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Environmental Negotiations: the Problem of Time–Inconsistent Strategies

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The problem of time–inconsistency arises when a strategy chosen because it has certain properties ceases to have those properties during the course of its implementation. There is then an "inconsistency" in continuing to implement it. This problem arises in particular for governments which have to implement a strategy in relation to the environment.

We compare an economists' formulation of the problem with a game–theoretic one, review the game–theoretic background, and discuss how "soft" game theory can be applied. Our argument is that time–inconsistency throws doubt on the credibility of a government's policy. It therefore requires an analysis of ways of establishing credibility.

Economists, by contrast, tend to assume that a government's policies can always be made credible, and propose solutions to the problem of time–inconsistency based on that assumption.

We examine an actual case of a government involved in environmental negotiations, and show that the economists' assumption seems not to have held true. We show that the "soft" game theory approach was applicable.

1. "Time–inconsistent" strategies: the economists' solution

Economists often assume, when considering government management of the economy or of pollution, that other actors in the economy will regard government policy, once it is chosen and announced, as fixed. In game–theoretic terms, this amounts to assuming that the government's policy will always be *credible* to other economic actors.

On this assumption the government can reason as follows. "Let us estimate how other actors would behave if they were to make this or that assumption about our strategy, x. We will then have estimated their joint strategy, y, as a function $y = R(x)$ of our strategy. We can then choose our strategy x so as to

maximize the welfare function $W(x, y)$ *with respect to* x

subject to the constraint $y = R(x)$."

Kydland and Prescott (1977) used this assumption of government credibility in trying to apply optimal control theory to economics. They came across a difficulty.

They looked at a dynamic version of the above model. Suppose there are two time periods $t = 1, 2$. Let x_t represent the policy of the government and y_t that of other economic actors at time t. Then the government would have a maximization problem in each period. At time 1 it would have the problem

maximize $W(x_1, x_2, y_1, y_2)$ *with respect to* x_1, x_2

subject to $y_1 = R_1(x_1, x_2)$; $y_2 = R_2(x_1, x_2, y_1)$

whereas at time 2, when x_1 and y_1 are fixed, it would face the problem

maximize $W(x_1, x_2, y_1, y_2)$ *with respect to* x_1, x_2

subject to $x_1 = k$; $y_1 = j$; $y_2 = R_2(k, x_2, j)$

where k and j are constant values of x_1 and y_1, obtained from a solution of the problem at time 1.

The problem identified by Kydland and Prescott is that a value of x_2 which solves the problem at time 1 will not necessarily solve the problem at time 2!

Indeed, the calculus condition for x_2 to solve the first problem is

$$\frac{\partial W}{\partial x_2} + \frac{\partial W}{\partial y_2}\frac{\partial y_2}{\partial x_2} = -\frac{\partial y_1}{\partial x_2}\left(\frac{\partial W}{\partial y_1} + \frac{\partial W}{\partial y_2}\frac{\partial y_2}{\partial y_1}\right)$$

whereas to solve the second problem it is

$$\frac{\partial W}{\partial x_2} + \frac{\partial W}{\partial y_2}\frac{\partial y_2}{\partial x_2} = 0.$$

These equations, which have the same lefthand side, are inconsistent unless the righthand side of the first is zero. Now this righthand side has two factors. We cannot suppose the second to be zero, as there is no reason to expect each marginal change in welfare due to y_1 to be exactly cancelled out via a corresponding change in y_2. For the first factor to be zero means that changes in x_2 (government policy at time 2) do not affect y_1 (the behaviour of economic agents at time 1); that is, the behaviour of economic agents in any time period is affected by government policy in that period, but not by future government policy. In other words, these economic agents have no foresight!

This seems an intolerable assumption to make in economics. It follows that the government cannot attempt to solve both these maximization problems.

Kydland and Prescott therefore recommend that the government should fix x_1 and x_2 at time 1, thus foregoing the chance of having a flexible policy which, in every time period, chooses the policy which is optimal at that time. In effect, at time 2 the government should be mindful of what *was* optimal at time 1; it should "cry over spilt milk" and refrain from altering its policy to one which is *now* optimal. Thus, they conclude, optimal control theory is not applicable to economics.

They recommend that government policy should be based in this way on "rules rather than discretion" on the grounds that a policy of flexible response is sub–optimal — the second of the above problems being a subset of the first. Their proposed "solution" to time–inconsistency — "choose an overall optimum at the beginning of the game, and stick to it" — seems to have been echoed by other economists (see the *Economist* magazine, 1991).

2. A game–theoretic formulation

The game–theoretic formulation of time–inconsistency is more general than that of Kydland and Prescott. It is the statement that *not all the strategic properties*

of a normal-form strategy are retained during the course of its implementation through the game tree. This statement marks something of a revolution in game theory, as it contradicts the original von Neumann–Morgenstern idea that the normal form is strategically equivalent to the extensive–form game.

A form of time–inconsistency was first noticed when Harsanyi (1968) proposed his theory of games with incomplete information. He represented such games by a tree in which chance makes a prior move, thereby determining the state of the players. It was clear that it made a considerable difference whether players in this game chose their strategies before or after this prior move: prior moves could affect the strategic properties of players' strategies.

Aumann and Maschler (1972) pointed out this general fact, and showed that prior moves could affect even the strategic properties of an optimal strategy in a two–person zero–sum game. This author (Howard 1975, 1976) then examined a number of strategic properties in order to see which *did* remain unchanged during the course of implemenation. Few did, other than the "equilibrium" property of being a "best reply" to a particular combination of others' strategies (the case noticed by von Neumann and Morgenstern). Even here, Selten (1973) had pointed out that a best reply to a particular combination of others' strategies might become quite incredible (eg because not a best reply to anything) if, at a later point in the game tree, that combination had not been implemented. He defined a "perfect" equilibrium as one which did not suffer from this defect.

Inconsistency in this general sense always relates to some strategic property which, though present when a strategy is chosen, may vanish in the course of its implementation. A player may thus find, midway through a strategy, that it no longer has the properties for which it was chosen; it is "inconsistent", therefore, to continue with it.

Kydland and Prescott concentrate on the particular strategic property of being "optimal" in the sense of inducing the best possible outcome *assuming* that other players will find one's strategy completely credible — ie will regard it as fixed. We note that "optimality" in this sense is not always well defined in a game, since it leaves us with the problem of predicting behaviour in the $(n-1)$–person game defined by fixing one player's strategy. In special cases, however, especially when there are only two players, it is well defined. Kydland and Prescott show that even when well defined, this kind of "optimality" may be inconsistent.

To clarify the problem, let us look at a simple game–theoretic example which

exhibits this and other kinds of inconsistency. It concerns a government dealing with an environmental problem.

Suppose a company has to decide whether to build a factory to produce a non–polluting product. The government wishes to encourage this, and has to decide whether or not to subsidize the output of the factory. Assume that unless subsidized, the expected profit from the factory would not be enough to cover both building and running costs, but would be enough to cover running costs.

The game tree is shown in figure 1. To be realistic, we assume that the "payoffs" shown represent ordinal preferences only — ie they show preference rankings rather than quantitative utilities.

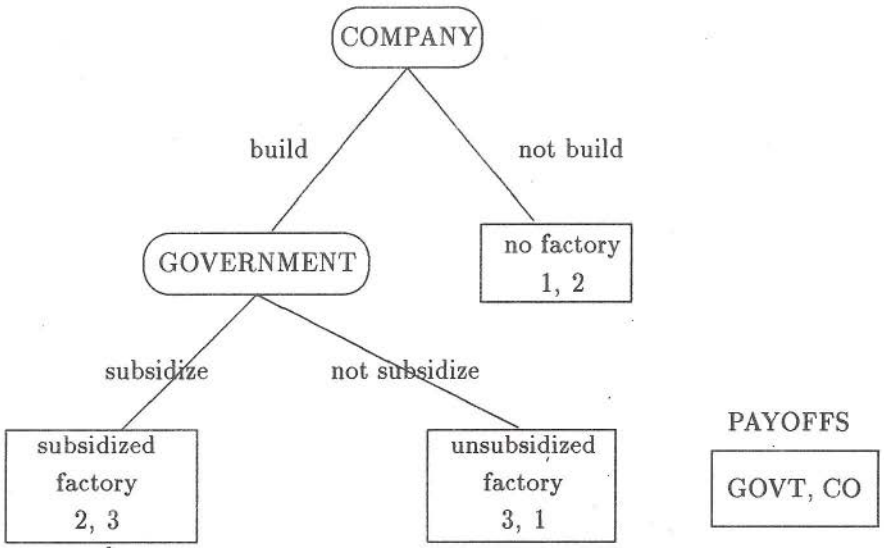

Figure 1. Game tree of factory location problem

It is clear that when the time comes for the government to implement its decision, it no longer has to consider any effect on the company's decision; this is now in the past. It therefore seems obvious that it will choose not to subsidize the factory's output (for a payoff of 3) rather than subsidize it (payoff 2).

Though this seems obvious, the Kydland–Prescott "solution" to time–inconsistency assumes that the government can decide, at the beginning of the tree, that it will ignore its own preferences when it later finds itself in the decision

situation at bottom left. It can decide, at the beginning of the tree, that it will later on deliberately choose a payoff of 2 rather than 3! It is this decision, made and announced at the beginning of the game tree, that is "optimal" for the government because it induces the firm to build.

If, however, the company doubts such an announced decision, and makes the "obvious" prediction instead, it will not build the factory in the first place. Consequently, payoffs will be $(1, 2)$. The payoffs $(2, 3)$ will be unobtainable.

Clearly, much depends on the government's credibility.

Figure 2 represents the same example in terms of normal–form game matrices.

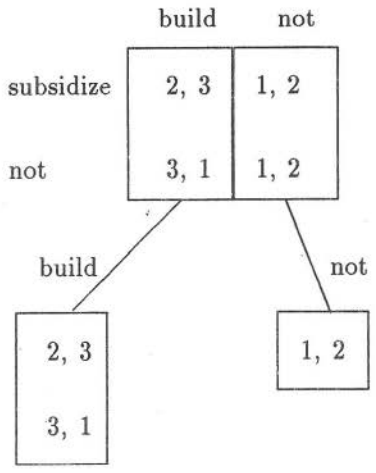

Figure 2. Normal forms of the game & subgames of Figure 1

Figure 2 illustrates time–inconsistency in the case of the following properties of strategies or strategy–pairs:

(1) *The property of being "optimal" for a player in the Kydland–Prescott sense.* "Subsidize" is optimal for player 1 in the initial game, but not in the two–by–one subgame.

(2) *The properties of yielding a payoff at or above (respectively, below) a player's "maxmin security level".* 1's security level is 1 in the initial game, so that $(2, 3)$ is above it. In the subgame it is 3; $(2, 3)$ is below it. 2's security level is 2 initially; $(3, 1)$ is below it. In the subgame, it is 1; $(3, 1)$ is not below it.

(3) *Pareto optimality*. (1, 2) is not Pareto optimal in the initial game, but is so in the one–by–one subgame.

(4) *Membership of the core* (the α–core or β–core, here the same). It follows from the inconsistencies of (2) and (3) above that membership of the core may be inconsistent. In fact, in the initial game, (2, 3) is the only member of the core. In the two–by–one subgame, (3, 1) is the only member. In the one–by–one subgame, (1, 2) is the only member.

3. The problem of asserting and assessing credibility

The problem of time inconsistency is essentially one of credibility. If it is known that a strategy will cease, halfway through its enactment, to have any of the characteristics for which it was chosen, it becomes incredible that it should continue to be chosen. Hence such a strategy is, on the face of it, incredible: it cannot be chosen, and if it were, other players would not believe it.

Yet we have seen that it may be advantageous to choose an incredible strategy, or at least to make others believe it. The Kydland–Prescott "solution" goes straight from this observation to the conclusion that a government can choose such a strategy!!

The idea that governments are privileged players, uniquely able to make themselves credible, may come from the fact that they can often adopt "constitutional" measures which effectively set the rules of the game. In the above example, the government might pass a general law subsidizing certain kinds of non–polluting product. In another example, considered by Kydland and Prescott and by the *Economist*, the government might set up an independent central bank to give credibility to its anti–inflation policy.

This is an important observation. It means we should look, in any particular case, for special ways open to the government by which it may strengthen its credibility. It does not mean that governments have no credibility problem!

Some recent experience, reviewed below, of work with a government conducting environmental negotiations with industry suggests that governments may indeed need methods of strengthening their own credibility. They may also need methods by which to assess others' credibility.

Thus a general theory of credibility is needed. In Howard (1987, 1989, 1990) I have proposed such a theory based on "soft" game theory. This investigates

how players in pursuit of credibility may alter their own and each others' actual or perceived preferences and strategy sets; that is, they may alter the "soft" game.

This theory as it stands applies to the credibility of ordinary normal–form strategies. We shall review it and see how it applies to time–inconsistent strategies.

4. "Soft" game theory explanations of credibility

The problem of credibility in the normal form game arises when players have a strategic need to make others believe in two kinds of "unwilling" commitments — unwilling "promises" and unwilling "threats". The need arises during preplay communications, when players are using threats, promises, and other forms of persuasion to influence each others' intentions.

An *unwilling promise* is a commitment by a player (or coalition) C to adhere to a strategy s_C which is not a best reply to a strategy s_{N-C} which it *hopes* the complementary coalition $N - C$ will adopt. For example: in figure 2, in the initial two–by–two game, the government is making an unwilling promise in committing itself to subsidize if the company will build. This commitment is "unwilling" because it is not a best reply. It is a "promise" because the government is hoping the company will build.

An *unwilling threat* is a commitment by C to adhere to an s_C which is not a best reply to a strategy s_{N-C} which it *fears* $N - C$ will adopt. Thus the difference between a threat and a promise is the difference between a hope and a fear; a promise is meant to induce, a threat to deter.

One can find a threat in figure 2: the company might threaten not to build if the government will not subsidize. But this threat is not "unwilling": not building is a best reply to not subsidizing. Consider therefore the game in figure 3, created by supposing that the government's option is to subsidize, not the output of the factory, but the building of it. Figure 3 further supposes that the plant will certainly be built if the government will subsidize it, and that it would be profitable for the company to build even without a subsidy.

This game contains a possible unwilling threat. In the initial normal form of figure 3, a commitment by player 2 not to build if the government will not subsidize would be an unwilling threat: "unwilling" because not a best reply; a

"threat" because the company would be trying to make it credible in order to avoid it happening.

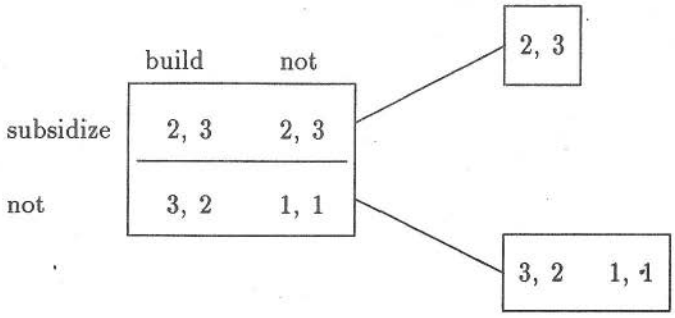

Figure 3. Game when building of plant is subsidized

In figures 2 and 3 unwilling threats and promises occur in the initial normal form — the situation at time 1, when players try to influence each others' intentions during preplay communications.

In both games the credibility of the threat or promise is further undermined by dynamic considerations. It is already unwilling at time 1. There is already then a problem of making it credible. This is made worse by the fact that its status as a threat or promise is not time–consistent.
At time 2 it remains unwilling — but no longer serves any purpose as a threat or promise. There is no longer any reason at all to carry it out.

We now review the various methods by which, according to "soft" game theory, an unwilling commitment can be made credible.

Method 1 : Preference change. *A player can make a commitment credible by changing its preferences so as to make the commitment a best reply.* In Figure 2, if player 1 could change $(2,3)$ to $(3,3)$ and $(3,1)$ to $(2,1)$, then it would prefer to keep its promise, and the promise would become credible. In Figure 3, player 2 makes its threat credible by changing $(1,1)$ to $(1,2)$ and $(3,2)$ to $(2,1)$.

There are two kinds of preference change. Objective preference change is effected by changing contextual conditions — as when a company stockpiles its product so that it will prefer to ride out a threatened strike. It can also be a matter of developing new options — in figure 2, the government might

attempt to make its promised subsidy credible by framing it in a piece of general legislation. Objective preference change may also be possible simply by making a public commitment; this will often apply if a player has an overriding need to safeguard its credibility in other, later games.

Subjective preference change is different. It is mediated by emotion — positive emotion in the case of a promise, negative emotion when it is needed in order to make a threat credible. It consists of a change of values. In figure 3, the company's anger at being refused a subsidy might cause it to lose interest in what would be a profitable project.

Preference change, if real and permanent (cf the next two methods), is a convincing and adequate way to make a commitment credible. It abolishes time–inconsistency; an inconsistent policy becomes consistent. One would therefore expect time–inconsistency, if perceived by the players, to lead to greater attempts by players to change their preferences.

Method 2 : Irrationality. If a player can demonstrate sufficient irrationality ("they're mad enough to mean what they say!"), this may make it credible that it would decide against its own preferences. Hence *irrational behaviour can make an unwilling commitment credible*.

Such irrationality is distinct from non–strategic irrationality, due to error or ignorance. It can be recognized by the fact that it is mediated by emotion in the same way as subjective preference change: that is, communicating positive emotions helps to make promises credible, while negative emotions help to make threats credible.

Irrationality may indeed be equated with *temporary* preference change. It communicates preferences which are not rooted in a proper system of values, so that one expects the player to go back to its former preferences once it "calms down". This may not matter if the threat or promise is immediate — "I will shoot myself/sign a cheque *right now*" — but it makes irrationality as a method quite vulnerable to time–inconsistency.

The temporary preference change of irrationality therefore needs to become permanent if it is to be effective despite time–inconsistency; in other words, it needs to become a case of true (permanent) preference change. The question to ask, when under pressure from others' emotions, is: "Will they still love/hate me tomorrow? If not, will it matter? "

This raises the question — how can you tell? How is it possible to distinguish between irrationality and subjective preference change? This is answered by

method 4. The question itself introduces method 3.

Method 3 : Deceit. Instead of changing its preferences or becoming irrational, a player may pretend to do so. This will be called deceit by other players; the player who practises it may call it 'not revealing our bottom line', 'being economical with the truth', etc.

Objective preference change is simulated by misleading others about objective facts; subjective change by misleading them about feelings and values.

If successful, deceit, by definition, has the same effect as the real thing. It may suffer from the disadvantage of harming too much a player's credibility in other situations; in that case, as we have said, the player can achieve credibility in another way — by making its commitment public. Of course, deceit is possible in relation to this too.

The possibility of deceit generates *disbelief*, in that if there is reason for A to deceive B, there is reason for B to disbelieve A. As a result, all the above methods of enhancing credibility may undermine it instead!

The next method tries to overcome this dilemma.

Method 4 : Rational argument in the common interest. Where there is an advantage for a player in making credible an unwilling commitment, there is necessarily a common interest for the players; they have a common interest either in not having the threat carried out, or in having the promise carried out.

Arguments may be built upon this common interest by examining the facts and values which create it and building a convincing rationale out of them. As they appeal to a common interest, such arguments will tend to create a single, unified player out of different ones. They help to make the implicit promise or threat credible without attracting disbelief in the same way as other methods, since they are based upon the real facts of the situation.

Rational arguments in the common interest can be emotional without sacrificing rationality. Indeed, they demand emotion, since the rational arguer needs to make credible its readiness to sacrifice its *individual* interest for the sake of the *common interest* — ie, that particular part of the common interest which makes the promise (or threat) it is making preferred (or not preferred) to the alternative it puts forward.

We have now reviewed the methods for making an unwilling commitment credible and their efficacy against time-inconsistency. Which of them are in fact efficacious?

Not irrationality; not, therefore, deceit as to irrationality.

Those that remain are preference change backed by rational argument and appropriate emotion; also, deceit as to such preference change. In interpreting this, both in regard to actual preference change and deceit, one must be clear about the roles of emotion and rational argument. Emotion indicates that a change of values is taking place, but is unconvincing on its own, as it then indicates only a temporary (irrational) change. It needs to be backed up by adequate arguments and convincing evidence.

5. Experience with time–inconsistent strategies in environmental negotiations

We now review some recent work on environmental negotiations where unwilling commitments, some of them time–inconsistent, seemed to play a role.

The work consisted of game–theoretic consultancy for government officials in a certain country who were conducting negotiations with their packaging industry, the aim being to reduce packaging waste. The conclusion had been reached, on technical grounds, that a large degree of re–use of packages (such as bottles and plastic or cardboard containers) would be necessary in order to achieve environmental goals. The industry was resisting this conclusion.

As the deadline set for the negotiations approached, there was inevitably a desire, transmitted from the minister down, to reach an agreement of some kind with industry. Thus attention was focussed on the outcome of the negotiations themselves (which constituted the first stage of the game) rather than on what was done afterwards, which constituted the second stage.

We will use the "analysis of options" technique (Howard, 1971, 1989) to model the situation — though I should stress that while various analysis of options models were built and analysed in the course of the consultancy, this particular model was not. It is a later view of what was going on.

Use of this method involves first specifying *who are the actors (ie players) involved in the situation*. In this case they were, at the highest level of resolution, the *GOVERNMENT* and the *PACKAGING INDUSTRY*.

At the next level of resolution, each actor decomposed into a number of subactors playing a subgame between themselves. The GOVERNMENT was composed of

- the civil servants in various government departments, headed by the Environment Ministry, with Economic Affairs having a strong secondary role, and Finance also being important. Economic Affairs tended to speak up for business firms when it felt that Environment was being too unsympathetic toward their problems. Finance wanted to make sure that over–generous commitments were not made which might have to be met out of the public purse.
- the Ministers in charge of these ministries, together with the cabinet and the Prime Minister. These subactors of the actor *GOVERNMENT* were subject to political pressures not felt by their civil servants. For example, they felt political pressure to reach an agreement with industry, having advertised that negotiations would take place. Also, they had to listen to representations from industry at a higher level than that of the industry representatives the civil servants talked to.

The preferences, strategies and tactics of the player *GOVERNMENT* in the *GOVERNMENT–INDUSTRY* game were determined by the interactions between these subplayers. Similarly the player *INDUSTRY* was composed of a number of subplayers. The packaging industry comprised a number of industrial sectors: the supermarkets industry, the glass bottling industry, the laminates industry (making packages for milk & fruit juice), and so on. Each sector was structured differently; in many of them a few big firms predominated. The packaging industry as a whole was represented in negotiations with the government by an association which had been set up for this purpose; but it would have been a mistake to regard this association as an independent player confronting the player *GOVERNMENT*. Again, the preferences, strategies and tactics of the player *PACKAGING INDUSTRY* had to be seen as determined by an internal game going on between various subactors.

Step two in the method is to decide *what are the policy options in this situation and who (which actors) controls them*. An "option" means a yes/no policy alternative: not (usually) an action taken at a particular time, but a policy for the indefinite future. Options model the basic policies to be decided now and implemented in the future which will determine, or strongly affect, the future history of the situation. They need not, but can be mutually exclusive; if they are not, it's possible to explore the situation by combining them in various ways.

Here the big issues seemed to be

- should re–use of packaging (ie of the packages themselves, not just packaging materials) predominate in future?
- would industry, if faced with the need to convert to re–usable packaging, receive financial and non–financial aid from the government in order to make the transition?

The first of these issues had come to the fore when the government (led by the civil servants in the Environment ministry) concluded from technical studies that predominant re–use of packaging would be necessary in order to meet environmental targets. These technical studies were supposed to have been conducted in cooperation with environmental pressure groups and packaging industry representatives. In fact, the cooperation of industry had not been as enthusiastic as had been hoped for. Consequently, the government's conclusion about the need for re–use had not been accepted by industry.

The second issue — aid for industry in making the conversion — had been brought in consciously by the civil servants responsible for negotiations largely as a result of using soft game theory. Game–theoretically, it served two purposes: it made it more possible for industry to accept conversion; and it made it possible to make an ally, in the internal game going on within the government, of the Ministry for Economic Affairs. An important role would open up for this ministry if industry's transition to new products were to be aided, financially and otherwise, by the government. Obtaining this role would provide an incentive for the ministry's civil servants to begin to work for the Environment ministry's aims, rather than against them.

Game–theoretic analysis may have been responsible for making civil servants conscious of the importance of this option. It was because it was judged to be implicit in the situation, and to have intrinsic importance, that it had real significance. Its intrinsic importance came from the judgement that government aid would be both necessary and demanded by industry once they became convinced that they would have to convert.

The actors and their options were then as shown in Table 1.

Briefly to explain these options:

> To *ban non–reusable packages* meant to phase in a system of compulsory reuse. Note that for firms converting to re–usable packaging, it would be in their own interest to do so under a compulsory regime, as this would give them an advantage over foreign competitors (who would have to go

GOVERNMENT
ban non–reusable packages
aid industry to convert
PACKAGING INDUSTRY
agree to ban
agree to targets
meet targets

Table 1. Actors and options in the PACKAGING game

through importers working within the re–use system) and would prevent "free riders" taking advantage of others' compliance.

To *aid industry to convert* meant installing an ongoing system of consultation, help and guidance to enable industry to adopt re–usable packaging. This might be seen as necessarily accompanying a ban, since a ban would wipe out whole industries; however some, including the Finance ministry, would question the need for so much expense.

For the *PACKAGING INDUSTRY* to *agree to ban* meant to accept not only the government's waste–reduction targets, but the need for re–use of packaging in order to meet them. As noted, once this was accepted, a compulsory regime, or "ban", would be in the interest of firms themselves. The option *agree to ban* also meant to cooperate with a compulsory regime and heip the government to set up and develop it.

To agree to targets without *agreeing to ban* meant to accept the government's waste–reduction targets but to insist that they could be met without the major disruption of a strategy of converting to re–use. This was the position currently being taken by industry.
But this, in the view of civil servants in the Environment ministry would mean that the industry would not in fact find itself able to *meet targets*, which is the last option in our list.

We now have a skeleton game model. Within this model we can see a game/subgame structure. At time 1 there are negotiations between government and industry, during which intentions can be formed for all the options listed. Some will then be carried out more or less at the same time (ie, before intentions really have a time to change). This is so for all except the second *(aid industry to convert)* and last *(meet targets)*. These intentions will be carried out, if at

all, in a piecemeal way over a period of 10–20 years. This is time 2.

6. Examining various scenarios

The next stage in the analysis–of–options method is to *examine various possible "scenarios"*. A scenario is a future history of the situation as it would unfold, in the — perhaps differing — judgements of the actors, if a certain combination of options were implemented.

We represent a scenario, as in Table 2, by a column of 1s (for "yes") and 0s (for "no") written against the options. We interpret it as a history of the future.

GOVERNMENT						
bad non–reusable packages	1	(1)	0	(0)	0	1
aid industry to convert	1	0	0	(0)	0	0
PACKAGING INDUSTRY						
agree to ban	1	(1)	0	(0)	0	0
agree to targets	1	(1)	1	(1)	0	0
meet targets	1	1	1	0	0	1
	1	**2**	**3**	**4**	**5**	**6**
	GOVT'S AIM			*GOVT'S SUSPICION*		
		IND'S FEAR			*STATUS QUO*	
				IND'S ALTERNATIVE		
						CONFLICT PT

Table 2. Various scenarios in the PACKAGING game

Column 1 in Table 2 represents the *GOVERNMENT'S AIM* as seen by the civil servants leading the negotiations. They hoped for an agreement with industry to meet waste–reduction targets by means of a phased ban on non–reusable packaging; this ban to be accepted by industry so that the details could be worked out and implemented harmoniously and realistically; in return for which there would be a program of aid for industry to help it convert to new products. They saw this scenario as leading to a phased, cooperative programme of waste reduction being implemented over the next 10–20 years. They foresaw that it would give the country's industry a competitive advantage by being the first to employ methods which would eventually be adopted elsewhere.

The packaging industry did not share this view. They disliked scenario 1 because under it certain industries — particularly glass bottling — would be virtually wiped out, and transitional aid would have to be heroic indeed if alternative uses were to be found for the capital and labour employed in them. Other industries involved in packaging would have to make large changes. All of them naturally found this prospect more daunting than the government did.

The prospect could be made more acceptable to them by strong and dependable help from the government. But the option *aid industry to convert* was not made very credible. In part this lack of credibility arose because the idea of transitional help was introduced into the negotiations rather late and without the full backing of all players on the government side. But in any case, there was a time–inconsistency.

Column 2 of Table 2 shows what might be expected to happen at time 2, given that *GOVERNMENT'S AIM* had been accepted by all parties at time 1 as the scenario they would adopt. At time 2, the bracketed options would have become fixed. A ban on non–reusables would have been legislated, and with it a framework for industry–government cooperation and government aid. Would not then the scenario *INDUSTRY'S FEAR*, in which the government fails to deliver adequate aid but industry would be compelled by legislation to *meet targets*, be preferred by the government in later years to actually carrying out *GOVERNMENT'S AIM?*

The time–inconsistency consists in the fact that though the government's strategy under the scenario *GOVERNMENT'S AIM* is not a best reply to industry's strategy (because government has a "unilateral improvement" in not giving aid) yet at time 1 the scenario *GOVERNMENT'S AIM* is a member of the core: industry has a "sanction" (the threat of not agreeing to a ban) which is sufficient to deter government from the above "unilateral improvement". This is at time 1. At time 2, giving aid is still not a best reply for the government. The difference is that there is now no longer any sanction to deter it from not doing so. The scenario *GOVERNMENT'S AIM* is no longer a member of the core!

It is clear that this time–inconsistency might well have undermined the credibility of the government's proposed scenario. Industry might well have asked itself "Will they still love me tomorrow?"

Industry in fact proposed an alternative, summed up in scenario 3. This was that there should be no legislative ban on non–reusables nor any agree-

ment to convert to such a system — which industry continued to maintain was unnecessary. Instead they proposed a government–industry agreement incorporating the government's targets, declaring industry's intention to meet them, and leaving industry free to decide how to do so.

This was the agreement that was finally adopted. It left a suspicion on the part of environmental experts that scenario 4 would be the actual result. Under this scenario industry would agree to meet targets but would not actually do so.

Why this suspicion? Partly because of the belief that industry, despite their protestations, would find it technically impossible to meet the government's targets without moving to predominantly re–usable packaging. But partly the suspicion was due to another time–inconsistency. Once the threat of a ban was removed by their having *agreed* to meet targets — so letting the government off the hook in the short term — it would no longer be in the interests of industry to actually meet targets.

To be clear about this second inconsistency: it consists in the fact that *INDUSTRY'S ALTERNATIVE*, though a member of the core at time 1, is no longer a member at time 2. At time 1 industry's improvement in not intending to *meet targets* is deterrable by a sanction - the threat that if it does not so intend, the government will *ban non–reusable packaging*. At time 2 the government has foregone the opportunity to impose a ban, and industry's improvement is no longer deterrable by any sanction.

7. Unwilling threats in the negotiations

So far we have found time–inconsistent unwilling promises in each proposal put forward by government and industry. We have not discovered why one proposal and not the other was adopted.

This was owing to a contest between two unwilling threats — neither of which, as it happened, was time–inconsistent. In this contest industry's threat was victorious because the higher levels of the government did not back up their negotiator's attempts to make the government's threat credible.

Industry's refusal to carry out their part of scenario 1 — ie the fact that they would not *agree to ban* — meant that the scenario could not be implemented as planned, since industry's acceptance of and cooperation with the waste reduction programme was essential. It also put the government in a difficult position,

since the Environment minister had to some extent staked his reputation on getting a satisfactory agreement with industry.

Had the government at this point decided to go ahead with a unilateral ban if industry would not agree, then industry's refusal to *agree to ban* would have created the scenario *CONFLICT POINT* (scenario 6 in table 2). This would have been uncomfortable for the government because it would have meant no agreement with industry. But it would also have been uncomfortable for industry, since it meant the government going ahead with a unilateral ban without aiding industry nor holding cooperative discussions with industry on the implementation process, and yet with industry nevertheless legally obliged to *meet targets*.

But the government did not make this decision. Instead ministers continued to announce that their policy depended upon agreement with industry. Hence the scenario created by industry's refusal to agree was apparently scenario 5 — called *STATUS QUO* because it represented "no change", ie a continuation of past policies. This also was uncomfortable for the government — but quite acceptable to industry!

What was happening at this point, with the time allowed for negotiations close to an end, was that the civil servants responsible for negotiations were trying to make the *CONFLICT POINT* credible, whereas the higher levels of government would not decide what to do if no agreement were reached. It seemed clear that they would not actually continue with the *STATUS QUO*, but they did not say what else they would do. Thus the credibility battle was lost to industry, who simply maintained that *INDUSTRY'S ALTERNATIVE* was the most they could agree to.

Why did the government need to make the *CONFLICT POINT* scenario credible? Because it was a point from which industry would have preferred to move to *GOVERNMENT'S AIM*. Thus making it credible was the only means open to the government of getting its aims accepted.

Thus the *CONFLICT POINT* represented a possible "unwilling threat" for both parties. It would have been a "threat" to both parties simultaneously because industry would have done better from *GOVERNMENT'S AIM*, and the government from *INDUSTRY'S ALTERNATIVE*, than from the *CONFLICT POINT*. It would have been "unwilling" for both parties because not a "best reply" for the coalition of government and industry, since this coalition would have had an "improvement" in moving to either of the above two alternatives. Each

party might nevertheless have refused to move from the *CONFLICT POINT*, not because it preferred this scenario, but in order to force the other to agree to the improvement it did prefer.

Though unwilling, the threat would not have been time–inconsistent. The governments' part of the threat — to *ban non–reusables* — would be carried out at time 1, not later. So would industry's threat to embarass the government by refusing to *agree*.

Time–inconsistency applied, in this game, not to the player's unwilling threats, but only to their unwilling promises.

8. Analysis of credibility using soft game theory

We have identified two unwilling threats and two unwilling promises in the negotiations between government and industry. The unwilling promises, but not the threats, were time–inconsistent. This means according to our theory, that only rational arguments justifying preference change should have lent credibility to the promises; in the case of the threats, irrational obstinacy might have sufficed.

We will look at the threats and promises one by one.

The government's threat to impose a unilateral ban if industry withheld agreement. To strengthen this threat, the government needed to argue convincingly that a unilateral ban was preferable to none at all, while taking a strong negative attitude toward the failure to meet targets which, arguably, would be inevitable if no ban was imposed. Such arguments were produced by the officials involved in negotiations; however, their efforets seem to have been undermined, as the deadline drew near, by the attitude of higher–level players in the government.

The government's promise to aid industry: Successful attempts were made, as noted, to change government preferences in favour of this option by persuading officials in Economic Affairs that it would be in their interest. Emotionally, a positive message was sent to industry concerning this. Rational arguments as to why it would be appropriate were listened to and welcomed by industry representatives. However, the effect of these tactics was again confined to the level of negotiators; the owners of large firms on the one hand, and government ministers on the other were not affected.

Industry's threat to refuse to agree to a ban. This threat won the contest for

credibility not by using rational arguments (which were not essential, since the threat was not time–inconsistent) but by various other means. Use was made of the internal structure of the player *PACKAGING INDUSTRY*: understandings reached with representatives of the industry association were subsequently rejected by the large firms supporting the association, with whom there were no direct negotiations. In this way rational arguments, etc, presented by government negotiators were rendered ineffective. Use was also made of the argument that, in principle, any proposition is capable of being overturned by further research! This provided an apparently rational response to arguments showing the need to enforce re–use: the answer was always "Further research may turn up some other alternative". Negative emotion was also used, in the form of hostility toward some government representatives who became too pressing.

Industry's promise to meet targets: This time–inconsistent promise was not in fact made credible to government representatives, but may have been believed at higher levels in the government. Assessments by government representatives were based on the rational arguments and emotional tone of industry representatives communicating the promise. Their rational arguments were judged to be poor, and emotionally they did not show great goodwill. Unfortunately, this assessment was not adequately communicated to higher levels within the government.

9. Conclusions

Our main conclusion is that government policy in environmental negotiations does not seem to have the automatic credibility which Kydland and Prescott, in common with most economists, assume; credibility needs to be sought and achieved.

This is so whether or not there is time–inconsistency. Governments like other players often need to make credible "unwilling" threats and promises, and time–inconsistency is one of many factors affecting the means by which credibility can be established. In fact, in the case we have reviewed the incredibility of the government's time–inconsistent promise was not its main problem; that was to make credible its unwilling threat — which was not time–inconsistent.

A second conclusion is that analysis using soft game theory does throw light on environmental negotiations, clarifying the motivation (conscious or otherwise) of some of the tactics used.

Lack of internal coordination existed within each of the two large players we have considered. This seems to have been helpful to the cause of the industry and harmful to that of the government. It helped industry by insulating higher–level decision–makers (the owners and managers of large firms) from pressures exerted on those who were supposedly negotiating on their behalf. It harmed the government inasmuch as negotiators were not able to communicate to higher levels their assessment of industry's credibility and their need for their own credibility to be enhanced.

Why this difference? Because by refusing to change course in response to their negotiators' advice, the industry players were de facto implementing the strategy of not agreeing — which was their threat strategy. Thus they made their threat strategy more credible. The government, on the other hand, made their threat strategy less credible by ignoring or overriding their negotiators — since until they decided what to do their *de facto* strategy consisted of a continuation of the *status quo*.

Lack of internal coordination on each side came about because they delegated the conduct of negotiations to lower–level representatives who reported back to higher–level decision–makers. This way of structuring negotiations may be appropriate for technical reasons. It works against any party for whom the *status quo* that existed prior to negotiations is an unacceptable or painful solution, since the other side then exerts pressure — ie makes its threat credible — simply by stalling negotiations or rejecting its negotiators' advice.

There may be a lesson in this for governments involved in environmental negotiations. They should ensure that the *status quo* prior to negotiations puts pressure on the other side and not, if possible, on themselves.

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