Viable Responses to the equity-responsability dilemna : a consequentialist view.

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Viable Responses to the Equity-Responsibility Dilemma: A Consequentialist View*

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Abstract

This paper aims at clarifying some conceptual flaws blurring the equity-efficiency debates involved in the setting of objectives of GHGs emissions control beyond 2012. To this end, it carries out numerical experiments that test the viability of agreements grounded on two contrasting target allocation rules: a “Soft Landing” rule prolonging a Kyoto-type agreement; and a “Convergence” rule progressively re-directing Kyoto towards a per capita emissions endowment. The paper demonstrates the sensitivity of the impact to the metric used to assess it and to assumptions regarding the interaction between the cap and trade system and accompanying measures such as domestic policies (characterised as simple fiscal reforms) and international public funding. In a third step it derives some lessons about how to reconcile two political imperatives: (a) an *ex-post* or "consequentialist" approach to equity, which however cannot fully avoid relying on *ex-ante* rules, and (b) the necessity of an agreement on such stable *ex-ante* rules to set up emissions targets and efficient emissions trading. The latter step suggests a coming back to the environment/development “Gordian Knot”, which underpins all global environmental affairs since the Stockholm Conference in 1972. We argue that the equity-efficiency dilemma has to be set in a broader sustainable development perspective whereby climate policies are integrated with development priorities of the poorest countries so as to create a leverage effect on development.

Key Words: equity, efficiency, development, quota allocation, post-Kyoto, welfare impacts, emissions trading

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Introduction

Beyond the vagaries of the ratification of the Kyoto Protocol, meeting the objective of the United Nations Framework Convention on Climate Change (UNFCCC) raises the challenge of finding incentives that can engage developing countries in specific commitments without preventing the adherence of the United States to an international climate regime. The 'semi-failure' of the 6th Conference of the Parties to the UNFCCC (COP-6) highlighted that the implementation of a cap and trade approach to climate affairs may face two major difficulties:

- The level of international financial flows: an international carbon trading mechanism, though minimizing the marginal cost of the aggregated carbon constraint, raises the concern of high external financial flows concentrated on a few big carbon exporters.[1] This issue is critical, as the most powerful argument balancing the disadvantages of a cap and trade approach is precisely that such transfers would serve as an incentive to developing countries (Grubb, 1998).
- The issue of quota allocation: the G77 and China almost blocked the Kyoto accord stating that "Until the question of emission rights and entitlements is addressed equitably, it [will] not be possible to have emission trading." (UNFCCC, 1998). But an agreement on equity principles is considerably complicated by the debate surrounding past responsibility for climate change.

These problems seem daunting, with the G77 refusing to consider the very idea of commitments for the second commitment period at COP-8 in 2002. Even though such a position could soften, it remains that commitments based on emission quotas confront equity issues very directly: they imply an *ex-ante* agreement on explicit rules, the per capita emissions ratio being a controversial but obvious candidate to judge the equity of the deal.

However, this paper builds on the recognition that, so far, there is no alternative to a Kyoto-type system that could trigger the financial flows needed to provide an incentive for developing countries to significantly curb their greenhouse gas (GHG) emissions; for lack of anything better, it is still worth exploring how obstacles arising from the equity-efficiency dilemma may be overcome within the Kyoto architecture.

To this end, after a clarification of some conceptual flaws blurring the debate, this paper carries out numerical experiments that test the viability of agreements grounded on two contrasting target allocation rules: a "Soft Landing" rule prolonging a Kyoto-type agreement; and a "Convergence" rule progressively aiming at a *per capita* emissions endowment. We demonstrate the sensitivity of the impact to the metric used to assess it and to assumptions regarding the interaction between the cap and trade system and accompanying measures such as domestic policies (characterised as fiscal reforms) and international public funding. In a third step we derive some lessons about how to reconcile two political imperatives: (a) an *ex-post* or "consequentialist" approach to equity and (b) the necessity of an agreement on *ex-ante* rules,

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[1] Such concerns were voiced during the negotiations around Kyoto's first commitment period, considering the potentially monopolistic power of Russia and Ukraine.

stable enough to set up efficient emissions trading. In a last section we suggest to overcome this deadlock by coming back to the environment/development "Gordian Knot", which underpins all global environmental affairs since the Stockholm Conference in 1972. We argue that the equity-efficiency dilemma has to be set in a broader sustainable development perspective whereby climate policies are integrated with development priorities of the poorest countries so as to create a leverage effect on development.

I. Beyond 2012: where to, and how to assess it?

I.1. Taxonomy of post-2012 commitment schemes

Several schemes have been proposed to quantify targets beyond 2012. They define both principles for the allocation of quotas and a timetable for developing countries to take on binding targets. Disregarding schemes that just outline vague principles, or that rely on controversial parameters, they fit within seven broad categories:

- "Grandfathering": allowances are distributed *pro rata* based on past emission levels; the timing of the entry in the system is governed by a development threshold.
- Immediate *per capita* allocation (Agarwal and Narain, 1991).
- Contraction and convergence: quotas are first allocated based on past emissions but gradually evolve towards a *per capita* rule (French proposal to the Ad Hoc Group on the Berlin Mandate, UNFCCC 1996; Manne and Richels, 1997; Meyer, 2000).[2]
- Ability to pay: supported by a large body of economic literature, this scheme was proposed by various Parties prior to Kyoto (submissions to the AGBM by Poland (UNFCCC 1997a), Estonia (UNFCCC 1996), Russia (UNFCCC 1996) or South Korea (UNFCCC 1997a)). The proposal by Henry Jacoby *et al.* (1999) fits in this category.
- Historical responsibility for temperature increase: the Brazilian government made a proposal on this basis (UNFCCC 1997b; Den Elzen *et al.*, 1999), including a Clean Development Fund, which would collect fines imposed on Parties with excess emissions.
- Carbon efficiency allocation: the key element suggested by the US administration in order to avoid the concept of an absolute cap on energy growth,
- "Bottom-up" approaches such as the Triptych proposal (Phylipsen *et al.*, 1998; Groenenberg *et al.,* 2000) used in the European burden sharing agreement (distinguishing between heavy industry, power generation and the domestic sector) or the Multi-Sector

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[2] Such a transition appears in the Marrakech Accords (2001), in a draft decision *Principles, nature and scope of the mechanisms pursuant to Articles 6, 12 and 17 of the Kyoto Protocol*. The sixth preamble of this decision reads "Emphasizing that the Parties included in Annex I shall implement domestic action […] with a view to reducing emissions in a manner conducive to narrowing per capita differences between developed and developing country Parties while working towards achievement of the ultimate objective of the Convention". This statement does not preclude the diplomatic choice Parties will ultimately retain but it suggests the attractiveness of the concept.

Convergence Proposal (Jansen *et al.,* 2001) (distinguishing between power production, households, transportation, industry, services, agriculture and waste).

- Multi-criteria allocation based on a wider range of parameters: proposals based on ability to pay (GDP *per capita*), opportunity to abate (ratio of emissions over GDP) and *per capita* emissions were submitted to the AGBM by Norway (UNFCCC 1996), Australia (UNFCCC 1997a) and Iceland (UNFCCC 1997a).[3] Under this category fits the voting regime suggested by B. Müller (2002), indeed a weighting of several criteria.

We hereafter examine two of these rules, whose interpretations of equity cut across all the other proposals. This will allow us to focus on the fundamental issues, without being confronted to the diversity of possible compromises between various rules as will occur in the real negotiation process:[4]

- The **Soft Landing** rule expands the Kyoto Protocol system, with the objective of a 20% reduction in global emissions by 2030 from the world business-as-usual level, with a progressive engagement of developing countries allowing for a stabilisation in total emissions along that horizon.[5] While Annex I countries continue with decreasing emission endowments along 'extended Kyoto-paths', the developing countries are committed to progressively reducing their emission growth rate to zero by a date that is set according to their per capita GDP, *i.e.*, 2015 for the emerging countries, 2045 for the poorest developing countries, and 2030 for the others. The design of this rule aims to minimize the shocks imposed on every region and leaves the equity question *a priori* unresolved.
- The **Convergence** rule retains the strong normative appeal of the *per capita* allocation (Baer *et al.*, 2000) but recognizes that its immediate enforcement would be unrealistic, in terms of acceptability by the North and of the risks of windfall credits to the South potentially generalizing a 'Dutch Syndrome'. Our numerical experiments simulate the convergence of *per capita* emissions in 2050, based on a -20% 2030 target identical to the Soft Landing one (for comparison purposes).

This paper does not discuss further the normative foundations of any such rules (see Godard, 2000 for a review). Given the irreversibility of the accumulation of GHGs in the atmosphere, there is little chance that long-standing controversies of moral philosophy about the foundations of ethics will be settled in time for the climate change control. Concepts such as equity, fairness or justice are polysemous; their implications cannot be derived without considering how they are translated in various cultural, political and social contexts. They are intrinsically controversial and there is no legitimate body to act as a referee in last resort.

Hence, making a formal agreement on equity a pre-condition to a climate regime risks inhibiting the timely emergence of any consensus (Hourcade, 1994). We are therefore condemned to test a "consequentialist" approach to equity, that is to abandon the search of an *ex-ante* formula that

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[3] On the Norwegian proposal, see Reiner, Jacoby (1997) or Ringius *et al.* (1998).

[4] Linking ability to pay and emissions quotas is not so obvious; in the same way, the Brazilian proposal did not so far overcome difficulties arising from uncertainty in General Circulation Models.

[5] See Blanchard *et al.*, 2003, for more details.

can be grounded on a consensual ethical principle, and, more pragmatically, to scrutinize whether expected outcomes or a given solution may or may not be acceptable by countries divided by their vision of equity in addition to their pre-existing conflicts of interests.

I.2. Assessing commitments: social vs. private costs, monetary vs. welfare impacts

However modest it may appear, this approach to equity requires a prior clarification of the distinction between net total social costs and private costs in the form of carbon prices.

On the one hand, Working Group III of the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR) (IPCC 2001) indicates that the social cost of carbon control may be more tolerable: GDP losses for meeting Kyoto targets would range between 0.2% and 2% in a no-trade case and in the absence of carbon sequestration; they could be halved through the Kyoto flexibility mechanisms within Annex B, and could even be lower through use of the clean development mechanism (CDM) or possibly turn into a gain, with a judicious use of revenue-raising instruments.[6]

On the other hand, carbon prices, if they are to equalize the marginal cost of carbon control, may be high enough to prove politically problematic, increasing the prospect of compliance default if they exceed the willingness of some quarters to pay for climate mitigation:[7] extensive experience demonstrates that energy consumers are much more sensitive to the gross signal of energy prices than to their net impact, including less tangible economy-wide compensating effects such as the recycling of the proceeds of a carbon tax or auctioned tradable emissions permits. This is why motorists or carbon-intensive industry can block measures like environmental fiscal reforms, even though such measures are supposedly Pareto-improving.

Governments seeking to stay in compliance even with high carbon prices could "socialize" compliance costs rather than letting energy prices bear the full brunt of the carbon constraint. However, annual carbon imports reaching billions of dollars would affect trade balances,[8] and their concentration on one or two main carbon permit exporters might entail geopolitical risks. The alternative of subsidizing domestic abatement entails higher welfare costs than a purely price-triggered compliance.

A second clarification to be operated is between the monetary cost and the welfare cost. It is imposed by the fact that to loose one dollar does not have the same welfare impact on a rich and on a poor individual. The Bowen-Lindahl-Samuelson (BLS) theorem on the provision of public goods states that contributions should be set so as to equalize marginal *per capita* welfare

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[6] The IPCC WG III report underlines the fact that simulations are made under the assumption that markets operate perfectly and that savings from carbon markets and from tax recycling are not systematically additive. What matters though is the fact that the macroeconomic costs can be viewed as moderate, while the marginal costs reach more striking figures.

[7] We refer the notion of “willingness to pay” not strictly to the revealed preference for the benefits of long-term climate control but to a political limit on the acceptability of short-term costs for precaution..

[8] With a potentially significant impact on the exchange rates of currencies (McKibbin *et al.*, 1998).

losses, which, assuming decreasing marginal utility of income leads to contributions inversely correlated to relative *per capita* income. The BLS theorem has paradoxically been disregarded in most of the literature on climate policies.[9] If, for simplicity's sake, we assume utility functions logarithmic in income, an American citizen should contribute twenty times more to climate change mitigation than an Indian citizen. This may seem a provocative interpretation of the “common but differentiated responsibilities” principle of the UNFCCC. However, it stems from a well-established theorem and relies on the (admittedly conservative) assumption that climate policies should not alter pre-existing discrepancies in income.

In its original form, the BLS theorem is normative and assumes some form of benevolent planner mandated to maximize global welfare without correcting pre-existing income distribution.[10] Its policy implication is that, in a heterogeneous world[11], while most of the economic literature argues that the economic efficiency of carbon abatement requires the equalization of marginal abatement costs and a single carbon price, this single price should be accompanied by transfers restoring the equalization of marginal welfare impacts. We can interpret this theorem as regards the viability of climate regimes: if their welfare impact diverges too much from a country to the next, it is likely that this regime will, sooner or later, confront strong opposition.

In sum, solving the equity-efficiency dilemma requires to comprehensively consider the following intertwined difficulties:

- The impossibility of finding a common agreement on *ex-ante* equity rules, given the "Varieties of Distributed Justice in Climate Change" (Müller, 2001),
- The difficulty of establishing a simple bijection between a given quota allocation rule based on observable parameters and its welfare impacts,
- The sensitivity of welfare impacts to the interaction between domestic policies, carbon trading and additional international funding.

To define how the Convergence and Soft Landing quota allocation rules lead to various prices of carbon and welfare impacts depending on assumptions regarding carbon trading and domestic policies (freely allocated emissions allowances versus tax or auctioned allowances), we use a modelling framework that couples, for 14 world regions, the POLES model (a world energy model developed at IEPE (Institut Economique et Politique de l’Energie) and the IMACLIM model (a general equilibrium model developed at CIRED (Centre International de Recherches sur l’Environnement et le Développement).[12] From a 2030 baseline scenario, we test policy scenarios combining various assumptions regarding the extension of an international carbon

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[9] With some exceptions such as Chichilnisky, Heal and Starett (2000).

[10] For reasons of political realism, we stick hereafter to this ‘no-redistribution’ mandate even though other value judgements can be made about the current income distribution.

[11] In addition to income distribution, other sources of heterogeneity of welfare impacts from a given carbon price are climate conditions, spatial distribution of human settlements, pre-existing infrastructures and industrial structure.

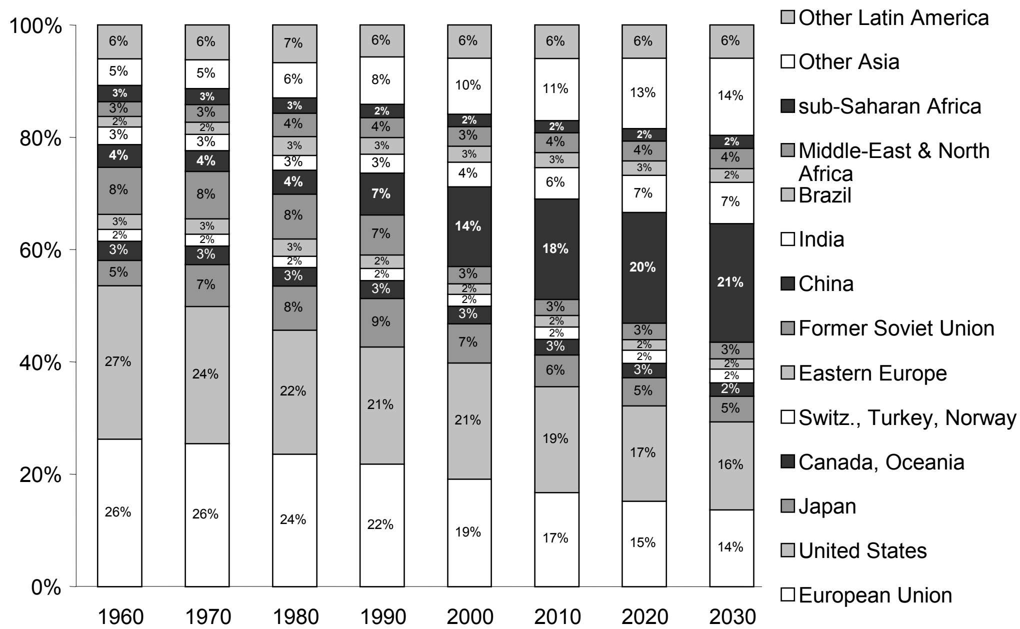
[12] Details on the IMACLIM-POLES architecture are available on the website http://www.centre-cired.fr/actualite/IMACLIM-POLES.htm

trading system and domestic policies. The acceptability of the two rules is assessed by comparing the price of carbon and the variation in the non-energy consumption they cause plus the amount of transfers they imply in the case of a global carbon market. A fourth (BLS-like) metric weights the marginal costs of each region according to their respective GDP *per capita*.

II. Lessons from numerical experiments: moving division lines

II.1. Baseline scenario

The baseline scenario from which emissions quota allocation will be assessed implies a 3% average annual global GDP growth between 2000 and 2030. The distribution of this growth confirms the current trend of a declining share for the OECD countries and countries in transition (from 57% down to 44%) and of a growing share for Southern Asia and China (from 24% up to 35%):



Shares are piled in the chart following the same order as in the legend

Figure 1. *Share of 14 world regions in global GDP*

Despite their demographic growth, the Middle East & North Africa, sub-Saharan Africa and Other Latin America just maintain their share, which leads to a weak performance in terms of increase in *per capita* income (table 1).

	2000 *$ per cap.*	Weighing factor in 2000[13]	2030 *$ per cap.*	Weighing factor in 2030
European Union (15)	18 695	1.5	31 422	1.3
United States	27 652	1.0	41 109	1.0
Japan	20 535	1.3	33 442	1.2
Canada, Oceania	18 937	1.5	29 043	1.4
Switzerland, Turkey, Norway	9 466	2.9	21 533	1.9
Eastern Europe	5 776	4.8	13 948	2.9
Former Soviet Union	3 985	6.9	10 912	3.8
China	2 535	10.9	9 404	4.4
India	1 568	17.6	4 527	9.1
Brazil	5 961	4.6	10 930	3.8
Middle-East & North Africa	7 519	3.7	10 545	3.9
sub-Saharan Africa	1 027	26.9	1 754	23.4
Other Asia	3 985	6.9	8 735	4.7
Other Latin America	6 186	4.5	11 682	3.5

Table 1. Per capita *GDP and scaling factor*

Not surprisingly, the distribution of carbon emissions evolves in a parallel way: the share of developing countries shifts from 39 to 58%, while that of the OECD plus countries in transition falls from 60 to 42% (table 2). Still, the *per capita* emissions of the developing countries, while getting close to, or over, 1 tonne of carbon (tC) - with the notable exception of sub-Saharan Africa - remain 4 to 10 times lower than in the US and 2 to 5 times lower than in the EU (table 2).[14]

	Share in Global Emissions		*Per Capita* Emissions (tonnes of carbon)	
	2000	2030	2000	2030
European Union (15)	13,98%	8,60%	2,41	2,83
United States	25,19%	16,33%	5,50	5,78
Japan	4,75%	2,77%	2,44	2,80
Canada, Oceania	3,63%	2,75%	3,82	4,09
Switzerland, Turkey, Norway	1,25%	1,42%	0,99	1,61
Eastern Europe	3,29%	2,36%	1,76	2,45
Former Soviet Union	8,89%	7,91%	2,06	3,21
China	14,41%	20,06%	0,84	1,63
India	4,89%	9,88%	0,30	0,85
Brazil	1,28%	1,89%	0,49	1,00
Middle-East & North Africa	5,24%	5,78%	1,99	1,86
sub-Saharan Africa	2,33%	4,92%	0,18	0,51
Other Asia	7,03%	11,29%	0,50	0,99
Other Latin America	3,83%	4,04%	0,72	0,97

Table 2. *Share in Global Emissions and Per Capita Emissions*

The overall picture confirms two major pieces of information: the first is the growing heterogeneity of the G77, with eastern Asia detaching itself from the rest of the group. The second is the persisting gap between the G77 and economies in transition and the OECD countries in terms of general productivity.

[13] GDP per capita for the US over each region's GDP per capita. It will be used below to scale the marginal costs born by each region in US terms.

[14] Emissions are CO_2 emissions from energy sources (consumption and production).

II.2. Allocation rules and carbon constraints

From such a baseline, the emissions reductions required from industrialized countries are, unsurprisingly, far lower under the Soft Landing rule than in the Convergence scenario (table 3). Less obvious is the fact that:

- Among industrialized countries, Russia would most benefit from the Soft Landing rule, which would let it take advantage of excess endowments for years to come; in a Convergence scenario, its current *per capita* emissions force it to decouple from its baseline emissions by the same order of magnitude as Japan or the EU.
- The Convergence rule, which is expected to be favourable to developing countries, imposes on China a carbon constraint far higher than the Soft Landing scenario: *per capita* carbon emissions in China increase so quickly that the 2050 convergence level becomes constraining as early as 2030. Conversely, under the Convergence allocation rule, sub-Saharan Africa, India and to a lesser extent Brazil, receive significant excess endowments that provide the basis for large foreign transfers.
- The Soft Landing scenario imposes significant constraints on most developing countries, the more so as they experience high economic growth between 2000 and 2030 starting from a relatively low *per capita* emission level.

	Convergence	Soft Landing
European Union (15)	42%	29%
United States	63%	41%
Japan	39%	22%
Canada, Oceania	59%	43%
Switzerland, Turkey, Norway	30%	26%
Eastern Europe	29%	8%
Former Soviet Union	38%	3%
China	26%	11%
India	-14%	16%
Brazil	-3%	20%
Middle-East & North Africa	19%	6%
sub-Saharan Africa	-78%	12%
Other Asia	-4%	32%
Other Latin America	-7%	9%

Table 3. *Reductions required from baseline in 2030*

All three points demonstrate the tension between the two allocation rules which may inhibit any chance of a compromise. It is therefore necessary to examine to what extent carbon trading and domestic policies and measures may reduce this tension.

II.3. The Convergence rule: an impossible deal?

Table 4 sums up the impacts of the Convergence allocation rule, assuming that quotas are distributed freely at the domestic level. It provides four indicators:

- MC, the marginal cost of the carbon constraint, in 1990 US$ per tonne. Figures between parenthesis provide an estimate of the marginal welfare cost (in US-equivalent monetary terms), by weighing the marginal costs according to the projected GDP *per capita*,
- ΔC, the variation in final consumption of non-energy goods. This indicator is used as a proxy of total welfare losses,
- Transfers in billions of 1990 $, in the event of a global emission credits market. In the developing world, the proceeds of carbon credits exports are assumed to fund investment on general productivity. In the OECD and economies in transition, carbon credits are paid for in a lump-sum manner by agents relative to their share in final consumption.

In the absence of an international market, the Convergence scenario leads to consumption losses close to or higher than 5% for the US, Japan, the former USSR and Eastern Europe. China, a developing country facing a constraining commitment, risks a 1.3% welfare loss that could be viewed as significant for a low-income country. The apparently low marginal private cost it faces, $34 per tonne, has the same welfare impact as a $150 price in the US context.

	No international market		International market		
	MC *$/tC*	ΔC	MC *$/tC*	ΔC	Transfers *billions $*
European Union (15)	197 (256)	-1.85%	43 (56)	-0,31%	12.2
United States	319 (319)	-7.38%	43 (43)	-0,94%	33.6
Japan	382 (458)	-6.22%	43 (52)	-0,62%	4.7
Canada, Oceania	406 (568)	-2.67%	43 (60)	-0,68%	5.9
Eastern Europe	89 (258)	-4.57%	43 (125)	-2,28%	1.6
Former Soviet Union	86 (327)	-8.19%	43 (163)	-2,45%	5.8
China	34 (150)	-1.33%	43 (189)	-1,57%	-4.2
India	–	–	43 (391)	-2,16%	-22.2
Brazil	–	–	43 (163)	-0,12%	-1.1
Sub-Saharan Africa	–	–	43 (1006)	+3,95%	-21.0
Other Asia	–	–	43 (202)	-0,77%	-15.3
Other Latin America	–	–	43 (151)	+0,28%	-2.8

Table 4. *Convergence rule, free quota allocation*[15]

With carbon trading including all developing countries, the cost of carbon falls to $43 per metric tonne[16] and consumption losses are moderate (below 1%) in all OECD regions. The price cut is triggered by substantial carbon trading (1.54 GtC) leading to financial transfers of about $69.8 billion, with ambiguous implications in terms of political economy:

- The transfers from industrialized countries, (close to half of these from the US) can be compared to the $27.5 billion Current Foreign Direct Investment (FDI) (World Bank data for 2000): if multiplied by the expected growth of the contributing zones, it reaches only $55 billion, and the transfers hence correspond to more than a doubling of 2030 FDI.

[15] Results are not reported for the regions with a predominant oil exporting activity, since the impact of decreasing exports and market prices is not taken into account in the interaction between POLES and IMACLIM (each regional model runs separately assuming fixed international prices in an Armington specification of imports and exports).

[16] POLES, in a partial equilibrium setting, concludes to a $106/tC market price. The divergence with a general equilibrium analysis is due to the input-output matrix inflating net energy prices for a given carbon price, and, to a lesser extent, to a lower GDP growth (which alleviates the carbon constraint).

- However, in contrast to the COP-6 context, these transfers are not concentrated on two countries (Russia and Ukraine), but spread over a number of developing countries. The third devoted to India is balanced by the comparative amount spread over sub-Saharan Africa, and the close to a fourth directed to non-Chinese eastern Asian countries.
- Moreover, the implementation of a high carbon constraint without distribution of the rent thus created can lead to a paradoxical consumption loss for carbon permit exporters, as is the case for Brazil, Other Asia and above all India. Consumers face indeed a high carbon price (up to $391 in US-equivalent terms for India) whose inflationist impact is not compensated for by the redistribution of the rent. In this case, the revenue of the carbon credit exports, assumed to be recycled in productivity investment, could be insufficient to balance the loss of purchasing power.[17] Discrepancies in the ultimate impact on consumption depend on the investment situation in the reference scenario: Africa, with its current capital scarcity still continuing in our 2030 projection, greatly benefits from the $21 billion gain from trade, whereas India experiences a consumption loss despite comparable gains from trading.
- The former USSR and Eastern Europe still suffer a significant consumption loss. Needless to say, simulations carried out for these zones are less reliable than those on regions benefiting from higher data quality and relatively stable current growth patterns. However, the direction and magnitude of the results deserve attention. The same carbon price will entail higher welfare losses in a country where, in 2030, energy still represents a share of production costs, household expenditure and investment that is far superior than that of other regions.

Lastly, the equalization of marginal nominal costs across zones hides a highly divergent marginal welfare cost. Scaling the $43 marginal cost according to table 1 for Other Asia, India and sub-Saharan Africa - the three main exporters, covering 91% of total carbon exports - respectively leads to price signals of $202, $391 and $1006/tC in US-equivalent terms. Such levels, and in particular the one faced by sub-Saharan Africa, suggest the potential for considerable political barriers since these energy price increases will have to be sold to public opinion against intangible gains in productivity and consumption.

Table 5 gives the same information as table 4, but assumes a redistribution of the rent created by the quotas. Regions auction their quota domestically rather than freely distributing it, and recycle the auction revenues in a restructuring of their tax systems.[18]

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[17] A lump sum recycling of the proceeds from trading to consumers leads to even worse results. Testing it for India only - transferring the $22.2 billion to households revenue - we obtained a minus 7% impact on consumption.

[18] For the sake of comparability the same recycling through a decrease in *ex-ante* payroll taxes is tested. It might not be optimal for all zones (*e.g.* in the US capital taxes are deemed more distortionary than labour taxes) .

	No international market		International market		
	MC *$/tC*	ΔC	MC *$/tC*	ΔC	Transfers *billions $*
European Union (15)	402 (523)	+2.00%	73 (95)	+0.77%	22.3
United States	406 (406)	-5.38%	73 (73)	-0.54%	50.7
Japan	654 (785)	-2.96%	73 (88)	-0.18%	8.0
Canada, Oceania	458 (641)	+0.04%	73 (102)	+0.13%	8.4
Eastern Europe	120 (348)	-0.22%	73 (212)	-0.24%	1.9
Former Soviet Union	168 (638)	+1.24%	73 (277)	+0.42%	10.4
China	63 (277)	+1.18%	73 (321)	+1.24%	-4.2
India	–	–	73 (664)	+2.57%	-35.7
Brazil	–	–	73 (277)	+0.79%	-2.3
sub-Saharan Africa	–	–	73 (1708)	+8.70%	-36.5
Other Asia	–	–	73 (343)	+1.78%	-19.9
Other Latin America	–	–	73 (256)	+1.25%	-5.9

Table 5. ***Convergence rule, auctioned quota allocation and payroll tax recycling***

Without an international carbon market, a striking result is the magnitude of the trade-off between the social and private (marginal) cost of the carbon constraint. On the one hand, all zones see their situation worsen in terms of private costs compared to the free quota allocation (China and Japan face costs that are close to twice what they were without redistribution of the rent). This is due to the fact that the inflationist effect of carbon prices is offset by the deflationist effect of a recycling in the lowering of labour costs. A given abatement target thus requires a higher nominal price signal. On the other hand, the variation in welfare of all zones improves, to an extent depending on their pre-existing tax structure and energy intensity (the former USSR energy system allows for a much higher gain than the Japanese system).

The addition of global emissions trading does not impact all zones in the same way. Its deflationist effect on carbon prices leaves part of a potential double dividend unexploited for the whole of Europe and the transitional economies. This leads to the result that such zones may be better off managing their carbon constraint on their own. Still, the opening of a global carbon market allows all zones to contain their consumption losses below 1%, and most of them to reap a positive consumption effect. One might be puzzled by the generalization of this positive outcome to all but a few regions and the extent of the second dividend thus obtained, but it must be kept in mind that:

- The second dividend is enhanced by the assumption of a recycling of the proceeds from international carbon trading in general productivity investment,
- Recycling assumptions are optimistic: considerable fiscal revenues are levied on carbon emissions - disregarding inefficiencies of the tax recovery systems – the revenues of carbon export are not diverted by frictional costs and the revenue-neutral nature of the fiscal reform is respected, notwithstanding compensations for adverse distributional impacts.

The reported consumption gains can thus be interpreted as double dividend potentials pointing out the importance of interactions between international and domestic climate policies, rather than automatic gains. The case of sub-Saharan Africa is very significant. The consumption increases because of the pre-existing dramatic capital scarcity and inefficiencies of the labour markets, but this raises the question of the institutional capacity of this sub-continent to concretise such a potential.

Besides, the caveat regarding welfare marginal costs as the sole indicator to be considered applies all the more strongly as the deflationist effect of the recycling assumption makes a higher market price necessary. At $73 a tonne, the US-equivalent price signal reaches a politically unthinkable $1708 level for sub-Saharan Africa. Moreover, trade on the international market reaches $114.5billion, corresponding to a tripling of business as usual 2030 FDI, the US contributing close to half that amount.

It thus appears that in all four configurations the Convergence scenario comes up against difficulties, all the more intricate as preferences between the four configurations differ amongst regions. Table 6 sums up those difficulties, raising questions about the political acceptability of this rule under any of its variants.

	w/o international market	w. international market
free allocation	▪ high marginal - private - costs for the OECD and transitional economies; ▪ exceedingly high consumption losses for the US and Japan;	▪ exceedingly high marginal - private - costs for the developing world; ▪ high consumption losses for the transitional economies and India;
auctioned allocation	▪ exceedingly high marginal - private - costs for the OECD and transitional economies; ▪ exceedingly high consumption losses for the US, Japan and transitional economies;	▪ exceedingly high marginal - private - costs for the developing world; ▪ exceedingly high foreign transfers for the US (and F.S.U.?);

Table 6. ***Political Barriers to the Convergence rule***

Soft Landing: an acceptable bargain for the South?

The first outcome of the Soft Landing scenario, compared to the Convergence rule, is unsurprisingly to cut down carbon prices in OECD countries, China and the Former Soviet Union (FSU). Considering a free quota allocation (table 7), and in the absence of an international market, domestic marginal costs in those regions are almost all kept below $200 per tonne. They do not exceed $260 per tonne in US-equivalent terms. They are low for the economies in transition and China, especially so for the FSU. The corresponding consumption losses are significantly less than under the Convergence rule in particular in the US, Japan and the FSU.

	No international market		International market		
	MC *$/tC*	ΔC	MC *$/tC*	ΔC	Transfers *billions $*
European Union (15)	106 (138)	-0.61%	43 (56)	-0.21%	6.5
United States	111 (111)	-1.49%	43 (43)	-0.66%	15.2
Japan	204 (245)	-2.13%	43 (52)	-0.54%	2.2
Canada, Oceania	186 (260)	-0.91%	43 (60)	-0.47%	3.7
Eastern Europe	19 (55)	-0.99%	43 (125)	-1.46%	-0.9
Former Soviet Union	5 (19)	-1.19%	43 (163)	+1.71%	-6.9
China	14 (62)	-0.50%	43 (189)	-1.18%	-18.9
India	19 (173)	-1.80%	43 (391)	-3.03%	-7.0
Brazil	105 (399)	-0.65%	43 (163)	-0.36%	1.0
sub-Saharan Africa	55 (1287)	+0.35%	43 (1006)	+0.22%	0.6
Other Asia	66 (310)	-1.95%	43 (202)	-1.15%	5.0
Other Latin America	53 (186)	+0.08%	43 (151)	+0.05%	0.3

Table 7. *Soft Landing rule, free quota allocation*

Considering that the global emission target is identical in both allocation rules, such price cuts are necessarily gained at the expense of the developing world. Brazil, non-Chinese Asia, Latin America and Africa do face binding commitments under this rule (table 3) that necessitate marginal costs reaching from $19 in India to $105 in Brazil. In US-equivalent terms those costs can reach very high levels. Consumption losses are experienced in almost all zones,[19] particularly in non-Chinese Asia where households are relatively big energy consumers.

An international carbon market has a starkly contrasting impact on such outcomes. On the one hand, it further alleviates the costs of most importing zones. On the other hand, it quite worsens the consumption costs of the carbon exporters, in the same paradox as in the Convergence case: The gains from trade do not compensate consumers for their loss of purchasing power.

With carbon quotas more uniformly distributed (table 3), international transfers are cut down to $35.2 billion, and their sources are much more differentiated than under the Convergence rule. However the source and direction of such transfers can still seem problematic, with more than half accruing to China - leading to a doubling of projected FDI to that country - and sub-Saharan Africa, the poorest zone (table 1), ending up as a net source in part because of its extra growth[20].

All in all, the results in terms of marginal costs in the absence of international market, and in terms of total costs with and without the international market, seem less divergent from one region to the other than under the Convergence rule.

Under the hypothesis of auctioned permits, and in the absence of international carbon trading, a strong form of double dividend is found in all zones except Japan and the US (table 8), with the

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[19] Africa enjoys a net benefit because of our assumption that the industrialization of Africa is going to be rather energy-intensive, compensating to some extent the dematerialization of growth in the OECD zones, and the potential for improvement in energy efficiency very high, the extreme increase of energy prices being compensated by the fact that African households remain relatively ‘energy-sober’ in terms of commercial energy.

[20] The fact that Other Asia, though on average slightly poorer than China (table 1), becomes a substantial source of transfers is due to the fact that, along with a collection of poor and heavily populated countries, South Korea ($32,440 GDP per capita) accounts for the transfers.

multiple caveats expressed in the Convergence scenario still applying. As for Japan and the US, the consumption losses they experience under the Convergence rule is almost null.

	No international market		International market		
	MC $/tC	ΔC	MC $/tC	ΔC	Transfers billions $
European Union (15)	224 (291)	+2.18%	75 (98)	+0.97%	12.6
United States	149 (149)	-0.04%	75 (75)	-0.08%	19.1
Japan	355 (426)	-0.11%	75 (90)	-0.06%	3.8
Canada, Oceania	206 (288)	+0.99%	75 (105)	+0.46%	4.6
Eastern Europe	27 (78)	+0.37%	75 (218)	+1.01%	-2.5
Former Soviet Union	7 (27)	+0.45%	75 (285)	+5.54%	-9.8
China	25 (110)	+0.83%	75 (330)	+1.96%	-29.7
India	38 (346	+0.67%	75 (683)	+1.26%	-9.8
Brazil	142 (540)	+0.77%	75 (285)	+0.38%	1.4
sub-Saharan Africa	69 (1615)	+2.08%	75 (1755)	+2.25%	-0.3
Other Asia	175 (823)	+1.69%	75 (353)	+1.13%	14.9
Other Latin America	62 (217)	+0.73%	75 (263)	+0.88%	-0.6

Table 8. *Soft Landing rule, auctioned quota allocation and payroll tax recycling*

Developing countries also benefit from a consumption increase, depending to some extent on their pre-existing input-output and tax structures. However, the deflationist effect of the recycling assumption again makes higher carbon prices necessary (up to $175 per tonne for Other Asia).. In US-equivalent terms, the marginal costs exceed a $500 per tonne signal in sub-Saharan Africa, Brazil and Other Asia.

Adding an international carbon market provision has two contradictory impacts:

- Some zones - EU, Canada & Oceania, Brazil and Other Asia - with a high potential for a double dividend do not exploit it as fully as without international carbon trading, because of the lower prices on the market. Such zones, however, see their private agents benefit from far lower carbon prices;
- On the contrary, others - the whole developing world except Brazil and Other Asia, plus the economies in transition - with a similar double dividend potential, experience a market price higher than the one demanded by their own commitment alone.

Transfers, compared to the free allocation case, swell with the international price, up to $58 billion (an amount equivalent to the projected FDI). Again, China attracts slightly more than half that amount, but sub-Saharan Africa, the poorest zone, is not a net contributor anymore.

Again, as under the assumption of a free domestic quota allocation, results are less divergent across regions, both in terms of marginal and of total costs, than in the case of the Convergence allocation rule. In sum, it does appear that the Soft Landing scenario, which is based on a pure consequentialist approach, narrows the contradiction of interests across regions and thus increases the prospect for a thin pathway towards a climate regime acceptable to all parties, despite their divergent perceptions of equity and the heterogeneity of their level of development and energy systems. But, as suggested by table 9, there remain a lot of political barriers to be overcome. The above simulations, as such, prove neither the legitimacy nor the negotiability of a Soft Landing compromise.

	w/o international market	w. international market
free allocation	▪ exceedingly high marginal - private - costs for sub-Saharan Africa; ▪ high consumption losses for Japan, India and Other Asia;	▪ exceedingly high marginal - private - costs for the developing world; ▪ exceedingly high foreign transfers and high consumption losses for Other Asia; ▪ exceedingly high consumption loss for India; ▪ high foreign transfers from Other Asia, and to China;
auctioned allocation	▪ exceedingly high marginal - private - costs for sub-Saharan Africa, Brazil and Other Asia; ▪ high marginal - private - cost for Japan;	▪ exceedingly high marginal - private - costs for the developing world; ▪ exceedingly high foreign transfers from Other Asia, and to China;

Table 9. ***Political barriers to the Soft Landing rule***

III. Quantitative targets as a foothold for solving the environment-development Gordian Knot?

Past experience demonstrates that there are many causes for the failure of a negotiation process, even if room for compromise exists on paper. One well known obstacle is related to divergent views on abatement costs (Ghersi and Hourcade, 2002). It can be argued that the POLES model gives too optimistic a view of abatement costs and that the version of the IMACLIM model used in this paper is too aggregates. But likewise, it can be argued that the POLES model does not consider the potential for negative costs that would expand the scope for resolving equity issues. But as envisaged in the run-up to COP-6, these controversies between pessimists and optimists regarding costs could be resolved through a restoration payment at a pre-determined price of carbon, which would cap the level of effort if the pessimistic expectations are proven to be right and would not affect the environmental performance if they are proven to be wrong.

Our set of numerical experiments reveals that the very concept of burden sharing, widely used in discussions about equity, may be a more serious stumbling block against any agreement. Considering indeed the political economy of the negotiations, we cannot but observe the conflict arising between results in Section 2 and the intellectual reflex tending to translate quantitative indicators of emission endowments or of emission abatement in terms of economic burden. Section 2 shows indeed that, for given abatement cost curves and for the same set of carbon constraints:

- Because of the pre-existing economic and fiscal conditions and income inequalities, the same carbon price will impact very differently the per capita GDP, energy bill and ultimate welfare of various regions.
- The various metrics that can be used to assess the required level of effort in each region does not lead to the same ranking amongst allocation rules.

- The result is highly dependent on the way in which each region articulates its own climate policy with the international carbon trading system[21].

Accounting for these sophistications is possible ‘on paper’ but very hard in a negotiation process since the indicators based on observable parameters (carbon prices) are not the most relevant, while the welfare variations, are model constructs. There is a tendency, among modellers, to assume that this is a second order problem. Past experience, however, demonstrates – be it the assessment of the effort required by the Kyoto targets for the US or of the development benefits of the CDM – that such neglected details ultimately come back as real deadlocks. Indeed, behind the abstract figures of welfare variations lie social problems that are likely to undermine the acceptability of climate policies.

Hence, a consequentialist view of equity issues, even freed from the daunting task of finding an *a priori* agreement on principles of justice, is not sufficient to secure an agreement on target allocation rules. A way out may thus be to question the very concept of burden sharing.

The reasons for this questioning bring back to the contradiction impinging, since the 1972 Stockholm Conference, on attempts to undo the environment-development Gordian Knot. The participation of developing countries in environmental policies is necessary, but these countries will not cooperate as long as they will perceive environmental protection as a new constraint and not as an opportunity for a more sound development. Originally, a diagnosis emerged about degradation of the local environment (soils, water quality, deforestation, urban dislocation) generating stumbling blocks for the development. This diagnosis reinforced previous concerns about the flaws in current development patterns. Dualistic development, distorted choices of techniques, structural unemployment, unfulfilled basic needs, drift from the land and urban congestion have been fully described in Myrdal’s ‘Asian Drama’, Sen’s early contributions, R. Dumont’s ‘L’Afrique Noire est mal partie’, and the works of the UNCTAD group (R. Prebisch). Twenty years later, with the emergence of issues such as ozone layer depletion, climate change and biodiversity loss, the focus has moved from the local to the global environment, and, despite the extensive use of the concept of sustainable development, global environment affairs tended to be disconnected, *de facto,* from the challenges of development.

The concept of burden sharing is symptomatic of this situation, since it supposes, in economic language, the non existence of ‘pareto-improving’ policies. It relies on the intellectual bias of starting from development baselines to which environment issues would impose new constraints. Typically, when prospective exercises on developing countries extrapolate high growth rates over a long time period, they to some extent do this, beyond technical reasons, for the sake of political correctness. But this comes to assume that the key obstacles to development have been ruled out such as the tension between capital scarcity and technical choices. As far as infrastructures in energy, transportation or water distribution are concerned, developing countries cannot repeat the experience of the Western World in the 19th and 20th centuries, and

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[21] The only domestic policy variables considered in this exercise are the domestic allocation of emissions allowances and the targeting of carbon exports revenues to productive investments in developing countries. However, these measures are illustrative of the consequences of a wider spectrum of measures, including nonprice incentives, which determine how increases in energy prices result in welfare variations.

failure to modify technological patterns result in a debt trap and in a social dualism. Since the 1980s, a way out has been sought through the mobilisation of private capital, but concerns still emerge about the reluctance of risk adverse investors to embark in long payback period investments and about possible contradictions between economic globalisation and sustainable development in low income countries.

The way out is a shift from a 'burden sharing' to a 'leverage effect' problématique, and the prioritisation of synergies between curbing carbon emissions trends, removing obstacles to development and reducing local environment problems. Section 2 has shown that such synergies may exist at a macro economic level depending on how domestic policies are articulated with the international carbon trading system and how revenues from carbon trading are used in permit exporting countries. Obviously, drawing benefits from this potential requires the combining of macro-economic analyses with sectoral or local ones to assess the capacity of North-South transfers due to carbon trading or the CDM to trigger a leverage effect on development (Mathy *et al.*, 2001) . This leverage effect in turn would have the virtue of removing the misunderstandings about carbon trading within 'negotiated targets', since these targets would result into a development benefit and not into a development cap.

This move, in turn, may alleviates the concern in Annex B countries about the magnitude of the transfers. Indeed, the concept of a 'leverage effect' on development paves the way to the building of large infrastructures in developing countries over the next century, which may result in the same type of virtuous circle as the Marshall Plan in the wake of the Second World War. Making these infrastructures compatible with both global carbon constraints and the local environment concerns would simply secure the sustainability of this 'virtuous circle'.

Conclusion

The first conclusion of this paper is that it is hazardous to ground the negotiation of GHG emissions targets on the basis of explicit equity principles. This is not only due to the fact that the rules meant to translate egalitarian principles, e.g. the Convergence rule, lead to an unacceptable burden for developed countries; such a rule may be unacceptable for countries such as China, and to all fast growing countries with a high fossil energy intensity. These difficulties are obviously exacerbated when these principles are invoked in terms of 'property rights entitlement'. [22]

The adoption of a consequentialist approach does not entirely overcome this deadlock. The Soft Landing scenario indeed narrows the contradiction of interest between the North and the South, but could provide an outcome acceptable to all parties only if associated with some kind of a hedging mechanism against uncertainty over abatement costs and with complementary devices to maximise the results in terms of development. A remaining difficulty is that the various

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[22] This often used notion is misleading, since emissions quotas are transitory emissions allowance which will be re-negotiated regularly

metrics that can be used to assess the acceptability of a proposed compromise do not deliver anything like the same results, and these results are very sensitive to the type of domestic policy implemented in each country.

We conclude that this set of difficulties should incite shift from an approach framed in terms of burden sharing to an approach framed in terms of leverage effect on development. This is, after all, coming back to the very language of Article 3.5 of the UNFCCC: *'the Parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change'*.

Disconnecting emission targets from the issue of property rights does not bypass discussions of equity and responsibility. Neither does it obviates the need of formal rules as a benchmark for negotiations. Rather, it gives more flexibility for an agreement thanks to a debate over the institutional devices to be added to the system in order to increase its development benefit, including by expanding the menu of future commitments beyond the 'Kyoto style' quotas (Philibert and Pershing, 2002). This being said, such a pragmatic approach needs an 'attractor', and this attractor of course should at least provide some degree of convergence, as does, for example, the triptych approach (Groenenberg *et al.*, 2000). If posed in terms of burden sharing, the question of how to connect this attractor to pragmatic scenarios has no chance of receiving a satisfactory answer. Conversely, this paper demonstrates that large rooms for manoeuvre may be found if this connection is operated under a prior reframing of the discussion within the perspective of achieving sustainable development in both the South and the North.

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