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Pooling sovereignty risks: The case of environmental treaties and international debt

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POOLING SOVEREIGNTY RISKS : THE CASE OF ENVIRONMENTAL TREATIES
AND INTERNATIONAL DEBT

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ABSTRACT

A model is analysed in which a sovereign country has independent obligations to repay a creditor bank and to keep an environmental treaty. It is shown that the linkage of both obligations through a cross-default contract may reduce the sovereign risk attached to both the debt and the environmental contracts. Moreover, such a linkage will create an incentive for the sovereign and the bank to engage in a debt-for-nature-swap, the anticipation of which increases the initial incentive for a cross-default contract to be entered into.

1. INTRODUCTION

The paradigm of country sovereignty, saying that nations are essentially above the law and need therefore not honour international contracts they are a party to, has had a substantial impact within economic theory. Notably the theories of international borrowing and lending (e.g. Eaton and Gersovitz, 1981; Kletzer, 1984; Bulow and Rogoff, 1989; Aizenman, 1989), and of international direct investment (e.g. Thomas and Worrall, 1989) have been thoroughly transformed under it. More recently the related issue of the voluntary nature of the participation of countries in international environmental cooperation has attracted substantial interest (e.g. Black et al., 1990; Mäler, 1990, Pethig, 1992; Chander and Tulkens, 1992).

A common feature of almost all theoretical studies on the sovereignty issue is that the analysis is artificially constrained because one particular dimension of sovereignty is singled out and analysed in isolation. This approach neglects the fact that countries are usually linked in more than a single way such that sovereignty, if a problem at all, is simultaneously a burden to several or all international relations a country maintains. (For an exception see Cole and Kehoe (1991), who study study reputational linkages between debt contracts.)

In this paper we depart from this tradition. We consider a situation in which two international relations are simultaneously burdened by country sovereignty. The two dimensions we jointly tackle are the dimension of international debt and the dimension of international environmental cooperation.

Recently Folmer et al (1991) have analysed the simultaneous play of an environmental and a non-environmental game. They argue that the introduction of a second game can substantially alter a sovereign's decision problem concerning the first if the two games are interconnected.

Mohr (1991) analyses a situation in which an international environmental treaty and international intertemporal trade are simultaneously subject to country sovereignty. It is shown that debtor sovereignty tends to alleviate the sovereignty problem that the environmental treaty is burdened with. Furthermore, if debt and the environmental treaty are strategically linked such that the sovereign cannot discriminate between her international obligations, then the environmental treaty may even be completely freed from sovereignty problems. Responsible for this stabilising effect of the debt market on the treaty are actions undertaken by forward-looking lenders geared towards the protection of the future value of their loans.

This protect-thy-loan mechanism has important implications for the design of international environmental cooperation. If policymakers achieve such a strategic linkage between an environmental treaty and international debt then the public good provided under the treaty is indirectly supplied by the private sector.

However, the analysis in Mohr (1991) neglects two important aspects. First, it concentrates on the process of intertemporal trade and thus neglects existing old debt. This is worrying as the protect-thy-loan mechanism cannot accommodate sovereigns locked in a debt-stalemate. Secondly, it abstracts from risk. Under risk competitive

loan markets accept the possibility of debt repudiation if compensated by a sufficiently large risk premium. Under conditions of risk there is therefore no hope that an environmental treaty's sovereignty problem can be completely resolved by a suitable linkage to international debt markets.

In this paper we analyse a situation in which a country is a party to an existing debt contract as well as to an environmental treaty, both of which are subject to sovereignty risks. We show that even without new lending and under conditions of risk a strategic linkage of the two international contracts can alleviate the sovereignty problems to be faced by both the environmental agency and the lender.

The linkage we propose is attainable through a cross-default contract. Cross-default contracts are frequently used between several lenders to protect their individual loans against country sovereignty (e.g. Newburg, 1991). In the present case it is, however, a cross-default contract between the environmental agency and the lender such that the sovereign cannot discriminate between the debt contract and the treaty when it comes to meeting her obligations.

The cross-default contract pools the individual sovereignty risks. We give conditions under which such a pooling reduces the sovereignty risks to be faced by both the agency and the lender. The pooling of sovereignty risks has an important implication. It creates an incentive for both the sovereign and the lender to engage in a debt-for-nature swap. Risk pooling therefore helps to overcome the claimed and observed disincentive of lenders to donate debt they hold for a debt-for-nature swap (Nunnemkamp, 1992).

In effect the treaty, the pooling of sovereignty risks and the induced debt-for-nature swap weave the three contractants together in a triple of successive bilateral contracts. We analyse this nexus and propose a set of contractual stipulations such that both parties exposed to sovereignty risks benefit from it and such that the sovereign maintains her ex ante incentive to join the treaty in the first place.

2. THE MODEL

We consider a two period consumption problem of a sovereign under risk. The sovereign raises debt b in the first period to finance consumption. Debt matures in period 2 entitling the lender to a total repayment $X(b)$. Let $\partial X/\partial b > 0$. Debt repayment is to be made by the sovereign out of exogenously given period 2 resources R .

Suppose the sovereign is a party to an environmental treaty with an environmental agency. Further suppose that she, in order to honour the treaty, must forsake $Y(v)$ units of R , in period 2, where v is the amount of environmental protection engaged in during period 1, measured in terms of its cost. More protection in period 1 will lead to lower costs in period 2: $\partial Y/\partial v < 0$.^{1/}

By definition the sovereign need not honour contracts. We consider initially an institutional setting in which the two contracts are strategically independent. By strategic independence we mean a setting in which the sovereign can discriminate between contracts such that she can violate either contract and honour the other without thereby in any way affecting her obligations under that contract which she decides to honour.

We take it, however, that any contract violation is associated with exogenous but random costs to the sovereign. Let the costs of violating either contract be proportional to period 2 resources, R . Let the proportionality factor for a debt contract violation be δ and let λ be the proportionality factor for a violation of the treaty. For simplicity it is assumed that the imposition of sanctions consequent upon contract violation does not benefit the creditor or the agency, although the sanctions are assumed to be credible. (If renegotiation after contract violation is allowed for, then we interpret δR and λR to be the ultimate costs to the sovereign after the renegotiation process.)

We take it that δ and λ are continuous random variables jointly distributed according to the density function $\phi(\delta, \lambda)$ where $\delta \in [\underline{\delta}, \bar{\delta}]$, $\lambda \in [\underline{\lambda}, \bar{\lambda}]$ and $\bar{\delta} + \bar{\lambda} \leq 1$.^{2/} The state of the world (δ, λ) is revealed at the beginning of period 2.

The sovereign's two-period consumption problem is:

$$(1) \quad \max_{b, v} EU\{c_1(b, v), c_2\},$$

where c_1 is first period consumption and we suppose $\partial c_1 / \partial b > 0$, $\partial c_1 / \partial v < 0$, and period 2 consumption c_2 is given by

$$(2) \quad c_2 = R - \min[X(b) + Y(v), \delta R + Y(v), X(b) + \lambda R, (\delta + \lambda)R].$$

Equation (2) represents the independence assumption that the violation

of one contract does not affect the other contract.

Let (b^*, v^*) be the solution to (1). Furthermore normalise the debt and environmental obligations so that $x \equiv X(b^*)/R$ and $y \equiv Y(v^*)/R$. Then the sovereign will honour the debt contract in period 2 if

$$(3) \quad \delta \geq x ,$$

and she will honour the treaty in period 2 if

$$(4) \quad \lambda \geq y .$$

Due to strategic independence each of the two contractual partners of the sovereign faces the sovereignty risk independently. With stakes outstanding the environmental agency and the lender each have an incentive to reduce these individual risks. In the next section we will investigate the potential for a pareto-superior risk reduction through the pooling of the two sovereign risks.

3. CROSS-DEFAULT CONTRACTS AND THE POOLING OF SOVEREIGNTY RISKS

The sovereignty risks can be pooled by a cross-default contract (C.D.C.) between the environmental agency and the lender. A C.D.C. strategically interconnects the contracts the sovereign is a party to such that she has only the choice of honouring both or violating both. In particular the C.D.C. might require that should the sovereign default on either contract then both parties must impose

sanctions and the sovereign suffers the consequent penalties. Hence the sovereign is deprived of all options which strategically discriminate between contracts.

In deciding over the joint fate of the contracts the sovereign compares the total costs of violating both with the total costs of honouring both. The sovereign will honour the joint contractual obligation if

$$(5) \quad \delta + \lambda \geq x + y .$$

The environmental agency will be prepared to agree to a C.D.C. if its specific risk falls,^{3/} i.e. if

$$(6) \quad \text{prob} [\lambda \geq y] < \text{prob} [\delta + \lambda \geq x + y]$$

and the lender will agree if

$$(7) \quad \text{prob} [\delta \geq x] < \text{prob} [\delta + \lambda \geq x + y] .$$

Risk pooling takes advantage of states of the world in which an overkill of costs associated with a violation of the debt contract can compensate for a deficit of deterrence against a violation of the treaty and vice versa. One would then rightly expect that the pooling of these risks is only Pareto superior if the individual risks are neither "too large" or "too different". In the remainder of this section we will derive a sufficient condition for the existence of Pareto superior pooling of the sovereignty risks.

We characterise values for x and y such that both parties agree to a C.D.C., that is, such that (6) and (7) hold. We assume that side-payments are not possible between the two external parties. (If they were possible, then although (6) and (7) holding is sufficient for a C.D.C. to be entered into, it would in addition be possible that one party whose repayment probability rose substantially would be prepared to bribe the other party into signing the C.D.C. if the latter's loss was sufficiently small.) The locus of (x, y) values in $x - y$ space such that the two probabilities in (6) are equal is determined by

$$(8) \quad \Psi(y) := \int_y^{\bar{\lambda}} \int_{\underline{\delta}}^{\bar{\delta}} \phi(\delta, \lambda) \, d\delta d\lambda = \int_{\underline{\lambda}}^{\bar{\lambda}} \int_{\max[\underline{\delta}, \min(\bar{\delta}, x+y-\lambda)]}^{\bar{\delta}} \phi(\delta, \lambda) \, d\delta d\lambda =: \tau(x, y)$$

And the locus of (x, y) values such that the two probabilities in (7) are equal is determined by

$$(9) \quad \Phi(x) := \int_{\underline{\lambda}}^{\bar{\lambda}} \int_x^{\bar{\delta}} \phi(\delta, \lambda) \, d\delta d\lambda = \tau(x, y) .$$

[FIGURE 1 ABOUT HERE]

Figure 1 illustrates condition (6). Without a C.D.C. the probability that the sovereign honours the treaty is given by the integral over that part of the support of the distribution for which $\lambda > y$. Under a C.D.C. the same probability is given by the integral over that part of the support of the distribution which is located above

and to the right of the line through (x, y) with slope -1 . This line is given by (5) with equality. A C.D.C. is to the benefit of the environmental agency in those states of the world characterised by points in area A, as a lack of incentive to honour the treaty is more than offset by the sanctions consequent upon a debt contract violation. However if the state of the world is in area B the excess deterrence against an individual violation of the treaty is more than offset by the incentive to renege on the debt contract and the treaty will be violated although it would not be in the absence of a C.D.C. Condition (6) requires that the integral over A exceeds the integral over B. Likewise condition (7) requires that the integral over area III exceeds that over area IV.

We will make

Assumption 1: For all $(\delta, \lambda) \in [\underline{\delta}, \bar{\delta}] \times [\underline{\lambda}, \bar{\lambda}]$, $0 < \phi \leq \phi(\delta, \lambda) \leq \bar{\phi} < \infty$.

The assumption ensures that the density is bounded below and above by some positive constants. This rules out, for example, perfect correlation (positive or negative).^{4/}

In the Appendix the following proposition is proved.

Proposition 1: Under Assumption 1 there exist (x, y) combinations in the support of the distribution such that both the environmental agency and the lender face a smaller risk under a C.D.C. and would therefore both sign a C.D.C.

The area of Pareto-superior risk pooling is depicted in Figure 2. The graph $\psi = \tau$ depicts (x, y) combinations satisfying (8). Inequality (6) holds only to the left of this graph. The graph $\phi = \tau$ depicts (x, y) combinations which satisfy (9). Inequality (7) holds only below this graph. The intersection of the areas where both (6) and (7) hold is given by the shaded area inside the lense enclosed by $\phi = \tau$ and $\psi = \tau$ in Figure 2. We can conclude that if the risk associated with both contracts is not too great then both parties can gain by signing a C.D.C.^{5/}

[FIGURE 2 ABOUT HERE]

Combinations of (x, y) such that one party gains from a C.D.C., and the other party is indifferent, are inside the shaded triangles. The diagonal line through $(\hat{\delta}, \hat{\lambda})$ is given by equality in (5) with $\delta = \hat{\delta}$ and $\lambda = \hat{\lambda}$. On this line the probability of default on the linked contract is just zero. Below it the costs of contract violations strictly exceed the benefits. If (x, y) is in the upper-left triangle then the environmental agency strictly prefers a C.D.C. and the lender is indifferent. If (x, y) is in the lower-right triangle then the agency is indifferent but the lender strictly prefers a C.D.C.

We can also state the following (proved in the Appendix):

Corollary 1: Under Assumption 1 there exist (x, y) combinations in the support of the distribution such that either/or both the environmental agency and the lender would face a larger risk under a C.D.C.

Note that the pooling of risks which are sufficiently large is impossible even in the presence of a large negative correlation. The intuition is that a large probability that δ is large if λ is small does not bring a lower risk on board the treaty if even large sanctions emanating from a debt contract violation do not deter debt repudiation.

If (x, y) is outside the shaded areas in Figure 2 at least one party faces a higher risk due to the introduction of the C.D.C. itself. Nevertheless, both may eventually turn out to be better off. This is because a C.D.C. will introduce an incentive to engage in a debt-for-nature swap which reduces the joint risk faced by the two parties.

4. DEBT-FOR-NATURE SWAPS IN THE PRESENCE OF A CROSS-DEFAULT CONTRACT

Once a C.D.C. has been entered into, if the risk associated with the environmental treaty declines, then the lender will be better off since the two contracts are strategically linked. The lender therefore gains a vested interest in furthering conditions that support the sustainability of the treaty. The lender becomes the environmentalist's friend.

Consider a debt-for-nature swap (for an overview over debt-for-nature swap operations see e.g. Hansen, 1989). Without a C.D.C. a lender has little overall incentive to support a swap beyond the incentive to grant pure debt relief (e.g. Krugman, 1988) and beyond the gains it may enjoy from improved public relations (Occhiolini, 1990). We shall show that this is different under a C.D.C.^{6/}

We are interested in swaps which require the sovereign to engage in environmental protection such that her future burden from honouring the treaty declines. We define a swap as a pair $(\Delta v, \Delta b)$, such that the period two costs of honouring the debt contract are $X(b^* + \Delta b)$ and the costs of honouring the treaty are $Y(v^* + \Delta v)$. Hence $\Delta b < 0$ is interpreted as a reduction in outstanding debt obligations, while $\Delta v > 0$ means that the costs of honouring the environmental treaty are reduced. However the additional environmental protection demanded under the swap has a cost in terms of first period consumption, which now equals $c_1(b^*, v^* + \Delta v)$; i.e. it is assumed that the swap takes place at the end of the first period when additional (or indeed reduced) environmental effort is still feasible.

The lender benefits from a swap if the value of debt outstanding,

$$(10) \quad V = \tau(x', y') \cdot R \cdot x' / (1 + i) ,$$

increases, where i is the risk free interest rate, $x' := X(b^* + \Delta b)/R$ and $y' := Y(v^* + \Delta v)/R$. We shall consider the case where the sovereign rationally anticipates the introduction of a C.D.C.: that is to say, for each choice (b, v) in the first period she correctly anticipates whether a C.D.C. will be introduced and chooses the optimum (b^*, v^*) taking this into account. Thus (2) is replaced by

$$(2') \quad c_2 = R - \min [X(b) + Y(v), (\delta + \lambda) R] ,$$

whenever (b, v) is such that a C.D.C. is introduced. We assume for the moment that (b^*, v^*) is indeed such that a C.D.C. is introduced.

We can now state (see Appendix for proof):

Proposition 2: Given (x, y) such that $0 < \text{prob} [\delta + \lambda \geq x + y] < 1$ and given that a C.D.C. has been agreed, there exist debt-for-nature swaps $(\Delta v, \Delta b)$ with $\Delta v > 0$ and $\Delta b < 0$ such that both the sovereign and the lender strictly prefer to swap.

Figure 3 illustrates the set of strictly preferred debt-for-nature swaps. The sovereign's expected utility at (x, y) is maintained along the indifference curve $I(x, y)$. The sovereign's indifference curve is decreasing as x' is reduced below x as a debt reduction (reduction in x') needs to be compensated by increased environmental efforts (decrease in y' below y) to maintain utility. Above and to the left of the indifference curve passing through (x, y) the sovereign gains from a swap.

The value of debt is maintained along the iso-value locus $V(x, y)$ passing through (x, y) . From (A4) in the Appendix $V(x, y)$ is increasing in x' for small values of x' and decreasing in x' for large values of x' . Below the iso-value locus the value of debt exceeds $V(x, y)$.

[FIGURE 3 ABOUT HERE]

In Figure 3 the scope for debt-for-nature swaps is depicted for two initial values of x and y , (x_1, y_1) and (x_2, y_2) . Any choice from points in the area enclosed by the swap indifference curve and the iso-value locus passing through (x, y) , such as (x_1', y_1') and (x_2', y_2') , is a Pareto-improvement for the parties to the swap.

The intuition is essentially straightforward. Since v^* is optimally chosen by the sovereign in the first period, locally a small increase in v has no first-order effect on the sovereign's utility. For the lender, however, under a C.D.C. the increase in v reduces the default risk and has a first-order benefit, for which the lender is prepared to bribe the sovereign by offering a reduction in debt.^{7/}

Not every Pareto-improving departure from (x, y) is however a rational choice for the lender. Consider for example swaps starting from (x_1, y_1) . The falling section of the iso-value locus $V(x_1, y_1)$ corresponds to the falling section, the "wrong" side, of a debt-relief-Laffer curve (Krugman, 1988), and for values of x , $x > \tilde{x}$, such as $x = x_1$, there is a debt overhang.

Being on the wrong side of the debt-relief-Laffer curve there exist (x', y') , with $x' < x_1$ and $y' > y_1$, such as (x_1', y_1') , such that (x', y') is Pareto-superior to (x_1, y_1) . However, the lender can do better than this by simply granting unilaterally a debt-relief $(x_1 - x')$. Hence the rational lender will only agree to Pareto-improving swaps such that $x' < x$ and $y' \leq y$. We call swaps with this property rational swaps. In Figure 3 rational debt-for-nature swaps are points in the shaded areas. Existence of Pareto-superior rational swaps follows from Proposition 2.

We can now state

Corollary 2: Any Pareto-superior rational swap reduces the sovereignty risk to be faced by the environmental agency.

Proof: As $x' < x$ and $y' \leq y$, $\tau(x, y) < \tau(x', y')$.

Proposition 2 and Corollary 2 imply that the Pareto superiority of risk pooling is not a necessary condition for the environmental agency and the lender to engage in a C.D.C. This is because the lender, though losing out from an initial C.D.C. in terms of risk, can improve the value of debt by a subsequent rational swap induced by the C.D.C. (Proposition 2). And an initial increase in the riskiness of the treaty due to the introduction of the C.D.C. may be over-compensated by the subsequent reduction in risk caused by a rational swap (Corollary 2). In the next section we will derive necessary conditions such that the parties to a C.D.C. gain from its introduction.

5. NECESSARY CONDITIONS FOR THE INTRODUCTION OF A C.D.C.

We derive conditions under which both the environmental agency and the lender gain from the introduction of a C.D.C. when the induced rational debt-for-nature swap is taken into account. To that end consider Figure 4. The loci for which (8) and (9) hold partition the support of the distribution into four regions.

(A) If (x, y) is in region A both parties gain from a C.D.C. and from Proposition 2 and Corollary 2 both the lender and the agency derive additional benefits from a rational swap. We proceed to show that both may be able to benefit from a C.D.C. even if (x, y) is in either region B, C, or D.

(B) Consider a point in region B such as (x_1, y_1) . At

(x_1, y_1) , $\psi < \tau < \phi$, so the lender would lose from a C.D.C. in the absence of an induced suitable swap. Taking into account the incentive to swap subsequently we can derive a necessary condition such that the value of debt does not fall.

Consider swaps represented by points in the area enclosed by the swap indifference curve $I(x_1, y_1)$ and the iso-value locus $V(x_1, y_1')$, where (x_1, y_1') satisfies (9), that is $\tau(x_1, y_1') = \phi(x_1)$ thus restoring the value of debt before the C.D.C.^{8/} Hence all swaps leading into the shaded area enclosed by $I(x_1, y_1)$ and $V(x_1, y_1')$ make the lender better off compared to the pre-C.D.C. situation and also benefit the sovereign. By Corollary 2 and as (x_1, y_1) is located in area B the environmental agency also gains from the C.D.C. plus induced swap.

(C) Now consider a point in region C such as (x_2, y_2) . At (x_2, y_2) , $\psi > \tau > \phi$, so the agency would lose from a C.D.C. in the absence of an induced suitable swap.

Consider, however, swaps leading into the shaded area enclosed by the swap indifference curve $I(x_2, y_2)$, the iso-value locus $V(x_2, y_2)$ and the locus $W(y_2)$ defined as the locus of $x' - y'$ conditions which satisfy $\tau(x', y') = \psi(y_2)$. $W(y_2)$ passes through (x_2', y_2) and is decreasing in x' as a larger x' must be combined with a smaller y' to keep $\tau(x', y')$ equal to $\psi(y_2)$. Below and to the left of $W(y_2)$ the environmental agency faces a risk which is smaller than that before the C.D.C. was introduced.

(D) Finally consider a point in region D such as (x_3, y_3) . At (x_3, y_3) , $\psi > \tau$ and $\phi > \tau$, as both parties to a C.D.C. would lose in the absence of an induced swap.

By a combination of both the decomposition undertaken in the case where (x, y) is in area B and the decomposition where (x, y) is in area C we can conclude that both the lender and the agency benefit from swaps leading into the shaded area enclosed by $V(x_3, y_3')$, $I(x_3, y_3)$ and $W(y_3)$.

[FIGURE 4 ABOUT HERE]

We can summarise these results in

Proposition 3: If the sufficient conditions of Proposition 1 are not met then necessary and sufficient conditions that rational debt-for-nature swaps exist such that both the lender and the agency gain from a C.D.C. (if such a swap is chosen) are:

- (a) If (x, y) is such that $\psi(y) < \tau(x, y) < \phi(x)$, then
 - (i) $I(x, y)$ and $V(x, y')$ must intersect, where (x, y') satisfies (9).
- (b) If (x, y) is such that $\psi(y) > \tau(x, y) > \phi(x)$, then
 - (ii) (x'', y'') must exist, satisfying $\tau(x'', y'') = \psi(y)$ and $V(x'', y'') > V(x, y)$ and $I(x'', y'') > I(x, y)$
- (c) If (x, y) is such that $\psi(y), \phi(x) > \tau(x, y)$, then (i) and (ii) must hold.

We have demonstrated the necessary and sufficient condition under which a swap exists which subsequent to a C.D.C. would make the lender and agency better off. This is also a necessary condition for

the C.D.C. to be entered into but it is not sufficient because once a C.D.C. has been signed, there is no guarantee such a swap will be agreed to.

For example if $\psi(y) > \tau(x, y)$ it follows under the condition in Proposition 3 that there also exist swaps which make the parties to it better off but the agency worse off compared to the situation before the introduction of a C.D.C. (i.e. the points to the north-east of $w(y_2)$). Furthermore the sovereign and the lender have no incentive to restrict Pareto-superior swaps to the subset which satisfies (ii) in Proposition 3(b). This needs to be ensured by a suitable contractual stipulation in the C.D.C., restricting the party to the swap which is also a party to the C.D.C. (i.e. the lender) to accept only swaps which satisfy the conditions of Proposition 3.

On the other hand, if (x, y) is such that $\tau(x, y) < \phi(x)$ then no restriction on Pareto-superior swaps need be written into the C.D.C. as the party interested in the restriction is also a party to the swap. However, if the lender's bargaining position vis-a-vis the sovereign is weak it can guarantee itself the reservation value $\phi(b) \cdot X(b)/(1 + i)$ by making the validity of the C.D.C. be contingent on the subsequent choice of a swap from the subset which makes it at least as well off as in the situation without a C.D.C.^{9/}

So far we have given conditions for the existence of two contracts which improve on the situations faced by the parties, both being locked into contracts with a common third party which is sovereign. In the next section we will investigate whether these contracts create an incentive or disincentive for the sovereign to join the environmental

treaty in the first place.

6. EFFECTS ON THE EX-ANTE INCENTIVE TO JOIN THE TREATY

A C.D.C. and an induced swap, if anticipated, have an impact on the expected utility of the sovereign when deciding whether or not to join the treaty. The incentive to join the treaty increases if an anticipated C.D.C. and swap increases expected utility of joining.

From Proposition 2 it follows that the anticipation of a swap itself increases the incentive to join. However, the effect of the C.D.C. alone, i.e. the effect of strategically linking the previously independent contracts bearing a sovereignty risk reduces the incentive for the sovereign to become a party to the treaty. This can be seen as follows.

From (2) it follows that without a C.D.C. the sovereign has a period 2 reservation consumption $R - X(b) - Y(v)$. She can also choose from either of three additional options. The optimal choice is illustrated in Figure 1 in which the support of the distribution is divided by a vertical and a horizontal line passing (x, y) into four areas I-IV. If (δ, λ) turns out to be in area III or IV then the sovereign will choose an option which discriminates between the treaty and the debt contract. As under Assumption 1 the probability that (δ, λ) will be in either area III or area IV is positive the value of these options is positive too. Under a C.D.C. the sovereign is deprived of these options. Therefore her expected utility declines if a C.D.C. is introduced.

Hence, combining the two effects on the expected utility before joining the treaty, we can conclude that the anticipation of a C.D.C. with a subsequent swap has an ambiguous effect on the sovereign's expected utility before joining the treaty. If the overall effect is negative then the sovereign would choose if possible to maintain a veto on the policy together of her obligations.

Such a veto power of the sovereign exists if international law requires that a declaration of a contract to be in default due to a failure to meet the sum of obligations from several contracts be contingent on the prior consent of a contractant to the pooling of her obligations. Nevertheless, such cross-default clauses are usually written into debt contracts the risk of which is intended to be pooled in a cross-default contract by a community of banks (e.g. Rosenberg, 1985; Newburg, 1991): such clauses prevent the sovereign from exercising its veto power. Likewise the environmental agency might well require that participating countries include such a cross-default clause. Our analysis shows that the agency has every incentive to do this.

Beyond the utility gains arising from an induced swap there can exist additional incentives for the sovereign to agree to a cross-default clause when joining the treaty. An additional incentive exists for example if the sovereign intends to raise (more) debt after having joined the treaty such that debt matures during the treaty's lifetime. In this case her permission to pool sovereign risks will reduce the new debt's risk and hence the costs of borrowing. Also, the sovereign may be able to negotiate a rebate on future interest payments from existing debt by permitting the pooling of the old debt's risk. Or, she may be able to participate in some other way in the windfall she can indulge

her old creditors.

7. CONCLUSIONS.

In this paper we analysed the feasibility of the Pareto-superior pooling of sovereignty risks to be faced by two parties each being locked into a different contract with a third and sovereign party. The contracts we examined were an environmental treaty between a sovereign and a foreign or multinational environmental agency and a debt contract between same sovereign and a foreign lender.

We propose to supplement these contracts with a nexus of other contracts between various subsets of the three parties involved such that all parties can gain. At the centre of this nexus is a cross-default contract between the agency and the lender which deprives the sovereign of all options to discriminate between the treaty and debt when meeting her obligations. Sufficient conditions are given such that the cross-default contract decreases the sovereignty risks to be faced by the agency and the lender.

This cross-default contract induces a second contract between the lender and the sovereign which involves a debt-for-nature swap. The induced swap provides additional gains for the agency and the lender such that either or both can accept some direct loss in terms of risk from the cross-default contract. To guarantee a net gain for the agency the cross-default contract may have to stipulate a restriction on the lender concerning its choice from the set of Pareto-superior swaps.

The sovereign loses from the direct effect of the cross-

default contract as she is deprived of options which have positive value. However, she gains from the induced swap and also from an improvement in her creditworthiness due to a lower risk of debt. As the net effect on her welfare may be negative or positive the environmental treaty must include a clause which allows the cross-default contract to be entered into without the consent of the sovereign.

This nexus of contracts allows some leeway in the hefty application of politically unpopular side-payments geared towards the contractual stabilisation of international environmental cooperation.

APPENDIXProof of Proposition 1:

Note that the locus given by (8) passes through $(\hat{\delta}, \hat{\lambda})$, the point such that both contracts just hold with probability one. We proceed to show that the locus has a slope of zero at this point under Assumption 1.

A sufficient condition for the integral over area A in Figure 1 to be larger than the integral over Area B, provided (x, y) is not too far from $(\hat{\delta}, \hat{\lambda})$, is

$$(A1) \quad (\bar{\delta} - (x + y - \hat{\lambda})) \cdot (y - \hat{\lambda}) \cdot \phi > (x - \hat{\delta})^2 \cdot \bar{\phi}/2 .$$

Consider points satisfying $(y - \hat{\lambda}) = \mu \cdot (x - \hat{\delta})$, where μ is a positive constant. Then (A1) becomes

$$(A2) \quad (\bar{\delta} - x) \cdot \mu \cdot (x - \hat{\delta}) \cdot \phi - \mu \cdot (x - \hat{\delta})^2 \cdot \phi > (x - \hat{\delta})^2 \cdot \bar{\phi}/2$$

which must hold under Assumption 1 as x converges to $\hat{\delta}$ as the second and third terms become insignificant relative to the first. Hence moving towards $(\hat{\delta}, \hat{\lambda})$ from the interior of the support of the distribution in any direction parameterized by $\mu > 0$ implies that (6) holds close enough to $(\hat{\delta}, \hat{\lambda})$. The locus of (x, y) satisfying (8) must therefore have zero slope at $(\hat{\delta}, \hat{\lambda})$.

Next notice that the locus also passes through $(\bar{\delta}, \bar{\lambda})$. By a symmetric argument its slope at $(\bar{\delta}, \bar{\lambda})$ must also be zero.

Also by an entirely symmetric argument the locus of (x, y) combinations satisfying (9), also passing through $(\underline{\delta}, \underline{\lambda})$ and $(\bar{\delta}, \bar{\lambda})$, has an infinite slope at $(\underline{\delta}, \underline{\lambda})$ and $(\bar{\delta}, \bar{\lambda})$.

Next notice from (8) that any (x', \tilde{y}) such that $x' < \tilde{x}$, where (\tilde{x}, \tilde{y}) satisfies (8), satisfies (6). Finally, notice from (9) that any (\tilde{x}, y') such that $y' < \tilde{y}$, where (\tilde{x}, \tilde{y}) satisfies (9), satisfies (7). Hence the set of points between the two loci satisfies (6) and (7) as required. Q.E.D.

Proof of Corollary 1:

In the proof of Proposition 1 it was shown that the graph $\psi = \tau$ has zero slope at $(\underline{\delta}, \bar{\lambda})$ and $(\bar{\delta}, \bar{\lambda})$, whereas the graph $\phi = \tau$ has infinite slope at these points. Hence both graphs must intersect inside the support of the distribution such that a second lense exists where both risks are increased under a C.D.C. By continuity of the distribution and the existence of this intersection there must also be areas such that either risk decreases and the other increases.

Proof of Proposition 2:

Suppose a C.D.C. has been signed but that there exist no Pareto-improving swaps. We shall demonstrate a contradiction. First it is shown that the sovereign's indifference curve for debt-for-nature swaps $I(x, y)$ has infinite slope at (x, y) . The sovereign's

utility is $u(b^* , v^* , \Delta b , \Delta v) := EU\{c_1(b^* , v^* + \Delta v) , c_2\}$ where

$$(A3) \quad c_2 = R - \min [X(b^* + \Delta b) + Y(v^* + \Delta v) , (\delta + \lambda) \cdot R] .$$

$$\frac{dy}{dx} \Big|_{V \text{ constant}} = \frac{-(dY/dv) (\partial u / \partial (\Delta b))}{(dX/db) \partial u / \partial (\Delta v)}$$

and $\partial u / \partial (\Delta b)$ is strictly negative in the interior of the support since in some states of the world the additional obligations will be met; thus reducing consumption.

Also at $\Delta b = \Delta v = 0$ we have $\partial u / \partial (\Delta v) = \partial u / \partial v = 0$. The latter equality follows because by assumption (b^* , v^*) is an optimum which leads to a C.D.C. but does not induce a swap. Hence (b^* , v^*) must optimise $u(b , v , 0 , 0)$ which is expected utility under a C.D.C. on the assumption of no swap: for values of (b , v) such that a C.D.C. is not introduced the sovereign's utility is at least $u(b , v , 0 , 0)$ since additional default options are available in such a case, hence if $u(b , v , 0 , 0)$ had a higher value in such a region, such (b , v) would certainly be preferred to the optimum (b^* , v^*) . Hence $\partial u / \partial v = 0$ follows. Using this in the expression for the slope implies it is infinite.

Next we show that the locus of constant value of debt $V(x , y)$ has finite slope. From (10)

$$(A4) \quad \frac{dy}{dx} \Big|_{V \text{ constant}} = - \frac{\partial \tau / \partial x}{\partial \tau / \partial y} - \frac{\tau(x' , y')}{\partial \tau / \partial y} \cdot x$$

By continuity of the density function $-\infty < \partial\tau/\partial x < 0$ and $0 < \partial\tau/\partial y < \infty$ whenever $0 < \tau(x', y') < 1$. Hence the slope of constant value of debt is finite whenever there is risk of contract violation under a C.D.C. Therefore $V(x, y)$ has a finite slope at (x, y) . Hence there exists to the left of $I(x, y)$ and below $V(x, y)$ an area representing Pareto-improving swaps. Q.E.D.

FOOTNOTES

- 1/ For illustration, suppose that under the treaty an international tradeable permit scheme or an environmental tax system is implemented. Let $h(v)$ be emissions of the pollutant and let p be the permit price per unit of pollution or the tax rate. Let e be that quantity of emissions which can be paid for by the sovereign's share in the total distributed quantity of permit issued or by her share in the total tax redistribution. Then
- $$Y(v) = p[h(v) - e] .$$
- 2/ $\underline{\lambda}$ may be interpreted as representing non-random costs from environmental damage as a fraction of resource R to be borne in the wake of violating the treaty, whereas $\lambda - \underline{\lambda}$ and δ are random economic sanctions.
- 3/ Recall that we are assuming that in the event of contract violation no recovery of outstanding obligations is made; hence the objective of both external parties is to minimise the probability of default.
- 4/ It is instructive however to consider these two extreme cases. With perfect correlation such that the support of the distribution is the line segment between $(\underline{\delta}, \underline{\lambda})$ and $(\bar{\delta}, \bar{\lambda})$, for any (x, y) not in the support one of the parties it is strictly worse off with a cross-default contract: no risk pooling is possible. With perfect negative correlation such that the support lies between $(\underline{\delta}, \underline{\lambda})$ and $(\bar{\delta}, \bar{\lambda})$, then for

any (x, y) to the south-west of the support each party gains from the cross-default contract hence (6) and (7) are both satisfied.

5/ Even when both probabilities are close to $\frac{1}{2}$ this can happen. For example if $\bar{\delta} = \frac{1}{2}$, $\underline{\delta} = 0$, $\bar{\lambda} = \frac{1}{2}$, $\underline{\lambda} = 0$ and λ and δ independently and uniformly distributed, we get the

$\Psi = \tau$ locus given by $y = -x + x^{\frac{1}{2}}$ for $0 \leq x \leq \frac{1}{4}$ and $y = 1 - x - (\frac{1}{2} - x)^{\frac{1}{2}}$ for $\frac{1}{2} \geq x > \frac{1}{4}$, and for $\Phi = \tau$, $y = (1 - 2x - (1 - 4x)^{\frac{1}{2}})/2$ for $0 \leq x \leq \frac{1}{4}$ and $y = (1 - 2x + (4x - 1)^{\frac{1}{2}})/2$ for $\frac{1}{2} \geq x > \frac{1}{4}$. Along the $x = y$ ray (6) and (7) both hold up to $x = y = \frac{1}{4}$.

6/ By definition of the secondary market price of debt a lender always has an incentive to sell debt at that price to a third party, e.g. to a NGO, which intends to donate that debt for a swap. Here we are concerned with incentives which go beyond that.

7/ There is in principle a symmetric deal - a nature-for-debt swap - which could be struck between the environmental agency and the sovereign in the form of a reduction in the treaty standards in exchange for reduced first-period consumption. We shall suppose however that the environmental agreement concerns some standard not open to renegotiation.

8/ Recall that ϕ , the probability that the debt contract is honoured with independent contracts, depends only on x . Consequently the reduction in y_1 to y_1' is just sufficient

to make the probability τ of the contract with a C.D.C. being honoured equal to $\Phi(x_1)$.

- 9/ In the absence of such a clause, once the C.D.C. has been signed the area of Pareto-improving swaps is that enclosed by $I(x_1, y_1)$ and $V(x_1, y_1)$, larger than that below $V(x_1, y_1)$. If however the lender had all the bargaining power, for example if he could make a take-it-or-leave-it offer, then the condition in Proposition 3(a) is also sufficient for a C.D.C. to be signed in this region.

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FIGURE 1

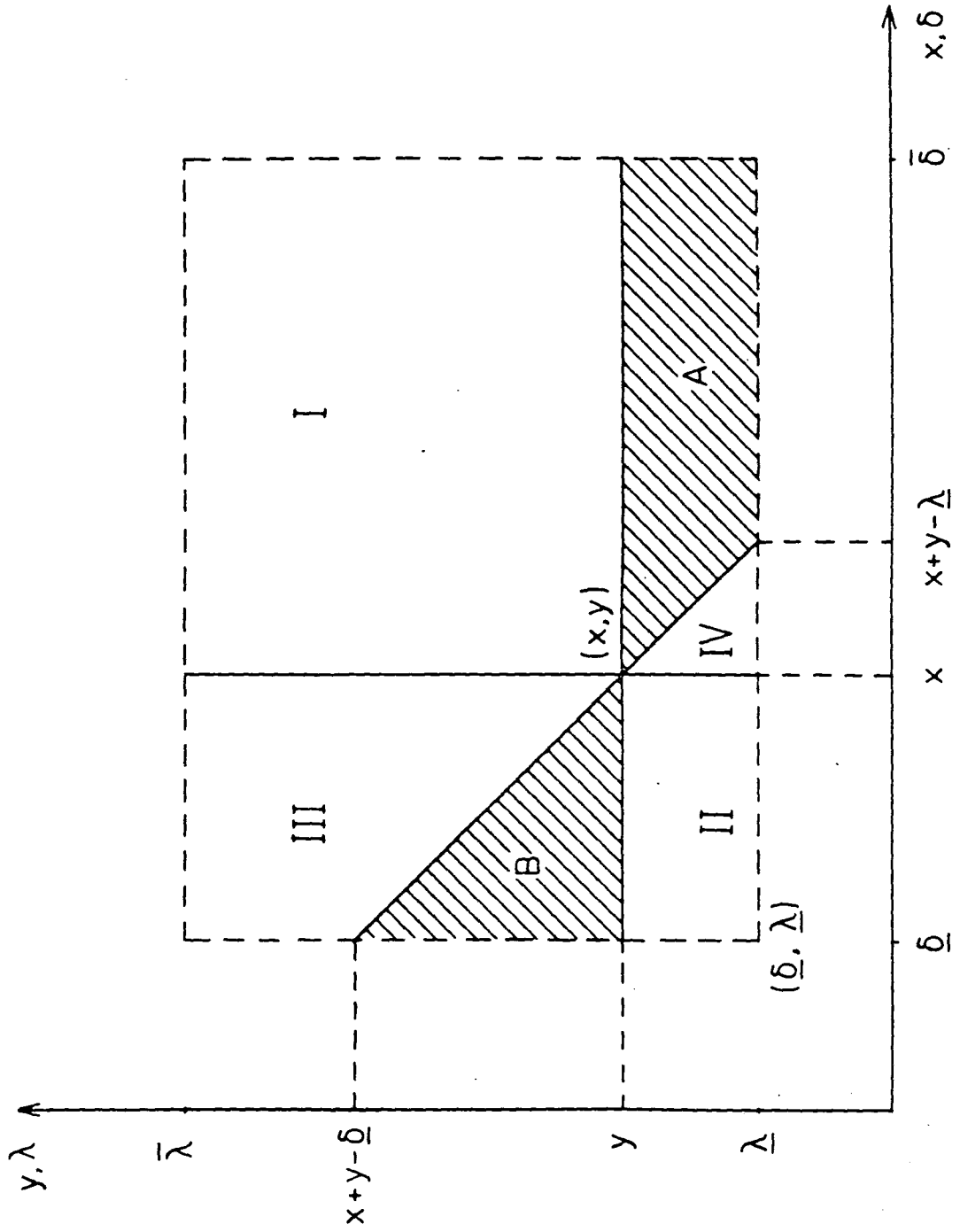


FIGURE 2

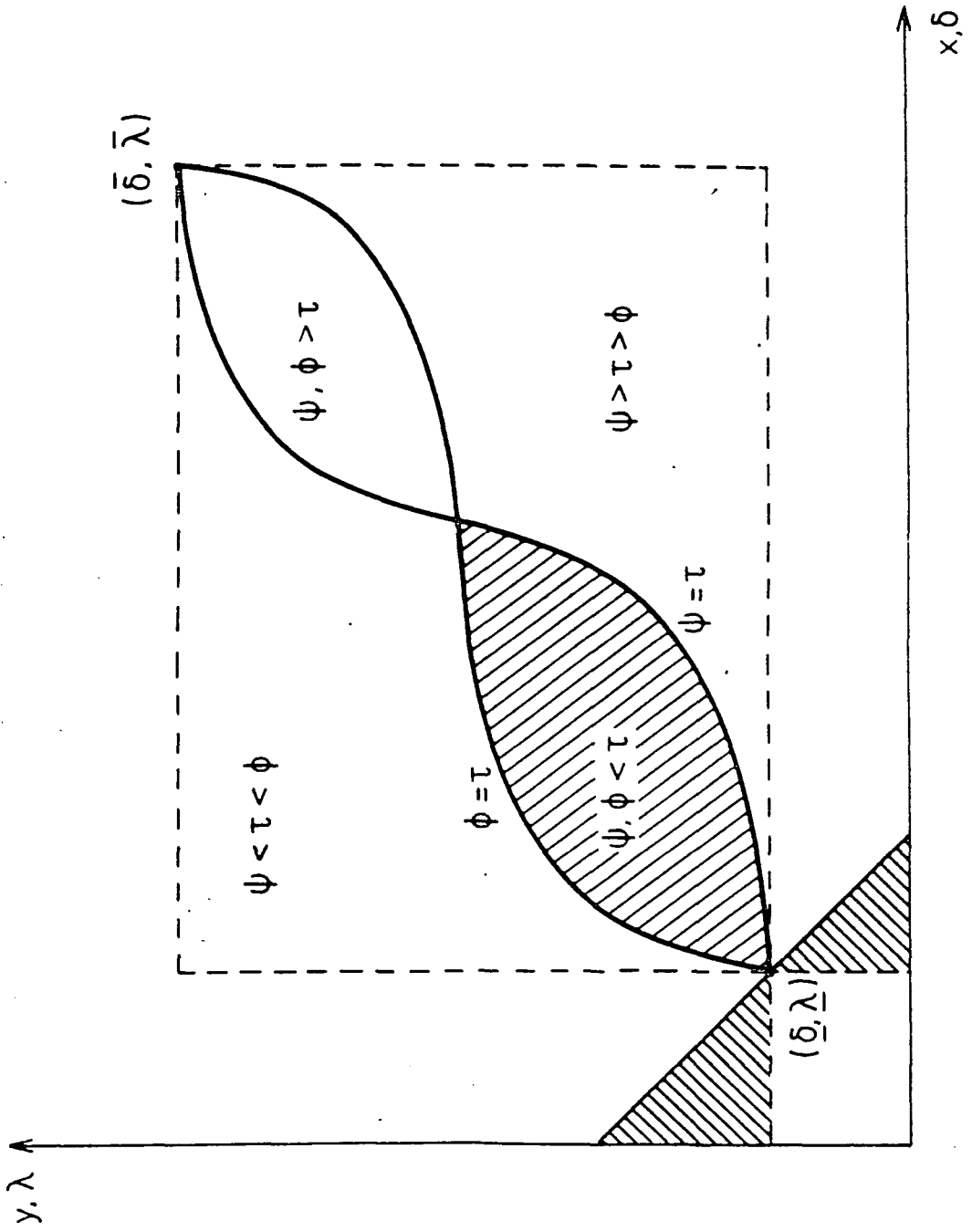


FIGURE 3

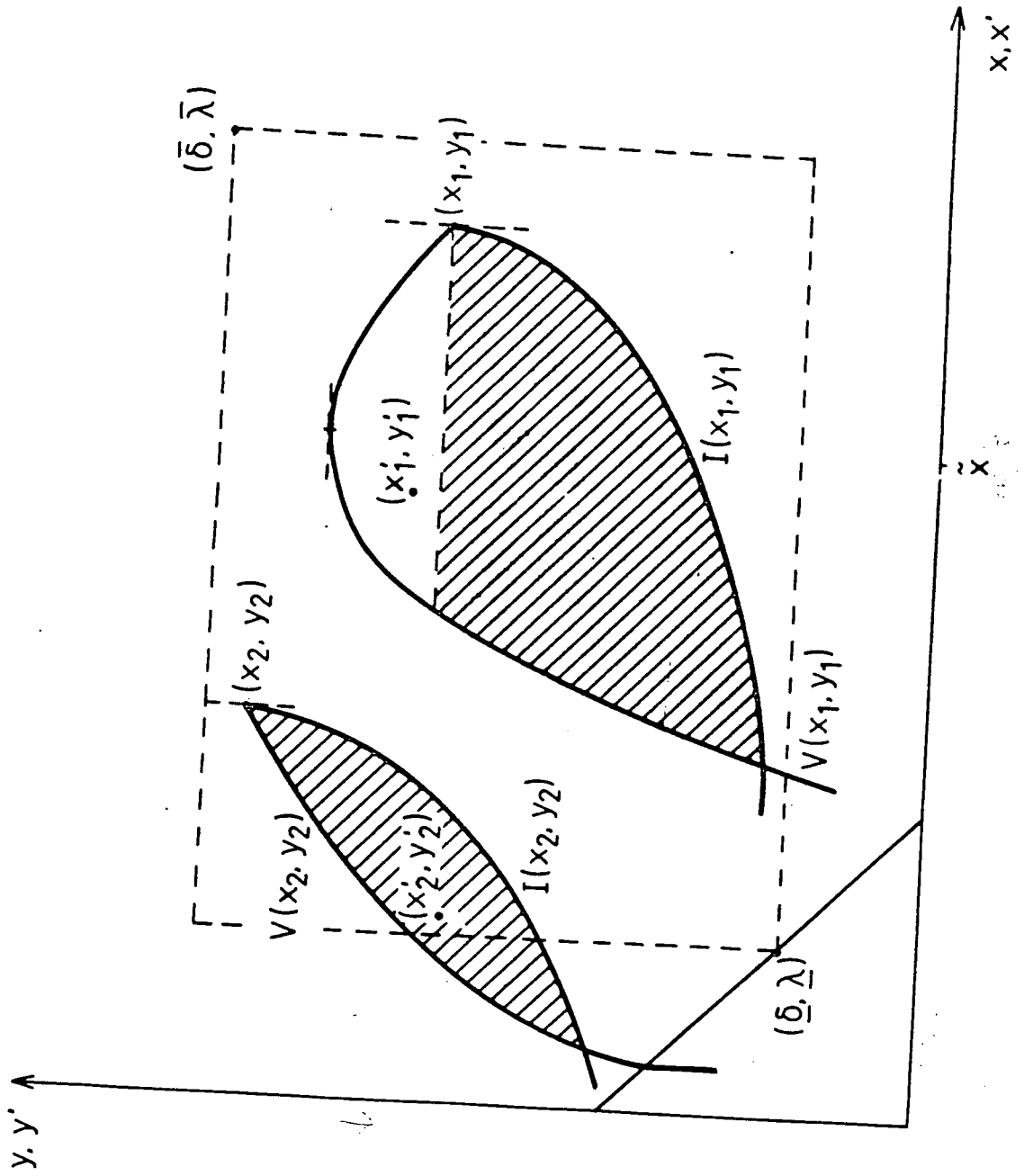


FIGURE 4

