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Rescheduling a sovereign debt: expected repayment, risk and time preference

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RESCHEDULING A SOVEREIGN DEBT:

EXPECTED REPAYMENT, RISK AND TIME PREFERENCE *

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ABSTRACT

By assuming that the probability of default increases with the debt-service burden, it is shown that the set of admissible rescheduling schemes of a sovereign debt to a private creditor can be depicted by a U-shaped curve in the plane spanned by the renegotiated annual debt repayment and the renegotiated length of the repayment period. By classifying creditors and debtors by risk and time preference, the choice of a rescheduling scheme from this set and the likelihood of agreement is analysed for eighty-one possible combinations of creditors and debtors (*JEL* F34)

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I. INTRODUCTION

Unlike a private debt, a sovereign debt is not subject to the laws of bankruptcy or to the enforcement of collateral. Thus, when the potential penalties on default are not substantial, a rise in a country's level of indebtedness reduces that country's inclination to service its external liabilities. It is possible, however, that the probability of unilateral repudiation is moderated by a country's concern about the adverse effect of a default on its trustworthy reputation and, subsequently, on its access to foreign loans (Eaton and Gersovitz, 1981; Kletzer, 1984; Grossman and Van Huyck, 1988; and Levy, 1992) and by a threat of direct sanctions (Bulow and Rogoff, 1989).

In view of the developing countries' high level of indebtedness, it has been argued by Krugman (1988) that a country's financial obligations act like a high marginal tax rate which deters governments from taking painful measures to improve a country's economic performance and discourages capital formation. Thus, when an indebted country is on the downward sloping side of the 'debt relief Laffer curve', both debtor and creditor can benefit from a debt-reduction. Kenen (1990) and Sachs (1990) have asserted that the external debt's overhang is a primary cause for economic slow-down for many of the developing countries and have recommended the establishment of an international institution for organising debt relief and debt-rescheduling negotiations between private creditors and indebted countries. In contrast, Bulow and Rogoff (1990) have argued that the external debt problem is a symptom of poor economic management and growth, that the presence of official creditors in debt negotiations ossifies the bargaining position of private creditors, and that efficiency would be best served by having less official involvement.

As argued in Krugman (1989), the basic approach for solving the developing countries' debt problem is rescheduling and concerted lending. The purpose of this paper is twofold: first, to identify the set of sovereign-debt rescheduling schemes which are admissable for both creditor and debtor for negotiation; and second, to analyse the creditor's and debtor's risk and time preference over the feasible set and to assess the prospects for agreement. Assuming that a country's inclination to repay its liabilities decreases with its debt burden, but that the costs of repudiation are substantial, and recognising that short-term illiquidity does not necessarily lead to long-term insolvency, this paper analyses the set of debt-rescheduling schemes which are admissible for both the debtor and the creditor. It is shown that this set can be depicted by a U-shaped curve in the plane spanned by the renegotiated annual debt repayment and period of repayment. The location of the preferred rescheduling scheme on this curve is identified for eighty-one possible combinations of creditors and debtors classified by their attitude toward risk and rate of time preference.

The structure of the paper is as follows. Section II analyses the probability of default and the expected annual debt repayment and constructs the debt Laffer curve. Section III presents the debt repayment constraint and constructs the admissible rescheduling curve. Section IV describes the effects of risk and time preference on the creditor's and debtor's choices of an admissible rescheduling scheme. Section V presents the possible combinations of creditors and debtors and indicates the likelihood of agreement between them about a rescheduling scheme. The degree of similarity between the creditor's choice and the debtor's choice is discussed further in the concluding remarks in section VI.

II. PROBABILITY OF DEFAULT, EXPECTED ANNUAL DEBT REPAYMENT AND THE DEBT LAFFER CURVE

Consider a situation in which a sovereign country is liable to a single private creditor, or to a well-coordinated syndicate of private creditors, and cannot service its external liabilities in accordance with the originally contracted terms, and in which both the indebted country and its creditor have a sufficient incentive for rescheduling the country's liabilities over a T-year period in equal (in constant prices) annual repayments of principal and interest. Dealing with a sovereign country whose asset holdings abroad are negligible, the creditor is aware of the fact that her control over the rescheduled repayment is limited. Nevertheless, assume that the probability of default perceived by the creditor is smaller than one due to substantial costs that can be inflicted directly by retaliatory sanctions, such as a ban on trade and credit, and indirectly through a loss of trustworthy reputation. Assume further that the perceived probability of default: 1. rises with the burden of servicing the debt, measured by the ratio of the *renegotiated* annual repayment to the indebted country's level of gross national product (GNP), as public pressure against tax-increase and subsidy-cuts mounts; and 2. decreases with the creditor's ability to retaliate by limiting the country's access to the international credit market proportionately to the creditor's market share.

These assumptions are incorporated into the following linear expression:

$$p = \alpha(M/Y) - \lambda s \qquad (1)$$

where

p = the probability of default,
M = a constant renegotiated annual repayment of principal and interest in constant prices,
Y = the indebted country's GNP in constant prices,
s = the creditor's share in the international credit market,
α = a positive scalar indicating the marginal effect of the debt burden on the country's inclination to default,[1] and
λ = a positive scalar indicating the deterrent effect of the creditor's power in the international credit market.

In accordance with the *debt-overhang hypothesis*, assume that the indebted country's investment is adversely affected by the annual debt repayments through a decline in the government budget for investment and through an (expected and actual) increase in tax rates, which, in the presence of capital mobility, discourages capital formation and repatriation of flight capital (Krugman, 1989; Helpman, 1989; Dooley and Helpman, 1992; and Boyce, 1992).[2] Since the country's GNP is directly related to investment, this assumption implies that the indebted country's GNP is adversely affected by the annual debt repayment as indicated, for convenience, by the following linear equation:

$$Y = \bar{Y} - \delta M, \quad \delta \geq 1 \qquad (2)$$

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1 Following Berg and Sachs (1988), it can be argued that a is affected by the indebted country's social, political and economic structure.

2 For tests of the debt-overhang hypothesis see Levy, Chowdhury and Wilson (1991), Cohen (1993) and Levy and Chowdhury (1993).

where $\bar{Y}$ is the highest level of GNP attainable had the annual debt-repayments been nil, and δ is a positive scalar indicating the potentially adverse marginal effect of the renegotiated annual debt-repayment on the country's GNP. Equation 2 also indicates that the renegotiated debt-repayment cannot exceed $\bar{Y}/\delta$.

The substitution of equation 2 into equation 1 for Y implies that the probability of default perceived by the creditor is given by

$$p = \alpha[M / (\bar{Y}-\delta M)] - \lambda s \qquad (3)$$

which, by differentiation, indicates that

$$p_M = \frac{\alpha \bar{Y}}{(\bar{Y} - \delta M)^2} > 0 \qquad (4)$$

and

$$p_{MM} = \frac{2\delta\alpha \bar{Y}}{(\bar{Y} - \delta M)^3} > 0. \qquad (5)$$

Obviously, the creditor requires that $0 \leq p < 1$. Since p rises with M, this requirement implies that the renegotiated annual debt repayment lies within the interval $M_{min} \leq M < M_{max}$, where $p(M_{min}) = 0$ and $p(M_{max}) = 1$. The substitution of these boundary conditions into equation 3 yields:

$$M_{min} = \left(\frac{\lambda s}{\alpha+\delta\lambda s}\right)\bar{Y} \qquad (6)$$

and

$$M_{max} = \left(\frac{1+\lambda s}{\alpha + \delta(1+\lambda s)}\right)\bar{Y}. \qquad (7)$$

Note that since $\alpha > 0$, $M_{max} < \bar{Y}/\delta$. Note further that the feasible interval $M_{max} - M_{min}$ is rightwardly shifted by larger values of $\bar{Y}$ and λs and by smaller values of α and δ. This interval is also enlarged by higher values of $\bar{Y}$.

In view of the above arguments, the annual debt-repayment (ADR) is perceived by the creditor to be distributed as follows:

$$ADR = \begin{cases} M & 1-\alpha M/(\bar{Y}-\delta M) + \lambda s \\ 0 & \alpha M/(\bar{Y}-\delta M) - \lambda s.^3 \end{cases} \qquad (8)$$

Consequently, the expected annual debt repayment (EADR) is:

$$EADR = [1 - \alpha M/(\bar{Y} - \delta M) + \lambda s]M \qquad (9)$$

and by differentiation

$$\frac{\partial EADR}{\partial M} = 1 - [p(M) + p_M(M)M] \gtreqless 0 \text{ as } M \lesseqgtr \tilde{M} \qquad (10)$$

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3 The nature of the analysis will not be substantially changed by replacing the assumption of a complete default by a partial default, i.e., an actual annual repayment of gM dollars ($0 < g < 1$) with probability p.

where

$$\tilde{M} = \left[1 - \sqrt{\frac{\alpha}{\alpha+\delta(1+\lambda s)}}\right]\frac{\bar{Y}}{\delta}. \qquad (11)$$

Intuitively, an increase in the renegotiated annual debt repayment reduces the probability of payment each year and, hence, the expected annual debt repayment is subject to a '*debt Laffer curve*'. That is, beyond the critical level $\tilde{M}$ an increase in the payment due causes the probability of default to go up so much that expected payment falls. Thus, EADR rises and then falls with M as illustrated in Figure 1.

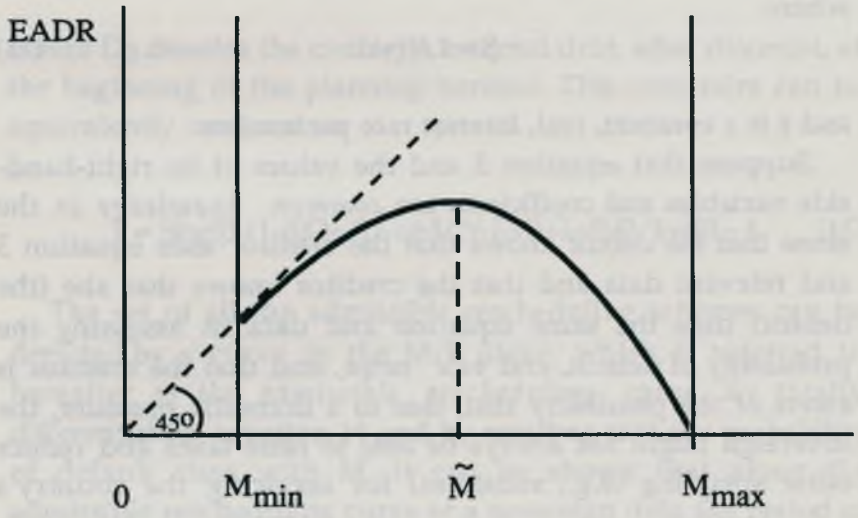

Figure 1 The debt Laffer curve

III. DEBT REPAYMENT CONSTRAINT AND THE ADMISSIBLE RESCHEDULING CURVE

Suppose that the distribution of the actual annual debt-repayment is perceived by the creditor to be stable over the repayment period.[4] In view of equation 9, the present value (PV) of the stream of the expected annual debt-repayments (SEADR) over a T-year period is given by:

$$PV(SEADR) = \sum_{t=0}^{T} [1-\alpha M/(\bar{Y}-\delta M)+\lambda s]M/(1+r)^t$$

$$= [1-\alpha M/(\bar{Y}-\delta M)+\lambda s]M[\beta(1-\beta^T)/(1-\beta)] \qquad (12)$$

where

$$\beta = 1/(1+r) \qquad (13)$$

and r is a constant, real, interest rate per annum.

Suppose that equation 3 and the values of its right-hand-side variables and coefficients are *common knowledge* in the sense that the debtor knows that the creditor uses equation 3 and relevant data and that the creditor knows that she (the debtor) uses the same equation and data in assessing the probability of default, and *vice versa*, and that the creditor is aware of the possibility that, due to a domestic pressure, the sovereign might not always be able to raise taxes and reduce other spending (e.g., subsidies) for servicing the country's

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4 Alternatively, one may incorporate, for example, an anticipation of economic growth, or economic slowdown, into the analysis by multiplying $(\bar{Y} - dM)$ by a shift factor g^t, where g is a positive scalar equal to one plus the anticipated growth rate.

external liabilities. Suppose further that the creditor's profits from retaliation are small and that the creditor believes that the sovereign is reliable in the sense that a short-term, or current, illiquidity does not necessarily lead to a long-term insolvency. In which case, the creditor prefers to tolerate the uncertainty about future repayments and negotiates new debt-repayment's terms which implicitly incorporate episodes of temporary illiquidity. In this setting, and in view of equation 12, it is suggested that the rescheduling schemes (M,T) which are admissible for negotiation by both the creditor and debtor should obey the following *debt-repayment constraint*:

$$[1 - \alpha M/(\bar{Y}-\delta M)+\lambda s]M[\beta(1-\beta^T)/(1-\beta)] = D_0 \qquad (14)$$

where D_0 denotes the country's external debt, after discount, at the beginning of the planning horizon. This constraint can be equivalently rendered as

$$T = \{\log\{\beta-(1-\beta)D_0/[1-\alpha M/(\bar{Y}-\delta M)+\lambda s]M\}/\log\beta\} - 1. \qquad (15)$$

The set of all the admissible rescheduling schemes can be depicted by a curve in the M-T plane, which is referred to hereafter as the *admissible rescheduling curve*. By totally differentiating equation 14 and by recalling that the probability of default rises with M, it can be shown that along the admissible rescheduling curve of a sovereign debt the period of repayment is initially shortened but later lengthened as the renegotiated annual repayment rises.

PROPOSITION: Along the admissible rescheduling curve

$$\frac{dT}{dM}\begin{cases} < 0 \text{ for } M_{min} \leq M < \tilde{M} \\ = 0 \text{ for } M = \tilde{M} \\ > 0 \text{ for } \tilde{M} < M < M_{max}. \end{cases} \qquad (16)$$

The proof of this proposition is given in the Appendix. Intuitively, note that $1-\beta^T$ rises as T rises. Hence, EADR must fall as T rises to satisfy the debt repayment constraint 14. This requires M initially to fall and then to rise as T rises. If M is small, the Laffer curve is upward sloping. Thus, for small values of M, a higher M means a higher EADR and subsequently shorter period of repaying D_0. At some point, however, EADR begins to fall as M continues to rise. At this point, T must be raised to maintain D_0 constant as M rises.

Figure 2 illustrates the above-mentioned proposition by displaying the set of all the rescheduling schemes which are admissible for negotiation by both the debtor and the creditor, $\Omega = \{(M,T) \in \mathcal{R}_+^2 : [1-\alpha M/(\bar{Y}-\delta M)+\lambda s]M[\beta(1-\beta^T)/(1-\beta)]=D_0\}$, as a U-shaped curve in the plane spanned by M and T.[5] Equation 14 indicates further that an increase in the debtor's initial liabilities and an increase in the international interest rate shift

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5 If the assumption of common knowledge is replaced by asymetric information, it is likely that the debtor would claim that the probability of default is lower than that perceived by the creditor, for any given annual debt repayment, in order to obtain a repayment period shorter than that required by the creditor. In which case, the admissible rescheduling curve considered by the debtor lies below the rescheduling curve considered by the creditor.

the admissible rescheduling curve upward, whereas an increase in the country's potential GNP level and an increase in the creditor's market share in the international credit market shift the curve downward by reducing the probability of default.

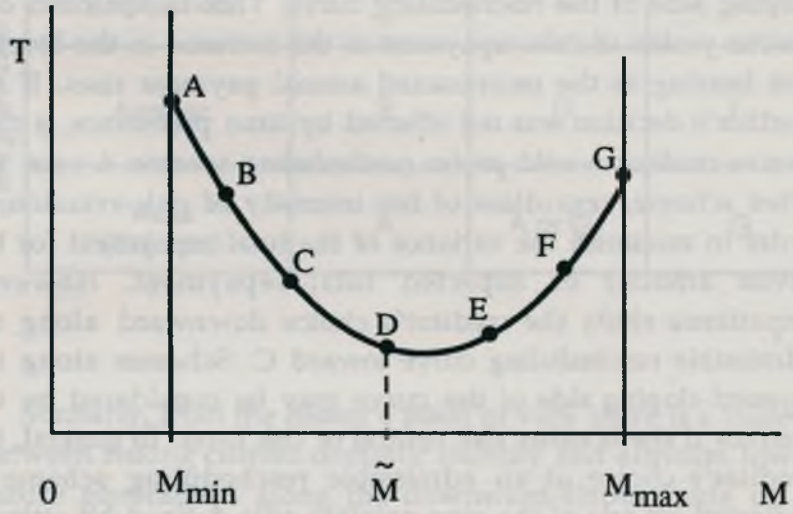

Figure 2. The admissible rescheduling curve

IV. RISK, TIME PREFERENCE AND THE CREDITOR'S AND DEBTOR'S CHOICES

The admissible rescheduling curve developed above is the locus of all combinations of M and T yielding a constant sum of discounted expected annual repayments which is equal to the remaining external debt after an initial and predetermined discount. Attitude toward risk and time preference, which may

affect the creditor's and debtor's choice of a rescheduling scheme, are not included in the construction of this curve. These factors are considered now to identify the preferred admissible rescheduling schemes by the creditor and the debtor.

From the creditor's perspective there is a trade-off between risk of nonpayment and impatience along the downward-sloping side of the rescheduling curve. That is, the costs of a shorter period of debt repayment is the increase in the level of risk bearing as the recontracted annual payment rises. If the creditor's decision was not affected by time preference, a risk-averse creditor would prefer rescheduling scheme A over any other scheme, regardless of her intensity of risk aversion, in order to minimise the variance of the total repayment for the given amount of expected total repayment. However, impatience shifts the creditor's choice downward along the admissible rescheduling curve toward C. Schemes along the upward-sloping side of the curve may be considered by the creditor if she is either risk neutral or risk lover. In general, the creditor's choice of an admissible rescheduling scheme is indicated by one of the nine possible cells defined by attitude toward risk and time preference and displayed by Table 1. The schemes chosen by the nine types of creditors are indicated on the admissible rescheduling curve in Figure 2 by A, B, C, D, E, F and G .

Table 1 The creditor's choice of an admissible rescheduling scheme

Time preference	*Attitude toward risk of nonpayment*		
	Aversion	Neutrality	Love
Strong (Impatience)	C	D	E
Average	B	D	F
Weak (Patience)	A	A or G	G

Similarly, from the debtor's point of view there is a trade-off between risking current domestic stability and altruism toward future generations along the downward-sloping side of the admissible rescheduling curve. That is, the costs of alleviating the current burden of the external debt by negotiating a small annual repayment and avoiding painful measures that might lead to social and political instability is the foregone consumption of future generations imposed by spreading the debt repayment over a long period. Schemes along the upward-sloping side of the curve may be considered by the indebted sovereign if she is either risk neutral or risk lover and ready to face the social unrest and the political risk stemming from a large annual repayment and believes that the high domestic pressure would lead to frequent and excusable nonpayment. In general, the choice of an admissible rescheduling scheme falls into one of the nine categories

defined by the sovereign's attitude toward risk and time preference as displayed in Table 2. For simplicity, the rescheduling schemes chosen by the nine types of debtors are also illustrated by A, B, C, D, E, F and G on the admissible rescheduling curve in Figure 2. More generally, the chosen schemes are rather likely to be in the vicinity of these points.

Table 2 The debtor's choice of an admissible rescheduling scheme

Attitude toward risking domestic stability

Time preference	Aversion	Neutrality	Love
Strong (myopia)	A	A or G	G
Average	B	C	F
Weak (Altruism)	C	D	E

V. CREDITOR-DEBTOR COMBINATIONS OF AGREEMENT AND DISAGREEMENT

The possible combinations of creditors and debtors, their choices and the degree of similarity or difference between their choices are summarised by Table 3. In each cell of this table, the upper entry indicates the creditor's choice and the lower the

debtor's choice. The degree of similarity between these choices is indicated by = in the case of consensus, ≈ in the case of a strong similarity, ~ in the case of a weak similarity, ≠ in the case of a substantial difference, and # in the case of a large difference. The combinations of creditor and debtor yielding consensus or similarity are further highlighted by shading. These combinations are located in the top-left, bottom-right, centre and centre-left regions of the table in which there is, in most cases, a similarity between the creditor's and debtor's attitude toward risk. In contrast, strong disagreement exists when one of the sides is risk averse while the other is risk lover as their choices lie on opposite sides of the admissible rescheduling curve and the debt Laffer curve.

Table 3 Combinations of types of creditors and debtors and their choices

DEBTOR \ CREDITOR	Risk Averse/Impatient	Risk Averse/Average	Risk Averse/Patient	Risk Neutral/Impatient	Risk Neutral/Average	Risk Neutral/Patient	Risk Lover/Impatient	Risk Lover/Average	Risk Lover/Patient
Risk Averse/ Myopic	C ≻ A	B ≻ A	A = A	D # A	D # A	A/G ≻/# A	E # A	F # A	G # A
Risk Averse/ Average	C ≻ B	B = B	A ≻ B	D ≠ B	D ≠ B	A/G ~/# B	E # B	F # B	G # B
Risk Averse/ Altruist	C = C	B ≻ C	A ≻ C	D ≻ C	D ≻ C	A/G ~/# C	E ≠ C	F # C	G # C
Risk Neutral/ Myopic	C ~/# A/G	B ~/# A/G	A =/# A/G	D # A/G	D # A/G	A/G =or# A/G	E #/~ A/G	F #/~ A/G	G #/= A/G
Risk Neutral/ Average	C = C	B ≻ C	A ≻ C	D ≻ C	D ≻ C	A/G ~/# C	E ≠ C	F # C	G # C
Risk Neutral/ Altruist	C ≻ D	B ≠ D	A # D	D = D	D = D	A/G # D	E ≻ D	F ≠ D	G # D
Risk Lover/ Myopic	C # G	B # G	A # G	D # G	D # G	A/G #/= G	E ≺ G	F ≺ G	G = G
Risk Lover/ Average	C # F	B # F	A # F	D ≠ F	D ≠ F	A/G #/~ F	E ≺ F	F = F	G ≻ F
Risk Lover/ Altruist	C ≠ E	B # E	A # E	D ≻ E	D ≻ E	A/G #/~ E	E = E	F ≺ E	G ≺ E

VI. CONCLUSION

This paper proposed that the set of admissible rescheduling schemes of a sovereign debt can be depicted by a U-shaped curve in the plane spanned by the renegotiated annual debt repayment and the renegotiated repayment period. The classification of creditors and debtors by risk and time preference led to eighty-one distinct combinations. Consensus and good prospects for quickly reaching an agreement may be obtained in the following cases:

- If both the creditor and debtor are risk averse and if the creditor is patient whereas the debtor is myopic, they would both prefer the rescheduling scheme A with the smallest annual repayment and the longest period of repayment.

- If both the creditor and debtor are risk averse and if the creditor is impatient whereas the debtor is altruist, they would both prefer the rescheduling scheme C.

- If both the creditor and debtor are risk averse and having average rate of time preference, they would both prefer rescheduling scheme B with a relatively small annual repayment over a long period.

- If both the creditor and debtor are risk averse and if the creditor has an average rate of time preference and the debtor is altruist, they are likely to reach an agreement about a rescheduling scheme between B and C with a relatively small annual repayment over a considerably long period.

- If the debtor is risk averse and altruist and the creditor is risk neutral and not very patient, or if the creditor is risk averse and impatient and the debtor is risk neutral and altruist, they are likely to reach an agreement about a rescheduling scheme between C and D with a substantial annual repayment over a short period.

- If both the creditor and debtor are risk neutral and if the creditor is not patient and the debtor is altruist, they would both prefer scheme D with the shortest period of debt repayment and a substantial annual repayment.

- If both the creditor and debtor are risk lover and if the creditor is patient whereas the debtor is myopic, they would both prefer scheme G with the largest annual repayment and a considerably long repayment period.

- If both the creditor and debtor are risk lover and if the creditor is impatient whereas the debtor is altruist, they would both prefer scheme E with a substantial annual repayment over a relatively short period.

- If both the creditor and debtor are risk lover and have an average rate of time preference, they would both prefer scheme F with a very large annual repayment over a substantially long period.

- If both the creditor and debtor are risk lover and the creditor is patient (or has an average rate of time preference) whereas the debtor has an average rate of time preference (or is myopic), they are likely to reach an agreement on a scheme between F and G with a high annual payment over a long period.

- If both the creditor and debtor are risk lover and the creditor is impatient (or has an average rate of time preference) whereas the debtor has an average rate of time preference (or is altruist), they are likely to reach an agreement on a scheme between E and F with a large annual payment over medium length period of repayment.

- If the creditor is risk neutral and not very patient and the debtor is risk lover and altruist, they are likely to reach an agreement on a scheme with a short repayment period and a substantially large annual repayment between D and E. Such a rescheduling scheme is also likely to be chosen if the debtor is risk neutral and altruist and the creditor is risk lover and impatient.
- If the debtor is risk neutral and altruist and the creditor is risk averse and impatient, they are likely to reach an agreement on a scheme with a short repayment period and a substantial annual repayment between C and D.

Finally, when it is unclear which of the extreme schemes A and G is preferred by either the creditor, debtor, or both, there is a scope for consensus, but there is also a possibility of strong disagreement. The rest of the combinations reveal a high degree of disagreement about an admissible rescheduling scheme. In such cases, a substantial level of mediation is required.

APPENDIX

Proof of the U-Shaped Admissible Rescheduling Curve's Proposition

Equation 14 can be rewritten as

$$EADR(M)B(T) = D_0 \qquad (A.1)$$

where EADR(M) is explicitly given by equation 9 and

$$B(T) = \beta(1-\beta^T)/(1-\beta). \qquad (A.2)$$

By totally differentiating equation A.1

$$\frac{dT}{dM} \mid D_0 = const. = \frac{-\partial EADR/\partial M}{\partial B/\partial T}. \qquad (A.3)$$

Since $\partial B/\partial T > 0$,

$$sign\left\{\frac{dT}{dM} \mid D_0 = const.\right\} = - sign\left\{\frac{\partial EADR(M)}{\partial M}\right\} \qquad (A.4)$$

and in recalling equation 10,

$$\frac{dT}{dM} \mid D_0 = const. \begin{cases} < 0 \text{ for } & M_{min} \le M < \tilde{M} \\ = 0 \text{ for } & \tilde{M} = M \\ > 0 \text{ for } & \tilde{M} < M < M_{max}. \blacksquare \end{cases} \qquad (A.5)$$

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