MAGKS

Joint Discussion Paper
Series in Economics

by the Universities of
Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen

ISSN 1867-3678

No. 34-2011

Sven Rudolph and Christine Lenz and Achim Lerch and Barbara Volmert

Towards Sustainable Carbon Markets: Requirements for Ecologically Effective, Economically Efficient, and Socially Just Emissions Trading Schemes

Coordination: Bernd Hayo • Philipps-University Marburg
Faculty of Business Administration and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

TOWARDS SUSTAINABLE CARBON MARKETS:

REQUIREMENTS FOR ECOLOGICALLY EFFECTIVE, ECONOMICALLY EFFICIENT, AND SOCIALLY JUST EMISSIONS TRADING SCHEMES[1]

Sven Rudolph, Christine Lenz, Achim Lerch, Barbara Volmert[2]

Abstract

Domestic climate policy emissions trading schemes appear to be spreading all over the word. However, carbon markets in existence often suffer from dilution in terms of ecological effectiveness, economic efficiency, and social justice. Thus, in order to firmly base carbon markets on the main pillars of Sustainable Development, this paper defines the criteria of ecological effectiveness, economic efficiency and social justice and operationalizes them for giving design recommendations for sustainable carbon markets. Methodologically, the paper uses welfare and institutional economics, jurisprudential reasoning, and modern climate justice thinking in order to discuss the three criteria. In addition, design and implication analysis is applied in order to develop design recommendations for sustainable carbon markets. By doing so, the paper provides evaluation criteria for emissions trading schemes in existence and in planning, but also allows for improvements in order to make emissions trading a valuable instrument of a sustainable global climate policy.

Keywords: sustainability, emissions trading, climate policy, justice, efficiency, effectiveness

JEL-code: D62, D63, Q48, Q54, Q58

1 Introduction

Although environmental economists have intensively analyzed tradable emission rights since the invention of the instrument by Dales (1968), have emphasized its merits in terms of ecological effectiveness and economic efficiency (Tietenberg 2006), and have even proven emissions trading scheme's (ETS) applicability e.g. in traditional clean air policy in the USA (Ellerman 2000, OECD 2004), it took until 1997 to introduce this instrument in climate policy. The Kyoto Protocol of 1997 allows the use of flexible mechanisms such as International Emissions Trading (IET) (Art. 17 KP), Clean Development Mechanism (CDM) (Art. 12 KP) and Joint Implementation (JI) (Art. 6 KP). Nevertheless, besides earlier experiments in EU member states such as Denmark and the UK, the EU ETS of 2005 was the first supranational carbon market aiming at substantially reducing emissions of carbon dioxide (CO_2) and lowering compliance costs. However, the results were ambiguous (Ellerman et al. 2010): The pilot phase (2005-2007) had almost no ecological effect, the carbon market suffered from

[1] This paper is part of the research project „Linking Emissions Trading Systems: Towards Socially und Ecologically Acceptable Cap-and-Trade Policies in Europe, the USA, and Japan (LETSCaP)", carried out at the Competence Center for Climate Change Mitigation and Adaptation (CliMA) at Kassel University and sponsored by the German Federal Ministry of Education and Research (BMBF).

[2] Dr. Sven Rudolph is Assistant Professor at CliMA, Christine Lenz and Barbara Volmert are researchers at CliMA; Prof. Dr. Achim Lerch is Professor at the Hesse University of Cooperative Education.

over-allocation (8.3% above 2005 level) and price fluctuations (30-1 Euro), and distributional effects (windfall-profits, competitive distortions) were unfavorable. The second phase (2008-2012), instead, proved to be more beneficial due to a more stringent cap (-5.6% below 2005 level) and an increasing share of auctioning (up to 10%). Still, major improvements are yet to come in the third phase (2013-2020), when a stringent single EU-wide cap is steadily decreased to 21% below 2005 levels, initial allowance distribution is increasingly based on auctioning (100% for utilities, increasing share for energy intensive industries), and revenues are used for climate protection and adaptation measures. Besides the EU (including European Economic Area, EEA, countries), carbon markets are implemented in Switzerland, Japan, New Zealand, and the northeastern USA, while they are seriously considered in many parts of the world, even on the regional and local basis.[3]

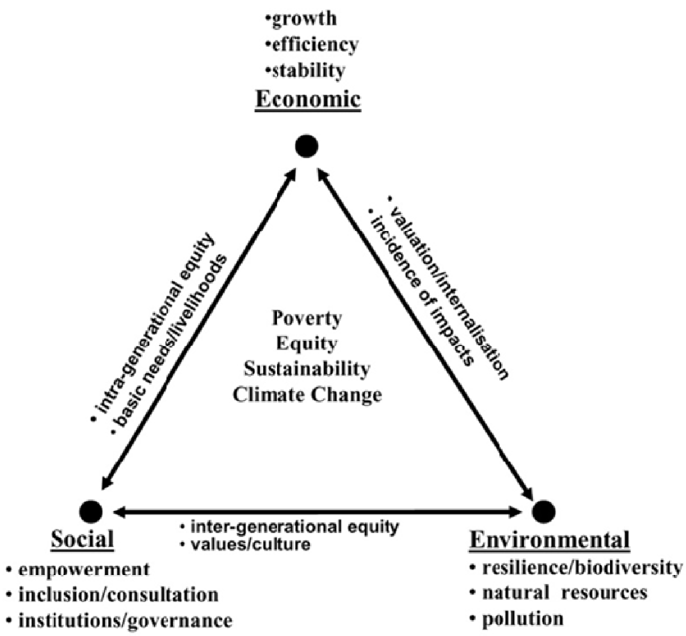
Figure 1: Implemented (bold) and planned GHG ETS

Despite its theoretical merits and its proven empirical capacity, ETS' detrimental ecological, economic, and distributional effects have been heavily criticized by environmental and social movements as well as by the industry (Altvater/Brunnengräber 2008). While some critique is exaggerated, in many cases, at least up to now, climate policy ETS in practice are not based on ambitious sustainability criteria. Nevertheless, effective, efficient, and just climate protection is undoubtedly necessary, because unrestrained global climate change will inevitably cause unpredictable and irreversible damage to the ecosystems mankind depends on (IPCC 2007), it induces adaptation costs way beyond the costs of immediate climate protection (Stern 2007), and it inflicts unethical harm to present as well as future generations (WCED 1987). Thus, any climate policy has to be based on sustainability criteria in order

[3] For Internet-information on the respective ETS see e.g. http://www.bafu.admin.ch/emissionshandel/05538/05540/index.html?lang=en; http://www.climatechange.govt.nz/emissions-trading-scheme/, http://www.rggi.org/home; http://www.kankyo.metro.tokyo.jp/en/climate/cap_and_trade.html; http://www.westernclimateinitiative.org/, http://www.midwesternaccord.org/index.html, http://www.pewclimate.org/federal/congress; http://www.climatechange.gov.au/, http://www.pointcarbon.com/news/asia/.

to prevent detrimental economic, ecological, and social effects. Despite ongoing debates on the definition and operationalization of sustainability and the even widespread abuse of the term (Pezzey/Toman 2002), the concept defined by the Brundtland Report (WCED 1987: 43) still appears to be useful: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Following Munasinghe (1992), sustainable development consists of three key elements: environment, economy and society.

Figure 2: Key Elements of Sustainable Development



Thus, sustainable policies have to meet environmental, economic, and social demands. In this sense, this paper answers the following questions:

- How can the criteria of ecological effectiveness, economic efficiency, and social justice be defined and operationalized for ETS applications?
- How should ETS be designed in order to fulfill these criteria?

To answer these questions, this paper uses welfare and institutional economics in order to formulate recommendations for ETS, so that e.g. abatement and transaction costs are minimized. In addition, environmental economics' and jurisprudential arguments are used to develop criteria that guarantee that ETS e.g. reach their environmental targets and set incentives to innovate. Ultimately, modern climate justice reasoning is used to define requirements, so that ETS meet demands of e.g. inter- and intra-generational justice. Thus, the paper proceeds in the following way: First, the criteria of ecological effectiveness, economic efficiency, and social justice are defined and operationalized for the discussion on ETS, and the main design features of ETS are described (2). Second, design recommendations for effective, efficient, and just ETS are developed (3). Ultimately, the results are summarized and existing ETS are briefly evaluated on the basis of the sustainability criteria for ETS (4).

2 Criteria for and Design Features of ETS

2.1 Design Features

Basically, as proposed by Dales (1968), the decisions to be made when cap-and-trade policies are implemented are twofold; other authors add a third dimension (Rudolph/Jahnke/Galevska 2005: 563f):

- overall amount of allowed emissions (cap)
- initial allocation of emission allowances (distribute)
- framework of the secondary market (trade)

In order to further differentiate these dimensions for the implementation of ETS in real-world climate politics, the following design features apply (Sterk et al. 2006, Roßnagel/Hentschel/Bebenroth 2008):

- coverage and bindingness
  - pollutants
  - emitters (incl. upstream vs. downstream)
  - bindingness (binding vs. voluntary)
- cap
  - total amount of emissions (incl. absolute volume vs. specific intensity targets)
  - dynamics of the cap (depreciation of allowances, reduction of cap size)
- initial allocation and validity of the allowances
  - free of charge (grandfathering, benchmarking) vs. for purchase (auction, fixed price)
  - banking and borrowing
  - offsets (domestic, international)
- trading system
  - compliance periods
  - marketplace
  - market interventions (safety valve, price limits etc.)
- monitoring and penalties
  - monitoring, reporting, verification (MRV)
  - registries (allowances, emissions)
  - penalties
- Additional Measures

In order to implement sustainable ETS these design features have to be adjusted to the following basic criteria of ecological effectiveness, economic efficiency, and social justice.

2.2 Criteria

2.2.1 Ecological Effectiveness

Theoretical as well as empirical studies on ETS (Michaelis 1996, Rudolph 2005, Tietenberg 2006; Ellerman 2010, OECD 2004) point to the importance of the following environmental effects of tradable pollution rights already emphasized by Dales (1968: 801ff):

- accuracy in reaching the target
- means to adapt to structural changes (increased environmental risk, economic growth etc.)
- incentives to innovate
- carbon leakage

First and foremost, once the environmental target of ETS including the corresponding total number of emission allowances is politically determined and emitters are obliged to hold an emission allowance for each and every unit of emissions, the overall environmental target is met with utmost accuracy, given monitoring is perfect. Contrary to environmental taxes, which represent a price control market-based instrument, ETS are quantity control instruments, in as much as the government decides about the total amount of emissions allowed.

In addition to ETS' accuracy, if necessary (e.g. due to higher environmental risks), the total quantity of emission allowances could be easily changed by the government either by depreciating the value of allowances over time, by buying allowances from the market, or by simply handing out fewer allowances in the next round of initial allocation. Anyway, after the readjustment of the total amount of allowances, again the new target will be met accurately without any delays. In the case of an increase in demand (e.g. due to economic growth), for environmental reasons, there is no need to revise the ETS, because the overall supply of emission rights has been fixed ex ante.

Cap-and-trade systems just as any market-based policy instrument and contrary to command-and-control set permanent incentives to innovate. As emitters have to pay for each and every unit of emissions, developing and using a more cost-efficient abatement technology not only saves them emission reduction costs, but also allows them to sell surplus emission allowances and make extra profits.

Ultimately, ambitious domestic climate policy including ETS may cause carbon leakage, if competing countries induce lower carbon costs on emitters. Production sites may then be moved to the new host country and emissions may even increase globally, if the new host has less stringent policies in place.

2.2.2 Economic Efficiency

In terms of efficiency, tradable permits follow the Standard-Price-Approach (Baumol/Oates 1971), thus inheriting its main economic characteristics (Rudolph 2005, Tietenberg 2006, Endres 2007):

- company-level efficiency

- society-level efficiency
- attribution of costs
- administrative costs
- transaction costs
- property rights
- competition

Company level efficiency is achieved by allowing emitters to choose their individual optimal level of emissions by matching marginal abatement costs and the allowance price, the latter being determined by supply and demand on the allowance market.

Due to a unique price signal from a competitive market and the matching of the market price with marginal abatement costs by each and every polluter, marginal abatement costs are equalized across all polluters, which in turn characterizes the efficient allocation of abatement efforts and emission rights across the economy. In this way, environmental target can be reached at lowest cost to society.

At the individual firm level, market-based instruments make the polluter pay not only for abatement – as is the case in command-and-control regimes –, but also for the remaining part of the emissions. For every emission unit caused, polluters have to acquire an emission allowance and pay its price. However, the additional burden to polluters depends on the initial allocation scheme. If allowances are sold, a real extra burden emerges; if allowances are handed out free of charge, there is no such burden. In the former case, however, the revenues can be used for redistributive purposes or for lowering distortional taxes in order to create a double dividend (Bovenberg 1999).

In terms of administrative costs, being the costs that governments have to bear when implementing environmental policies, theoretically ETS lowers the burden compared to command-and-control policies, because – in addition to monitoring measures – the administrative body only has to fix the total amount of emissions and distribute the allowances. Individual approval of facilities and abatement technologies would be redundant.

Transaction costs, which arise when property rights are transferred, lower the trade volume of allowances and thus can lead to efficiency losses (Stavins 1995). However, transaction costs can be kept to a minimum if allowances are traded on established markets or brokered by experienced agents and if additional approval requirements for individual allowance transactions do not apply.

In terms of property rights (Bromley 1991), property can be based either on natural rights (Locke) or on a social contract (Kant), whereat the first only allows expropriation if compensation applies, while in the latter case a societal consensus can change property regimes, e.g. if former free emission rights are auctioned off under ETS. By fixing a total allowable amount of emissions, ETS, as a first step, transforms open access to natural resources into state property. Afterward, by handing out emission allowances, state property is transformed into private property. Thus, ETS, as Bromley (1991) and

Daly (1999) demanded, separates the decision about the total scale of the economic subsystem from the distributional and the allocation decisions. In this way, also, only patrimonium, the right to use the resource (usus, usus fructus), is granted to emitters, while dominium is not, because the government prevents abusus by limiting the total amount of emission rights.

Competitive distortions can occur on emission allowance markets, if the underlying market (e.g. the electricity market) is imperfect; however these problems have to be dealt with at the level of the underlying market. Serious competitive distortions could also be induced by free-of-charge initial allocation schemes, and have to be dealt with by the issuing authority. In addition, market participants could stockpile emission allowances. If allowances are hoarded for future use or arbitrage profits, no distortion would occur. If, however, allowances are kept in stock in order to prohibit competitors' market entry, this would signify a serious competitive distortion. However, such kind of distortions is unlikely due to individual profit maximization, and they can be kept to a minimum by market surveillance authorities. Ultimately, higher carbon costs induced by ambitious domestic climate policies may lower this country's competitiveness on the world market and lead to leakage of production sites and jobs.

2.2.3 Social Justice

Contrary to the well-defined criteria of ecological effectiveness and economic efficiency, the criterion of social justice and especially its targets are controversially debated and rather insufficiently defined. It is even questioned if justice can be defined in abstract terms, or if justice is rather a concept of competing claims and case-by-case negotiations about a fair outcome, while others argue that even claims can be logically discriminated against and priorities can be defined without ethically discriminating against individuals. Anyway, as climate change strongly influences the livelihood of current and future generations, ETS distributes entitlements to use the commonly owned atmosphere. At the moment, these distributional decisions are not based on historic responsibilities for climate change. Therefore, it has to be considered how a just distribution can be achieved i.e. in which way different claims can be respected. In this context, the following concepts of social justice are important (Helmstädter 1997, Krebs 2000, Lerch 2003):

- procedural justice vs. the result of distributive justice
- justice in transfer and acquisition, justice within allocation and redistributive justice
- desert-based justice and welfare-based justice
- egalitarianism vs. non-egalitarianism
- inter- vs. intra-generational justice

Procedural justice assumes that only the procedures and rules of social processes can be just, while the result of distributive justice refers to fair outcomes of social processes. Critics state that the orientation towards the result of distributive justice implies presumptuousness with respect to the availability of knowledge (Nozick 1974, Hayek 1996). However, using some notion of the result of distributive justice is indispensable already on theoretical grounds, and studies from economic psychology show that individuals base their economic decisions on result-based concepts of fairness (Kahnemann/Knetsch/Thaler 1986). Thus, especially in the context of economic decision making, some concept respecting the results of a distribution is inevitable, whereat justice in transfer and acquisition, justice within allocation and redistributive justice (Helmstädter 1997) can be distinguished.

Justice in transfer and acquisition demands that an effort is compensated by an equivalent service, a requirement that is inherently fulfilled by ETS. Justice within allocation, in contrast, asks for a fair distribution of goods according to individual claims. Redistributive justice, however, refers to a fair outcome of a redistributive procedure subsequent to the market allocation. If these concepts are accepted, the question arises, what the criteria for the distribution are.

Welfare-based justice asks for a fair distribution based on the needs of individuals. If desert-based justice is applied, however, the distribution of goods is fair, if it is based on the share individuals have contributed to the goods' production. But desert-based justice is faced with problems of measurement, e.g. because effort can be measured in input or output terms. In addition, with respect to questions of access to natural resources, the concept of desert-based justice has its limits, because even if the appropriation of natural resources is legitimized by mixing natural service with human labor, still, a relevant part of the result is provided by nature. A combination of desert-based and welfare-based justice implicitly proposed by Marx (1972) – "from each according to his ability, to each according to his needs" – is heavily criticized by economists, because this mixture does not set the right incentives. Rawls (1971), however, proposed a combination of thee two concepts, which is still considered to be a groundbreaking contribution to the theory of justice and the discussion on equality.

In the "why equality"-debate (Krebs 2000) it is argued that, firstly, egalitarianism confuses equality being a goal of justice with it being a byproduct of justice; secondly, equality may have inhumane consequences; thirdly, equality underestimate the complexity of the concept of justice; and fourthly, equality is simply not feasible. As an alternative to equality, inviolable standards such as human dignity have to apply. Nevertheless, while equality cannot be considered as the sole criterion for justice and it most certainly has to be accompanied by minimum standards, preferring equality to inequality seems likely (Ott/Döring 2004). But even if equality is accepted, the "equality of what"-question arises. Reference points proposed in the literature are e.g. preferences and talents not under individual control (Sen), basic rights (Nozick), income (Daly). While a naïve notion of equality in terms of equal welfare for everybody seems rather inadequate, Rawls (1971) suggested aiming at equality in terms of rights and freedom as well as chances and opportunities, while inequalities can be accepted for income and capital, if, and only if they deliver the highest benefit to the poorest, and if offices and positions are equally open to everybody (difference principle).

Ultimately, questions of intra- and intergenerational justice are relevant. The Brundtland Report (WCED 1987) emphasized that the needs of current as well as the needs of future generations should be taken into account. While intra-generational justice refers to the distribution within one generation – e.g. on the national (rich vs. poor citizens) or international (industrialized vs. less developed countries) level – inter-generational justice accounts for differences between present and future generations.

3 Design requirements for effective, efficient and just ETS

In order to establish sustainable carbon markets that reach climate protection targets reliably at minimum cost to society and without major detrimental distributional effects, ETS have to be designed in a way that accounts for the above defined criteria. Considering the specific design features of ETS, the following recommendations can be given (Heister/Michaelis 1990, Boemare/Quirion 2002, Ott/Sachs 2002, Butzengeiger/Betz/Bode 2001, WBGU 2009, Fankhauser/Hepburn 2010, Harris 2010).

3.1 Coverage and Bindingness

Sustainable carbon markets should cover pollutants and emitters comprehensively but downstream, oblige participants to engage in climate protection, include opt-in provisions while excluding opt-out options for the following reasons.

As efficiency gains are the biggest when marginal abatement costs differ greatly amongst pollutants, coverage should include all pollutants. In addition, the share of scarcity costs charged to the originator of emissions is the biggest if coverage is comprehensive. Also from a competition perspective coverage should be comprehensive, in order to establish an efficient market and prevent thin markets, which might lead to efficiency losses. From an ecological perspective, covering all pollutants allows for the biggest environmental effects, because all emissions are capped. While CO_2 is the major GHG in terms of overall global warming effects, other GHG have a stronger impact per unit and their emissions are also increasing. Thus, all GHG should be included in a carbon market, whereat non-CO_2 effects can be calculated on the base of Global Warming Potentials (GWP). However, if monitoring cannot be guaranteed for some pollutants (e.g. non-CO_2 GHG), if administrative costs of greater coverage exceed potential efficiency gains, or if there are already regulations in place, these pollutants might be excluded. In this case, coverage should be focused on the most potential pollutants in terms of overall global warming effects (e.g. CO_2) in order to maximize ecological effects and optimize on abatement and administrative costs, while pollutants with only a small contribution to global climate change might be excluded; but again, the specification of criteria for exclusion increase administrative costs. From a justice perspective, also, coverage should be comprehensive, because only this would fulfill the equality and the polluter-pays criteria – here, the application of the polluter-pays principle as a criterion for social justice allows for taking into account historic responsibilities and therefore assures that desert-based justice is kept in mind. If only selected GHG would be covered, emitters of these covered gases would be discriminated against those who only emit other GHG but are also responsible for detrimental climate effects. CO_2eq should be used to include non-CO_2 GHG. Even though the social context of emissions is veiled by CO_2eq, procedural justice calls for CO_2eq, because distinct natural scientific criteria are applied and only CO_2eq would enable the ETS to treat all GHG equally. Nevertheless, there might be reasons to exclude some GHG either because they cannot be reliably monitored, which would violate the polluter-pays principle as well as the inter-generational-justice criterion, or unjustifiable competitive disadvantages would arise. While in the latter case, inter-generational justice would call for full coverage, intra-generational justice may justify exemptions.

In terms of emitters of GHG, the same economic, ecological, and justice arguments apply, making comprehensive coverage, independent of size, emissions, costs etc., most beneficial.

As a consequence, from the viewpoint of effectiveness and justice, upstream ETS, in which emissions are covered at the level of entrance into the economic system (e.g. fossil fuel producers or importers), appear to be preferable to downstream approaches, where emissions are covered at the point of actual emissions (e.g. utilities), because upstream ETS account for up to 100% of total emissions, while downstream ETS usually only cover about 50%. In addition, as upstream ETS are easier to monitor due to the smaller amount for sources, ecological targets can be reached more accurately, which also fosters inter-generational justice, and the polluter-pays principle is fulfilled to a larger extent. However, due to upstream system's usually smaller amount of market participants, from an economics' perspective, downstream ETS appear to be preferable for competition reasons, because they provide a more liquid carbon market. On the other hand, administrative costs might be lower in the case of upstream ETS, because fewer sources have to be monitored. If both approaches are combined, however, double burdens may arise, if some emitters face direct, downstream-induced emission costs and upstream-increased fuel prices. In order to achieve an efficient allocation, double burdens have to be avoided, because they distort the price signal; however, prevention measures make the system more complex and thus increase administrative costs. Altogether, while upstream ETS is advisable from an ecological and justice perspective, economics would recommend a downstream approach; thus a downstream system with broad coverage could be a compromise.

Participation has to be binding for covered sources. From an economics' perspective, in the absence of additional participation incentives, only allowance-sellers with low marginal abatement costs would participate in the carbon market, because only they expect profits from selling surplus emission rights why others expect an increase in costs. This would create a market with supply but without demand for allowances and thus prevent an efficient allocation. If in the case of voluntary participation additional incentives for potential participants are provided, these kinds of subsidies tend to increase the financial burden for the government, create competitive distortions, and thus lead to welfare losses. Also, only a binding ETS allows for charging additional emission costs to the physical originator of emissions, because in a voluntary system additional costs would be shunned. Ultimately, competitive distortions could only be prevented by compulsory participation of all emitters. From an environmental perspective, voluntary ETS tend to have less stringent targets (e.g. specific individual intensity targets), in order to give potential participants an incentive to take part. In addition, penalties are less feasible, because emitters would avoid them by not participating. Binding systems, however, on the other, can be used to implement ambitious targets that would be achieved accurately, because emitters are obliged to engage in climate protection and can be heavily penalized if they don't. From a justice perspective, only binding participation would guarantee compliance and thus be in line with inter-generational justice. Also, according to the polluter-pays principle, emitters must bear the costs of emissions. Ultimately, following the equality criterion, all emitters must be treated in the same way and thus have to participate on the same terms.

If ETS are already implemented, opt-out options allow emitters to withdraw from participation ex post, while opt-in provisions enable emitters to enter into an existing ETS after its introduction. If in the case of opt-outs emitters are not covered by comparable policies, losses in ecological effectiveness, economic efficiency, and social justice of ETS would occur, because the same arguments as in the case of voluntary participation apply. On the other hand, opt-ins may increase coverage and thus lead to a more efficient, effective, and just ETS. In the latter case, however, the cap and other design features have to be readjusted to the new coverage, which, in turn, might increase administrative costs.

3.2 Cap

Sustainable carbon markets should implement an absolute volume cap that is based on the ecological need of restricting climate change to +2°C, introduces scarcity and considers the needs of current and future generations according to the "Contraction & Convergence" concept.

While the optimal level of pollution is impossible to determine exactly by economics (Baumol/Oates 1971), cost-benefit-analysis can help approximating a reasonable level (Stern 2007). In any case, the politically given environmental target asked for by Baumol/Oates (1971) and thus the cap has to create scarcity in order to implement a price signal for individual emitters' internal emission level optimization. Greater scarcity increases the incentives to innovate and to develop more efficient production and abatement technology. By fixing an adequate cap size, also, the open access resource is transformed into state property and the scale decision is made independent of distribution and allocation, allowing the government to prevent abusus of the resource (patrimonium). In addition, other criteria such as environmental necessities or fairness criteria can be used, thus lowering decision-making costs. From an ecological point of view, the cap must be in line with the needs for global climate protection, e.g. keeping the average global temperature below +2°C compared to the pre-industrial level. Total allowable emissions can then be easily calculated in absolute volume terms. By using the Budget-Approach (WBGU 2009), a total allowable amount of emissions of 1,100 billion tons of CO_2eq for the period of 1990 to 2050 can be calculated, which, due to emissions in the past, leave only 600 billion tons of emissions for the period 2010 to 2050. If then for justice reasons (equality, polluter-pays principle) equal rights to use natural resources for each and every person all over the world are accepted, national emission caps can be derived immediately and even historic responsibilities can be accounted for following the polluter-pays principle. If however, intra- and intergenerational justice should apply, the “Contraction & Convergence”-concept (Meyer 2000) appears preferable, in which the total number of emission allowances decreases form the status quo to an ecologically acceptable level (contraction), and per-capita emissions rights converge (convergence). This would result in a steep decrease in the cap sizes of industrialized countries, while less developed countries might even increase their emissions. Anyway, a stringent absolute cap would support inter-generational justice, because future generations would be safeguarded against dramatic changes in their livelihood. However, all too stringent caps may interfere with intra-generational justice, e.g. because due to regressive distributional effects of higher energy prices poorer households are faced with comparably high burdens. Again, the “Contraction & Convergence”-proposal would, at least to a good extent, take account of those restrictions.

When specifying the target, intensity targets (e.g. emissions per product or per unit GDP) cannot guarantee compliance with an overall reduction target, because economic growth and output increases may increase total emissions. Thus, only absolute volume targets allow for ecological accuracy and intergenerational justice, because the overall amount of acceptable emissions is fixed ex ante and future generations are protected to a certain amount. Also, in economic terms, absolute volume allowances can be more easily made marketable than reduction credits, thus saving administrative costs.

Changing the cap size over time might be necessary from an ecological, economic, and justice point of view. A reduction of the overall cap size or a devaluation of the allowances over time (e.g. 2% per year) might be reasonable e.g. in order to countervail the decreasing incentive to innovate in the case of ongoing emission reductions, allowance sales, and resulting price decreases. This would also improve government’s ability to countervail abusus of the atmosphere’s capacity to absorb emissions revising its scale decision. In addition, moving slowly but steadily from status quo emissions to the target level may lower transformation costs for emitters and minimize detrimental distributional effects in terms of intra-generational justice. While cap size changes are legitimate, if property is defined by a social contract, anyway, these changes should be decided upon in advance, in order to give emitters planning reliability. In addition to cap size changes announced in advance, ex post adjustments to new scientific findings e.g. about ecological requirements may be necessary. These, however, should be kept to the absolute minimum, because they have negative economic and distributional effects such as price fluctuations, depreciation of property rights, etc.

3.3 Initial Allocation and Validity of the Allowances

Sustainable carbon markets should auction off emissions allowances and use the revenues for reimbursement. Banking should be allowed, while borrowing may cause detrimental effects. Offsets should be accepted but limited in quantity and quality.

The initial allocation of emission rights is less relevant for the environmental effects of an ETS. As long as the overall cap is kept intact and the allocation of additional emission rights to one emitter means fewer allowances to other emitters, the environmental accuracy is not endangered. However, if changes in the overall amount of emissions rights are suspected to occur due to new scientific findings on ecological necessities, auctioning allows for easier implementation, because simply a smaller amount of allowances has to be offered for sale. Within free of charge allocations, though, where allowances are handed out based on historic emissions or output levels in a base year multiplied by a compliance factor, the compliance factor has to be changed, which induces additional administrative costs. In addition, auctioning immediately sets incentives to innovate, because the price signal is instantly visible, while if the initial allocation is free of charge, the price signal only develops on the secondary market and incentives are postponed. From an economics' point of view, the transformation of state property into private property by the initial allocation should be done by auctions, which can be justified on a social contract based notion of property. Also, only auctioning of clearly defined property rights to emissions immediately set an optimal scarcity price signal and thus lead to an efficient initial allocation on a competitive carbon market. In a fixed-price sale, initially, an optimal price signal can be hardly achieved, because the authority does not know the overall abatement costs, which is necessary to determine the optimal price. Thus, a trial-and-error process similar to the one proposed by Baumol/Oates (1971) for the tax case has to be used; however temporary efficiency losses are inevitable. In the probable event of not setting the optimal price, this will only be reached on the secondary market, where allowances are reallocated. Again, this creates uncertainty about the real price and at least postpones an efficient allocation of abatement measures and emission rights. The same is true in the case of an initial allocation free of charge, while uncertainty is even intensified and administrative costs dramatically increased due to the complexity of the distribution scheme. If benchmarking is used, fuel-specific benchmarks constrain emitters when trying to find the optimal abatement strategy, because incentives to use a fuel-switch as an abatement option are undermined. In addition, only auctioning implements the strong polluter-pays-principle, while allowances are given out for free, emitters only pay abatement costs but not the costs for the remaining emissions. Those are borne by the society. The decision about the initial allocation scheme is clearly a distributive one. If allowances are handed out free of charge, the scarcity rents introduced by the cap are transferred to the emitters. If the emitters are able to pass on the costs to consumers, emitters make extra windfall profits. If, however, allowances are sold, at least parts of the scarcity rents remain with the government. The proceeds of these sales can be used either for environmental protection, adaptation measures, damage compensation, re-distributional means, or they can be used to lower distortionary taxes and create a double dividend (Bovenberg 1999), which in turn increases overall efficiency. Administrative costs usually increase dramatically, if other initial allocation schemes than auctioning are used. Fixed-price sales have to find the optimal price by time-consuming trial-and-error, while grandfathering-schemes need to determine base-year emissions, compliance factors, early action provisions, newcomer reserves etc., and benchmarking-schemes need to establish respective benchmarks for clearly defined goods or product groups, historic output levels or output forecast with ex post adjustment etc. Ultimately, competitive distortions within the group of incumbents but also between incumbents and newcomers, which cause inefficiencies, can only be prevented effectively by auctioning off all allowances. If allowances are given out free of charge, competitive distortions are inevitable. In order to minimize them, incumbents and newcomers have to be treated the same. This, however, is almost impossible, because grandfathering and benchmarking are based either on past emissions or past outputs, both of which newcomers cannot provide. In addition, in the case of grandfathering, early action has to be taken into account in order to prevent rewarding the laggards; however, determining the period, for which early action is acceptable, must remain a somewhat arbitrary decision. In the case of benchmarking, products and product groups have to be clearly defined, the classification of which is not competition-neutral. In addition, newcomers have to use output forecasts and ex post adjustments, which may lead to temporary over-allocation of newcomers and under-allocation of incumbents. Thus, altogether, auctioning appears to be the far best way of initial allocation. From a justice perspective, auctions are preferable, because they follow the strong polluter-pays principle. Also, all emitters are treated equally. As auctioning is the most efficient way, it saves money, which can be used for redistribution or adaptation measures and thus foster inter- and intra-generational justice. In addition, auctions raise revenues, which, as proposed in the Sky Trust (Barnes 2001), can be reimbursed to citizens on an equal share basis thus following the principle of equal entitlements to natural resources; they can be used for adaptation measures in countries that suffer the most from climate change, thus fostering intra-generational international justice; or they can be used for other environmental, economic, or social purposes. However, auctioning may introduce heavy burdens on current emitters and, if costs are passed on, to consumers as well. In addition, emitters may be faced with higher burdens if compared to emitters in other countries with less stringent climate policies, which may result in carbon leakage. Auctioning thus raises questions of intra-generational national and international justice as well as inter-generational justice. Well designed re-distributional schemes for auction revenues as well as protective measures, however, may address these issues adequately. Also, free-of-charge-schemes may cause unjustifiable windfall profits for emitters. Concerning newcomers, they should be treated the same way as incumbents in order to fulfill equality and polluter-pays requirements.

Banking and borrowing, being the saving of early reduction credits for later use (banking) and the present use of future reductions (borrowing), from an economics' perspective both allow for intertemporal flexibility and enable emitters to exploit differences in marginal abatement costs and thus optimize abatement over time. In terms of ecological effects, banking allows for early reduction. As global climate change is an environmental problem caused by the accumulation of pollution, early emission reduction, even if compensated by later increases in emissions, do not cause detrimental effects. Borrowing, however, may lead to a dilution of the stringency of ETS, if credits for future reductions are used at present for emission compensation but are not compensated by real reductions in the future.

Thus, from an ecological point of view, banking should be allowed while borrowing should not. From a justice perspective, while banking does not interfere with social justice, borrowing may violate inter-generational justice requirements, if real emission reductions are not made in the future.

Similar to banking and borrowing, offsets, from an economics' perspective, allow for more flexibility and additional abatement options. Offsets enable emitters to exploit differences in marginal abatement costs between themselves and emitters that are excluded from ETS due to e.g. geographical (external offsets), size, or pollutant restrictions (internal offsets), thus increasing overall efficiency. If, however, offsets are accepted, their total amount should be ex ante determined as a part of the overall cap in order not to ex post dilute the scarcity price signal of the cap, undermine incentives to innovate, and dilute the cap. In any case, including baseline-and-credit-based offsets into a cap-and-trade system increases administrative costs, due to the complex calculation of baseline and project emissions, and the need to fulfill ambitious quality requirements such as the sustainability of the projects. Also, from an ecological point of view, the total amount should be included in the cap and offsets have to fulfill stringent sustainability requirements. They have to be additional, verifiable, permanent, and feasible. From a justice perspective, offsets may foster technology and money transfers to developing countries, thus increasing intra-generational international justice, given that offsets are ambitious and trustworthy. Quantity limits, however, do not have to apply from a social justice perspective, because the polluter-pays principle always fully applies no matter if the emitter pays for his own reductions or if he covers the reductions costs of other emitters.

3.4 Trading System

Sustainable carbon markets should be based on a smoothly functioning place with equally easy access for all emitters. Compliance periods can be long, if interim compliance control is implemented. Market interventions, however, should be kept to the absolute minimum.

From an economics' point of view, allowances should be traded at a marketplace already established in order to minimize set-up costs. As far as possible, trading should be IT-based. Stock exchange trading as well as direct bilateral or brokered trading should be possible, because they can help in bringing together supply and demand of allowances thus lowering search costs (Stavins 1995: 145f). Additional state approval for transactions should be avoided in order to keep transaction costs down, while competition authorities should overlook the emissions market. Ultimately, as well from an economics' as from a social justice perspective, the market should be easily and equally accessible for all emitters in order to follow the equality principle and prevent competitive distortions and an increase in transaction costs. Other social justice and environmental issues, however, are of only minor importance.

Compliance periods mainly depend on the ecological targets, while from an economics' perspective, longer compliance periods allow for extra options for inter-temporal cost-minimization, from an environmental and social justice point of view, shorter compliance periods are preferable, because they allow for short-term, immediate control over reduction achievements and thus enhance ecological effectiveness and foster inter-generational justice. A compromise could be to have long compliance periods, but additional requirements for short-term submission of major parts of used emissions rights.

Market interventions like safety valves or price limits must not be implemented, from an economics' perspective, because they prevent the optimal allocation of emission rights and abatement measures, thus increasing costs. In addition, if additional emission allowances are handed out, when a certain price level is reached, and if these extra allowances are not ex ante included in the cap, ecological effectiveness as well as inter-generational justice are endangered. However, price limits may apply when intra-generational justice is at stake.

3.5 Monitoring and Penalties

Sustainable carbon markets should include robust monitoring, reporting, and verification (MRV), reliable registries for emissions and allowances as well as rigorous penalties in case of non-compliance.

In ETS, basically, the authority only has to check if emitters can compensate each and every unit of emissions by an emission allowance in its hold. This would guarantee that emissions at one point would be compensated by emission reductions at another point, which in turn would lead to total emissions below the cap. Thus, from an ecological, economic, and justice perspective, reliable monitoring is necessary in order to guarantee compliance with regulations, because only this would lead to real emission reductions, efficiency gains, and the protection of future generations while making the polluter pay. Necessary individual elements are monitoring procedures as well as a registries emissions and allowances. In order to guarantee steady compliance and lower administrative costs, monitoring of emissions as well as allowance tracking should be reliable, continuous, and IT-based. Compliance monitoring based on periodically (verified) emission reports, however, is more cost intensive and suffers a higher risk of fraud and less environmental certainty. If, however, the reporting and verification option is chosen, the authority has to assign this task to independent and competent verifiers.

If at the end of a compliance period registries show a shortage of allowances, severe penalties have to apply for economic, ecological, and justice reasons. Penalties should act as an ex post punishment for breaching the law and they should ex ante discourage emitters from non-compliance. From an economics' point of view, penalties act as quasi prices, the payment of which may appear as a cheap compliance option to emitters. Thus, fines have to be significantly higher than the allowance price, e.g. double the average allowances price of the past compliance period. As the risk of non-compliance is determined by multiplying the fine and the probability of getting caught, both have to be sufficiently high. In addition, for ecological reasons, a shortage of allowances must be fully compensated not later than in the next compliance period in order to not endanger the cap. Justice reasoning emphasizes that all non-compliance by emitters should be equally and severely punished including ex post shortage compensation in order to fulfill inter-generational-justice and polluter-pays requirements.

3.6 Additional Design Features

Ambitious domestic ETS may suffer from leakage, if competitors do not use a comparably stringent policy to cope with GHG emissions. However, leakage can be prevented by different strategies. Firstly, the domestic ETS could be made less stringent, a solution, which neither from the ecological nor from the economic or justice perspectives would be favorable. Secondly, major competitors on the world market, e.g. OECD countries, could design a common carbon market or interlink their domestic systems. Ultimately, if other alternatives fail, protective measures such as border tax adjustments could be implemented on the domestic level. They would raise the prices for imported goods by charging a premium on imported products originating from countries with less stringent environmental regulations and thus adjust production costs. This would level the playing field for emitters covered by ambitious domestic ETS, which would be advisable from an economic (competitiveness) and social justice (equality, intra-generational international justice, inter-generational justice) point of view and could even prevent a global increase of emissions.

4 Conclusions

By defining and operationalizing the sustainability criteria of ecological effectiveness, economic efficiency, and social justice for the application on GHG ETS, design recommendations for sustainable carbon markets shown in figure 3 can be derived. Surprisingly, ecological, economic, and justice-based recommendations in many parts tend to point in the same direction. Thus, in designing sustainable carbon markets, major problems do not arise from contradictory demands by different sustainability criteria. All criteria rather emphasize the need for a strict implementation of ambitious ETS with stringent absolute volume caps, comprehensive coverage, compulsory participation of all or at least major sources, auctioning of allowances, restricted use of temporal and geographic means to optimize on abatement costs (banking, borrowing, offsets), a smoothly working trading system, reliable MRV and severe penalties for non-compliance including ex post compensation of surplus emissions.

However, carbon markets in existence do not fully comply with sustainability criteria. ETS in Japan, e.g., are voluntary and allow intensity targets (Rudolph/Park 2010), the Regional Greenhouse Gas Initiative suffers from a loose cap (Rudolph 2011), and even EU's ETS is still waiting for major improvements to come after 2012 (Ellerman 2010). Reasons for that can be found in the political economy of emissions trading (Rudolph 2005). Nevertheless, for future political debates on emerging ETS, political claims of sustainable carbon markets not being feasible, because economic, ecological and social justice requirements differ greatly and cannot be matched are proven to be ill-founded.

Figure 3: Design Recommendations for sustainable Carbon Markets

	Economic Efficiency	Ecological Effectiveness	Social Justice
Coverage and Bindingness			
pollutants	all	all	all
emitters	all	all	all
upstream vs. downstream	downstream	upstream	upstream
bindingness	binding	binding	binding
Cap			
total amount of emissions	scarce	target-oriented	fair
absolute volume vs. intensity target	absolute volume target	absolute volume target	absolute volume target
dynamics	decreasing cap	decreasing cap	decreasing cap
Initial Allocation, Validity of Allowances			
free of charge vs. for purchase	auction	auction	auction
banking and borrowing	banking and borrowing	banking, no borrowing	banking, no borrowing
offsets	limited (amount, quality), below cap	limited (amount, quality), below cap	limited (quality), below cap
Trading System			
compliance period	long	short	short
marketplace	established markets		equal access
market interventions	none	none	limited
Monitoring and Penalties			
MRV	IT-based, continuous, reliable	reliable, accurate	reliable
registries	IT-based, reliable	reliable	reliable
penalties	>allowance price	discouraging, ex post compensation	discouraging, ex post compensation
Additional Measures	e.g. border-tax-adjustment	e.g. border-tax-adjustment	e.g. border-tax-adjustment

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