03	+
CNA	Canada, New Zealand and Australia	0,09	++
EU15	European Union	0,06	+
REC	Russia , Eastern and Central European Countries	0,87	+++
LSA	Latin America (Mexico, Argentina, Brazil, Chile, Rest of Latin America)	0,08	+
ASIA	India and other Asia (Republic of Korea, Indonesia, Malaysia, Philippines, Singapore, Thailand, China, Hong Kong, Taiwan)	0,04	+
MIDE	Middle East and North Africa	0,32	++

Table 2: HEV Comparison of Annex B permit trade: trade versus no trade

As described before, within this scenario the initial permit allocation is defined by the Kyoto protocol, the revenue is lump- sum transferred back to the individual economies. Annex I emissions permits trading offers the opportunity for participating countries to sell and buy permits due to their reduction targets and marginal abatement costs. As expected within a general equilibrium modelling framework, global welfare is improved by Annex B permit trading revealing permit trading as a Pareto - improving policy measure.

A comparison of a trade versus non trade scenario demonstrates that all countries can benefit by Annex B permit trading, mainly countries in transition as REC because of the “hot air” effect, that is if regions do not face binding reduction targets and hence get the opportunity to sell permits if the baseline emissions path lies higher than base emissions in 1990 which is a result of poor economic performance and economic restructuring. As a consequence, these regions are not expected to regain their 1990 emissions levels by 2010.

Emissions permit trading better off all Annex B countries as well as non Annex B or developing countries because of international trade spill over effects. Annex B countries facing high emissions reduction targets and high domestic marginal abatement costs like Japan and USA will certainly benefit by Annex B emissions permit trading. Essentially, USA and EU 15 will trade permits within a full trade scenario because of their high share on total carbon emissions. Assuming a modest

development of world emissions, USA, Canada, Japan and EU 15 will buy emissions permits because of their marginal abatement costs higher than the permit price, main seller of emission permits will be REC, Russia and other Eastern European countries because of their non binding committed reduction targets.

By allowing full global trade, that is including developing countries within the permit trading scheme, regional and global welfare in terms of real income effects adjust substantially. Full global trade is reached by the initial allocation of permit endowments and hence the allowance of all world regions to contribute by trading permits. If the initial distribution of emissions permits is ruled by the egalitarian principle in that way that permits are allocated in proportion to population, model simulations exhibit a substantial welfare gain to non Annex I countries. Non Annex I countries will not face binding reduction targets and get the opportunity to sell permits. Because Annex I countries face now higher reduction targets than without any emissions reduction commitment, developed regions suffer higher abatement and adjustment costs which leads to higher welfare losses measured as real income losses (Hicksian equivalent HEV) to Annex I regions whereas non Annex I regions can benefit by welfare increases. These effects are higher in comparison to the BAU case as the Kyoto case except of the REC regions which was the main seller before within the Kyoto scenario. REC suffers by welfare losses because the additional supply not only leads to a decrease of the permit price and therefore permit revenues but also to demand of permits from this region (see Figure 1 and Figure 2).

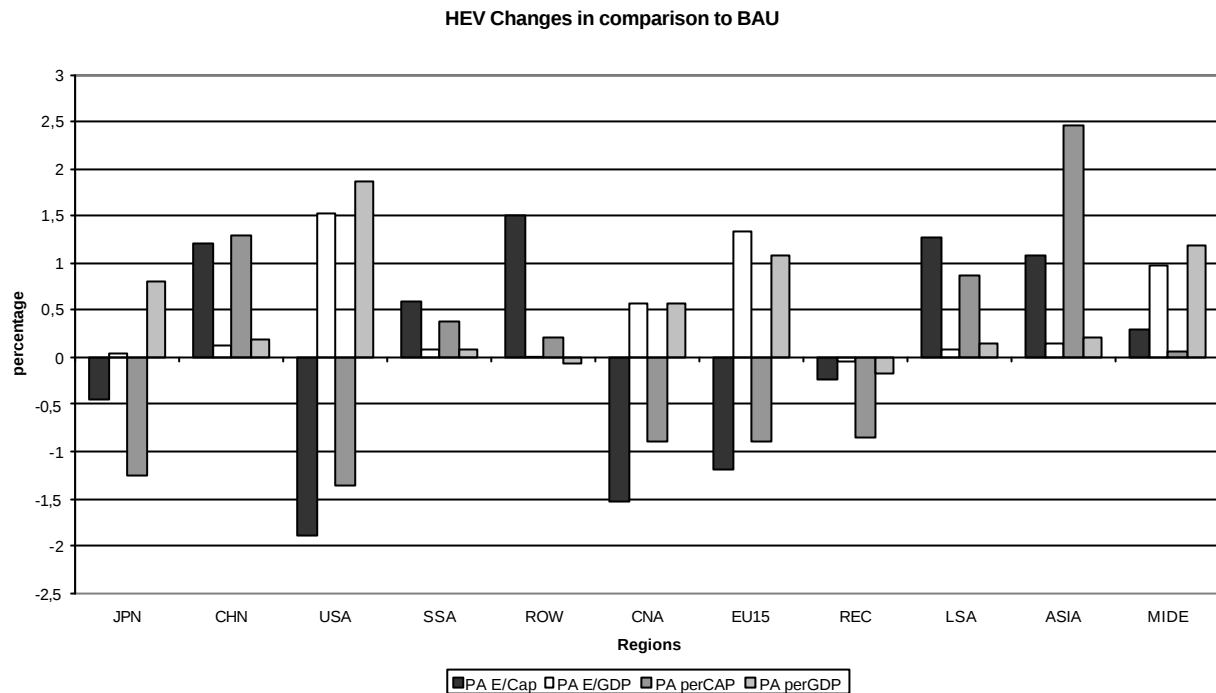


Figure 1: HEV development in comparison to the BAU scenario

In particular, Figure 1 and Figure 2 appraise these developments and reveal the equity aspects. The initial endowment of permits ruled by an equalisation of emissions per capita leads also to non binding reduction targets of developing countries with high population shares like ASIA, CHN, LSA or SSA whereas Annex I countries face higher reduction targets and higher welfare losses as if the initial allocation is chiefly controlled by the distribution per capita. These effects could be lessened if we compare the results with the Kyoto scenario, where Annex I countries already face binding targets and permits can be traded. Because of global permit trade, the supply is enhanced which leads to an decrease of the permit price resulting in decreased abatement costs but less economic gains for permit seller. Because permit trade becomes cheaper, abatement costs are lowered for Annex I regions which as a result increases the real income effects more effectively.

As demonstrated, the ability to pay equity criteria as the initial allocation of emissions entitlements by the share of GDP trigger not as high welfare gains to developing countries as in the case described before in comparison to the BAU case because developing countries will get only small amounts of initial permits which increase welfare benefits only marginally. In contrast to the previously described welfare developments Annex I regions can benefit by the initial permit allocation per GDP in comparison to the BAU or Kyoto base scenario because Annex I countries tackle binding abatement targets but get more initial emissions entitlements which lowers abatement costs.

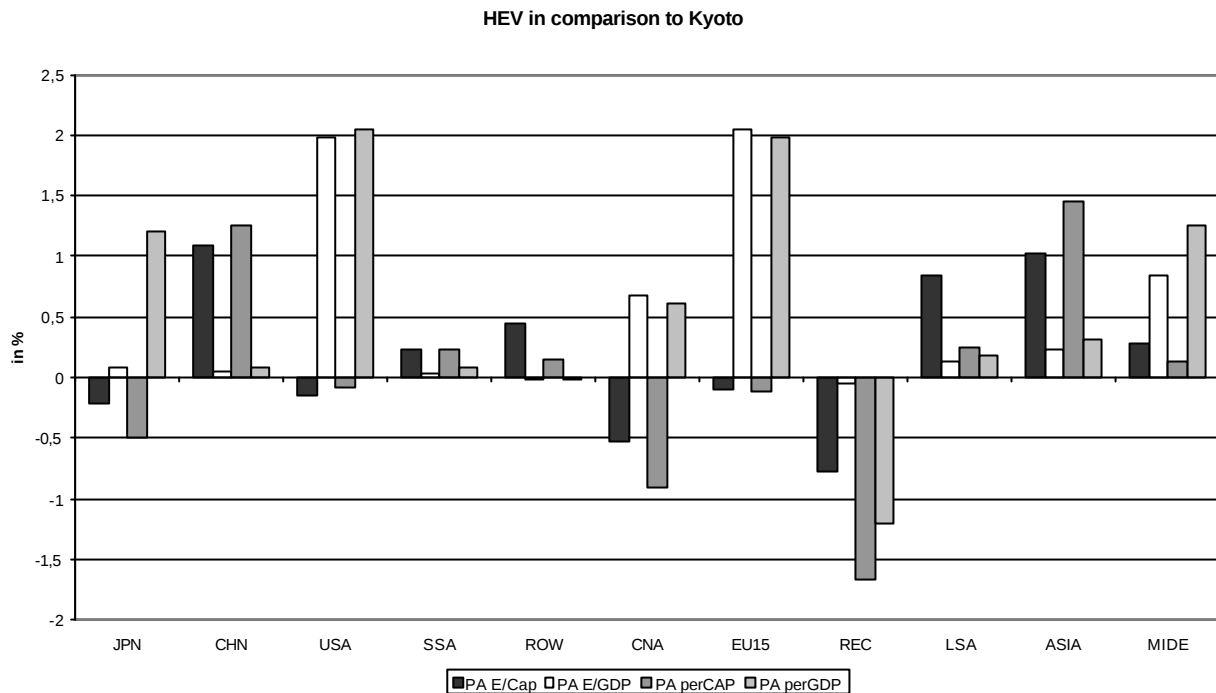


Figure 2: HEV development in comparison to the Kyoto scenario

Non Annex I countries suffer a disadvantage because of lower GDP developments and therefore lower initial allocation of permits which leads to lower welfare gains. By arguing from an ethical point of view, the initial allocation of permits by GDP shares leads not necessarily to a support of more vulnerable and disadvantaged regions like SSA or ASIA. In order to assist non Annex I regions not to suffer welfare losses as demonstrated in model calculations of the Kyoto reduction targets, it is more helpful to take a first step to equity by allocating permits to the egalitarian criteria. The initial allocation per capita seems to be the most valuable method to alleviate negative welfare effects to non Annex I countries by improving real income significantly. Welfare losses to developed countries remain not as high by an equalisation of emissions per capita shares as the initial allocation of permits due to per capita criteria. Annex I regions suffer only small welfare losses if the initial allocation is ruled by capita criteria in comparison to the Kyoto case, because on the one hand Annex I regions are getting a higher share of initial permits in the Kyoto case but on the other hand, permit trade becomes more cheap which lowers abatement costs to these regions. The initial allocation measured in emissions or shares per capita favours non Annex I regions.

	PA E/Cap	PA E/GDP	PA perCAP	PA perGDP
JPN	0,252	-0,019	0,600	-0,303
CHN	-0,218	-0,010	-0,725	-0,020
USA	0,180	-0,277	0,077	-0,571
SSA	-0,288	-0,023	-0,288	-0,028
ROW	-0,090	0,012	-0,180	0,014
CNA	0,624	-0,578	1,080	-0,171
EU15	0,108	-0,510	0,144	-0,554
REC	0,936	0,095	1,086	0,411
LSA	-0,170	-0,076	-0,300	-0,103
ASIA	-0,204	-0,058	-1,233	-0,065
MIDE	-0,336	-0,487	-0,168	-0,313

Table 3: Regional net capital outflows

Real income and GDP losses are influenced negatively by facing higher reduction targets and costs leading in a worsening of terms of trade effects, imports tend to enhance whereas exports diminish. For non Annex I countries, the additional initial endowments of permits improve the economic situation drastically, negative economic effects by meeting the Kyoto emissions reduction targets can be overcompensated. This offers the opportunity for those countries to rise the exports levels, especially the export of permits due to non binding reduction targets cause substantial capital inflows in comparison to the Kyoto case(see Table 3). Because of binding abatement targets, Annex I countries like USA or EU have to buy permits and suffer by economic losses initiating declining terms of trade effects which all leads to an increase of capital outflows. This reveals substantial financial wealth transfers from countries that are buyers to countries that are sellers of permits. The permit allocation by GDP shares largely reverse some of the above mentioned effects so that USA or EU will become permit seller, this explains also the welfare gains displayed above. In contrary, Russia has to buy permits which clarifies the huge welfare losses in both scenarios.

If we compare these results with the compensation criteria where the responsibilities transfer the revenues from permit trade within Annex I regions to non Annex I regions due to the egalitarian and the GDP criteria, welfare effects are not as significant as if we allocate initial permits endowments due to population proportions or GDP shares. By comparing first a per capita share redistribution of revenues with a base Kyoto reduction target scenario or a 25 % emissions abatement case, welfare effects in terms of real income changes lead to equity by improving welfare to less developed countries, whereas Annex I countries suffer higher welfare losses. The revenue redistribution per GDP causes welfare increases of Annex I countries, but cannot balance inequities.

This is because the revenue redistribution is ruled by GDP shares of all world regions and not as ability to pay compensation criteria due to the responsibilities, which is simulated as Polluter Pays Principle (PPP) demonstrated later.

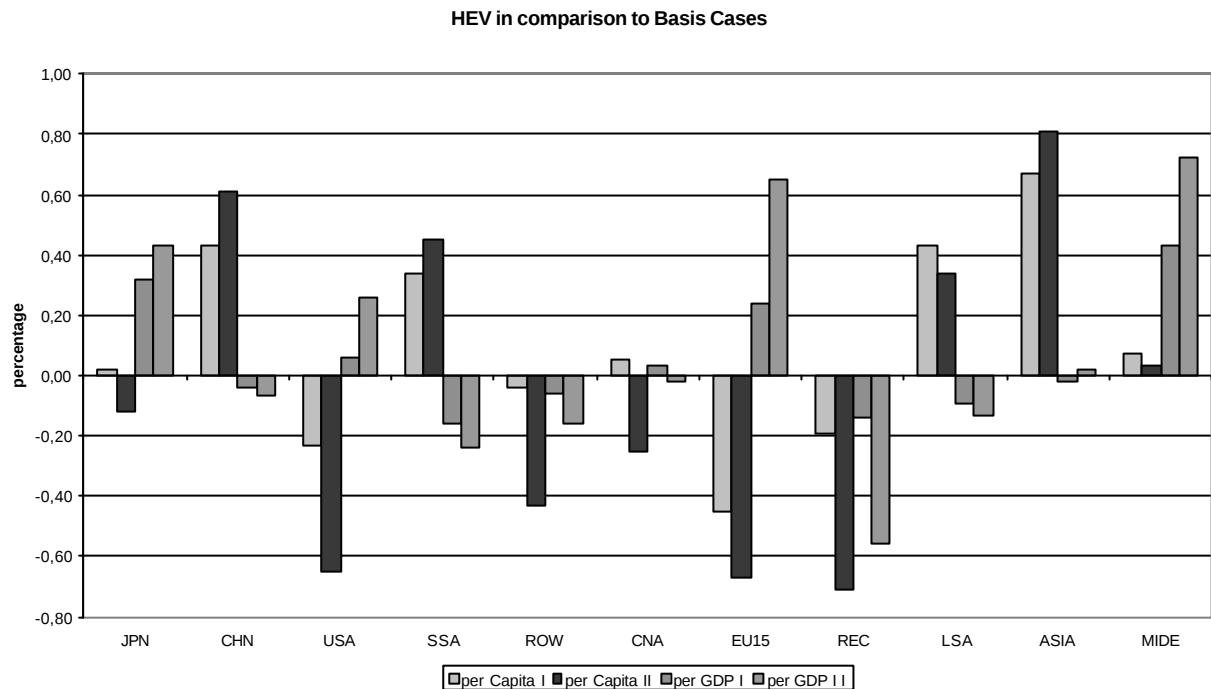


Figure 3: HEV developments of diverse equity scenarios in comparison to base cases

These scenarios are compared against Kyoto reduction scenarios of 5 or 25 % emissions abatement and Annex I permit trade. This explains why the regions of Russia and Eastern Europe (REC) suffers such high welfare losses. Formerly, REC was the main permit seller within the Annex I permit trade because of the previously described “hot air” effect. Because of the revenue redistribution due to per capita or per GDP rules, this region has to allocate the revenue to nations with high population like Asia, China or South America. In the same way, the revenue distribution due to GDP shares means that its revenues of permit sells have to be redistributed to countries with high GDP shares. From a pure equity perspective, this does not lead to a fair development in that sense that countries with high GDP shares will become better off although there are most responsible for climate change.

A very pragmatic translation of the Sovereign equity criteria leads to an equal emissions reduction which induce welfare losses to all world regions. From an ethical point of view the Kantian criteria should be translated into a huge abatement target for developed regions whereas vulnerable regions should be compensated. However, this is simulated as the Polluter Pays Principle PPP which will be demonstrated later. Interpreting the Kantian principle “do not to others what you would not want to

happen to yourself” as the Sovereign criteria in that sense that each country choose the abatement level that everyone would like to others to undertake means that each country chooses a significant abatement level. Because of the general equilibrium framework of this analysis, the Kantian paradigm is interpreted as equal percentage reduction targets for all world regions.

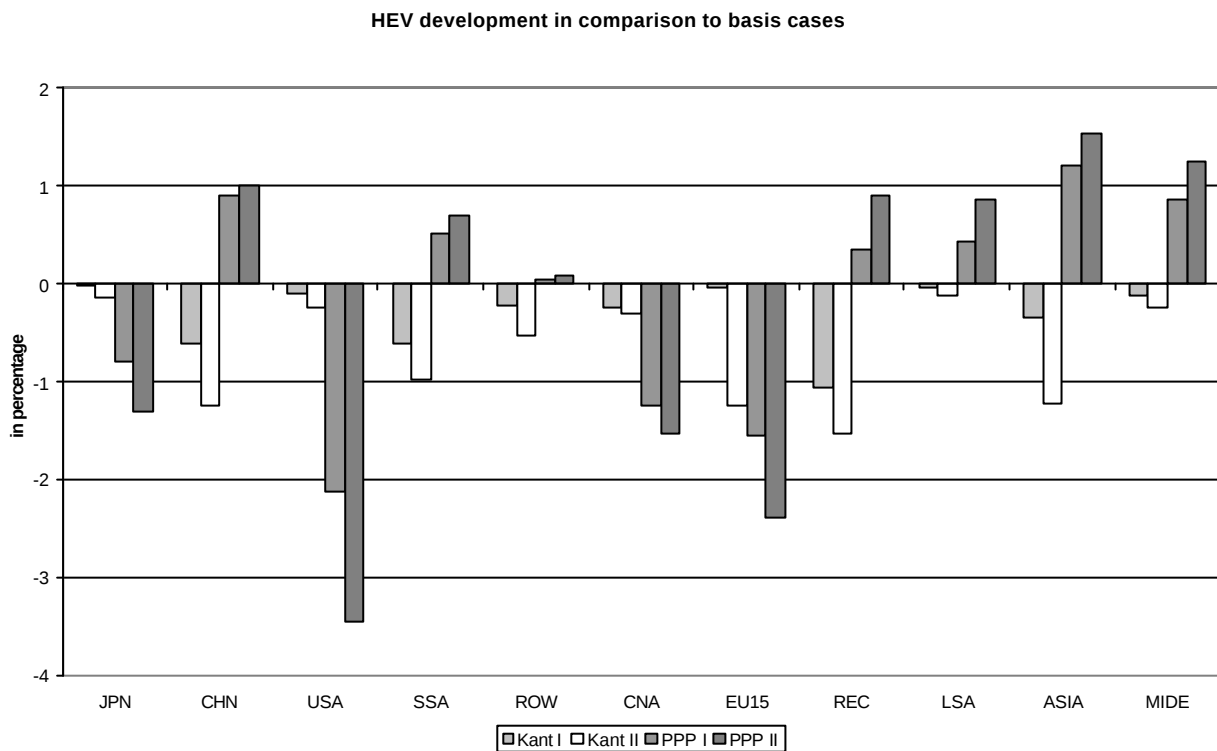


Figure 4: Real income effects of different equity scenarios

Due to the Sovereign scenario we distinguish between two cases where we assume equal emissions reduction targets to all world regions which cannot alleviate the negative welfare effects to developing and developed countries. If all nations face equal binding reduction targets, not only developed regions will be triggered by welfare losses but also and especially developing countries suffer by huge economic losses. By interpreting the Sovereign equity criteria as an equal percentage share of emissions abatement in all world regions, total and regional welfare is diminished drastically.

The polluter pays principle encourages all regions responsible for high pollutions to compensate the most vulnerable, in our case the less developed regions. These capital flows leads to an increase of economic welfare to regions like ASIA and CHN but significantly reduces the economic welfare of the polluting countries, i.e. the main responsibilities like USA and EU.

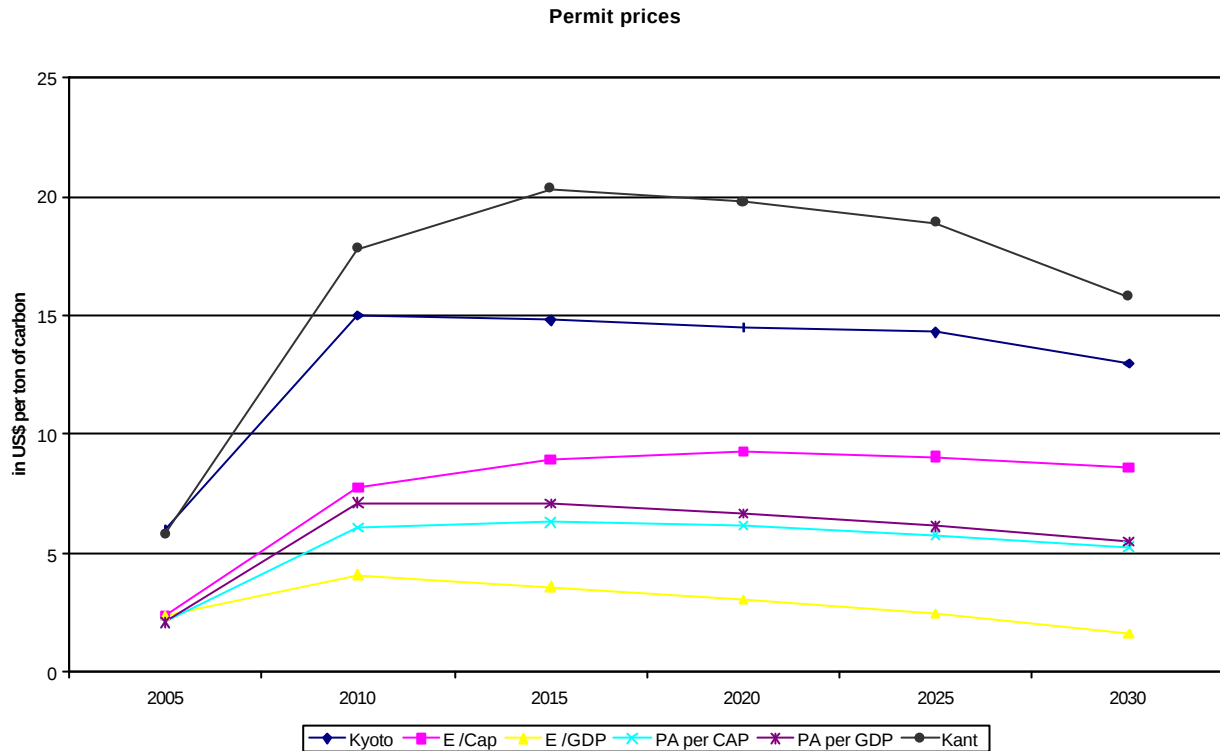


Figure 5: Permit Prices

Permit prices vary as open the market for tradable permits will be, in the case of Kyoto reduction commitments the permit price is higher because of binding abatement targets for most Annex I countries, main seller of permits is the REC region (“hot air”). The world trade of permits signifies an increase of supply which causes a falling permit price. An equal permit allocation due to emissions per capita shares intends higher reduction targets for Annex I countries which induce a higher demand resulting in an increasing permit price whereas an initial permit allocation ruled by GDP shares lowers the demand for permits because of lower abatement costs due to less obligatory reduction targets. An uniform reduction target for all world regions leads obviously to an increasing permit price because of rising demand but not increasing supply.

IV. Evaluation and assessment

Within climate change negotiation processes, equity contributes essentially as an argument to balance burden of climate changes between all world nations. Fundamentally, most vulnerable regions fear substantial burden of climate changes without being responsible. Equity as balance of burden and costs or as balance of welfare gains is especially interesting for economic analysis. This paper

investigates potential economic impacts by diverse interventions due to equity definitions and presents several outcomes:

1. Global emissions permit trade augments economic welfare of all world regions but mainly of developing regions, this is confirmed also by several other studies
2. Global permit trade lowers abatement costs of Annex I countries substantially; carbon leakage is avoided by global permit trading
3. Model results reveal substantial financial wealth transfers from countries that are buyers to countries that are sellers of permits
4. The initial allocation of tradable permits reveals to be crucial, under pure equity concerns the initial distribution of permits can be an instrument to enhance welfare of developing regions considerably
5. By allocating emissions permits due to the equal share of per capita emissions Annex I countries face high emissions reduction targets and emissions trading encourages developing regions to participate
6. The distribution rule of initial emissions permits due to the GDP shares favours Annex I regions and do not lessen inequities between rich and poor
7. The initial allocation of permits due to per capita shares offers higher welfare increases to developing regions than a revenue redistribution because of the market efficiencies of permit trading
8. World trade of permits lowers the permit price because of rising supply which also moderates the abatement costs of Annex I countries substantially
9. The Polluter Pays Principle (PPP) causes surely high welfare losses to the most responsible regions like USA or EU, but cannot enlarge the welfare gains of developing regions in that considerable extent as the initial permit allocation rule per capita
10. If Sovereignty is interpreted as an equal percentage emissions reduction target to all world regions, world economic simulations expose substantive economic losses
11. Under pure equity concerns, the initial allocation of permits due to per capita shares brings benefits to developing regions and is revealed as one of the most favourable equity criteria by this analysis

In comparison to the Kyoto reduction agreement, global and regional welfare can be improved by the permission of global emissions trading. Special attention is paid on the economic welfare development of non Annex I countries, due to different equity criteria extensive burden of climate

change can be avoided. From a pure equity point of view, economic losses of developing regions by implementing the Kyoto emissions reductions targets can be prevented by either emissions permits allocation or revenue redistribution by capita rules or by a compensation of most vulnerable regions.

V. Conclusion

Within the context of climate change negotiation processes, equity is discussed in the literature and in reality very comprehensively. The literature and also model calculations pay distinguished attention to equity aspects. From the beginning of climate change negotiations developing countries stressed on equity concerns. But, because the world regions responsible mainly for climate change are triggered by the major interest of minimising negative economic costs of emissions abatement, equity aspects has become only a secondary decision factor. In active climate change negotiation processes, equity is confirmed to be a valuable and principal criteria of burden sharing, but real policy implementation is largely directed by hard facts of economic interests. As long as most vulnerable regions facing high costs of climate change are represented by countries with less economic and political power within the world context, negotiation results will be dominated by the interests of the developed world and its benefits.

This paper demonstrates that the economic implications of implementing the reduction targets of the Kyoto protocol vary extensively by taking into account equity criteria. Developing regions could benefit significantly by allowing world emissions permit trade where the initial allocation of permits is ruled by per capita shares. But, developing regions could also benefit by merely allowing permit trade globally. This knowledge could bring together contrary interests conflicts of future climate change negotiation parties.

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