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The Economics of a Lost Deal

Working Paper

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Content

The Economics of a Lost Deal[1]

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Summary

This paper examines compromise spaces between competing perspectives on four key climate change issues: costs, level of domestic action, environmental integrity, and developing world involvement. Based on extensive simulations of a model integration tool, SAP12 (Stochastic Assessment of Climate Policies – 12 models), the analysis considers options for fine tuning the Kyoto Protocol, such as concrete ceilings or levies on carbon imports; restoration payments to be made on excess emissions; credits for sequestration activities in Annex B countries; and others. It shows out the critical importance of the baseline against which the performance of each tool has to be assessed in the absence of direct economic penalty for non compliance. It concludes that a restoration payment (also known as a 'safety valve') emerges as a superior means of addressing every one of the key policy issues, including environmental integrity, and provides a large compromise space between $35 to $100 a ton of carbon.

Introduction

Many interpretations can be given for the inconclusive outcome of the 6th Conference of the Parties (COP6) to the United Nations Framework Convention on Climate Change: diplomatic misconduct, cumbersome negotiation machinery, lack of political will[4] or intrinsic defects of the Kyoto Protocol (Victor 2001). This paper builds on the intuition that, besides such factors and obvious divergences in

[1] This paper builds on a series of workshops organized by the CIRED and RFF to bridge the gap between the US and EU views about the Kyoto Protocol. The modeling tool providing numerical assessments was developed by Frédéric Ghersi during a stay at RFF supported by the French *Agence De l'Environnement et de la Maîtrise de l'Énergie* (ADEME) and *Entreprises pour l'Environnement*, and Resources for the Future, Washington, D.C. We gratefully acknowledge helpful contributions to the text by Henry Jacoby, Franck Lecocq, Richard Morgenstern and Michael Toman.

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[4] For an overview of an EU perspective on the process see Gupta & Grubb (2000) and Metz & Gupta (2001).

interests, the uncertainty about the costs of meeting predefined targets was the key parameter fueling two opposite concerns regarding the ultimate implications of the agreement reached in Kyoto, at the risk of undoing "Kyoto's unfinished business" (Jacoby *et al.* 1998).

The European insistence on the use of flexibility mechanisms being supplemental to domestic action stems from the fear that, because of low abatement costs and the excess emissions quota assigned to Russia and Ukraine, carbon prices may not reflect the long term value of a significant carbon constraint (Ha-Duong *et al.* 1999), while carbon trading may become a way of escaping real reductions. A symmetric concern is shared in the JUSCANZ[5] negotiation group that costs of meeting Kyoto commitments could be high enough to undermine the economic and political viability of the system; it lead to question, at least implicitly, the Kyoto targets and timetables and to envisage options hedging against risks of excessive costs.

To address a number of the key uncertainties in this debate, we developed a model integration tool, SAP12, incorporating harmonized reduced forms of a dozen global climate-economy models that encompass the various degrees of optimism and pessimism fueling negotiation stances (see Box 1 below)[6]. This enabled us to analyze various negotiation packages under different values of parameters such as compliance payments, supplementarity constraints (following Article 17), share of the proceeds and carbon sequestration, with a view to delineating a compromise space between competing interests and worldviews. The larger this space for a given negotiation package, the more apt this package to facilitate an agreement, at least from a pure economic perspective.

Although they are but the fruits of a cross-section study of 12 models, SAP12 results reported in this paper will be presented in the synthetic way of 'likelihood spaces'. Such a probabilistic interpretation is grounded in the fact that, despite some form of Delphi process in the runs that were used to produce our reduced forms, the underlying models encompass a large scope of values for abatement costs and requirements –2010 cost projections vary by almost an order of magnitude. Policy-makers may well regard the distribution of modeling results as representing uncertainties in the real world, and attach subjective probabilities to them in function of their own beliefs. Unless otherwise stated, likelihood intervals reported assume equiprobability between models.

As a first step, the clarification of some conceptual ambiguities about compliance costs will lead to rethinking the supplementarity quarrel in the light of the impact of compliance systems on the level of domestic action. The second section, focusing on environmental performance and costs, delineates compromise spaces within the Annex B around packages that exclude extended activities under Article 3.4. The third section compares such compromises with those including the latter option. A final section 'closes the triangle' between the EU, the JUSCANZ and the G77 by examining how the alternative Annex B compromises hold the potential for a strong incentive for the developing world to join international climate control regimes.

1. Conceptual ambiguities behind the negotiation game

The post-Kyoto process was *de facto* structured by divergences among Annex B countries, on compliance costs and supplementarity. Ironically, these divergences overshadowed what are probably more fundamental long run conflicts between the Annex B and G77 nations. The failure to reach an agreement

[5] Japan, the US, Canada, Australia and New Zealand.
[6] Ref of a web page with a technical handout about the model.

among Annex B nations was due, in part, to the very negotiation language, formed of casual rhetoric compromises which blurred the perception of critical points of contention. This is why some conceptual clarification is necessary prior to numerical analysis in order to minimize further misinterpretation.

The model integration tool SAP12 (Stochastic Assessment of Policy - 12 models) incorporates reduced forms of marginal abatement cost curves of twelve major climate-economy models. The curves are constructed by backward calibration from data published in *The Energy Journal* Kyoto Special Issue (Weyant and Hill 1999) for 10 of them and from the modelers themselves for POLES and WAGEM. Five of these models are American (MERGE 3.0, MIT-EPPA, MS-MRT, RICE and SGM), two Australian (ABARE-GTEM and G-Cubed), one Japanese (AIM) and four European (Oxford Model, POLES, WAGEM and Worldscan). All models were peer-reviewed either as members of the Stanford Energy Modeling Forum or by the International Panel on Climate Change for its *Third Assessment Report*.

Given the available data, calibration has been made in a consistent manner for four zones –the European Union, the US, Japan, and the remaining non-Eastern European Annex B countries gathered under the 'CANZ group' tag; assuming linear cost curves the Annex B- and Global trading equilibria suffice in deriving abatement potentials for the Economies in Transition (EIT) and the Clean Development Mechanism. For a given model the resulting set of six curves allows the computation of a market equilibrium under various assumptions regarding the modalities and rules of the flexibility mechanisms.

Note that the resulting marginal costs correspond to levels of lump-sum recycled carbon taxes inducing a given abatement. They hence embody not only assumptions on technical costs but also the macro economic feedbacks as described in each model. Accordingly, 'Total costs' are derived by integrating below the curves for domestic costs and adding the volume of imports priced at the international equilibrium price (all runs suppose an international market of emission credits resulting from the three flexibility mechanisms).

The underlying methodology is grounded on the premise that policy-makers can interpret the variance in results from the twelve models as revealing uncertainty in the real world regarding key parameters of cost assessment, such as technical change and behavioral reactions to policy signals. A conventional stochastic treatment is thus applied:

SAP12 runs each of the models separately and provides an expected value of basic economic and environmental indicators for the policy packages tested. Perhaps more importantly, we derive from its comprehensive results a) the percentage of chances to be above or below a certain value of each indicator given some subjective probability attached to the results of each model –in most of the runs we will assume equiprobability or an equal level of confidence– b) the 'likelihood intervals', used in most of the results reported, whose bounds are the average of the twelve results minus and plus one standard deviation as observed: a **[16 ; 45]%** domestic action in a region under a given policy means a $\frac{16+45}{2}$ **= 30.5% average, with a 15.5% standard deviation.**

Box 1. ***Model integration tool***

1.1. A core division line: compliance costs and supplementarity

Available modeling results fuel the main concern behind the supplementarity condition: six of the SAP12 models give a carbon price lower than $30/t under global trade, and one model even gets the same result under an Annex B-restricted trade. The figures are all the more impressive as simulations do not incorporate carbon sinks and their price deflating effect. It cannot be overlooked that such prices may fail to represent the social value of the carbon constraint which will ultimately prove appropriate. Therefore they may fail to give enough incentive to governments and private industries –in particular in activities characterized by a high inertia such as infrastructure and R&D–, which may make further ambitious targets very costly (Lecocq *et al.* 1998). Along the same line, it can be argued that likelihood intervals of domestic abatement -percent of domestic action on total abatement required for full compliance– staying as low as [16 ; 45]% in the US, [12 ; 32]% in the EU and [10 ; 28]% in Japan, will not trigger a significant learning by doing process. In May 1999, to compensate for this risk, the European Council of Environmental Ministers proposed the adoption of concrete ceilings to limit carbon imports based on two alternative formulas[7], completed by a *however clause* resulting in a 50% ceiling. This 50% ceiling was drafted in Pronk's package[8] by a sentence stating that Parties "shall meet their emission commitments *primarily* through domestic action since 1990" (our emphasis).

Conversely, the same sample of models also fuel concerns about excessive costs: in a no-trade case, 67% of them give costs higher than $150/tC[9] for the US, a percentage that climbs up to 83% for the EU and Japan; for $250/t those percentages are still 33% for the US and the EU, 67% for Japan. A full-trade scenario with perfect markets mechanically lowers this risk, with only one scenario giving an international carbon price higher that $100/t. However, such a numerical experiment is misleading since, as pointed out in Weyant and Hill (1999) gains from trade will depend mostly on transaction costs impeding the functioning of the flexibility mechanisms, particularly so for project-based mechanisms, an administratively cumbersome form of emission trading. Thus, with no ceiling on the use of flexibility mechanisms, what we deem realistic (some will say optimistic) assumptions regarding transaction costs[10] result in a 50% risk that the international price of carbon exceed $100/t, a level at which it can no longer be disregarded. Two ways have alternatively been advocated to address this problem:

- a pre-determined dollar-per-ton payment by which Parties can cover their excess emissions and stay in compliance (Kopp *et al.* 1997). Such a provision creates a 'safety valve' against both excessive marginal and total costs and opens the possibility of an *ex-post* revision of Kyoto objectives, while conserving a chance of proving that they can be fulfilled cheaply. The original proposal was refined into a 'restoration payment', with collected funds recycled in supplementary abatement during a 'true up' period through a reverse auction mechanism[11] (CIRED-RFF 2000);
- under Article 3.4 of the Protocol, the extension of eligible sequestration activities, which increases the availability of 'cheap' tons in Annex B countries but is viewed in many quarters as an *ex-ante* redefinition of Kyoto targets.

Typical of the difficulty in surmounting the division line between optimists and pessimists regarding costs, both options can be perceived as ways to reduce domestic action. Conversely the supplementarity condition was viewed in the JUSCANZ as exacerbating risks of too high compliance costs; this lead the advocates of supplementarity to propose, as an amendment to the concrete ceilings proposal, a waiver that operates when domestic abatement costs exceed a given level; as a substitute to it, a per-ton import charge to be levied by parties on their emission credits acquired via all mechanisms.

1.2. Private and social costs: the overlooked distinction

Discussions about how to hedge against excessively low or high compliance costs do not always clearly distinguish between the net total costs and the marginal abatement costs. A high marginal cost of carbon mitigation may indeed prove problematic, increasing the prospect for compliance default if it exceeds the

[7] Net carbon importers must respect the least constraining of two ceilings, option A: 5% of the average between five times their base year emissions and their assigned amount, and option B: 50% of the difference between five times their emissions in any given year between 1994 and 2002, and their assigned amount. But they can benefit from the however clause. Net exporters are subject to the 5% limit without alternative.
[8] We define 'Pronk's package' as the document handed out at The Hague by Jan Pronk, President of COP6, on November 23rd, with the title *Note by the President of COP6 - 23 November 2000.*
[9] Throughout this paper marginal costs are 1990 USD per metric ton of carbon in 2010.
[10] In the following simulations, transaction costs are calibrated so as to restrict accessibility to potentials in the global market cases for each of the models: 2/3 for emission trading and joint implementation (JI), 1/4 for the CDM –a figure higher than the 15% retained in the EMF study (Weyant and Hill, 1999); a $10 minimum price is set for hot air trading, corresponding to a minimum transaction cost on CDM.
[11] Proposals are registered until the tonnage priced at the marginal cost clears the fund.

willingness of energy consumers to pay for carbon mitigation[12]. Extensive experience demonstrates that energy consumers are much more sensitive to the gross signal of energy prices than to a net impact with possible but less tangible compensating effects –such as the recycling of the proceeds of a carbon tax or auctioned tradable emission permits. This is why motorists and carbon-intensive industries can block measures such as environmental fiscal reforms, even though these measures are supposedly Pareto-improving in specific circumstances.

While, as noted earlier, the marginal cost of carbon control may be high, the overall social cost of control may be more tolerable –especially if revenue-recycling measures are put to use. A survey of major models by the IPCC Working Group III (2001) indicates that 2010 GDP losses range between 0.2% and 2% in a no-trade case and in the absence of carbon sequestration; even when these impacts are not small, they can be halved through the Kyoto flexibility mechanisms, and could even be lower (possibly turning into a gain) in case of a judicious use of revenue raising instruments.

It thus appears that a possibly too-high marginal carbon cost constitutes the main obstacle to compliance. Governments seeking to circumvent it can socialize compliance costs by funding carbon imports through public expenses, rather than let the energy prices bear the full extent of their brunt. However, this *'communicating vessels'* mechanism between the two metrics is not unlimited: first, annual carbon imports possibly reaching billions of dollars[13] would impact on trade balances[14], second the concentration of the corresponding transfers on one or two main exporters might entail unacceptable geopolitical risks. The only alternative, allowing to avoid such perverse impacts, is a subsidy to domestic abatement. Ultimately though, both options imply higher welfare costs than a straightforward price-triggered compliance because of the shadow price of public funds.

1.3. Paradoxes regarding compliance systems

The reference document for compliance is Pronk's package. It proposes that excess emissions from the first compliance period should be subtracted from the second budget period quota negotiated in 2005, with a 1.5 penalty rate that should *"be increased by 0.25 after the subsequent commitment period if [still needed]"*; in economic terms, this provision constitutes a *borrowing facility*. However surprising to an economist, the absence of any compliance payment is explainable, as follows.

Let us assume a country where consumers show a $100/t willingness to pay, while full compliance requires a $150/t carbon price. Under the threat of a $200/t compliance penalty, a 'good faith' government will obviously use public funds to support domestic action and pay carbon imports at $150/t, rather than submit itself to the $200/t penalty. Conversely, a 'bad faith' government – having taken the risk of deliberate non compliance while facing a $150/t price, rather than confronting its tax payers–, will logically not change its position for a $200/t payment. In neither case will the compliance payment be effective.

In fact, any economically credible compliance system would require a threat beyond the internal rules of the UNFCCC. An obvious candidate would be the WTO legitimating trade barriers against countries in compliance default with global environment treaties. But a linkage between the UNFCCC and the WTO

[12] We are using the notion of 'willingness to pay' here not strictly in the classical sense of revealed preference for the benefits of long-term GHG abatement. Rather we refer to a politically salient limit on the willingness to bear a certain level of short-term cost. Note that the latter notion may well be less restrictive than the former, which currently available empirical studies set at a level much lower than those we consider in this text.
[13] [8 ; 22], [4 ; 26] and [2 ; 11] billions of 1990 USD annually for the EU, the US and Japan respectively under a full-trade full-compliance hypothesis, including transaction costs as defined in footnote 10.
[14] Models representing trade and capital flows point out the impact of transfers on the exchange rates of currencies (Mc Kibbin *et al.* 1998).

has never been envisaged so far, and an option of Pronk's sort appears the only possible compliance provision.

This has a critical implication for the benchmark to which negotiation packages should be compared: a scenario in which governments socialize costs of meeting their targets regardless of their extent is misleading because it assumes a form of 'Candide' conduct[15]; a more realistic benchmark is one considering that even *bona fide* governments rather take full advantage of the borrowing flexibility given by existing legal provisions.

1.4. The Real terms of the supplementarity problem

The three preceding sections force to rethink the terms of the supplementarity quarrel.

Transaction costs associated with the CDM credits, because they raise the international carbon price, considerably reduce the risk of not complying with a '50% condition': this risk altogether disappears for the US, seems low for the EU, and is significant for Japan only (columns 1 and 2 in Table 1) –an unsurprising result since all models reveal a flatter marginal cost curve in the US than in the other countries or zones.

	Global Trade w/o transaction costs	Global Trade with transaction costs...	...and a 1.3 shadow price of carbon imports	...and a 1.5 shadow price of carbon imports
European Union	[12 ; 32]%	[43 ; 65]%	[45 ; 68]%	[47 ; 70]%
United States	[16 ; 45]%	[58 ; 85]%	[61 ; 89]%	[63 ; 92]%
Japan	[10 ; 28]%	[33 ; 55]%	[35 ; 58]%	[36 ; 59]%
Market price	$[6 ; 74]	$[39 ; 204]	$[32 ; 169]	$[29 ; 151]

Table 1. *Domestic abatement over total abatement, under full compliance*

In addition, governments may consider the hidden cost of foreign carbon payments, depending on their shadow price of imports and concerns about the geopolitical implications of foreign transfers concentrated on one or two main exporters. Table 1 provides results for a 1.3 estimate[16], and a 1.5 value embodying a strong geopolitical concern[17].

The odds of domestic action exceeding a symbolic 50% seem very substantial. A closer scrutiny of detailed results by model (following the methodological considerations in Box 1) gives a 100, 92 and 42%

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[15] Candide is a character from Voltaire, a naïve young man who, while a repeated victim of the common flaws of human nature, sticks to the very end to its mentor's teaching that "they, who assert that everything is right, do not express themselves correctly; they should say that everything is best."

[16] In macroeconomic terms, the shadow price of imports is the social cost of the balance of payments. It is very dependent upon each economy's specifics: share of traded goods on total output, level of foreign debt, size of the economy, credibility of the domestic currency, with some of these elements obviously hardly predictable over a ten year horizon. For illustrative purposes we present results for estimates commonly found in macroeconomic literature (CGP 1984), 1.3 and a more drastic 1.5 factors weighing the trade-off between domestic and foreign expenses: governments are indifferent between a $1 expense abroad and a $1.3 or $1.5 expense home.

[17] The fact that the shadow price of carbon has a low impact on domestic action is explained as follows: consider one importer with target T and linear abatement cost $p=aA$, and an exporter with linear abatement cost $p=b(I-H)$, where H is hot air. Compliance yields $\frac{\partial A/T}{\partial b}=\frac{T-H}{T}\frac{a}{(a+b)^2}$ ..and a variation in b (*e.g.* including the shadow cost of imports) has little impact on domestic abatement because of the hot air.

probability for such an outcome for the US, Europe and Japan respectively: the supplementarity issue appears less worrisome, at least as long as the CDM does not encompass a large amount of sequestration that compensates its transaction costs.

However, it reappears through a totally different channel: Table 2 displays how domestic action drops from a Candide conduct –governments ready to socialize the cost of any reduction necessary for compliance if it surpasses the private willingness to pay (in a political sense, as defined previously)[18]– to a more realistic assumption: governments take advantage of borrowing facilities when facing a limited willingness to pay (WP). Three levels of WP are here considered, Annex B-wide $50, 75 and 100/t.

	'Candide' (No postponement)	With postponement ... ...beyond $50	...beyond $75	...beyond $100
European Union	[43 ; 65]%	[22 ; 43]%	[30 ; 53]%	[34 ; 59]%
United States	[58 ; 85]%	[27 ; 65]%	[39 ; 74]%	[47 ; 78]%
Japan	[33 ; 55]%	[15 ; 41]%	[21 ; 48]%	[26 ; 51]%
Market price	$[39 ; 204]	$[47 ; 52]	$[59 ; 80]	$[64 ; 105]

Table 2. *Domestic abatement in 2012 under limited willingness to pay (no shadow cost of imports[19])*

The contraction of domestic abatement is striking: under a $75 and 100/t WP its expected value falls below 50% for the EU. At a $50/t WP it does so for the US too, while the entire likelihood interval drops below this symbolic level for the EU and Japan. The existence of an implicit borrowing facility is thus unsurprisingly confirmed as a major threat against significant domestic effort.

2. Annex B compromise space without extended 3.4

Let us now turn to the numerical analysis of various compromise packages. For the sake of clarity, we keep a clear distinction between results under a 'Candide' conduct and those with more realistic behavioral assumptions.

2.1. Supplementarity and compliance costs under Candide conduct

We first analyze the consequences on supplementarity of a 50% concrete ceiling[20] on buyers only[21]. As noted, such a condition has a significant impact on Japan only, being binding in seven of the SAP12 models: Table 3 displays a lower bound increase of twelve percentage points for Japanese domestic

[18] The cost of public funds, whose value is quite controversial, was ignored all along in the 'Candide' results reported in this text. They hence correspond to a full compliance by private agents.
[19] They are drastically reduced as compared to the Candide case since postponements have been substituted to imports.
[20] We drop here the concrete ceiling on sellers because of its implications in terms of market power for carbon exporters.
[21] This is a laxer constraint than the option A defined in footnote 7 in all cases, and than the option B in 46 out of 48 cases, the only exception being the US and CANZ in one scenario. Estimates for option B are derived from Baron *et al* (1999).

action. The increase is only of four points for Europe, but the US show a decrease; the explanation of this paradox is that reduced Japanese demand results in a slight decrease of international carbon prices, causing those zones with marginal costs below the 50% ceiling to increase their imports.

	Unrestricted compliance	50% concrete ceiling	50% ceiling + waiver $75	50% ceiling + waiver $100
European Union	[45 ; 68]%	[49 ; 66]%	[47 ; 68]%	[49 ; 67]%
United States	[61 ; 89]%	[60 ; 88]%	[61 ; 89]%	[61 ; 88]%
Japan	[35 ; 58]%	[47 ; 57]%	[37 ; 58]%	[39 ; 58]%
Market price	$[32 ; 169]	$[30 ; 168]	$[32; 169]	$[31 ; 168]

Table 3. ***Domestic abatement with European ceilings on buyers (Candide conduct)***

All in all, a '50% condition' increases Annex B abatement by an average of 1 MtC only: the expected value of imports shifts from 117.5 to 113.5MtC for the EU, from 53.5 to 48.5 for Japan, while it increases by 8MtC in the US.

	Unrestricted compliance	50% concrete ceiling	50% ceiling + waiver $75	50% ceiling + waiver $100
European Union	$[6.1 ; 32.4]B	$[6.1 ; 32.4]B	$[6.1 ; 32.4]B	$[6.2 ; 32.5]B
United States	$[12.4 ; 48.4]B	$[11.9 ; 48.2]B	$[12.3 ; 48.3]B	$[12.1 ; 48.3]B
Japan	$[2.6 ; 12.7]B	$[2.7 ; 13.1]B	$[2.6 ; 12.7]B	$[2.6 ; 12.7]B
Market price	$[32 ; 169]	$[30 ; 168]	$[32; 169]	$[31 ; 168]

Table 4. ***Annual costs of compliance with European ceilings on buyers (Candide conduct)***

The deflating effect on carbon prices also explains why the likelihood space of total compliance costs (domestic abatement expenditures plus carbon imports) does not change for the EU, decreases by [4.2 ; 0.4]% for the US and increases only by [3.8 ; 3.1]% in Japan (Table 4).

These findings suggest that the dispute about a concrete ceiling is mostly rhetoric under a Candide conduct assumption, since the 50% ceiling dramatically increases neither domestic action as hoped by its proponents nor the total burden as feared by its detractors. Rather, it has the paradoxical but fairly explicable outcome of placing more burden on Japan and making the US better off.

The discrepancy between the constrained and unconstrained scenarios explains why adding a waiver to the concrete ceiling has little numerical impact: it decreases both the extra burden for Japan and the US gain. However, the total of domestic abatement in the importing parties increases only by an average 0.4% for a $100 waiver.

The economic logic of an import charge is different since it necessarily increases domestic effort in all countries for all scenarios, but its supplementarity effect is significant with high charges only (Table 5): for a $5/t it is negligible for Japan, and yields a one percentage point gain for the US and EU; it shifts to two to three percentage points in the case of a $15 charge, which means an increase of 6 to 8% of domestic abatement.

	Unrestricted compliance...	...with \$5 import charge	...with \$10 import charge	...with \$15 import charge
European Union	[45 ; 68]%	[46 ; 69]%	[47 ; 70]%	[48 ; 71]%
United States	[61 ; 89]%	[62 ; 90]%	[63 ; 91]%	[63 ; 92]%
Japan	[35 ; 58]%	[35 ; 58]%	[36 ; 58]%	[37 ; 59]%
Market price	\$[32 ; 169]	\$[33 ; 170]	\$[35 ; 171]	\$[36 ; 172]

Table 5. *Domestic abatement with import charges (Candide conduct)*

The paradox that occurred with ceilings disappears since US costs increase along with those in other zones. Domestic abatement by importing zones increases by [0.8 ; 1.1]% with a \$5 charge, [2.0 ; 2.3]% and [3.4 ; 3.4]% for \$10/t and \$15/t respectively, to be compared to [0.2 ; 0.4]% under a concrete ceiling plus a \$100/t waiver[22].

2.2. *Beyond a Candide conduct*

Let us now turn to the hypothesis under which even *bona fide* Parties, facing a limit on consumers' willingness to pay, take advantage of the compliance provision of Pronk's package by postponing abatements that would imply higher domestic energy prices.

2.2.1. Ineffective supplementarity tools

Under such hypothesis, neither a 50% concrete ceiling nor an import charge significantly increase domestic abatement:

- a 50% concrete ceiling only impacts zones that simultaneously have a domestic effort below this level and face a carbon price lower than the consumers' willingness to pay: this occurs at the most –under a \$100 WP– in 9 cases out of 48 (in 2 cases under a \$50 WP). The largest upward shift of the likelihood interval is for the Japanese domestic effort at \$100 WP, but it is quite compensated by the opposite impact on the US, due to the price deflation as explained above. On average, the general tonnage of domestic abatement in the importing zones shifts only by 0.2, 0.5 and 0.8% for \$50, \$75 and \$100 respectively.
- an import charge increases domestic abatement only when the carbon price is lower than the WP: a \$10 charge over a \$100 WP causes a three percentage point increase of the likelihood space for all zones, with a 2.6% increase of the expected value for domestic abatement. However, when the WP is binding, imports cease at a marginal price equal to the WP minus the import charge; thus total abatement decreases since domestic abatement is unchanged.

[22] This modest result is due to transaction costs impairing the flexibility mechanisms. The impact would be more substantial with high amounts of cheap sequestration in the CDM.

2.2.2. The supplementarity effect of restoration payments

In the first analysis, a restoration payment (RP) set at the same level as the WP of private agents does not change the level of domestic abatement. At second thought though, a RP dramatically increases the risk of high foreign transfers for importing countries: even if the funds are collected nationally, the cheaper projects selected through a reversed auction (see footnote 11) will likely be in developing countries, Russia and Ukraine. As stated earlier, it is impossible to predict how the shadow price of carbon imports considered in public policies might evolve, given the specific risks attached to a narrowly polarized destination. But to illustrate the magnitude of the problem, let us say that the shadow price of carbon imports that equates the total foreign transfers under an RP regime to those obtained without such payments and a null shadow cost of carbon imports, is between 2.4 to 3.7 for a $50/t RP and still 1.4 to 1.7 for a $100 RP (see footnote 16). This suggests that the additional foreign payment will not be neutral *vis-à-vis* the level of domestic action.

Table 6 indicates the order of magnitude of how a 1.3 coefficient[23] applied by all zones impacts on domestic action. Compared to Table 2, likelihood intervals for domestic abatement shift upward by 3 to 10 %. The same supplementarity effect appears in the tonnages of domestic abatement by importing zones, with [24 ; 16]%, [19 ; 11]% and [11 ; 7]% increases for $50, $75 and $100 WP respectively.

	RP $50	RP $75	RP $100
European Union	[28 ; 50]%	[35 ; 61]%	[38 ; 65]%
United States	[34 ; 75]%	[47 ; 81]%	[53 ; 82]%
Japan	[18 ; 47]%	[26 ; 52]%	[29 ; 54]%
Market price	$[44 ; 53]	$[52 ; 80]	$[53 ; 98]

Table 6. *Domestic effort under restoration payments with 1.3 shadow cost of imports*

Of course this higher domestic abatement, while maintaining the level of marginal effort, comes at some expense in terms of total costs –all the more so as the WP is low since it implies a greater amount of tons to be covered by the RP. On average, total costs of importing zones increase by 70, 36 and 17% for a $50, 75 and 100 RP respectively as compared to what they are with postponement beyond the same price levels. This is significant but it does not undermine the purpose of the restoration payment, since it implies gains of 44, 28 and 19% compared to a Candide full compliance scenario (first column of Table 4).

A restoration payment thus significantly makes up for the absence of compliance payment or of border taxes against countries out of compliance: good faith governments can guarantee consumers a maximum energy price increase, and have a rational incentive to adopt supplementary public policies to attenuate both geopolitical risks and the pressure on their current account, without incurring a dramatic additional macroeconomic burden. Formulated to respond the concerns of the pessimists on costs, the tool is useful in promoting domestic action compared to the borrowing implicit in Pronk's package.

Perhaps more importantly, the distinction between a good faith and a bad faith government will immediately be observable since the latter will not pay the restoration payment. This is an improvement over the initial Pronk proposal where both types are undistinguishable, ultimately diverging only in the

[23] Contrary to the Candide case, under a restoration payment a shadow price will necessarily induce increased public spending –subsidies to carbon saving technologies, investment in infrastructures– since any diminution of the imports through a tax would be exactly compensated by increased restoration payments.

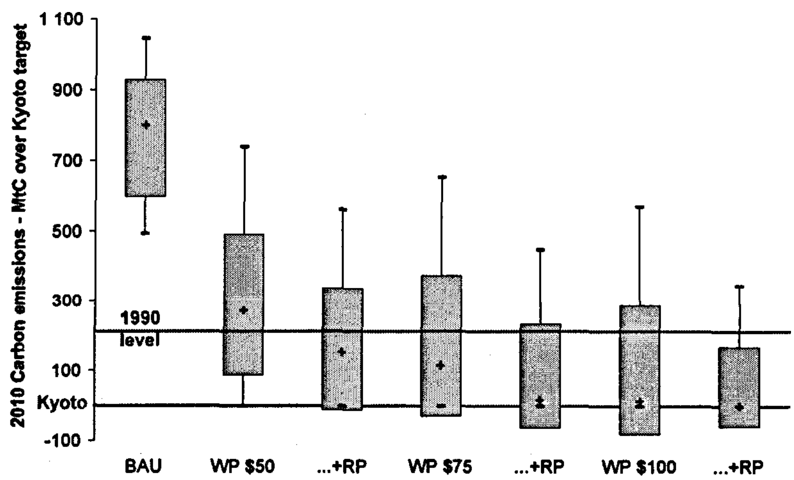
long run. A bad faith government will act only if the political cost of the cumulated environmental debt becomes significant, with the possibility that, as the total postponed tonnage reaches too high levels, the debt will be downgraded and the corresponding abatement definitively abandoned. This mechanism repeatedly functioned in the case of conventional economic debt and there is no reason why it should not operate in the case of an environmental debt.

2.3. Environmental assessment of compromise packages

Despite the significant supplementarity effect of a restoration payment, it is still uncertain whether any particular price cap exists that would be acceptable to those who defend environmental integrity as well as those who prioritize cost control. The search for a compromise implies that both camps make a step in each other's direction.

Judgment on environmental integrity under a non Candide scenario and Pronk's compliance only depends on the level of confidence attached to the recuperation of postponed abatement. One easily computable indicator of the risk of ultimate default is the total tonnage postponed: 291MtC under a \$50/t WP, still 104MtC for a \$100/t WP, with upper bounds of 741 and 572MtC respectively, when the likelihood space of the overall abatement required to meet Kyoto targets is [810 ; 1077]MtC.

As noted earlier none of the envisaged supplementarity tools improves significantly upon this result, whereas a restoration payment lowers the risks of endlessly postponed abatement by pre-paying part of the restoration. However, placing an upper bound on carbon prices comes at the expense of an uncertainty on environmental performance. A measure of this uncertainty is shown on Graph 1, which displays the likelihood interval (shaded boxes), extreme bounds and median value (dashes and cross) of emissions for various levels of willingness to pay with and without RP.



Graph 1. *Restoration Payment - Effect on environmental integrity*

The gain from a RP provision can be caught in a glimpse, from the downward shift of the likelihood intervals of environmental performance for various levels of willingness to pay. While a \$100/t RP secures a high probability of meeting Kyoto targets, the chance is still 50% with a \$75 RP (the median is close to Kyoto level)[24]. With a \$50/t RP there is still a good chance of abating to 1990 levels, but meeting Kyoto is much more uncertain, at a low 25%. It follows that a negotiable range of RP levels could be between 75 and a 100 dollars a ton. Although this is not a very wide range, it can be enlarged from two perspectives.

First, in order to facilitate full ratification, objectives laxer than Kyoto targets might be accepted instead of an implicit revision under Article 3.4. A stabilization of emissions from the energy sectors at 1990 levels could amount to a 1% emission reduction from 1990 levels with some carbon sinks, thus falling into the span defined by Dominique Voynet, France's environment minister during COP6: *"[...] what really matters: to begin reducing GHGs emissions [...]. Starting from there, the reduction level, be it 1 % or 5 %, is not essential"* (Le Monde, 21 April 2001, our translation)[25]. Back to Graph 1, this would be consistent with a \$50 RP, and even a \$35 level, the lower limit for a 50% chance of reaching the redefined target.

A second perspective, without *ex-ante* revision of targets, assumes that the EU, consistent with its concerns of too low prices, gives more credibility to optimistic models.

	Neutral stance		Optimistic stance	
	Models reaching *Kyoto commitments*	Models keeping emissions below 1990 levels	Models reaching *Kyoto commitments*	Models keeping emissions below 1990 levels
RP \$35	8%	50%	13%	67%
RP \$50	25%	75%	50%	83%
RP \$75	50%	83%	67%	92%
RP \$100	75%	83%	83%	92%

Table 7. ***Impact of restoration payments on environmental integrity Detailed results***

Table 7 displays how probabilities of reaching both Kyoto and 1990 levels evolve from a 'Neutral stance' to an 'Optimistic stance' obtained by weighting models results with the following factors: one for the four most pessimistic, two for the four medium, and three for the four remaining. Chances of meeting Kyoto targets with a \$50 only RP switch from 25 to 50%, with the laxer target quite guaranteed at 83%, which again makes the \$50 level acceptable. Besides, the \$35 level yields a 67% chance of meeting the relaxed target, the odds for Kyoto improving slightly, from 8 to 17%.

3. Sequestration *versus* restoration payment

Let us now turn to the option of increasing carbon sequestration in Annex B, which was considered during the last days of the first part of COP6 as a way to control compliance costs and alleviate the burden on the energy system.

[24] Note that the extension of some likelihood intervals beyond Kyoto targets is solely due to their statistical nature. Models do not consider any sort of overshooting, and the fact that a likelihood interval (standard deviation around the expected value) reaches below Kyoto simply indicates that the underlying probability distribution is biased in that direction.

[25] This passing point is still compatible with keeping greenhouse gases concentration under a 450 ppm level (Ha-Duong *et al.* 1997, 1999).

To discuss the pros and cons of an extended 3.4 sequestration option as opposed to a restoration payment, we compared levels of both options yielding the same reduction of the expected value of compliance costs. The cost of carbon sequestration, while quite uncertain, is generally expected to be far lower than that of carbon abatement in the energy sector. To avoid arbitrary assumptions which would have blurred the core of the argument, we assumed a null cost for sequestration in the following simulations: the estimated tonnages for different proposals were simply subtracted from the Kyoto targets to obtain the new level of abatement to be achieved in the energy sector. This was done for all the existing proposals but, for the sake of simplicity we report hereafter on the only 'extended sequestration' option: the Umbrella proposal as circulated during COP6, with the following tonnages estimated by French forestry experts:

	European Union	United States	Japan	CANZ group	EIT
Kyoto abatement requirements	[190 ; 336]MtC	[430 ; 546]MtC	[74 ; 120]MtC	[64 ; 125]MtC	[-301 ; -56]MtC
Abatement from sequestration	13 MtC	115 MtC	4 MtC	29 MtC	21 MtC

Table 8. ***Abatement from sequestration under the Umbrella proposal***

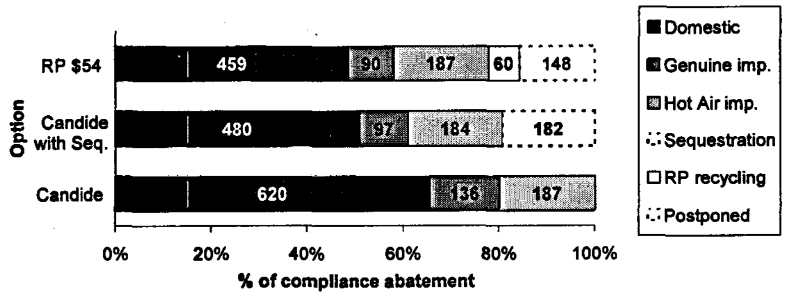
Under these assumptions, overall costs for the importing zones drop to $37.7B on average, a 40% decrease from their $67.7B full compliance level. To achieve an equivalent (expected value) cost reduction, a restoration payment should be set at $54/t.

3.1. Effect on environmental integrity, compliance and supplementarity

The environmental assessment of each option is very dependant on judgments regarding the integrity of postponed and sequestrated tons. As stated earlier, the integrity of postponed tons depends on the credibility of the recuperation during further commitment periods. Regarding sequestrated tons, some quarters argue that they correspond to reductions that would have occurred anyway and/or that the underlying activities were not taken into account at Kyoto[26]; others oppose this critique and support the view that the IPCC LULUCF special report gives far greater credence to the legitimacy of activities beyond those recognized in Article 3.3 if properly monitored. We will not venture to settle this controversy but rather report on basic outcomes.

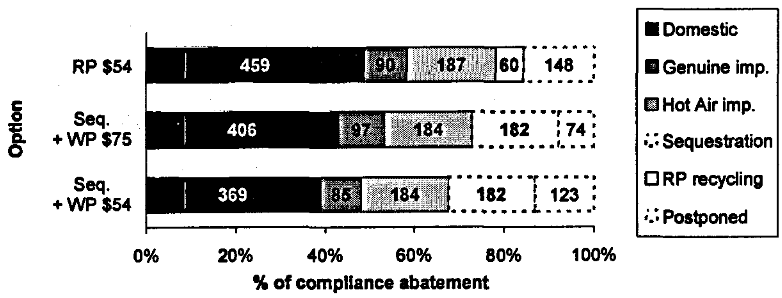
Under Candide conduct, Graph 2.A distinguishes among domestic (energy sector) abatement (a); genuine tons imported (b); hot air imported (c); tons abated during a true-up period through the restoration payments (d); tons sequestrated (e); and tons postponed to a subsequent compliance period (f). For those who deem that action in the energy sector is indispensable to the long term objective of climate control, a computation of the relevant abatement (categories a, b and d) gives a slight advantage to the restoration payment: it guarantees 64.6% of the target, as compared to 61.2% for the sequestration option.

[26] Note that the 'hot air' does not raise the same problem regarding the ultimate environmental achievement: the larger its amount, the higher the emissions from importing countries, but without consequence on total Annex B emissions.



Graph 2.A ***Split of annual abatement for the importing zones, Candide perspective***

However, an equal average of expenses masks that, while marginal carbon prices are capped at a $54 level by the RP, they can go far beyond this level under the sequestration option (see section 3.2 below). This takes us back to the question of limited willingness to pay and to the comparison between Candide and non Candide conducts: under a $75 limit the Umbrella proposal decreases the domestic and imported tons, inducing 74 MtC of postponed abatement since the sequestration remains at the same level as without limited WP. Going down to a $54 limit causes a postponement of 123 MtC, and action in energy sectors consecutively drops to 48.1% of Kyoto target (Graph 2B).



Graph 2.B ***Split of annual abatement for the importing zones, realistic perspective***

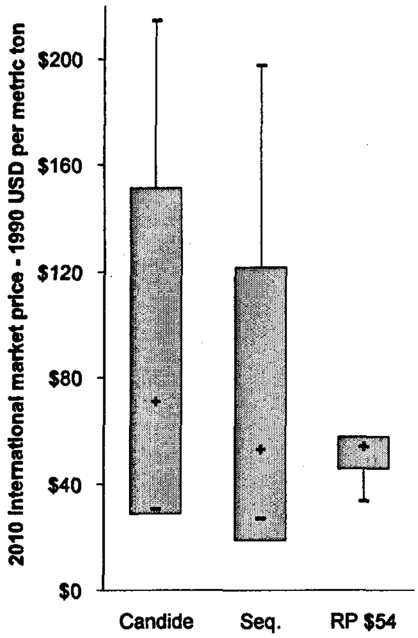
Furthermore, the slight advantage sequestration had in terms of supplementarity (Graph 2.A) is gone: the 50.9% domestic action in the energy sector drops to 43.1 and 39.1%, substantially below the 48.7% expected value for the $54 RP.

3.2. Effects on costs uncertainty

The very principle of a restoration payment is to give an upper bound to the marginal cost to energy consumers. It is a different economic rationale than that of extended sequestration, which *de facto* amounts to a downward shift of all cost curves. For this reason the qualitative insights derived from Graph 3 are not surprising. But the order of magnitude of the difference between the two options in terms of width of the likelihood interval of carbon prices is more striking. Graph 3 presents the modeling results in a format equivalent to the one used in Graph 1. The reduction in uncertainty is dramatically higher with a RP than with sequestration proposal: in a Candide scenario, the $54/t RP reduces the width of the likelihood interval by 90%, to be compared to an almost negligible 16% for the sequestration option.

We do not plot here the results in terms of total compliance costs, although the differences are of the same order of magnitude: sequestration produces a $[13 ; 63]B likelihood interval, to be compared to $[31 ; 44]B for the restoration payment.

Note at last that the lowest bound of carbon prices (and compliance costs) is higher with a RP than with an extended sequestration. This is due to the fact that the $54 price cap is never reached in the very optimistic models, and thus does not impact on the results, while tons from sequestration translate the cost curves of every model in the same downward way, whatever their optimism on costs.



Graph 3. ***Sequestration vs. RP Effect on marginal prices***

The policy implications from these results can be derived in two different ways corresponding to the symmetric and contradictory concerns about compliance costs:

- for a reduction of the expected value of compliance costs identical to the one obtained with a $54 restoration payment, extended sequestration is less efficient in allaying concerns of the pessimists on abatement costs. A closer scrutiny of modeling results reveals that risks of carbon costs exceeding $120 and $90 are still of 17 and 25% respectively, while a $54 level is of course guaranteed by the RP;
- the difference in the lower bound of the likelihood intervals has a very important implication in terms of minimizing risks of too-low price signals over the first budget period, which is the basic rationale behind the supplementarity condition. A $19 lower bound under sequestration aggravates the deficit in supplementarity as compared to a $45 one with a $54 price cap.

4. A long term division line: the North-South issue

The Clean Development Mechanism is the main provision of the Protocol liable to reconcile two contradictory demands: one by the G77 that developed countries demonstrate their willingness to combat climate change; another one from the US Senate (Byrd-Hagel resolution, June 12th, 1997) that developing countries face "new specific scheduled commitments to limit or reduce greenhouse gas emissions". However, the CDM is from the outset the subject of a misunderstanding: it is viewed by Annex B countries as a flexibility mechanism similar to Joint Implementation, while Article 12.2 clearly assigns it three objectives, a) to assist non-Annex I countries in achieving sustainable development, b) to assist non-Annex I countries in contributing to the ultimate objective of the Convention, c) to assist Annex I countries in achieving compliance with their quantified emission limitation and reduction commitments.

Policies in accord with this implicit ranking are still unclear: in many quarters of the G77 the argument prevails that technological and financial transfers through the CDM may not provide development benefits (Estrada 1998, Thorne *et al.* 1999). The extent of the contribution of CDM projects to development is conditional both upon the very content of the projects[27] and upon the split of the net economic rent generated by the difference between their incremental cost and the international value of carbon. What proportion of the rent will remain in the host country depends on its bargaining power relative to the investor's, a key issue in the designing of the CDM modalities.

The first proposal put forward as yielding less uncertain gains is the extension to all flexibility mechanisms of the 'share of the proceeds' (SP) of CDM transactions (Article 12.8). Our calculations reveal that such an extension would multiply by 4 the expected value of a $2/t SP fund; still, at $[0.4 ; 0.9]B it would approximately amount to only a tenth of the expected surplus on CDM markets. Reaching the symbolic billion dollars envisaged in Pronk's text would necessitate doubling the extended levy, at $4/t. Then these figures assume the extensive market volume of a Candide scenario, thus overestimating the ultimate gain. This does cast a doubt on the appropriateness of the SP mechanism as an answer to the G77 concerns[28].

The second proposal made by Brazil before Kyoto is the creation of a compliance fund, akin to the restoration payment envisaged in this paper. Table 9 displays how total transfers and surpluses are modified considering $50 and 75 willingness to pay, if, for the sake of simplicity, the auction is directed to the developing world only[29].

	WP $50	RP $50	WP $75	RP $75
Market transfers	$[0.8 ; 4.2]B	$[1.0 ; 3.6]B	$[2.7 ; 6.7]B	$[2.4 ; 5.5]B
Transfers from RP	-	$[0.8 ; 21.8]B	-	$[-5.1 ; 23.5]B
Market surplus	$[0.3 ; 1.6]B	$[0.4 ; 1.4]B	$[1.2 ; 2.8]B	$[1.0 ; 2.3]B
Surplus from RP	-	$[-0.3 ; 8.5]B	-	$[-2.3 ; 8.7]B

Negative values do not correspond to actual results, cf. footnote 30.

Table 9. *Transfers to the developing world with and without restoration payment*

Developing countries appear strikingly better off, with higher bounds for their potential surplus multiplied by around 6 and 4 respectively. Admittedly, a restoration payment restricts the first market for CDM projects because of a higher level of domestic action in Annex B, but this contraction is overcompensated by the fact that the reverse auction guarantees that the rent accrues to the host country. Both levels of RP even allow a net gain over a full compliance situation, where total transfers are $[-0.5 ; 17.3]B, with a corresponding $[-0.6 ; 8.1]B surplus[30].

[27] Under certain circumstances, CDM projects can operate a leverage effect on development (Mathy, Hourcade, de Gouvello 2001). The corresponding field of research, is marred by the continuing confusion between the CDM and JI.

[28] Note at last that legitimating the extension by advocating that a levy on CDM transfers only constitutes an inequitable competitive distortion is arguable: at $2/t simulations reveal that the consecutive decrease in market transfers is roughly compensated by the level of the SP fund levied; CDM hosts are neither better nor worse off.

[29] This places an upper bound to the capacity of the system to attract developing countries in an active participation to climate policies. Without such a constraint though, postponed abatements would be lower (a larger carbon supply would decrease the equilibrium price of the reversed auction), total external payments as well.

[30] Obviously, none of the models actually give negative market transfers to the CDM hosts (they do not face any binding commitment). The negative lower bounds are caused by the way the likelihood intervals are built (see Box 1).

Conclusion: the thin pathway towards a recovered deal?

The core division line of the post-Kyoto process was that hedging against uncertainty on compliance costs, either in the form of a price cap or through the extension of sequestration activities, was in direct conflict with the claims that the Kyoto cap-and-trade system should not be turned into a pure loophole. Above analysis suggests however that the two hedging tools are very different in nature, a restoration payment being apt to provide a rather large negotiation space respecting all the prevailing worldviews:

- as regards environmental integrity, it compensates for the absence of financial penalties or formal linkage to the WTO in the compliance system, making immediately distinguishable *bona fide* (contribution to the restoration fund) and *mala fide* conducts; it is an efficient supplementarity tool because of the risks of extraterritorial payments; it limits the risks of endlessly postponed abatements in case of limited willingness to pay of energy consumers.
- as regards costs control, a given amount of tons under Article 3.4 provides a less efficient hedging against the risks of too high prices than a restoration payment lowering the expected value of compliance costs by the same percent. It symmetrically exacerbates risks of too low carbon prices.
- concerning developing countries, a restoration payment provides a significant source of transfers in the spirit of the Brazilian 1997 proposal, while extended Article 3.4 undermines the prospects for significant CDM and share of the proceeds revenues.

Ultimately, the restoration payment option, instead of *ex-ante* revising Kyoto targets, gives them a chance until an *ex-post* assessment in 2012: it does more than triple their 8% probability in case of a $50 willingness to pay, and can even raise it to 50% if one gives greater credibility to the more optimistic models.

The secrete hope of the engineering economists tradition is to inject some objectivity into policy discussions. To pursue this aim in climate affairs is a daunting task since modelers are far from being able to provide uncontroversial information to Parties characterized by opposing expectations and visions of fairness. The rational lesson from discrepancies in modeling results is that it matters to incorporate uncertainty into the very framework of international coordination, rather than enter infinite controversies that delay action and could make ambitious targets unreachable.

Beyond Kyoto targets and timetables, it appears that a hybrid quantity-price instrument is robust to cope with uncertainties, hence facilitating the negotiation of further budget periods and the adhesion of developing countries to active climate policies. The usefulness of such an economic message has two conditions: the first is that every Party be self-consistent with its own worldview and not conducted by a hidden agenda; the second is that diplomats, policy-makers and environmentalists remember this old Roman saying: *audi alteram partem* (listen to the argument of the other).

Postscript

Most of this work was conducted to provide an insight on the economic background of COP6. We decided not to address Bonn's accord in the core of the text, because our objective was to derive general lessons regarding the role played by the cost uncertainty in global environment agreements. Concerning the environmental cost of The Hague's Lost Deal, however, SAP12 provides the following information in the absence of monopolistic behavior by the EIT:

- the Bonn agreement implies a 50% chance of a carbon price lower than \$28/t; the 50% threshold is at \$54 for the \$54/t RP option, and at \$53 for the Umbrella sequestration option;
- the total of domestic abatement in the energy sector for the Annex B countries, US excluded, is in a [65 ; 200] MtC likelihood space for Bonn, to be compared to [120 ; 250] MtC for the RP option, a 53 MtC decrease of the average; a loss appears even compared to the sequestration option, with an average 13 MtC lower;
- the net transfers to the developing countries fall drastically, to an average of \$2.4G in CDM projects (with 50% of SAP12 models giving a total below \$1G);

The assessment regarding US abatement depends both upon whether the US would have ultimately endorsed either of the two deals examined in this paper, and upon the extent of its future domestic abatement outside the Kyoto framework. Relevant data from SAP12 is the following: assuming ratification, US domestic abatement under a restoration payment at \$54/t is between 172 and 377 MtC; under the Umbrella sequestration option it ranges from 206 to 366 MtC.

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