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**STRATEGIC LINKS BETWEEN FUTURE STUDIES,
POLICY INSTRUMENTS AND DECISION-MAKING
CRITERIA FOR A NEGOTIATED MANAGEMENT OF
GLOBAL ENVIRONMENTAL RISKS.
THE GLOBAL WARMING CASE**

SUMMARY FINAL REPORT

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I. OBJECTIVES:

The aim of this project was twofold: to understand better the specifics of negotiation processes on international actions for tackling global warming issue, and to provide analytical tools apt to facilitate the definition of the minimal conditions for their successful achievement.

Three intertwined questions were answered: what should be the greenhouse gas (GHGs) abatement targets? what are the incentive structure to trigger the implementation of the most cost-effective solutions? how to solve the burden sharing problem and the possible contradictions between equity and efficiency? The framing of this project stemmed from the idea that answering these questions is made difficult less by the technical difficulties due to long run uncertainties per se than by a legitimacy gap due to the fact that agreements must be made between actors who do not, and will not, share the same vision of the long term and the same value judgements. The success of negotiation processes will be determined less by the reduction of uncertainties than by the capacity to reach a consensus for action despite scientific and ethical controversies which cannot be solved in the near future, about the magnitude of environmental costs, about the cost-efficiency of various technical and economic alternatives and about the equity principles.

From this starting point the objectives of this project were:

a) to point out the normative and procedural reasons why the only way to operationalise the precautionary principle adopted in the Climate Convention is to frame the policy-making problem in terms of sequential decision-making and what are the implications of this framing for the negotiation process. In this respect the focus has been placed on the linkages between "no regret" actions and the content of self-enforcing international agreements about precautionary policies.

b) to provide a simulation tool flexible enough to convey information from various models in various countries so as to translate in the same framework the implications of controversial expert statements and policy judgements. This model was designed as a communication tool apt to translate numerically the short term and long term expectations and beliefs of the national policy-makers as regards to baseline scenarios and to the linkages between price and non-price incentives and technical change.

c) to illustrate the interest of a sequential-decision making framework through repeated games negotiation scenarios. The focus has been placed on the relationships between the negotiation patterns (negotiating on targets, incentive instruments or reporting mechanisms) the extension of a "climate coalition", and its stability. In this setting, the importance of competition and co-operation about carbon free technologies has been pointed out both as a way to lower the cost of abating GHGs emissions and as a way to secure the stability of the coalitions. These exercises were meant only to demonstrate the interest of the intellectual framework and of the modelling tools elaborated during the project; a dissemination of these tools for more detailed studies reflecting actual national contexts was envisaged after the completion on this research project.

II. METHODOLOGY

The project articulated a theoretical research on the coordination procedures for achieving an international agreement about climate policies and the construction of modelling tools apt to "predict" the outcome of various policy parameters and various negotiation patterns.

The first step of the project reviewed the current literature in policy sciences and economics of cooperative games in order to point out the gaps between the conclusions of this literature as regards to the formation of international regimes, and the specifics of the negotiation about global warming. The *problematique* of the research was organised around the concept of decision under controversies, which embraces a context where agents do not have a well-shaped and stable vision of their own interest, and where scientific expertise in earth sciences and in economic sciences is used as a strategic tool.

The following dimensions were re-examined within this framework:

- the axiomatic basis of "no regret" and "double dividend" strategies: taxonomy, assessment of the information and option values of "no regret" strategies;

- the key role of “no regret” potentials and “double dividend” as regards to the formation of international agreements in a sequential negotiation process;
- the role of innovation and the nature of the incentive tools apt to foster carbon saving technologies;
- the lessons from economic theory about the features of international carbon tax systems: uniform versus non uniform taxes;
- the lessons of game theory about expanding coalitions by means of transfers and commitments and the role of technological co-operation for self-reinforcing coalitions.

The conclusion of this first step was to define the conditions for expanding climate coalitions and the various negotiation patterns likely to be adopted by each country as a function of its perception of its own interest and of its degree of concern for climate change.

The second step aimed at exploring the possibility for a first limited coalition of concerned countries to involve less concerned countries in a sequential process while respecting the overall limits of strict no-regret strategies at least in a first period.

The critical difficulty stemmed from the use of scientific controversies as strategic tools. This required building a simulation framework apt to capture various expert judgements on both the baseline development scenarios of a given country and about the margins of freedom for curbing GHGs emissions. This modelling framework had to meet the following two requirements:

- to tackle the critical issues behind the so-called top-down/bottom-up controversy by conveying into a static general equilibrium model, the information from a technico-economic model about the efficiency of various policy tools (carbon-taxes in the current version of the model) in terms of energy consumption reduction and substitution between fossil and non fossil energies; the design of this model was made to capture various viewpoints of innovation and technical adoption processes and to represent explicit saturation limits to technical change.
- to be easily computable in order to simulate a large amount of co-operation scenarios and to vary input hypothesis (on technical and economic parameters) at a minimum time cost.

This modelling framework was then used to simulate stylised co-operation games in order to illustrate the implications of the sequential negotiation framework defined in the theoretical part of the research and to find out the most critical parameters for the expansion of climate coalitions. These games involved six type of countries selected so as to represent critical features of actual discussions. These countries portray countries relatively easy to identify: four middle-sized economies belonging to an economic union and two large developed countries. Two time period were encompassed: from 1990 to 2005 and from 2005 up to 2030. Except for French and Italian type countries, the baseline scenarios were calibrated on the basis of the Energy Profiles of the World Energy Council (1992).

III. MAIN RESULTS

III.1. Decision under controversies and sequential negotiation process

Institutional and economic conditions of the international coordination to tackle global warming cannot be derived without considering the three following critical features of this issue:

a) a combination of exogenous and endogenous uncertainties

A problem of decision under uncertainty is usually framed in terms of expected utility maximisation given a set of possible but unknown "states of nature", a set of feasible acts and a set of impacts. This remains logically self-consistent as long as one accounts for "exogenous uncertainties" where the probability distribution of uncertain parameters remains independent from human action (e.g. the possible chaotic nature of the climate machine).

However, uncertainties on innovation trends or structural change have been proved critically important in the climate policy debates. These are "endogenous uncertainties" where states of the world beyond ten or twenty years cannot be held as independent from today's decisions. The most challenging consequence of these endogenous uncertainties is due to possible bifurcations (irreversible or quasi-irreversible trends) in technology because of lock-in effects, in consumption patterns (connection between urban planning and transportation patterns), land-use. Alternative possible baselines are indeed available ex-ante which will ultimately be taken, often "in passing", for reasons unrelated to climate or energy policy issues and whose discrepancies in carbon content may be of the same order of magnitude that the GHGs abatement requires due to specific measures.

b) the role of scientific and ethical controversies

Concerns towards global environment issues do not result from a learning process where agents have a direct experience of a nuisance; the risk perception is determined by the way the warnings from the scientific community are conveyed to public opinion and policy-makers by the mass media. This is complicated by earth sciences not being able to provide uncontroversial answers about the incurred risks, by engineering sciences being uncertain about the potential of competing technologies, and by ethical debates about the burden sharing.

The result of any negotiation process depends consequently on the power of conviction of the defender of each technical (nuclear energy, biofuels) or institutional economic project (taxes, tradable permit system) and of its capacity to mobilise controversies in technical fields, economics or ethics; uncertainty becomes a strategic space for actors. Then because of the fear of a dictatorship over the short term resulting from arbitrary technological or economic policies in the name of the long term, the trap to be avoided is a collective paralysis by an infinite regress of controversies impeding a minimum consensus for action.

c) from optimal decisions to sequential decisions

In this context, a procedural problem of co-ordination of expectations is to be solved. Related to this objective, the difficulties of carrying out an agreed cost-benefit balance of climate policies are easy to point out: uncertainties about the avoided costs of climate change and about non-directly observable parameters determining GHGs abatement costs (baseline scenarios, timing of penetration of backstop technologies, transaction costs for removing the barriers to negative costs potentials, side-effects of recycling carbon tax revenues).

The only way to operationalize the precautionary principle is thus to enter a sequential decision process. From a normative point of view this framing points out that short term quantitatively limited actions may have significant information and option values: to curb GHGs emissions today provides more time for getting a better scientific knowledge, benefiting from technical innovation and for preventing the bifurcation risks.

In terms of procedural efficiency, this allows for first step agreements between actors who do not share the same view of the long term, and share value judgements on the burden sharing. But the logical implication is that a policy can be agreed on in such a context only if it is expected to be strictly pareto-improving for each country. If none of them is ready to pay incremental costs for mitigating climate risks, the objective of a sequential negotiation process should be to find out the core of actions apt to be held as "no regret" by each of the covenants, namely which will not be regretted if, ultimately, the climate change is proved to generate a second order risk.

III.2. Sequential co-operation games, no-regret and precaution strategies

Most of analytical approaches of international agreements rely on the assumption that each country has a well-defined objective function, knows the GHGs abatement costs and assesses marginal damages of climate change, at least qualitatively or in the form of a risk-aversion coefficient. In this framing, the obstacles to international co-operation are manifold: the pioneer phase costs, the missing of a collective body having the monopoly of legal strength for enforcing new rules, the risks of free-rider behaviours, the size of the coalition (there is a bottom critical scale below which the interest of joining the coalition may be undermined).

III.2.1 Rationale for co-operative games in a "no-regret" strategy

These classical stumbling blocks may not play in the same way in a process where, to overcome the risks of a general paralysis of action, a pivotal role is given to the adoption of "no-regret strategies" by a first phase coalition which could expand through demonstration effects in a second phase.

Semantic differences between various definitions of the "no regret concept should not mask the fact that it embraces rather well identified elements:

- negative costs potentials (efficiency gap) due to market imperfections inhibiting the adoption of the most cost-effective technologies at given prices;
- spill over effects of low carbon intensive innovations;
- environmental double-dividend (both at global and local levels);
- economic double-dividend yielded by recycling the revenues of a carbon tax, by removing subsidies to energy use or by lowering energy imports.

There is no agreement about the magnitude of each of these components, but the reasons why estimates differ are growing less controversial. Debates between top-down and bottom-up modellers in the energy field about the negative costs potential, or between public finance experts and many macroeconomic modellers as regards to the economic double dividend, demonstrate that disagreements on technical assumptions matter less than the judgement on the degree of suboptimality of baseline scenarios, and on the transaction costs entailed by removing existing market imperfections or reforming fiscal systems.

The research team defined here as "no regret" any strategy which entails no net costs. This is analytically clear and politically meaningful for expressing that the overwhelming majority of countries are not ready to go beyond this strict limit, the more concerned ones being only ready to pay the internal transaction costs of implementing zero incremental costs measures.

Such policies provide a way to remove three of the classical obstacles to international co-operation: the pioneer phase costs are theoretically zero, the incentive for free-riding, which in turn makes less stringent the necessity of a central enforcement administration. In a collective perspective, the benefit of a climate coalition would be to incite countries to remove those of their market and fiscal imperfections which result in increasing GHG emissions while respecting the "subsidiarity principle".

But this does not explain why countries should be incited to enter this type of coalition; if no-regret strategies are mainly technology-based and microeconomic in nature, they should be adopted by each country in the name of its national interest whatever the behaviour of the others.

At this stage, a distinction has to be made between countries in which concern for climate change is high enough to create political pressures for action and those with a low level of concern.

For the concerned countries, and despite the country specific nature of the "no-regret" elements, the *first incentive* for a government to play a cooperative game is that international co-operation may lower the barriers which inhibit the measures apt to yield economic or environmental double-dividends: information costs, risk-aversion, market structures, imperfections of incentive systems (pricing rules, subsidies). Participating in some form of climate coalition could enhance the legitimacy of "no regret" measures, lower the associated transaction costs and help overcome the internal contradictions between political pressure for climate policy and vested interest threatened by such policies. A small group of countries may then commit themselves to a co-operative behaviour with the object of facilitating the use of no-regret potentials in a first step. Over the long run, this coalition may be viable under the strict "no regret" boundary only if a climate policy opens a new technological frontier and if the progress towards low carbon intensive technologies yields other positive technical externalities (more efficient industrial processes, progress in material transformation technologies).

As to non concerned countries, they can theoretically choose to enter a climate coalition:

a) if the non climate related benefits from joining such a coalition are proven to be positive:

- verification of the interest of tapping no-regret potentials;
- -degree of innovation spillovers are larger among countries which cooperate on environmental issues than among countries which do not cooperate;
- not meeting technical standards prevailing in the coalition results in a risk of being evinced from a significant part of international markets.

b) if an international political impetus is high enough: loss of leadership, fear of being isolated in the international arena, weaker convincing power on other international issues.

Over the long run, the expansion of a climate coalition will obviously depend on the increase of climate concerns which may incite some countries to go beyond strictly no-regret policies. However considering expected time horizons for getting clear proofs of anthropogenic climate change, it is more likely that overcoming the limits to the expansion of the coalition imposed by decreasing environmental returns to the size of this coalition, will be possible only if joining it yields dividends other than the mitigation of climate change.

III.2.3. Negotiation patterns: how to reveal the relevant information?

Beyond the current phase where only reporting mechanisms have been agreed, the pattern of international negotiations on climate change will necessarily be determined by the objective to be pursued: emission abatement targets to be met by each country (possibly facilitated by tradable permit systems), international uniformed carbon

tax, internationally harmonised but differentiated carbon taxes. The choice between these negotiation patterns will ultimately be a matter of procedural efficiency; however economic theory indicates that the expected marginal losses (or gains) in welfare should be equalised among countries and this indication should be seriously taken into account. For example, an agreement on a uniform tax (such as the 1992 Commission carbon tax proposal) will be inevitably complicated by the demand for compensatory mechanisms to account for differentiated losses (or gains) in the welfare in each country.

The cost assessment of given objectives made by the representatives of each country depends on the choice of the baseline scenario and the degree of optimism about the efficiency of policy tools. The plurality of plausible *ex-ante* baselines raises a critical problem for the negotiation process; it is easy to point out this problem in the case of targets calculated from a given baseline scenario. Each government will indeed select the scenario which will give it the better strategic position at the negotiation table: if the negotiation process aims at setting abatement targets from given baseline scenarios, an unconcerned government will never recognise that the lowest emission scenario could be selected for reasons other than climate policies; this would lead it to accept incremental abatements whose costs may be high. He will then try and impose the highest of the plausible baselines as the starting point of negotiations; with regard to the adoption of ambitious abatement targets this would result in a self-defeating process.

This type of mechanism prevails, to a lesser extent, for any other negotiation pattern. That is why it is critical to examine what type of negotiation is apt to incite each country to reveal informations about the plurality of *ex-ante* baselines and on margins of freedom for abatement. Numerical experiments carried out during this research the project assumed that only a few concerned countries would accept to reveal the existence of low level baselines; it was then possible to check the efficiency of each type of negotiation process in terms of expansion of the coalition and of ultimate GHGs abatement. The outcome of these exercises is very sensitive to exogenous hypothesis; however a robust conclusion can be derived: the advantage of negotiating on carbon taxes is that a casual change in the baseline trends for reasons other than climate concerns yields an additional abatement unexpected *ex-ante*; conversely, if the agreement is made on physical targets, this change in baseline may result in lowering the intensity of climate policies in non-concerned countries.

III.3. The role of technological co-operation for expanding climate coalitions

The main lesson that can be derived from the numerical experiments is the critical role of technology for determining both the size of the carbon coalition and the level of the GHGs abatements likely to be met within the limits of strict "no regret" policies. The main reasons are the following:

- a) the double-dividend yielded by a carbon tax recycled through lower payroll taxes is due, over the long run to the combination of two economic parameters: higher final demand which drives an endogenous technical progress and lower capital requirements in the energy sector thanks to a lower energy demand. This double-dividend is higher in countries with a high unemployment.
- b) this double-dividend decreases as a function of three parameters: the capital intensity per unit of final energy production when costly carbon-free techniques become cost-effective, increases in households investment in energy efficiency (heating, cooling mainly) and increased energy bills for the household. The two first parameters cause an eviction effect on the investment in the other economic sectors which results in decreasing overall productivity. The third one undermines the quasi-multiplier effect of higher employment levels on final demand. But this occurs only for very high tax levels when technical asymptotes in energy efficiency are met.

Numerical experiments suggest that the combined effect of these three parameters remains low for the first increases in carbon taxes but that, when it dominates, the positive effect of the tax recycling, it triggers very quickly a drastically recessive loop: higher production costs of non-energy goods, restriction of final demand in physical terms, decrease in exports, decrease in investment and lower productivity. The non linearity of the process is systematic for all countries; it occurs more quickly in countries with a low productivity in the energy sector and a high productivity in the non-energy sectors.

The size of the coalition permits a slight increase of the "no regret" domain by lowering the impact of higher production prices on exports; however this parameter does not changes drastically the result. Because of the non-linearity stemming from the tension between two opposite forces, the main determinant of the size of coalitions is an accelerated tapping of negative costs potentials for the first period and, for the second period, the capital costs of carbon saving *techniques* both on the supply side and in the demand side. For very high tax levels, the costs of investments in the households demand plays a critical role because they may offset the Keynesian effect of higher employment. The role of external effects of carbon-free innovation on overall technical progress may be also significant but to a lesser extent. Lowering capital cost of carbon-free *techniques*, *techniques* suffices in insuring the

expansion of an initial carbon coalition by including the less concerned countries without undermining the economic position of the pioneers.

IV. SCIENTIFIC INTEREST AND POLICY RELEVANCE

IV.1. Framing the decision-process in the face of global risk and providing analytical tools for strategic analysis

The first scientific and policy relevant result of the research was to provide a conceptual framework integrating the logical linkages between various dimensions of climate policies: sequential-decision making in the face of scientific and ethical controversies, axiomatic definition of "no regret" strategies, procedural efficiency of the "no regret concept" for reconciling divergent long term expectations and beliefs, technological dimension of the "double-dividend", negotiation patterns and the role of technology in the formation of expanding climate coalitions. This framework aimed at demonstrating the possibility of forming coalitions between countries whose perception of self-interest is neither well-shaped and stable and who have various levels of concerns about climate change.

The second result of the project was the availability of a modelling structure apt to test the consequences of various negotiation games at an international level. So far an obstacle for analysing these games is due to the fact that two types of models are able to support comparative analysis: global models such as GREEN or the Second Generation Model of Batelle Institute, which work with regional aggregates and do not easily capture the specific strategic behaviours of each country, and macroeconometric models such as DRI or Hermes which can convey informations on the specifics of each country but are not flexible enough to translate various sets of expectations about technology adoption behaviours and cannot encompass very long term time periods. The modelling structure provided in this project was not designed to carry out forecasts in a conventional way and does not duplicate existing models. It was primarily designed to translate into the same conceptual framework the outcome of any model in each country (even "rule of thumb" forecasts in developing countries or countries in transition). These results translate indeed numerically the short and long term expectations, beliefs and rationale of the national policy-makers which will ultimately explain their negotiation behaviour. In other words this modelling structure aimed at being used mainly as a communication tool. More specifically it tried to account for the gap between the so-called "engineering viewpoint" and the "economists" viewpoint on technology by capturing the macroeconomic impact of various representations of linkages between economic signals and technical change. Representing explicitly the technical asymptotes for energy efficiency or for given supply technologies, it enables to easily represent non-constant elasticities of prices in the case of high carbon tax levels.

IV.2. The conditions for an European leadership for implementing Climate Convention

One of the policy relevant conclusion of the research was to clarify the potential role of carbon tax initiatives at the European level as a way to meet the targets of the Climate Convention. Interestingly it provided a theoretical ground for the Essen 1994 agreement which opened the window for harmonised but differentiated carbon-energy taxes. In a setting where such carbon taxes contribute to yielding a double-dividend which offsets the gross costs of abating GHGs emissions, there is no reason why a carbon tax should be internationally harmonised (differences in the content and the amount of double-dividend) on pure efficiency grounds. If, for procedural reasons (simplicity, transparency), a uniform carbon tax is adopted, compensation mechanisms must be settled if such a tax does not remain within the domain of a strict "no regret" policy for each country.

A second policy-oriented lesson concerns the conditions for implementing the 1993 White Paper on Growth, Employment and Environment. This research pointed out to what extent the very existence of an economic double-dividend from environmental policy is determined by the technical change likely to be triggered by these environmental policies. Environmental policies, fiscal harmonisation policies cannot be isolated from technological policies and technical co-operation. Beyond, this provides a ground for Europe to take up a pro-active strategy at an international level for implementing the Berlin March 1995 commitments. There is a margin of freedom for taking a world leadership on global environment issues as long as Europe is in position to reinforce environmentally friendly innovations.