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The Impact of Sovereign Intertemporal
Trade and Cross-Default Clauses
on the Sustainability and Efficiency
of Environmental Treaties

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Institut für Weltwirtschaft an der Universität Kiel

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The Impact of Sovereign Intertemporal Trade and Cross-Default Clauses
on the Sustainability and Efficiency of Environmental Treaties

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August 1992

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I. Introduction

Global warming illustrates, perhaps better than any other environmental problem, the need for an international coordination of environmental policy. This need arises from the general inefficiency of uncoordinated national policies in the presence of transboundary or global pollution (Markusen, 1975). These inefficiencies are brought about by international differences in costs and benefits of implementing environmental policy. Under an uncoordinated policy environmental efforts are concentrated in countries with relatively high benefits from environmental policy. An efficient allocation requires, on the contrary, that environmental efforts be concentrated in countries with relatively low costs.

This discrepancy motivates the call for environmental treaties. Efficiency can be brought about under an environmental treaty if it requires the application of a single market instrument, such as a tax or a tradeable permit system, to the entire domain of the treaty. Pollution activities then carry the same price tag everywhere, thereby directing abatement into low and pollution into high abatement cost locations.

There are, however, three problems to be faced when following this road to efficiency. These problems arise from the fact that countries are sovereign. Due to sovereignty, countries neither need to participate in a treaty in the first place, nor need they behave well under it, nor can they be prevented from overt treason once it is in their interest to terminate cooperation for good.

Quite fortunately, there exists a simple solution which, in theory, can be applied to all these problems: Side-payments to countries out of the pool of total international efficiency gains. With respect to the first

problem, side-payments can be used to bribe a country into an agreement. With respect to the second, they can be used to guide a country to a desirable behaviour within the bounds of a contract. And lastly, they can be used as a carrot to keep a country inside a treaty it otherwise would vacate.

However, the universal application of side-payments in international relations appears to be severely limited. Country sovereignty is therefore in practice a more serious obstacle to the emergence, success and survival of environmental agreements than in theory. There are a number of reasons why the applicability of international side-payments is limited.

In order to stabilise a treaty, side-payments need to flow from high benefit and cost locations to low benefit and cost locations thereby disregarding in general and violating in practice the polluter-pays principle. Side-payments seem therefore to carry the stigma of bribes and blackmail. They cannot therefore easily survive in the domestic political process leading up to a treaty.

Beyond that, even if side-payments are accepted in principle their use may be restricted; or the game theorists' blueprint recommendations may be extensively revised and modified. The side-payments ultimately chosen may therefore be inadequate in magnitude to resolve the sovereignty problem.

A further obstacle is the substantial uncertainty surrounding most international environmental problems. New information on the distribution of gains and losses may emerge, requiring a revision of payments planned. However, once side-payments are fixed they may turn out difficult to adjust. Such an inflexibility can even be necessary to avoid a

permanent quarrel about the distribution of surpluses and to prevent strategic behaviour in the presence of asymmetric information.

Lastly, fiscal restrictions may put a lid on total side-payments well below the theoretical potential. This discrepancy may emerge because side-payments are usually to be made in money terms and by a donor government. On the contrary the benefits from an environmental treaty will in general also fall onto the private sector and materialise also in utility terms. If the donor country cannot (costlessly) tax away all these private gains some of the total surplus to be gained from a treaty is not available for redistribution.

For these reasons it seems warranted to take a pessimistic view with respect to an easy resolution of the sovereignty problem with help of side-payments. This view is taken in this paper.

We investigate into an environmental treaty under which exogenously given side-payments need not necessarily suffice to guarantee its sustainability. Under sustainability of a treaty we understand its long-term survival despite country sovereignty. Tackling such a situation it becomes interesting to ask which factors, other than (additional or lack of) side-payments, contribute to or are detrimental to sustainability.

Amongst other things it is to be expected that the nature of international links other than environmental cooperation influences a sovereign's incentive to stick to or pull out of an international environmental treaty. One such additional link is international borrowing. The impact of this link on the sustainability of an environmental treaty is analysed in this paper. International intertemporal trade is interesting in this context for several reasons.

Empirically, the investigation of international indebtedness can be motivated by the nature of international environmental problems. These

frequently require the participation of LDCs.¹ LDCs are heavily indebted, with the party of international lenders (industrialised countries) being accidentally or systematically identical to the party which requests environmental cooperation. A full understanding of the problem of sustainability of an environmental treaty therefore also requires an understanding of the relationship between intertemporal trade and international environmental cooperation. This relationship is rich.

Income generated from the international redistribution of the gains from environmental cooperation alleviates the net debt burden of LDCs (Bertram, Stephens and Wallace, 1989). In turn environmental tax payments or permit imports of industrialised countries reduce their balance of payments surplus with respect to LDCs.

Beyond that country sovereignty itself adds a potentially important and particularly interesting aspect. Country sovereignty not only poses a problem to an environmental treaty, it can also be exerted with respect to foreign debt. The paradigm of country sovereignty has been extensively applied to international debt itself (e.g. Aizenman, 1989; Bulow and Rogoff, 1989; Cohen and Sachs, 1986; Eaton and Gersovitz, 1981; Grossman and Van Huyck, 1988; and Kletzer, 1984). However, the joint existence of sovereignty with respect to debt and other international contracts has drawn little attention.

Considering the sovereign debt link jointly with the sustainability problem of an environmental treaty implies that countries simultaneously face two strategic links. And the nature of international relations depends on the nature of the interrelationship between these links.

If the debt game and the environmental game are strategically independent, then a country can violate an environmental treaty while maintaining good debtor-creditor relations and vice versa. Nevertheless

international debt influences the sustainability of an environmental treaty by affecting the conditions under which the environmental game is played.

However, strategic independence need not necessarily hold. If the sovereignty decision with respect to either game affects the sovereignty options available with respect to the other game, the games are interconnected (Folmer et al., 1991). For example, if a country cannot repudiate debt without at the same time also violating the environmental treaty and vice versa we have in fact a single international game. In this case the fate of the environmental treaty hinges on the overall incentive of a country to maintain "good" international relations. A disincentive to stay within the environmental treaty may then be outweighed by the incentive to maintain good creditor-borrower relations.

The paper addresses these issues. To keep the analysis simple a stylised world with only two countries is considered. However, the sovereignty problem of only one of them is investigated. By convention it is presumed that this is the debtor country. Also by convention, let the debtor country be the foreign country. Furthermore it is presumed that the environmental objective of the treaty is implemented with a tradeable permit scheme.² Side-payments to a country are made indirectly by way of an exogenously given and hence potentially insufficient initial allocation of permits. In particular it is presumed that the country whose sovereignty poses a threat to the sustainability of the treaty receives more permits than it needs to cover domestic emissions. Hence the analysis is concerned with the risks to the sustainability of an international tradeable permit scheme arising from the sovereignty of an internationally indebted net exporter of permits.

II. The Model

The analytical framework is a two country world with overlapping generations of the Samuelson (1958) - Diamond (1965) type. International intertemporal trade is caused by differences in preferences (Buiter, 1981) or technology (Schmid, 1987). Two generations live in each period, the young and the old. Generation t , consisting of L households, enters the economy at the beginning of period t and disappears from the economy at the end of period $t+1$.³ Each young member of generation t works in period t , receives a wage w , which is used for youth consumption, c_t^j , lending, $-b$, and investment into the malleable capital stock of period $t+1$, k_1 . In period $t+1$ when old, a member of generation t retires from work and finances old age consumption, c_t^o , from interest earnings out of the provision of real capital and loans, and from dissaving. Technology is given by a Cobb-Douglas production function in which capital and labour is employed to produce a single consumption-cum-capital good, implying per capita output $f(k)$ as a function of the per capita real capital stock, k . We take it that international debt is bond-financed.

Let $L=L^*$.⁴ To represent growth, let n denote the one period proportional rate of growth of successive generations in both countries. Hence $L_1=(1+n) \cdot L$.

Environmental damage is represented by emission functions

$$(1) \quad \begin{aligned} e &= h \cdot k \\ e^* &= h^* \cdot k^* \end{aligned}$$

where h and h^* are constant, $h > h^*$, $h, h^* > 0$. That is, per capita emissions in period t , e_t , are proportional to per capita capital employed in period t in the production process.⁵

Suppose the two countries agree to impose an international tradeable permit scheme in order to reduce emissions. Suppose permits are valid only in one period and each permit entitles the owner to one unit of emissions. It will be presumed that capital owners are made responsible for emissions in that period in which capital is employed in production. Required permits must be purchased when investment into real capital is undertaken. Under these assumptions a young household in the home country must purchase $h \cdot (1+n) \cdot k_1$ permits when investing $(1+n) \cdot k_1$ at the end of period t , to cover $h \cdot k_1$ emissions per member of generation $t+1$ in period $t+1$.

The specification of the emission technology (equations 1) and the requirement to purchase permits in the period before they are needed for covering emissions catches in a simple way two important factors which can potentially endanger the sustainability of any environmental treaty: (i) Development (in the model investment in the future capital stock) conflicts with environmental protection, thereby increasing the costs of international cooperation. (ii) Abiding by the stipulations of the treaty in the course of development requires front end investment in environmental protection (i.e. holding permits in advance), thereby unfavourably affecting the returns on development.

Suppose the tradeable permit scheme restricts average emissions of the world community to \bar{e} . In the two country world of size $2 \cdot L$ this imposes the global emission restriction

$$(2) \quad 2 \bar{e} \geq h \cdot k + h^* \cdot k^*$$

To sustain the emission target in each period $(1+n) \cdot 2 \cdot \bar{e}$ new permits must be supplied to the world economy in each period. Suppose this is achieved by providing each young household in the home country with an "equitable" endowment $(1-\lambda) \cdot (1+n) \cdot \bar{e}$ and each household abroad with an endowment $(1+\lambda) \cdot (1+n) \cdot \bar{e}$, where $-1 \leq \lambda \leq 1$. The parameter λ may be interpreted as the equitability spread from an egalitarian distribution of permits. Given the price p paid in period t for permits valid to cover emissions in period $t+1$, the permit endowment raises youth income above the wage rate w and w^* to $w + (1-\lambda) \cdot (1+n) \cdot \bar{e} \cdot p$ and $w^* + (1+\lambda) \cdot (1+n) \cdot \bar{e} \cdot p$.

Given this tradeable permit scheme, consumption when young and consumption when old in the two countries is given by

$$(3) \quad \begin{aligned} c^j &= w + (1-\lambda) \cdot (1+n) \cdot \bar{e} \cdot p + b - (1+n) \cdot k_1 - h \cdot (1+n) \cdot k_1 \cdot p \\ c^{j*} &= w^* + (1+\lambda) \cdot (1+n) \cdot \bar{e} \cdot p + b^* - (1+n) \cdot k_1^* - h^* \cdot (1+n) \cdot k_1^* \cdot p \end{aligned}$$

and

$$(4) \quad \begin{aligned} c^o &= (1+n) \cdot (1+r_1) \cdot k_1 - (1+r_1^i) \cdot b \\ c^{o*} &= (1+n) \cdot (1+r_1^*) \cdot k_1^* - (1+r_1^{i*}) \cdot b^* \end{aligned}$$

The first three terms on the RHS of equations (3) represent the sources of disposable funds when young: wage income, permit endowment and borrowing (if $b, b^* > 0$). The last three terms on the RHS of (3) represent the use of disposable income besides consumption: lending (if $b, b^* < 0$), investment and the purchase of permits to cover emissions in period $t+1$.

Old age consumption in the two countries is augmented by investment into the domestic capital stock with marginal physical return r_1 , $r_1=f'(k_1)$, at home and r_1^* , $r_1^*=f^{*'}(k_1^*)$, abroad. It is further increased by lending (if $b, b^*<0$) or decreased by borrowing (if $b, b^*>0$). The international component in households' portfolios, debt or loans, bears an interest rate r_1^i at home and r_1^{i*} abroad. Household preferences in each country are given by well-behaved utility functions $U(c^j, c^o)$ and $U^*(c^{j*}, c^{o*})$. Throughout we will presume that the environment is a public good to be provided by an environmental treaty.

As the tradeable permit scheme fixes allowable emissions, if the scheme is a binding constraint under the treaty, then environmental quality is constant for as long as the treaty sustains. However, if the country in question pulls out, world emissions are larger, possibly reducing utility of foreign households. These costs of quitting cooperation could be represented by letting environmental quality be an argument of household utility.⁶ An alternative approach, followed here, is to count these costs directly against the benefits from violating the treaty.

It will be presumed that all decisions are made under conditions of perfect competition.

III. The Sovereignty Restrictions

Under sovereignty, instead of a country's ability it is its willingness to honour a contract which is critical for its fate. Having two (sets of) contracts which can be imperilled by the execution of sovereignty, several restrictions may have to be imposed on the economy. The number of restrictions, however, depends on the nature of the relationship between these (sets of) contracts. Until we revise this assumption in Section VI it will be presumed that debt contracts and the environmental contract are strategically independent. That is, it will be presumed that debt contracts can be violated while the environmental agreement is honoured and vice versa. Under strategic independence there exist two restrictions arising from sovereignty, one for the set of debt contracts and one for the permit scheme.

These restrictions will depend on the relative strength of incentives to break or honour a contract. In general these incentives can be both public and private. For simplicity, however, in what follows only private incentives will be considered.⁷

Determining a foreign household's costs from a continued participation in the environmental treaty, the treaty's impact on returns on investment must be determined. Without the treaty an investment of 1 unit of the good in period t bears a return of $1+r_1^*$ in period $t+1$. That investment causes, however, h^* additional emissions. Hence, under the treaty a foreign household is required to forsake $p \cdot h^*$ additional units of consumption in order to invest one unit. Hence under the treaty the effective return on investment is $(1+r_1^*)/(1+h^* \cdot p)$. Therefore foreign households need to accept under the treaty a discount on the rate of return.

To determine the sovereignty restriction for the permit scheme consider the following intertemporal arbitrage options a foreign household possesses in case the foreign country honours the contract and in case the contract is violated. If the contract is honoured in period t , then generation t has to bear costs $(1+n) \cdot h^* \cdot k_1^* \cdot p$ in period t . Alternatively, if the contract is breached in period t this amount could be invested, without having to acquire permits. This would yield $[(1+n) \cdot h^* \cdot k_1^* \cdot p] \cdot (1+r_1^*)$. This breach of contract would be associated with a loss of $(1+\lambda) \cdot (1+n) \cdot \bar{e} \cdot p$ in permit income. This, if invested under the rules of the permit scheme, would yield $[(1+\lambda) \cdot (1+n) \cdot \bar{e} \cdot p] \cdot (1+r_1^*) / (1+h^* \cdot p)$. Hence under consideration of this investment arbitrage the net discounted (period t) value of not breaching the contract in period t is given by

$$[(1+\lambda) \cdot (1+n) \cdot \bar{e} \cdot p] \cdot \frac{1}{1+h^* \cdot p} - (1+n) \cdot h^* \cdot k_1^* \cdot p$$

The value of honouring the treaty is further increased if a violation is associated with additional costs. These can arise from economic sanctions and environmental degradation caused by a pullout of the treaty. For simplicity let these costs be specific to a violation of the environmental treaty and let them be proportional to economic output.⁸ If δ_1 , $\delta_1 \geq 0$, is the proportionality factor linking economic activity with costs from both sanctions and environmental degradation, then the treaty will be honoured in period t if

$$(5) \quad [(1+\lambda) \cdot (1+n) \cdot \bar{e} \cdot p] / (1+h^* \cdot p) - (1+n) \cdot h^* \cdot k_1^* \cdot p + \delta_1 \cdot f^*(k^*) \geq 0$$

Restriction (5) gives the condition under which it is optimal for the foreign country not to violate the treaty in period t . In the following we will be concerned with steady states in which $k=k_1$ for all t . In a steady state condition (5) ensures that the treaty is honoured forever. This is because in a steady state a necessary and sufficient condition that a contract is honoured forever is that it is not violated today. Hence under steady-state conditions restriction (5) must be fulfilled in order for the environmental treaty to be sustainable.

The sovereignty restriction (5) suggests that a treaty violation is in general not prevented by turning a country into a net exporter of permits, i.e. by having $(1+\lambda) \cdot \bar{e} \cdot h^* \cdot k^* > 0$. This is due to the non-neutrality of the treaty with respect to returns on investment in environmentally harmful capital.

Let us now turn to the sovereignty restriction for the world debt market. It will be presumed that a violation of debt contracts is associated with an immediate cutoff from new loans. These costs of a debt contract violation may be further enlarged by economic sanctions. Suppose again that sanctions are specific to a debt contract violation, and suppose they are proportional to output, with proportionality factor δ_2 , $\delta_2 > 0$.

Debt service obligations with respect to past borrowing are given in period t by $b_{-1}^* \cdot (1+r^*)$. Honouring debt, however, preserves access to the world credit market in period t . As compared to period $t-1$ there are

$(1+n)$ times as many households in period t , the foreign country receives $(1+n) \cdot b^*$ per member of generation $t-1$ if debt is honoured in period t . Economic sanctions increase the incentive to honour debt by $(1+n) \cdot \delta_2 \cdot f^*(k^*)$ per member of generation $t-1$. It is optimal for the foreign country to honour debt in period t if

$$(6) \quad b_{-1}^* \cdot (1+r^{i^*}) \leq b^* \cdot (1+n) + (1+n) \cdot \delta_2 \cdot f^*(k^*)$$

from which

$$(7) \quad \frac{b^*}{1+n} \cdot (r^{i^*} - n) \leq \delta_2 \cdot f^*(k^*)$$

follows in the steady state in which $b_{-1}^* = b^*$.

The LHS of condition (7) is the steady-state net debt obligation of the foreign country per period. If it is positive, debt repudiation can only be prevented if the net debt obligation is exceeded by the costs of economic sanctions. Again, if the condition for honouring debt in period t is fulfilled in the steady state, then debt is never repudiated.

We are now ready to investigate the impact of international debt on the sustainability of the treaty.

IV. From Financial Autarky to Non-Sovereign Borrowing

Suppose in an initial situation the environmental treaty is in operation but intertemporal trade cannot take place. Suppose it is a steady state. Under the treaty returns on investment in the two countries are given by $(1+r)/(1+h \cdot p)$ and $(1+r^*)/(1+h^* \cdot p)$. As intertemporal trade does not take place returns on investment will in general differ across countries.

Let

$$(8) \quad \frac{1+r}{1+h \cdot p} < \frac{1+r^*}{1+h^* \cdot p}$$

Suppose the distribution of world capital and of permits is such that

$$(9) \quad e > (1-\lambda) \cdot \bar{e}$$

That is, emissions in the home country are too large to be covered by the home country's initial permit allocation. Hence permits must be imported from abroad. The foreign country earns therefore an income from permit exports. Finally suppose these exports are large enough to ensure that restriction (5) is fulfilled. In other words, suppose the environmental treaty is sustainable under financial autarky. In the remainder of this section we shall compare the autarky steady state with a steady state in which intertemporal trade takes place.

Continue to suppose that the treaty is subject to country sovereignty. But assume, as an intermediate step, that a country cannot exert sovereignty with respect to debt.

Under non-sovereign borrowing and lending debtors service debt to the limit of their ability. The ability to service debt imposes a limit on how much can be borrowed. Let this solvency restriction be \bar{b} , $\bar{b} > 0$.

Now open non-sovereign intertemporal trade. Because of (8) it is beneficial for domestic households to hold claims against the foreign economy and for foreign households to hold liabilities against the domestic economy in their portfolios. Hence, because of (8) the foreign country raises debt in the home country.

Consumption smoothing then requires from foreign households to invest at least some of the debt raised to finance additional old age consumption. Likewise, domestic households smooth consumption by divesting some of their domestic real capital holdings. The capital stock increases abroad and decreases at home.

Because of equation (4) a foreign household can service debt whenever $c^0 > 0$. For well behaved preferences over youth and old age consumption it is optimal for households to have positive old age consumption. Hence $b^* < \bar{b}$. That is, the solvency restriction is non-binding. Foreign households are unconstrained on international loan markets.

As loan markets are unconstrained by the solvency restriction, capital will be shifted from the home country into the foreign country until returns on capital are the same at home and abroad. Therefore in the unconstrained debt steady state

$$(10) \quad \frac{1+r}{1+h \cdot p} = \frac{1+r^*}{1+h^* \cdot p}$$

with $b^* < \bar{b}$.

Consider now the impact of non-sovereign borrowing and lending on the sustainability of the treaty. Compared to the autarky situation (8) intertemporal trade has decreased the capital stock at home and increased the capital stock abroad. In turn domestic economic activity and hence emissions have decreased and foreign economic activity and emissions have increased. Compared to financial autarky the foreign country must now hold more and the home country needs to hold only fewer permits. Hence the foreign country can export fewer permits.

This decline in the quantity of permits exported is *ceteris paribus* detrimental to the overall incentive of the foreign country to honour the treaty. Hence as a consequence of opening intertemporal trade the sovereignty restriction (5) may be violated. In conclusion, unconstrained borrowing and lending can imperil the sustainability of an environmental treaty.

However, this need not necessarily be the case. Other factors, for example the elasticity of the permit price, have an impact on the sustainability of the treaty too. This ambiguity need not surprise. As is the case with any other restriction imposed on an economy, sovereignty restrictions are either binding or not.

It is, however, worth bearing in mind for future reference that under the assumptions made so far there is no systematic link between the private sector's decision making problem and the sustainability of the

treaty. There are no private incentives to sustain the treaty. The provision of sustainability remains a public good.

V. From Non-Sovereign to Sovereign Borrowing

So far we have disregarded the sovereignty problem on debt markets. If the foreign country is sovereign with respect to debt also, lenders will set a credit limit such that restriction (6) will never be violated. Let this credit limit be \bar{b} .

If \bar{b} is a non-binding constraint on the foreign economy, foreign households can raise debt, and capital is shifted from the home country abroad, until the rates of return on investment are the same in both countries. Hence if country sovereignty is a non-binding constraint on debt markets, the steady state is characterised by (10), with $b^* < \bar{b}$. Sovereignty over debt obligations affects the world economy only if the incentive of lenders to protect their loans cuts off borrowers from desired additional loans.

In case sovereignty is a binding constraint on debt markets borrowers are constrained by \bar{b} before the difference in rates of returns on investment disappears. Hence in a steady state constrained by debtor sovereignty

$$(11) \quad \frac{1+r}{1+h \cdot p} < \frac{1+r^*}{1+h^* \cdot p}$$

with $b^* = \bar{b}$.

In order to investigate the impact of debtor sovereignty on the sustainability of the treaty suppose, for sake of argument, that in the non-sovereign debt steady state the treaty is not sustainable.

Compared to the non-sovereign debt steady state (10), less capital has been shifted from the home country abroad in the steady state (11). The capital stock in the lender economy is larger and in the debtor economy it is smaller than under unrestricted borrowing and lending. Consequently the debtor country can export more permits. *Ceteris paribus* the incentive of the debtor country to honour the treaty has increased. Hence a treaty which is not sustainable under non-sovereign borrowing may be sustainable if country sovereignty effectively constrains international borrowing and lending.

The mechanism which is responsible for this potentially stabilising effect warrants close attention. If economic activity (development) is detrimental to the environment, and if a treaty sets market incentives such that environmental degradation is punished, then development is detrimental to the incentive of a country to honour the treaty. Access to international capital spurs development and consequently is detrimental to overcoming the sovereignty problem of the treaty. However, the same sovereignty problem restrains access to international capital and therefore indirectly contributes to its alleviation in the sphere of environmental cooperation.

Interestingly, if the sovereignty problem encompasses both public (environmental) and private (financial) international relations the public good "sustainability of the treaty" may (partially) be provided by the private sector. Alas, the private provision is sufficient for sustainability only by chance. This motivates a search for possible institutional arrangements which could make the private provision of this public good systematically sufficient.

VI. Cross-Default Clauses and the Sustainability of Treaties

The analysis in the previous sections shows that the sustainability of an environmental treaty is affected by international borrowing and lending. In particular, lenders exert a potentially stabilising effect on the treaty in the wake of actions meant to manage their own exposure to country sovereignty. This private contribution to the provision of a public good can be systematically exploited.

This can be achieved by strategically linking the debt with the treaty game. This linkup can be made by a suitable contract between the parties which each and individually face a sovereignty problem with respect to a common third party. This contract is designed such that the third party has only the options of violating all obligations against all members to the contract or honouring all. This contract is therefore a cross-default clause. As a consequence of such a cross-default clause the sovereign is deprived of all options of discriminating between individual obligations.

In the present model such a cross-default clause would be an agreement between the government of the home country, which supports the treaty for environmental reasons (the net importer of permits), and the group of lenders. Under the cross-default clause a sovereign's debt service payment $(1+r^{i*}) \cdot b^*$ and the payment made to purchase the necessary quantity of permits $(1+n) \cdot h^* \cdot k^* \cdot p$ are pooled. The pool is jointly held by the parties to the cross-default clause. If total payments made are short of $(1+r^{i*}) \cdot b^* + (1+n) \cdot h^* \cdot k^* \cdot p$, lenders and the home government share arrears. Hence under the cross-default clause the sovereign is forced to either honour both the treaty and debt or default on both.

Under a cross default clause there is a single sovereignty restriction in the model. It is given in the steady state by⁹

$$(12) \quad \frac{(1+\lambda) \cdot (1+n) \cdot \bar{e} \cdot p}{1+h^* \cdot p} + b^* \cdot (1+n) + [\delta_1 + \delta_2 \cdot (1+n)] \cdot f^*(k^*)$$

$$\geq (1+n) \cdot h^* \cdot k^* \cdot p + b^* \cdot (1+r^{i^*})$$

The cross-default sovereignty restriction (12) allows for a substitution between insufficient incentives to honour the treaty and more than sufficient incentives to honour debt and vice versa.

In the model, under the cross-default clause the treaty is always sustainable. This is achieved because lenders protecting the value of their loans set a credit limit \bar{b} such that restriction (12) is never violated. The public good "sustainability of the treaty" is provided on an entirely private basis.

Who benefits from a cross-default clause? To answer this question we must distinguish between certainty and risk, and in case of risk between ex ante and ex post.

Under the model assumptions (certainty) the party interested in the treaty's sustainability (the home country government) benefits from a cross-default clause in situations in which the treaty would be violated otherwise. Under the model assumptions lenders are competitive and therefore obtain a return on loans equal to the return on other assets. Lenders are therefore indifferent as to the portfolio composition. As from the point of view of a competitive lender a cross-default clause affects only the amount which can be lent, he or she must be indifferent concerning the introduction of the clause. Neither party to the clause will therefore veto it.

Matters are, however, more complicated if we depart from the model assumption and allow for risk associated with debt and the treaty. In this

case we have to distinguish between ex post and ex ante too, where ex post refers to the (point in) time when loans have been already made, the treaty has been already signed but the state of world to is not yet known.

Ex post the purpose of the clause is not to prevent default in all states of the world. Rather, with stakes outstanding, the purpose is to reduce the risk affecting the parties to the clause. Ex post lenders will benefit from it if the risk of default on debt outstanding is smaller under the clause than without it. Similarly the party interested in the sustainability of the treaty will benefit from the clause if it reduces the treaty's risk. Apparently, in order for the clause to be ex post beneficial for both parties the risk of debt and the treaty's risk cannot be "too" different. Otherwise either party would object against taking on board the bad risk brought into the clause by the other party. If the risk properties are similar a clause can be introduced.

A cross-default clause can be beneficial beyond reducing the sovereignty risk. It substantially improves the otherwise at best modest incentives to implement debt-for-nature swaps.¹⁰ Under strategic independence of debt and the environmental treaty lenders themselves do not benefit from a swap beyond what they would gain from pure debt relief. However, under a cross-default clause, debt and the treaty are strategically dependent such that the risk of debt is reduced if the risk of the treaty is. Hence lenders benefit from a suitable swap more than from debt relief. Under a clause lenders want to become active participants in swaps. Thereby they take away the sole burden from non-profit environmental organisations and governments in financing them.

Does the sovereign benefit from a cross-default clause? There are two opposing effects affecting the ex post utility of the sovereign. By the introduction of a clause the sovereign loses some options it would take in some states of the world. This reduces the sovereign's utility. Contrary to this effect works, however, the lenders' newly gained incentive to trade debt reduction against environmental protection. Hence the ex post effect of the clause on the sovereign's utility is ambiguous.

Does the anticipation of a clause diminish the sovereign's incentive to join a treaty in the first place? This ex ante incentive does not only depend on the ex post effects of an (anticipated) cross-default clause. It also depends on ex ante effects too. For example, a clause reduces the risk of future debt. The risk premium to be charged by lenders when making the loan will therefore be smaller. The cost of borrowing therefore declines in anticipation of a clause. In sum, these effects can either negatively or positively affect the sovereign's utility.

An anticipated utility reduction needs, however, not diminish the chances of getting the country on board of a treaty. Although ex post it cannot block the clause as it is not a party to it, ex ante it is a potential party to the treaty. Hence it can join the treaty on the condition that the clause shall not be introduced. Furthermore, in anticipation of a future clause it continues to have available the outside option of not joining the treaty. Hence in principle, a sovereign cannot be forced to accept an expected utility below the utility it would enjoy without the treaty. Furthermore, it can arrange for utility to be no less than the utility it would receive under the treaty if the clause were not available. Consequently a country will join a treaty whenever it would do so without the availability of the clause.

This result hinges, however, on strong information assumptions, a hypothesis which is unlikely to hold in reality. Further research in the properties of the cross-default clause policy instrument is therefore needed.

VII. A Trade-off between Sustainability and Efficiency

The original motivation for and ultimate purpose of environmental treaties is, at the minimum, economic efficiency of environmental policy. Unfortunately, the efficiency properties of market instruments when applied in a domestic setting do not always survive in an international setting.

Consider for example the present model. Efficiency requires that the marginal permit be channelled into coverage of those emissions which emanate from investments with the highest return. Notice that under non-sovereign or sovereign but unconstrained borrowing rates of returns on investment are identical in both countries (see equality (10)). Hence under unrestricted intertemporal trade the treaty brings about efficiency in international environmental policy.

Now consider the sovereignty-constrained steady-state (11). As rates of return on domestic investment are exceeded by rates of return on foreign investment efficiency would require from permit markets to channel more permits into the more productive foreign economy. However, this does not happen. This is because the foreign economy neither creates additional capital-cum-emissions (to be covered by additional permits) out of additional savings nor can it raise additional capital abroad. Hence under sovereignty-restricted borrowing and lending the treaty is inefficient.

This result is an example of a second-best problem. If another market is imperfect (the debt market) it need not be optimal selecting a first best policy instrument for the environmental problem. This is not surprising. It is nevertheless troublesome for environmental policy making that the very institutional arrangement designed to resolve an international efficiency problem can fail exactly because the situation is international.

Interestingly there can be a trade-off between the sustainability and the efficiency objective. The free intertemporal trade steady state (10) is efficient but the treaty may not be sustainable. The sovereignty-restricted debt steady state (11) is inefficient but the treaty may be sustainable even if it is not sustainable under unconstrained borrowing. This trade-off, which is exogenous to policy making under strategic independence, causes a serious policy problem if sustainability is to be systematically brought about by a cross-default clause. Following this avenue to sustainability the loss of efficiency is the costs of ensuring the survival of the treaty.

This trade-off reduces the attractiveness of the cross-default approach. However, it is not due to it. Rather, the underlying mechanism will remain valid if, instead, other stabilisation instruments, e.g. side payments, are applied. If emissions are tied to physical capital and the allocation of the latter is restricted such as is the case in a sovereignty constrained world capital market, then international environmental policy is inefficient.

Nor is this inefficiency due to the tradeable permit instrument. If the treaty is instead implemented by way of an international environmental tax system (with tax rate p) it remains inefficient if borrowers are sovereignty constrained.

Nor is it unique to the specific form of financing. For example, if debt financing is substituted by foreign direct investment the sovereignty problem survives in the form of an expropriation risk to direct investment. Although investors apply also other techniques in protecting the value of their investment, an important technique is capital rationing for a reasoning similar to that applied by lenders. Hence capital mobility remains restricted. A treaty under which market instruments of environmental policy are applied cannot therefore bring about an efficient allocation of pollution.¹¹

The potential inefficiency of an environmental treaty in face of country sovereignty will not hold anymore if emissions are independent from capital formation. However, for some pressing environmental problems this inefficiency problem must be faced.

A point in case is an international CO₂ policy. CO₂ emissions are roughly proportional to energy input, which, given energy efficiency, rises with the level of economic activity. The latter in turn increases with the capital stock of an economy. Given an optimal fuel mix, putting a lid on CO₂ emissions therefore puts restrictions on capital formation and development. Therefore, the arguments put forth in the analysis of the model can be applied to CO₂.

The CO₂ efficiency problem hence is not only to get LDCs up to energy efficiency standards. Nor is it only to make permits move out of LDCs and into the industrialised world. The efficiency of CO₂ policies also requires capital to move out of the industrialised world and into debtor countries which face capital shortages, in order to take advantage of high rates of return there. Hence in a world with imperfect international capital markets, resolving the debt stalemate and making debt markets more efficient also contributes to a more efficient allocation of greenhouse gas emissions.

VIII. Summary

In this paper we investigate the impact of international debt on the sustainability of an environmental treaty. In this context sustainability refers to the continued participation of a country in a treaty, despite the fact, that due to being sovereign a country can pull out of a treaty at any time. Side payments, by assumption, cannot be applied to ensure sustainability. Furthermore it is assumed that sovereignty not only affects the sustainability of a treaty but also intertemporal trade.

It is shown that free intertemporal trade can be detrimental to the sustainability of a treaty. Counter to this effect works, however, an effect emanating from the desire of lenders to protect the value of their loans against debt repudiation. As a consequence a treaty may be sustainable which, without this protective behaviour on the supply side of international debt, were not. This private contribution to the provision of the public good "sustainability" is, however, sufficient only by chance if international debt and the environmental treaty are strategically independent.

By the introduction of a cross-default clause international debt and an environmental treaty can be strategically linked. Such a clause is a contract between the party which has a vested interest in the sustainability of the treaty and the party of international lenders. Under the clause the sovereign has only the option of honouring both debt and the treaty or defaulting on both. Under such a cross-default clause and under certainty lenders will impose a credit limit such that the treaty is always sustainable. There is no need for further public action. It is, however, argued that under risk the applicability of cross-default clauses is restricted.

It is also shown that the efficiency property of market instruments of environmental policy need not necessarily survive if they are applied internationally. In particular, it is shown that it is lost if country sovereignty also poses a problem on international debt markets in conjunction with emissions rising with economic activity. This adds, for example, to the plethora of difficulties in designing an efficient international CO₂ policy for which it is indispensable to bring heavily indebted LDCs into a climate treaty.

Notes:

- 1 Global warming is, again, a particularly revealing point in case (see e.g. Grubb, 1989).
- 2 See e.g. Bohm, 1991; Grubb and Sebenius, 1991; Heister et al., 1991; Pearce, 1990; and Whalley and Wigle, 1990.
- 3 To simplify notation, variables without a time index refer to period t . Hence, L , for example relates to the size of generation t and L_1 to the size of generation $t+1$.
- 4 By convention, let all unasterisked parameters and variables relate to the home country and all asterisked variables to the foreign country.
- 5 Equations (1) may be interpreted as a crude approximation to the current CO_2 emission technology.
- 6 See Mohr, 1991a.
- 7 For an analysis of public incentives to break a permit scheme under conditions of financial autarky see Mohr (1991b).
- 8 Expressing environmental costs in terms of goods is reasonable if environmental damage can be monetised. Furthermore, the proportionality hypothesis is reasonable if environmental costs have to be

borne mainly in production. See e.g. Nordhaus (1991) for an attempt to calculate the costs of forsaking greenhouse gas abatement in terms of percentage losses of US output.

- 9 It is supposed that all costs of contract violations which are proportional to economic activity are additive. For an alternative hypothesis see Mohr (1991a).
- 10 Incentive deficits in implementing debt-for-nature swaps have been widely acknowledged in the literature (e.g. Occhiolini, 1990).
- 11 Under country sovereignty, financing (bond-, bank credit financing or direct investment) is, however, not neutral. It affects the international allocation of capital (see Mohr 1991c). Under strategic independence the sustainability of a treaty is therefore affected by the kind of financing of foreign capital.

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