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48, Bd JOURDAN – E.N.S. – 75014 PARIS
TÉL. : 33(0) 1 43 13 63 00 – FAX : 33 (0) 1 43 13 63 10
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A future for Kyoto?

Roger Guesnerie

JEL Codes : Q5, H2, F18

**Keywords : Kyoto protocol, less developed countries,
price versus quantity, fossil fuels, trade and environment**

A future for Kyoto ?

By Roger Guesnerie¹

Abstract : This text is based on the English translation of extracts from a report to an advisory economic group to the French Prime Minister (Conseil d'Analyse Economique). This report was presented on July 2002 and published in 2003, (Guesnerie(2003)). These extracts have been chosen and reorganised to provide an assessment of the future of the Kyoto protocol, as emphasized in the title. The sections successively treat: the present flaws of the Kyoto protocol, the improvement in design that can be thought of, the issues underlying the durability of Kyoto-like arrangements. The main lessons of the analysis are stressed again in conclusion.

Résumé : Ce texte présente une traduction en langue anglaise d'un rapport au Conseil d'Analyse Economique, organisme rattaché au Premier Ministre français. Le rapport a été présenté en Juillet 2002 et publié en 2003 (Guesnerie (2003)). Ces extraits ont été choisis et réorganisés pour esquisser des avènements possibles aux arrangements du protocole de Kyoto. On traite successivement des faiblesses présentes du protocole, de la conception statique et des manières de l'améliorer, et de la permanence temporelle de l'arrangement. Les conclusions volontaristes qui sont tirées sont finalement soulignées

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Mots clés : Protocole de Kyoto, Pays en Développement, Prix ou Quantité, Carburants fossiles, Commerce et Environnement.

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1-Kyoto : present flaws.

Elsewhere in the report, (Guesnerie 2003a) we have established that the incentives to reduce emissions and stimulation to technical progress are complements rather than substitutes. On that basis, we argued for a division of a given economic and financial efforts between R&D and emission reductions¹ according to some principles that need to be refined . Whatever it may be, , the relative weight of the total collective efforts planned in Kyoto is too biased in favour of emissions reduction initiatives and, therefore, unsatisfactory. The flaw of the Kyoto scheme in this regard is obvious and already calls for action. . For instance, the countries having ratified Kyoto, or at least some of them, should involve themselves in collective research on carbon-free technologies.² On this matter, a European initiative proposing cooperation on the basis of costs and benefits sharing would be particularly welcome.

Another urgent problem, however, concerns the developing countries. Non participation of the Southern countries, while limiting the 'carbon tax' base, increases the costs to the Northern countries, at first because it increases the level of the tax to attain a given quantitative objective and then it increases the incentive to move activities abroad. From this point of view, the Clean Development Mechanism (CDM) is not very satisfactory even if the arrangement succeeds in keeping the South in the negotiation. Secondly, the Southern countries are rightly refusing a costly effort for the moment. To ask India to pay for reducing its emissions per capita, which is considerably lower than the figures for the United States, is shocking.

Mutually advantageous solutions exist nevertheless: participation of the developing countries with attractive conditions for them also reduces the abatement costs considerably for the developed countries. Most analyses have converged on this conclusion. A simulation exercise done by using the model GEMINI E3³ on an enlarged Kyoto to the world level with the initial emission rights distributed on per capita basis shows, in a speculative but spectacular

manner, a possible middle run reconciliation of *equity and efficiency*. For example, on a world-wide market for permits with rights proportional to population and a given target, the price of the permits would be two or three times lower in 2040 compared to the price on the assumption of an extended Kyoto scheme with the same target but without participation of the developing countries. The cost for the annex B countries (the list of the Annex B countries is given in Appendix 1) would be three times lower, while the transfers from Annex B countries to the rest of the world would be about 0.5 percentage points of the Annex B GDP.. Even if the situation is less simple in the long run, we would like others to share our conviction that *participation in the fight against climate change can be made attractive to the developing countries*. Without going into detailed technical discussions, the proposal (see also Philibert (2002)) could be based on either:

- Generous national quotas of ‘hot air’ such that as soon as the beneficiaries make some minimal efforts it assures them a positive transfer. Or
- Non binding quotas, which implies that exceeding them does not entail any penalties whereas any improvement gives access to the international market for permits.

This alternative scheme could replace rather than be juxtaposed to the current CDM. Without doubt they would have to be linked with an increase in the objectives of the Annex B countries, in order not to exacerbate the difficulties of implementing an international market for emissions rights to which the United States would not participate. In this case, the cost of observance would decrease in the end and the system would provide significant transfers towards the ‘virtuous’ Southern countries. Lastly, to avoid the legitimate mistrust of the developing countries regarding some highly temporary ‘carrots’, these schemes should provide guarantees in the medium run; for example, by accepting the principles which, in the medium or long run, reflect an egalitarian logic such as quotas on the basis of population, at least until a definite level. We will discuss this point in detail later.

The exploration of the track that has just been suggested should be given high priority today. We have previously discussed in the report (Guesnerie 2003a) the predictable effects on

development of the total greenhouse gas (GHG) emissions, the narrow feature of the Kyoto framework, the limits that competitiveness puts to the effectiveness of an environmental policy with a too restricted base. All this and the mutually advantageous character of the suggested extension indicate how decisive this question will be for the future of the policies against the climate change. Let us also point out that even though this paper does not deal with the geopolitical aspects of the question, the position of the three big partners of this negotiation, India, China and Brazil, who could be affected in the future by some notable damages linked to the climate change, offers hope for a realistic treatment of the question that has just been suggested.⁵

Of course, it would be desirable to have the United States come back to the bargaining table. In the light of *a posteriori* judgement and better information, it is clear that Kyoto asked too much from the United States.⁶ The late concession of the EU on the issue of market for permits might have been the first acknowledgement of this error. It is astonishing that the well known extreme reluctance of the US citizens to reduce their energy consumption did not make the negotiating partners recognise how difficult it was for them to ‘swallow’ the Kyoto potion, leaving aside the electoral contingencies. Naturally, it does not appear unreasonable to ask the the biggest polluter in the world (6 tons carbon equivalent per capita) to reduce 7% of its emissions. To evoke its responsibility as both the biggest polluter and the richest country is not out of place. But this is a ‘moral’ argument and it does not take account of core economic issues such as the cost and what we called earlier ‘willingness to pay’. Let’s note that today the American trend of the emissions between 1990 and the Kyoto phase 1 is about +25 to +30% due to inaction and the demographic and economic growth. To reduce the emissions by 30 to 35% even between 1997 and 2012 would have meant a rate of decarbonisation of 2% per year, which is a very difficult task given the inertia of equipments and institutions, even if some strong reduction potentialities exist in the USA with weak or negative costs. The strategy that seems most reasonable now is to attempt, by negotiation, to convince the developing countries to rejoin the annex B countries as soon as possible. Paradoxically, the absence of the United States,

which is apparently suspicious of solutions implying advantageous transfers to the developing countries in the short run or an egalitarian agreement in the long run, could make this negotiation easier.

2. Kyoto: can the basic design be improved?

The Kyoto protocol has been designed around two basic dispositions: First, it sets quantity objectives, (for participating nations that are given individual quotas, but consequently for the set of participants, as a whole); second it organizes a world market for exchanging quotas. We come back successively on these two central features of the arrangement and question them: is this basic design flawed, can it be improved?

Most experts agree that the function which links the global damages to the concentration of GHG, in the relevant intervals of carbon concentration, is linear in the short run. Therefore, the marginal damages would be relatively constant. Many economists think that in such a context regulation through a *price instrument* (to give a price signal in accordance with the expectation of the marginal damage) should be preferred over regulation by *quantity* (to set a quantitative target according to the calculation of mathematical expectation) from an efficiency point of view (see Weitzman (1974), Philibert 2002). The argument can be explained intuitively: as the marginal cost of reduction, expressed in the variable stock, is rapidly increasing, while the marginal benefit is relatively constant, the rigidity of the quantitative objective entails an important and socially useless increase in costs in the case of unfavourable realisation of hazard on the cost, while it does not allow exploitation of the opportunities of welfare gains in the favourable case.

This argument was used either to refute the whole architecture of the Kyoto Protocol or to propose amendments to it. Here it is necessary to discuss the nature of the argument first and its scope next. We must note first that quantity policy with market for permits constitutes a first insurance mechanism for the participants against internal specific shocks. The argument in favour of a 'price' solution applies therefore to a structural mid-term uncertainty on the costs

rather than to a temporary one. Moreover, it raises a lot of technical issues,⁷ and one has to keep in mind a more fundamental criticism for the case of the long run; viz. the argument neglects one of the possible factors of ineffectiveness of a price instrument, i.e. it transfers the rent linked with the fossil energies without necessarily reducing their rate of extraction-- a remark that pushed to its limits would invalidate all policies of taxation.

The invoked argument in favour of the 'price' solution therefore is not a devastating criticism of the whole architecture of Kyoto, as some people think. If, however, a lesson has to be recommended from this discussion, it is that *a quantity policy is likely to increase the variability of costs beyond what is desirable*. This is because an insufficient smoothing has negative effects on welfare, but also perhaps because economic agents are risk averse. Therefore, in order to limit the certainty-equivalent of the costs, it is desirable to reduce their exposure. A combination of this argument with the one concerning the pattern of the damage function then suggests the usefulness of *a ceiling price* on the emissions permit market. Nevertheless, the analysis just sketched raises some question marks on the adequacy of the recommended measures given the objectives. One may wonder, shouldn't the ceiling price apply rather than to the price of the permits to the "total" price of GHG, a price that adds to the price of the permit itself the market price of the underlying resources (for example oil, gasses or coal for the CO₂). In that case, the ceiling price of a permit instead of being ideally rigid might be ideally fluctuating to help stabilizing the global ceiling price,⁸

Let us summarize: reducing intervention costs to the minimum helps in the success of any environmental policy. In this respect, the implementation of a policy that sets exclusively quantitative targets triggers cost variability; hence it calls for some insurance mechanism. This is why one may regret *the absence of any safety valve* in the Kyoto scheme and wishes its inclusion in the future (Kopp *et al.* 1997). 'Safety' would be obtained by a guaranteed supply of permits at a ceiling price, whenever the market price goes over it. As said before, such a ceiling price should ideally vary in certain cases in order to partially offset significant although possibly irrelevant variations in the energy prices. In any case, the corresponding revenues could be

recycled by an international institution following methods experienced at the national levels, although they may be more difficult to implement at the international level. Similarly, an introduction of a *floor* price of the permits would help limit the randomness of the market value of abatements beyond the national quotas.⁹

Apart from these flaws of the quantitative regulation, the performance of the instruments set by the Kyoto Protocol is uncertain. For example, *the prejudgement in favour of the markets for emission permits* relies on the relative empirical success of experiments, especially experiments done in the SO₂ market in the United States. But the scope of the international market implemented by the Kyoto Protocol is completely different and nothing guarantees that such or such adjustment that has appeared effective in a special context will still be effective in a more general context. For instance, the '*banking*' or emission credits accruals that allows a temporal smoothing of the effort, may compromise in certain circumstances an effective stabilization of the expectations. Despite the favourable precedent of the SO₂ market, the time that has been historically required to implement such adjustments in some of the existing financial markets should not be forgotten. There is therefore an *experimental* dimension in the implementation of the Kyoto mechanisms,¹⁰ (which may be considered a merit and not a defect).

In this respect, a band with a ceiling and a floor prices, within the logic discussed above, would have other virtues beyond the inter-temporal smoothing of the costs emphasized so far (Cournède and Gastaldo, 2001). First, it would contribute *to frame expectations*, which tackles the risk of market volatility, the reality of which has been confirmed by our few experiences so far. Second, a safety valve, which introduces a price regulation in a system based on quantitative objectives, is not a denial of the Kyoto principles. The ceiling price can be seen as a penalty for exceeding the quotas (it had been discussed as such in the previous negotiations without being adopted). The '*safety valve*' would be a substitute for the supervision mechanisms that Kyoto succeeded in making compulsory but in a framework that leaves some grey areas. In the absence of a ceiling price, any country that finally grumbles to the required effort could simply postpone the foreseen reductions and undergo, as planned in the Marrakech agreements, a penalty

involving a multiplier effect, which requires that 1.3 tons must be ‘recovered’ for each lacking ton during the second commitment period. However, despite the ban on participation in the permits market that the failure would entail, the environmental debts could be accumulated until it becomes irrecoverable unless there is a sharp cutting date in place.

3. Can Kyoto-like arrangements be made durable?.

The above proposed improvements deal with the architecture of the Kyoto Protocol, and especially with its static aspects. To answer the question of the “durability” of Kyoto-like arrangements we need to return to the inter-temporal dynamics of the agreement and to the legitimacy of the international ‘*grandfathering*’ clause that Kyoto phase 1 introduces.

Kyoto lends to two extreme interpretations. *At minima*, it is a *mutually advantageous agreement* that takes into account the differences of costs and exposure to the greenhouse effect, and does not necessarily call for a universal participation. Apart from the difficulties of the initial negotiations, the renegotiation of the agreement after the contractual period is subject to much potential inefficiency, as all sequential negotiations are. We will not give an exhaustive list here, but simply underline a type of Achilles’ heel quite common in such cases, *the ratchet effect* (see Freixas *et al.*, 1985). First, let us ask the just evoked question, how to punish a country which fails to fulfil its commitments? This question, however, masks a less visible but more fearsome problem, i.e., what will be the starting point for the later period renegotiations? The response, in principle, is crystal clear: to do as if the previously accepted objectives had been met. It is, however, not very realistic to think that it will be so : the ‘default’ would, of course, be an argument for future discussion.¹¹ It will probably increase the *de facto* bargaining power and then, through successive agreements, give an increasing part of the surplus to the defaulting party.

A more ambitious or a more utopian interpretation of Kyoto is to read it, like many commentators have, as the first step towards a *progressive cancellation of the historic rights (grandfathering)* which give advantage in the short run to the biggest GHG polluters.¹² One

would substitute thus to the logic of the historic rights a more ‘egalitarian’ logic entailing for instance an allocation of the national emission rights based on population criteria. Such a formula cannot claim to be ‘fair’ in a deep sense, and even less a solution to the general and widely indefinite problem of implementation of international justice. However, economic development today has generated a need to limit the use of a former free good, and calls for a definition of new rights on *a worldwide scale*. An egalitarian distribution seems to be, all things being equal, a basis for the allocation of rights that is quite natural and is a step forward in the direction of ‘equity’, whatever the exact meaning one gives to this word. Without discussing further the above formula, we may think that this utopia was implicit in the Kyoto Protocol. It might have contributed in setting up a high required effort for the US beyond what was politically realistic. On the contrary, an explicit recognition of an egalitarian principle could have contributed to the consent of the developing countries by ascribing to them some ‘hot air’ today and offering them some good perspectives in the long run.

This brief analysis suggests two conclusions:

- In the long run the sustainability of an international agreement like Kyoto would have considerably improved if it had incorporated an agreement *on the principles of burden sharing in the long run*. Such an agreement should focus on the implicit or explicit property rights that will emerge at the end. In the absence of such an agreement, which might be linked to *an indicative target* of the long-term objective (and also perhaps with indicative trajectories), opportunistic behaviours that reduce the effectiveness of the action will be recurrent. Even if the adopted scheme must remain simple, it should be flexible so that in particular the transition trajectories may react to a set of considerations absent from the long-term target. For instance *transitional indexation* on growth (as an insurance mechanism) is compatible with a certain equality of the registered rights in a long-term perspective.

- The arguments of simplicity, equity and political consent at a worldwide scale give a ‘focal’ status to *the egalitarian solution*. The egalitarian solutions which allow for real transfers to the developing countries, also bring advantages to the Northern countries: they are hence

more politically realistic than what seems at first sight. The efficiency surplus that these solutions determine in the short run, since they entail the consent of the developing countries, has a counterpart in the long run.¹³

However, there are two reasons to believe that a purely egalitarian policy, in spite of its focal position, is not the “solution”. First, the residual inequality of the emissions distribution would remain important for long. This inequality is clearly shown in the graphs (figure 1) depicting the cumulated emissions according to the cumulated population and to their Gini index, for different scenarios of property right allocation.¹⁴ Second, it should be noted that egalitarian solutions, however, entail unacceptable costs to certain parties (e.g., Russia), given their expected “willingness to pay” as is shown by the Criqui, Vielle and Viguiier study (see Guesnerie 2003b), which indicates the middle-term efforts required for North America and the Former Soviet Union countries, under the scenario of convergence of per capita emissions (also see Germain and Steenberghe 2001).

The combination of these two remarks lead us to recommend a widening of short and mid-term agreements like Kyoto and to assign them an agreement not on the amount but on the principles of allocation of the emission rights till 2050-2070. Whatever the exact formulation of this principle, the allocation formula should remain simple and strike a compromise between the egalitarian logic and the one of acceptability.¹⁵

One cannot deal with the question of acceptability without returning to a more basic problem of participation. The permanence of an environmental agreement like Kyoto, as well designed as it could be, is constantly threatened by the *free rider* problem. It means that it is impossible to exclude someone from the use of the collective good produced by the agreement. Each country’s most likely best interest is not to join an agreement when the others have already joined.¹⁶ This problem does not disappear even in the framework of a limited action and increases with increase in the efforts demanded. It is difficult to build an international order when the reasons to participate are so fragile. To reinforce it, do we need to widen the framework of the agreement?

The earlier reflection on the relations between international trade and global collective goods started with the necessity to preserve the efficiency of the environmental efforts undertaken by a group of countries (the signatory countries) and led to the reconsideration of the well-founded separation between the fields of trade and global environmental goods. But the issue is wider: in the absence of any world governmental institution, should ideally international agreements on trade or any global public goods be globalized? We will make only a few remarks here. Economic analysis suggests that the widening scope would increase the range of the mutually advantageous agreements, a conclusion that do not invalidate, it seems, most of the realistic theories of negotiations available today. This suggestion, which of course should be established by more studies, does not imply that the preparatory works for a global agreement cannot or should not be separated. It does not at all imply that the technical agencies such as WTO and a future possible agency for the environment should merge. Let us admit that the compromises are better, from the efficiency point of view, when made global on both trade and environmental policies. Still, it cannot be denied that such a solution also changes the bargaining powers of the partners. In the context of the contention of Kyoto, it would without doubt modify it in favour of Europe and to the detriment of the United States.

The assessment of the feasibility and diplomatic opportunities of such actions is of course out of the scope of this paper. It is nevertheless worth mentioning the fact that an environmental compromise like Kyoto is necessarily fragile and that it can be reinforced only by coupling it with some other international agreements (trade, other environmental agreements, etc.) that are less subject to free-riding. It means that a widened space for compromises is beneficial and is likely necessary for the viability of an ambitious environmental agreement.

4- Some final words on perspectives.

The whole report (Guesnerie (2003a,b) renders an overall judgement in favour of the initial action envisaged in Kyoto regarding both its scope and methods. Let us recall the reasons adduced for this judgement.

First of all, in the present state of the scientific knowledge, it is difficult to come to terms with the climatic risks while postponing significant action to an indeterminate date. The timeliness of implementing the ‘hardware’ and the ‘software’ of a policy of world-wide control of the greenhouse gas emissions is not very doubtful. The scope of the initial effort envisaged in Kyoto can be discussed. It takes place within a reasonable range, in the sense that there are good reasons, but no convincing proof, to think that Kyoto does too much or too little. The nature of the uncertainty and the temporal horizon make cost-benefit analysis difficult. But the arguments that conclude that the Kyoto reductions pace is too quick rely on simplistic economic calculations, and are rather less convincing than those that conclude, for example using option values arguments, in favour of insufficient present abatement. The truth is that our comprehension of the climatic consequences of the growth of the greenhouse gas concentration is insufficient, and that this position pleads for prudence. Prudence and credibility, as aimed in Kyoto, recommend going well beyond symbolic actions.

The flexibility mechanisms notably aim at lowering the implementation costs of policies. The markets for tradable emission permits constitute a major innovation, which most likely would considerably increase the efficiency of the action, even if the scheme has never been experimented on this scale before. On the other hand, however, this paper points to some reservations about the implementation of the Clean Development Mechanism (CDM). More generally, the architecture envisaged in Kyoto is based on rigid quantitative commitments that, ideally, should be more flexible. But this quantitative frame is excessively criticized. The implementation of alternative mechanisms, considering probable supply reactions in the energy market, is more difficult than generally expected. Nevertheless, some form of price supervision, like the ‘safety valve’ mechanism alluded above, is desirable. Besides, the Kyoto architecture allows renegotiations and opens the door to limited transfers between nations. It is an improvable evolving scheme that could possibly lead to other ‘Kyoto compatible’ architectures.

Even though this paper does not evaluate most of the political aspects of the subject, in particular the political willingness of Europe placed in a position of ecological leader, it

underlines the costs of renunciation of Kyoto and argues in favour of keeping it alive and improving it. Nevertheless, before recapitulating the principal suggestions that were made in this direction, it is useful to evoke several scenarios of the post-Kyoto period, starting with two extreme scenarios, an idealized Kyoto and a weak and frayed Kyoto.

Vigorous and “idealized” post-Kyoto governance could include:

- Some quantitative Kyoto-like targets, agreed upon by sovereign entities. But the agreement would be widened to the definition of long term allocation principles for national emission rights. It would match with provisional perspectives of the implementation of these principles. Equality of rights for all the inhabitants of the world would be the focal position of the discussion, even though the long-term principles should necessarily compromise to reconcile it with mobilisation capacity and economic and political realism. Therefore, the agreement would also reflect the exposures of the protagonists to the climatic risk.
- An assignment of binding objectives to be fulfilled within a period together with some indicative paths coherent with the long-term perspectives.
- The possibility of meeting the targets of the period, not only by internal reduction efforts but also by trade on international markets for emission. In this respect, the regulation of these markets by a floor price and a ceiling price would operate, according to the circumstances, as a tax or a subsidy, and would help provide insurance and entail at least a minimum incentive for abatement. Such a regulation, however, should aim to frame the user prices of fossil fuels, that ultimately determine GHG emissions, and not only the price of the permits. The expected receipts of the scheme would be collectively managed and could help implement some specific assistance to developing countries, and also finance an international research network, etc.
- The solidity of the agreement would be guaranteed by its inclusion in a “*package deal*” of international agreements including trade agreements, and defining rules of the game for interdependent and supportive international order.

The idealised Kyoto sketched here, which can be pleaded at least from the point of view of efficiency, is likely to be utopian. One essential obstacle to such a Kyoto utopia may be the

reluctance of a part of the international community, not only the US, with regard to the solutions implying a significant, although still very modest, redistribution of the planet's income. The state of things today, therefore, makes this utopia not very probable. But a spectacular increase of the danger of the climatic change, if it was proved, would make an increasing number of people aware of it and thus could give the Kyoto utopia a chance. Nevertheless, in the short run, the situation is less favourable and the danger of seeing a Kyoto becoming weaker and weaker is real.

The demonstration effect of a limited club of nations who have been unsuccessful in convincing the international community to join them and who represent a minority both in terms of number and volume of emissions may neither be very productive nor rewarding. In order not to lose the political support of their citizens worried about a low value of benefit/cost ratio, it may lead to limited efforts by their governments. Moreover, these countries may find their competitiveness weakened in some segments of the world market of goods and services. In a nutshell, the 'demonstration effect' risks being highly limited.

One fears that there stands out another kind of frayed Kyoto today, that is the Russian "hot air", rather than the political erosion of the European determination. Russia due to its recent deindustrialisation is in possession of excess permits for the "hot air" and may lower the price of permits on the market to the extent that it deters abatement efforts by other countries. Furthermore, both the credibility of the climate policy and incentives to research on clean technology that a significantly high carbon price insures, and which are the cardinal virtues of the international permit market, disappear with it. Until the end of the first commitment period in 2012, the European Union has the responsibility to contain these risks. It must proceed in an effective manner to a significant reduction of its emissions, while managing the question of the Russian hot air.

Finally, the action taken within the Kyoto framework will be fully meaningful only if it can go on after 2013, a period for which it is necessary to prepare now. The feeling expressed in this paper is that the ambition of the Kyoto Protocol will be lasting only if at least an important

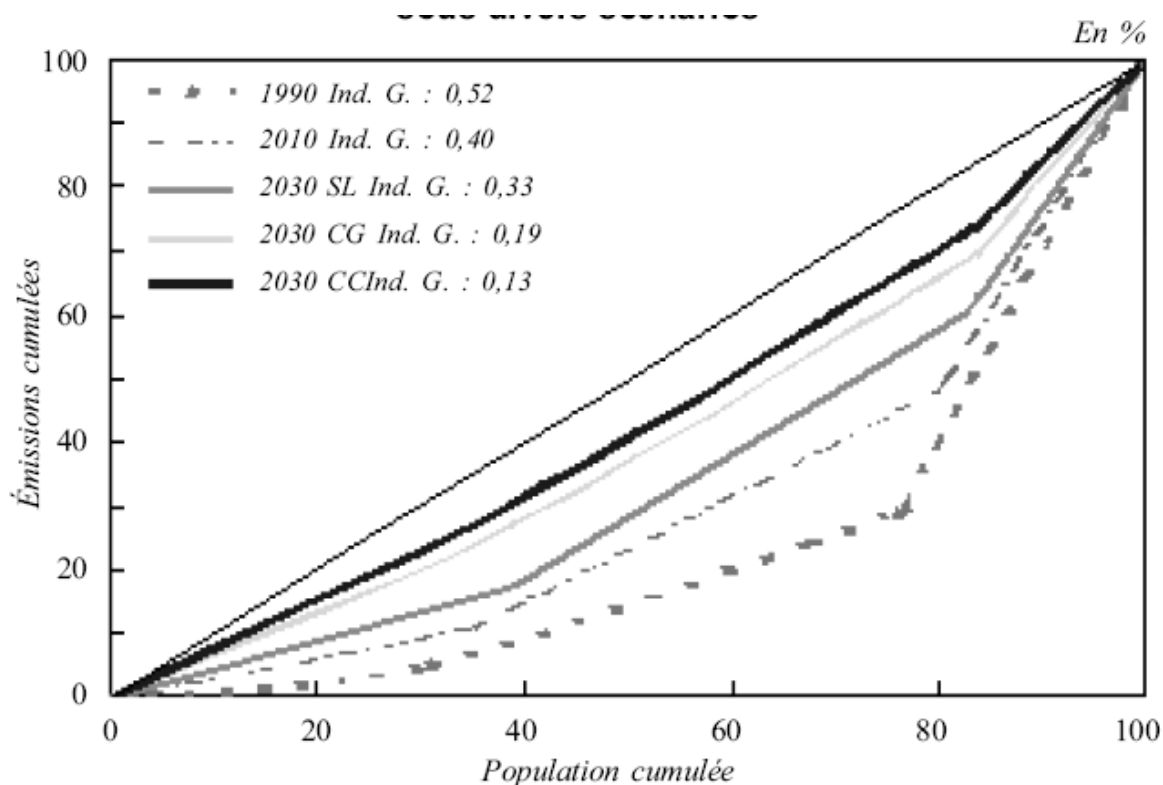
part of the developing countries is associated with the extension of the agreement. For that the Annex B countries will have to present economically attractive solutions to the developing countries, which they have the capacity for.

These solutions could be more or less inventive (as explained in the report). But to be mutually advantageous, i.e., to lower the cost for the rich countries and trigger significant income transfers on a sufficiently long period to the developing countries, they will have to be generous in the short run and give solid guarantees on the rules of the game in the middle run. Without broaching the diplomatic and geopolitical questions, this report expresses the conviction that an agreement on the basis of the suggested solutions is possible, as soon as the two conditions that have just been underlined are met. Supporting the implementation of efficient systems of measurement for emissions in the developing countries is also a concrete priority today.

Still in the middle run, together with a quantitative control, some form of control of the GHG price, that comes either within a *safety valve* and/or sets an inferior bound to the incentive with a price floor, should be integrated to the scheme. But, although this point deserves more elaboration, the mechanism might be all the more satisfactory if it will stabilize the total price of carbon and not only the “carbon tax”. Moreover, the agreement could evolve towards adopting architectures that are “Kyoto compatible”, either more effective or more adaptable to the political economy of negotiation. It is necessary, in whatever manner, to solve the problem of the inter-temporal inefficiencies that come with ratchet effect more satisfactorily than we do it today. It is also necessary to widen the space of the carbon tax to the whole planet. In the strict Kyoto logic, the solution of these problems is likely to require an agreement on the principles of a long run distribution of the emission rights on the one hand, and, on the other hand, a coercive participation, of which the privileged mean could be the merging or logrolling of international compromises outside the lone field of environment. However, these problems have other Kyoto compatible solutions the understanding of which future studies must imperatively deepen.

Figure 1.

Cumulated emission according to cumulated population under different scenarios.



Source : Complément Criqui, Vielle et Viguier à ce rapport. Voir le complément pour la signification des scénarios *Soft Landing* (SL), « contraction et convergence » (CC), et « compromis global » (CG) ; Ind. G = indice de Gini.

Scenario SL : *Soft Landing*

Scenario CC : *contraction and convergent*

Scenario CG : *Global Compromise*

Ind G .: *Gini Index*

Appendix 1

List of Annex B countries

Party Quantified emission limitation or reduction commitment

(percentage of base year or period)

Australia 108, Austria 92, Belgium 92, Bulgaria* 92, Canada 94, Croatia* 95, Czech Republic* 92, Denmark 92, Estonia* 92, European Community 92, Finland 92, France 92, Germany 92, Greece 92, Hungary* 94, Iceland 110, Ireland 92, Italy 92, Japan 94, Latvia* 92, Liechtenstein 92, Lithuania* 92, Luxembourg 92, Monaco 92, Netherlands 92, New Zealand 100, Norway 101, Poland* 94, Portugal 92, Romania* 92, Russian Federation* 100, Slovakia* 92, Slovenia* 92, Spain 92, Sweden 92, Switzerland 92, Ukraine* 100, United Kingdom of Great Britain and Northern Ireland 92, United States of America 93**

- * Countries that are undergoing the process of transition to a market economy.
- ** The USA later declared its intention not to ratify the protocol and not to decide any target of emission reductions.

Thirty nine countries are part of Annex B to the Kyoto protocol. Even though Annex 1 and Annex B are often used as if they were the same, only countries from Annex B have some obligations of emission reductions in the frame of the Kyoto protocol. Moreover, Bielorrussia and Turkey are part of Annex 1 but not of Annex B. Croatia, Liechtenstein and Monaco are part of Annex B but not of Annex 1.

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End Notes

¹ Ideally, part of the effort should be devoted to adaptation (to global warming), but action on this front today may be quite premature.

² These actions would eventually involve the private sector but could make creation of some ambitious collective institutions, such as an International Commission for research on free-carbon energies, meaningful, bypassing the too narrow national scope.

³ See Criqui, Vielle and Viguier (in Guesnerie 2003b), as well as Bernard (2001) and Criqui *et al.* (1999).

⁴ Within the same logic, one nevertheless may prefer equivalent monetary transfer for the hot air.

⁵ We may, however, note the success of the first Chinese efforts regarding reduction of the emissions, despite the effective and potential role of the coal in the Chinese economy.

⁶ Despite the apparent contradiction between the positions of the candidate Al Gore and the elected president George W. Bush, most of the observers think that another result of the American elections might not have basically changed the situation. One might argue that this American position reflects a bad interpretation of their interests, in view of the rate of substitution between moral leadership and military leadership and the economic cost of the latter.

⁷ The technical argument of Newell and Pizer (2000) in favour of the price solutions calls for some reservations. It relies on a formalization of costs, some convex cost functions in each period, which raises the question of inter-temporal aggregation. See the report (Guesnerie 2003a) for details. Lastly, regulations by quantities have advantages that are not taken into

account in the model. For example, one could argue that a price fluctuation around the average value will have a positive effect on the incentive to research (the “convexity in prices” of the revenue function of the innovator does not, however, seem to be empirically validated).

⁸ This suggestion deserves a greater theoretical discussion as well as a more practical precision, since it raises the question of the relevance of the spot price signals for the energy market on the one hand and since the prices of the various GHG sources are themselves likely to vary in a different manner on the other hand.

⁹ Some suggestions were made by Victor (2000) to avoid “junk permit” coming from countries not respecting their commitments. Let us also note the requirements of already adopted solutions, for example, that of a reserve for the commitment period. This is an unrecognized but essential mechanism: every country must keep in reserve an important part of its initial emissions. But the buying countries can also sell (temporarily) a part of their assigned quantity (10%). The environmental integrity of the market is preserved (one cannot flood the market with permits which the country would need later to cover its emissions), while assuring its liquidity. A firm which is located in a net buying country, but surpasses its target, would have nonetheless access to the international market.

¹⁰ The price volatility observed on the American market for SO₂ is somewhat disturbing.

¹¹ Even if some dispositions envisage an early renegotiation that would limit this risk at the first steps. In that way Kyoto Protocol specifies in its item 3.9 that “Commitments for subsequent periods for Parties included in Annex I shall be established in amendments to Annex B to this Protocol[...]. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall initiate the consideration of such commitments at least seven years before the end of the first commitment period.

¹² The Bonn agreement stipulates that the Annex I countries will have to implement some domestic actions that aim to reduce emissions such that it reduces the per capita differences

between the developed countries and the developing countries, while working towards the ultimate objective of the Convention.

¹³ In the long run, the political acceptability of per capita emissions convergence scenarios can be improved by the fact that the “veil of ignorance”, even very incomplete, reinforces the acceptability of the distributive argument that they incorporate.

¹⁴ One of which integrates the convergence objective of the per capita emissions at the planetary scale and leads to the curve nearest to the bissectrix.

¹⁵ One can, for example, define for each country a fictitious population taking account of its present and future population and its degree of exposure to the greenhouse effect (Russia having then a fictitious population that is greater than its real population).

¹⁶ One can envisage penalties, of which Adly, Orzag and Stiglitz (2002) suggest a list, including the most anecdotic ones like exclusion from the Olympic Games or Soccer World Cup.