NBER WORKING PAPER SERIES

EXTERNAL DEBT, PLANNING HORIZON AND DISTORTED CREDIT MARKETS

Joshua Aizenman

Working Paper No. 2662

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 1988

I would like to thank Enrica Detragiache, Mike Dooley, Elhanan Helpman, Paul Masson, Maurice Obstfeld, Assaf Razin and the participants in the conference on "The International Credit Market: Perspectives and Policy Problems", Organized by Guillermo A. Calvo and Maurice Obstfeld, and the Research Department seminar at the IMF for useful comments. The research reported here is part of the NBER's research program in International Studies. Any opinions expressed are those of the author not those of the National Bureau of Economic Research.

NBER Working Paper #2662
July 1988

EXTERNAL DEBT, PLANNING HORIZON AND DISTORTED CREDIT MARKETS

ABSTRACT

The purpose of this paper is to study the role of policies in the presence of country risk with overdiscounting by the policy maker. Overdiscounting may reflect political uncertainty, which makes the effective planning horizon of the centralized government shorter than that of the private sector. The consequence of overdiscounting is to shift the supply curve facing the economy leftwards. The role of optimal borrowing policies in the presence of country risk is to discourage borrowing for consumption purposes, encourage investment in openness, and discourage investment in activities that reduce openness. The effect of overdiscounting by the policy maker is to increase the values of the optimal policy instruments (i.e. to increase the magnitude of the borrowing taxes and subsidies). Increasing the relative importance of open activities can be viewed as a way to reduce the harmful consequences of overdiscounting. Overdiscounting may rationalize various conditionality clauses that will induce the economy to follow the desired credit market policies.

Joshua Aizenman
The Hebrew University
Jerusalem, Israel
011-972-2-883249

1. INTRODUCTION AND SUMMARY

Most developing countries are presently credit rationed in the international credit markets. This is reflected in the segmentation of the international and domestic credit markets. The domestic market is characterized by high real interest rates where domestic agents find it impossible to raise new external credit. As is well documented in the literature, this situation is related to substantial borrowing in the seventies followed by the reversal of the 'easy borrowing' policy in the early eighties. This reversal corresponds to the growing awareness to the role of country risk in determining international credit flows[1].

The experience of the debtor countries in recent years suggests that there are tight linkages between the political infrastructure in the various countries and the debt problem. Obviously, these linkages are not unique to the debt issue, and a growing literature has studied the interaction between political structure and the economy. The purpose of this paper is to focus on one dimension of these linkages - the possibility that the planning horizon of the policy maker differs from that of the economic agent. This issue may be of special relevance for the default decisions in the context of country risk. Typically, the default decision against external creditors is undertaken by a centralized policy maker whose decision affects the private debtors in his country. The purpose of this study is to investigate the consequences of discrepancies between the policy maker's and the private agents' planning horizons. The importance of differences

---

1 For an analysis of country risk see, for example, Harberger (1976), Kharas (1981), Eaton and Gersovitz (1981), Sachs (1984), Kletzer (1984), Krugman (1985), Smith and Cuddington (1985), Edwards (1985), Folkerts-Landau (1985), Dooley (1986), Aizenman (1986), Bulow and Rogoff (1986), Calvo (1987), Helpman (1987), Alesina and Tabelline (1987) and Aizenman and Borensztein (1988).

between the planning horizons of the private and the public sectors has been recently highlighted in the context of fiscal policy. A growing literature [2] has attributed deviations from Ricardian Equivalence to the possibility that the private sector operates with a shorter planning horizon relative to the public sector because of life-time uncertainty. An important characteristic of country risk is that the opposite presumption may apply - because of political uncertainty, the effective planning horizon of the centralized government may be shorter than that of the private sector. The purpose of this paper is to explore the economic consequences of this presumption.

This research has both positive and normative aspects. At the normative level, it is well understood that country risk may imply that competitive equilibrium is inefficient. This result may explain the role of credit market policies, yet it cannot explain why, frequently, such policies are not voluntarily implemented by the indebted countries themselves. We have frequently observed that rescheduling agreements entail various conditionality clauses attached to the provision of fresh credit. One purpose of our analysis is to demonstrate that various conditionality clauses may be rationalized in a framework where the planning horizon of the centralized decision maker is shorter than that of the representative agent.

We start our analysis by considering the positive aspects of planning horizon discrepancy: we investigate how it affects the behavior of the debtor nation and of the international credit market. We specially investigate the consequences of planning horizon discrepancies on the investment undertaken by the private sector. First we present the case where the only source of uncertainty stems from uncertainties regarding the centralized decision maker's discount factor. The Appendix demonstrates that symmetrical results can be obtained for the case where the centralized decision maker's discount factor is known, and the uncertainty stems from a stochastic default

---

2 See, for example, Blanchard (1985), and Frenkel and Razin (1986).

penalty. Then we explore the normative consequences of exogenous changes in the various variables, such as the volume of investment and consumption borrowing. Such a change may be implemented by conditionality arrangements that set guidelines for domestic credit market policies. We derive the desirable conditions characterizing the proper conditionality in the presence of a limited planning horizon of the centralized decision maker. These conditions are defined by the policies that maximize the expected utility of the representative agent in the economy. We close the paper with concluding remarks regarding extensions and qualifications.

Our key results are that the consequence of overdiscounting by the policy maker is to shift the supply of credit facing the economy leftwards. The role of optimal borrowing policies in the presence of country risk is to discourage borrowing for consumption purposes, encourage investment in openness, and discourage investment in activities that reduce openness[3]. The rationale for these policies is that investment in openness generates positive externality: it increases the penalty associated with default, thereby bonding the policy maker and the country to honor their financial obligations, shifting rightward the supply of credit facing the country. The economic agent does not have the incentive to internalize this effect, and the role of policies is to induce him to do it by taxing activities that reduce openness, and subsidizing (relative to the competitive equilibrium) activities that increase openness.

The effect of overdiscounting by the policy maker is to **increase** the values of the optimal policy instruments. Overdiscounting increases the optimal investment in openness, and reduces the optimal investment in activities that are not biased towards

---

3 Throughout the paper we refer to openness as synonymous with trade dependency. A country is more open if its welfare depends more heavily on international trade, or alternatively if it faces higher costs of trade embargo.

openness. Overdiscounting can be viewed as a new distortion: the policy maker understates the future penalty triggered by default. Consequently, the decision maker defaults too frequently relative to the default rate that maximizes the welfare of the representative consumer. This distortion operates on the top of the distortion introduced by country risk. Increasing the openness of the economy increases the costs of default and reduces the incidence of non-optimal defaults, mitigating thereby the harmful consequences of the distortion generated by the policy maker's short horizon.

In the presence of overdiscounting these policies will not be implemented voluntarily by the decision maker, because he is not maximizing the welfare of the representative consumer. An obvious source of a distortion in the presence of short planning horizon is the default rule in the indebted country. Assuming a given institutional structure we cannot affect the default rule. Instead, a proper conditionality may reduce the consequences of that distortion. Consequently, implementing the policies that maximize the welfare of the representative consumer will require various conditionality clauses that will induce the economy to follow the desired credit market policies.

2. THE MODEL

We construct a simple model to evaluate the dependency of investment decisions and policies on the planning horizon in the presence of country risk. There are three periods. In the first period agents in the economy make the borrowing decisions. The borrowed funds are used to finance investment or consumption. To simplify we assume that, due to relative scarcities of funds, the first period investment is financed by external borrowing. Repayment is due in the second period. Default in the second period triggers a penalty that reduces available resources in the second and third periods. The default decision is made by a centralized policy maker, such as the central bank, who compares the costs and the benefits of a default. Default will occur if the costs fall short of the benefits associated with the default. We study an economy where the central decision maker's planning horizon differs from that of the representative agent[4]. We present the case where the discount factor applied by the centralized decision maker may differ from the one applied by the private agent. In period one there is uncertainty regarding the identity of the decision maker in period two, and thus regarding his future discount factor. The decision maker's discount factor is $\varepsilon \frac{1}{1+\delta}$, where $0 \leq \varepsilon \leq 1$ is a random variable. The available information in period one is summarized by a distribution function of the future values of ε, denoted by $f(\varepsilon)$.

To simplify analysis we consider risk neutral agent whose utility is given by[5]:

---

4 Because the only decision made by the centralized decision maker concerns the default decision in period two we need at least three periods in order to evaluate the role of planning horizon.

5 All the key results of the present paper apply also to the case of a general utility.

$$(1) \qquad U = C_1 + \frac{1}{1+\delta} C_2 + \left(\frac{1}{1+\delta}\right)^2 C_3$$

where δ stands for the subjective rate of time preference and C_t is the consumption of traded goods at time t (t = 1, 2,3).

The role of the centralized decision maker is limited to the default decision and to the implementation of credit market policies. These policies are in the form of borrowing taxes for consumption and investment purposes. We assume that if the country is facing credit rationing the policy maker will impose the appropriate tax on consumption borrowing, denoted by ρ. The purpose of this tax is to capture the wedge between the external supply price of credit and the domestic price of credit needed to clear the domestic market for credit[6]. The domestic interest rates are given by

$$(2) \quad 1 + r = (1 + r^*)(1 + \rho) \quad ; \qquad 1 + r_i = (1 + r^*)(1 + \rho_i)$$

where r^* is the external interest rate facing the country, and ρ_i is the domestic tax on borrowing for investment in activity i, $0 < i \le q$.

The budget constraints for a representative consumer are given by

$$(3) \qquad C_1 = Y_1 + B_c$$

$$(4) \quad C_{2,n} = Y_{2,n} - \{B_c(1 + r) + \sum_{i=1}^{q} I_i(1+r_i)\} + R \, ; \qquad C_{2,d} = Y_{2,d}$$

$$(5) \qquad C_{3,n} = Y_{2,n} \quad ; \qquad C_{3,d} = Y_{2,d}$$

6 For further discussion regarding the role of such a tax see Aizenman (1987).

where $C_{t,d}$ ($Y_{t,d}$) and $C_{t,n}$ ($Y_{t,n}$) stand for consumption (G.N.P.) at time t in case of default (d) and no default (n), respectively. Consumption borrowing and investment borrowing in activity i are denoted by B_c and I_i, respectively. Lump-sum transfers are given by R.

The role of the lump-sur transfer is to rebate the public of the net tax collection generated by credit market policies. To simplify, we focus on the case where investment decisions are carried only in the first period, and we assume equality of output in the second and third period.

Suppose that the value added in sector i depends on two factors. First, it may be affected by the decision regarding default. For example, if default raises the costs of imported inputs it will tend to depress output. Second, the value added in sector i depends positively on the capital stock, which in turn is determined by past investment. We can summarize the value added in sector i at time t by:

$$(6) \quad Y_{t,i} = \begin{cases} Y_{t;i}(n, K_{t;i}) & \text{if no default occurs} \\ Y_{t;i}(d, K_{t;i}) & \text{if default occurs} \end{cases}$$

The GNP in our economy is the sum of the value added in all activities, given by

$$(7) \quad Y_t^s = \sum_{i=1}^{q} Y_{t;i}(s, K_{t;i});$$

where s = n or d (no default or default, respectively) and there are q sectors.[7] Equation (7) should be viewed as a reduced form equation, and Appendix A.1 provides a detailed example of the factors determining the value added.

We define the default penalty (denoted by Ω) as the drop in the GNP resultant from the default: $\Omega = Y_t^n - Y_t^d$ (see Appendix A.1 for the analysis regarding the factors determining Ω).

The default decision is made by the centralized decision maker who compares the cost of default (given by the drop of output by Ω in period two and three) to the gain in period two, given by $(1 + r^*)\bar{B}$, where $\bar{B}$ is aggregate borrowing, given by $\bar{B} = B_c + \sum_{i=1}^{q} I_i$.

Thus, default will occur if

$$(8) \qquad (1 + r^*)\bar{B} > \Omega(1 + \varepsilon \frac{1}{1+\delta})$$

The right-hand side stands for net present value of the default penalty, discounted to the second period applying the decision maker's discount factor, $\varepsilon \frac{1}{1+\delta}$. In the first period ε is unknown, and the information on its possible value is summarized by a density function $f(\varepsilon)$[8]. Let ε_0 be the marginal value of ε associated with default, and defined by:

---

7 Note that the GNP is a function also of the vector of capital $(K_{t,1}, K_{t,2}, \ldots, K_{t,q})$. For notational simplicity this vector is suppressed.

8 To simplify the discussion we treat the political infrastructure generating overdiscounting as exogenously given. One example of an economy generating our results is the case where the government's effective tax collection is a fixed proportion

(8') $(1 + r^*)\bar{B} = \Omega(1 + \varepsilon_0 \frac{1}{1+\delta})$

Assuming symmetric information between lenders and borrowers, if the lenders are risk neutral they will require an interest rate r^* such as

(9) $1 + r_f = (1 + r^*)\Pi$

where r_f is the risk free interest rate and

(9') $\Pi = \int_{\varepsilon_0}^{1} f(\varepsilon)\, d\varepsilon$

Note that Π is the probability of no default, and equation (9) requires equality of expected yield and risk-free yield. The representative agent in the economy is fully informed about the decision rule guiding the centralized decision maker. His expected utility is given by

---

of the private sector's consumption, and these taxes are used to finance the fiscal consumption. Let ε be the probability of government's survival from the second to the third period. The government preferences are given by a separate utility function [like (1)] where we replace the private sector by government consumption (i.e., the public sector's utility is $G_1 + \frac{1}{1+\delta} G_2 + (\frac{1}{1+\delta})^2 G_3$, and $G_i = t\, C_i$). It can be shown that if, in that economy, the government maximizes its expected utility we may generate a default rule of the type summarized by (8). This is only one possible example of an economy where the results of our policy discussion may be relevant.

(10)

$$Y_1 + B_c + \frac{1}{1+\delta}\int_0^{\varepsilon_0} \{Y_{2,n} - \Omega\}\{1 + \frac{1}{1+\delta}\} f(\varepsilon)\, d\varepsilon +$$

$$\frac{1}{1+\delta}\int_{\varepsilon_0}^{1} [Y_{2,n} + R - \{B_c(1+r) + \sum_{i=1}^{q} I_i(1+r_i)\} + \frac{1}{1+\delta} Y_{2,n}]\, f(\varepsilon)\, d\varepsilon$$

where the second and third terms stand for the expected net present value conditional on default and no default decision, respectively.

3. BORROWING FOR CONSUMPTION AND INVESTMENT: THE AGENT PROBLEM

A representative agent will choose consumption and investment as to maximize the expected utility, given by (10). Assuming that each agent is price taker, he views his borrowing as negligible relative to the aggregate borrowing of the country. Thus, he treats the probability of default (and consequently ε_0) as being exogenously given to him. The condition for optimal consumption borrowing (assuming an internal equilibrium) is obtained by maximizing (10):

$$(11) \qquad 1 = \frac{1}{1+\delta}(1+r) \ \Pi$$

Applying (2) and (9) we get a unique borrowing tax consistent with internal equilibrium with positive borrowing. This tax is given by

$$(12) \qquad \tilde{\rho} = (\delta - r_f)/(1 + r_f)$$

Since we assumed that consumers are risk neutral and that the rate of time preference rate is constant, then for a tax rate below $\tilde{\rho}$ consumers will borrow until the credit constraint is reached, and for a tax rate above $\tilde{\rho}$ no borrowing for consumption will occur[9]. We will assume an internal equilibrium where the tax $\tilde{\rho}$ is imposed. At that

---

9 Once the credit constraint is reached the policy maker will impose the tax $\tilde{\rho}$ to capture the wedge between the external supply price of credit and the domestic price of credit that is needed to clear the domestic market for credit. For further discussion regarding the role of such a tax see Aizenman (1987).

tax consumers are indifferent to the volume of consumption borrowing. As we will demonstrate later the optimal level of consumption borrowing will be obtained by also taking into consideration the 'social' consequences of country risk on the default penalty.

The investment in activity i is determined by the following condition [derived by maximizing (10)][10]:

(13) $NVMP_i = (1 + r_f)(1 + \rho_i)$

where $NVMP_i = (\frac{\partial Y_2}{\partial I_i} - \{1 - \Pi\} \frac{\partial \Omega}{\partial I_i})(1 + \frac{1}{1+\delta})$.[11]

This condition equates the net present value of the marginal productivity of investment to the expected marginal costs of investment. Note that the left hand side of (13) is the expected net present value of the marginal product of investment, taking into consideration the consequences of the investment on the expected default penalty. The right hand side is the expected cost of borrowing. We close this section by evaluating the consequences the overdiscounting on the supply of credit facing the country and on the level of investment. Appendix A.3 demonstrates that higher overdiscounting will shift the supply credit facing the economy leftward. Thus, given borrowing will be associated with a raise in the interest rate facing the country and a drop in the probability of repayment (Π). Inspection of the investment rule (13) shows that this

---

10 We use the fact that (9) implies that

$$(1 + r_f)/(1 + r^*) = \int_{\varepsilon_0}^{1} f(\varepsilon)\, d\varepsilon$$

11. Alternatively, $NVMP_i = (\frac{\partial Y_2}{\partial I_i} - \frac{r^* - r_f}{1+r^*} \frac{\partial \Omega}{\partial I_i})(1 + \frac{1}{1+\delta})$.

adjustment implies a drop in the expected marginal product of capital, thereby reducing the investment.

4. OPTIMAL BORROWING: OVERDISCOUNTING AND THE ROLE OF POLICIES AND CONDITIONALITY

We would like to evaluate the role of policies in the presence of limited planning horizon. These policies may be either in the form of conditionality imposed by international institutions or in the form of taxes and subsidies implemented domestically. The presumption is that in the presence of overdiscounting these policies will not be implemented voluntarily by the decision maker, because he is not maximizing the welfare of the representative consumer[12]. Consequently, implementing the policies that maximize the welfare of the representative consumer may require various conditionality clauses. We start our analysis by evaluating how marginal change in borrowing will affect the expected utility. We can accomplish this by differentiating the expected utility subject to the constraint on the supply of credit [i.e., where ε_0 and r^* are determined by (8') and (9)].

The expected utility is given by[13]

---

12 Maximizing the welfare of the representative consumer will require a default rule like (8) with no overdiscounting (i.e., with $\varepsilon = 1$). As is elaborated in footnote 8, the decision rule in our paper may reflect uncertainty regarding the survival of the policy maker and is consistent with the case where the policy maker maximizes his own expected welfare.

13. Equation (14) is obtained by applying the assumption that the lump-sum transfers are rebating the consumer of the net collection of borrowing taxes.

(14) V =

$$Y_1+B_c + \frac{1}{1+\delta}\int_0^{\varepsilon_0}\{Y_2 - \Omega\}\, f(\varepsilon)d\varepsilon + \frac{1}{1+\delta}\int_{\varepsilon_0}^{1}\{Y_2 - (1+r^*)(B_c + \sum_{i=1}^{q} I_i)\}f(\varepsilon)\, d\varepsilon$$

$$+ \left(\frac{1}{1+\delta}\right)^2 \int_0^{\varepsilon_0}\{Y_2-\Omega\}f(\varepsilon)\, d\varepsilon + \left(\frac{1}{1+\delta}\right)^2\int_{\varepsilon_0}^{1} Y_2\, f(\varepsilon)\, d\varepsilon$$

As is shown in Appendix A.2 , marginal changes in B_c and I_i (i = 1, ...q) will change the expected utility by:

(15) ΔV =

$$\left\{1 - \frac{1+r_f}{1+\delta}\left[1 + \frac{\bar{B}}{B_c}\eta_c\{1 + U\}\right]\right\}\Delta B_c +$$

$$\sum_{i=1}^{q} \frac{1}{1+\delta}\left\{NVMP_i - (1+r_f)\left[1 + \frac{\bar{B}}{I_i}\eta_i\{1+U\}\right]\right\}\Delta I_i$$

where $U = \dfrac{\Omega/(1+\delta)}{\bar{B}(1+r^*)}(1 - \varepsilon_0)$; $\eta_c = d\log(1 + r^*)/\, d\log B_c$;

and $\eta_i = d\log(1+r^*)/\, d\log I_i$.

U measures the relative importance of overdiscounting the future default costs by the policy maker, and it is zero if no overdiscounting occurs (i.e. if ε_0 = 1)[14]. η_c and η_i are

---

14. Note that $\varepsilon_0/(1+\delta)$ is the decision maker's marginal discount factor associated with default. For this decision maker the future costs of default are $\Omega\, \varepsilon_0/(1+\delta)$ (in terms of the second period). For the economic agent the future costs of

the elasticities of the interest rate with respect to borrowing for consumption and investment.

Equation (15) has been derived for the case where the source of uncertainty is stochastic rate of time preference (or equivalently stochastic overdiscounting). Our welfare discussion in thi section will be based on that equation. Appendix A.4 demonstrates that the same equation can be derived for the case where the source of uncertainty is stochastic future productivity and where the overdiscounting by the decision maker is exogenously given. Consequently, it can be shown that all the welfare discussion in this section applies to both cases: stochastic productivity and stochastic overdiscounting.

Marginal borrowing will change welfare by the sum of the initial distortion times the change in the distorted activity. The distortions in the various activities are given by the terms in large brackets in (15), which measure the wedge between the marginal benefit and the marginal social cost associated with extending the distorted activities. For example, a raise in consumption at period one will increase welfare by 1, but will generate a marginal cost of $\frac{1+r_f}{1+\delta}[1 + \frac{\bar{B}}{B_c}\eta_c\{1 + U\}]$. The value of η_c is the elasticity of the interest rate with respect to consumption borrowing. In the absence of country risk $\eta_c = 0$ and the cost of borrowing is simply given by the the risk-free interest rate discounted by the rate of time preference. With country risk and full discounting (U=0) the social cost of

---

default are $\Omega/(1+\delta)$ (in terms of the second period). Consequently, $\frac{\Omega/(1+\delta)}{\bar{B}(1+r^*)}(1-\varepsilon_0)$ is the penalty overdiscounted by the decision maker relative to the debt due in the second period.

consumption borrowing is given by expected discounted increase in future repayment[15]. Country risk introduces a distortion that raises the social cost of funds. The distortion arises from the fact that individual borrowers treat the rate of interest as given even though, from the perspective of the country as a whole, the rate of interest increases with the volume of consumption borrowing due to the rise in the probability of default. Each small consumer overlooks the marginal rise in the probability of default induced by his marginal borrowing. The increase in the probability of default entails a negative externality because of the consequent rise in the expected default penalty inflicted on all domestic consumers.

As can be seen from (15), country risk increases the expected social cost of consumption borrowing at a rate of $\frac{\bar{B}}{B_c} \eta_c \{ 1 + U\}$. If the policy maker's discount factor equals that of the economic agent (i.e., if $1 = \varepsilon_0$ and thus $U = 0$), the social cost will increase at a rate given by the weighted interest rate elasticity $(\frac{\bar{B}}{B_c} \eta_c)$. The implication of overdiscounting by the policy maker is that the policy maker defaults 'too frequently', relative to the desired default by a representative consumer, because he

15. Note that the social cost of consumption borrowing for $\varepsilon_0 = 1$ is $\frac{\Pi}{1+\delta} \frac{d[(1+r^*)\bar{B}]}{dB_c}$, where Π is the probability of no default. Applying definitions one can show that $\frac{\Pi}{1+\delta} \frac{d[(1+r^*)\bar{B}]}{d\,B_c} =$ $\frac{1+r_f}{1+\delta} [1 + \frac{\bar{B}}{B_c} \eta_c]$. This will be the case with full discounting by the policy maker ($\varepsilon = 1$), where the uncertainty is due to a stochastic default penalty generated by a productivity shock [see Aizenman (1987) for such an example, and Appendix A.4 for an example with a fixed overdiscounting in the presence of productivity shock].

overlooks some of the future costs of default. This result in increasing the distortion introduced by country risk by $\frac{\bar{B}}{B_c}\eta_c U$.

Similar interpretation applies to the welfare change introduced by marginal investment borrowing: the benefit of investment in period two is $NVMP_i$ (in terms of the second period). The marginal social cost of the funds is $(1 + r_f)[\, 1 + \frac{\bar{B}}{I_i}\eta_i \{ 1 + U\}]$, and country risk and short planning horizon increase the costs of funds at a rate of $\frac{\bar{B}}{I_i}\eta_i\{ 1 + U\}$.

We can apply (15) to infer the conditions characterizing the optimal allocation, by equating the terms in the large brackets to zero. This allocation can be obtained by a proper conditionality. An obvious source of distortion is the default rule in the indebted country. This rule reflects the overdiscounting due to the limited planning horizon of the decision maker. Assuming a given institutional structure we cannot affect the default rule. Instead, a proper conditionality may attempt to reduce the distortions (holding the institutional structure as given). From (15) we infer that the proper 'quotas' for consumption and investment borrowing are given by the conditions:

$$(16) \qquad \frac{\delta - r_f}{1+r_f} = \frac{\bar{B}}{B_c}\eta_c \{ 1 + U\}$$

$$(17) \qquad NVMP_i = (1 + r_f)[\, 1 + \frac{\bar{B}}{I_i}\eta_i \{ 1 + U\}]$$

Recalling that with the borrowing tax $\tilde{\rho}$ consumers are indifferent to the volume of consumption borrowing, equation (16) determines the condition for the socially desirable level of consumption borrowing. Equation (17) determines the optimal investment rule. Comparing (17) to (13) shows that the optimal investment can be implemented by imposing investment borrowing taxes at a rate of ρ_i. With this tax the interest rate for investment in activity i is given by $(1+r^*)(1+\rho_i)$, where :

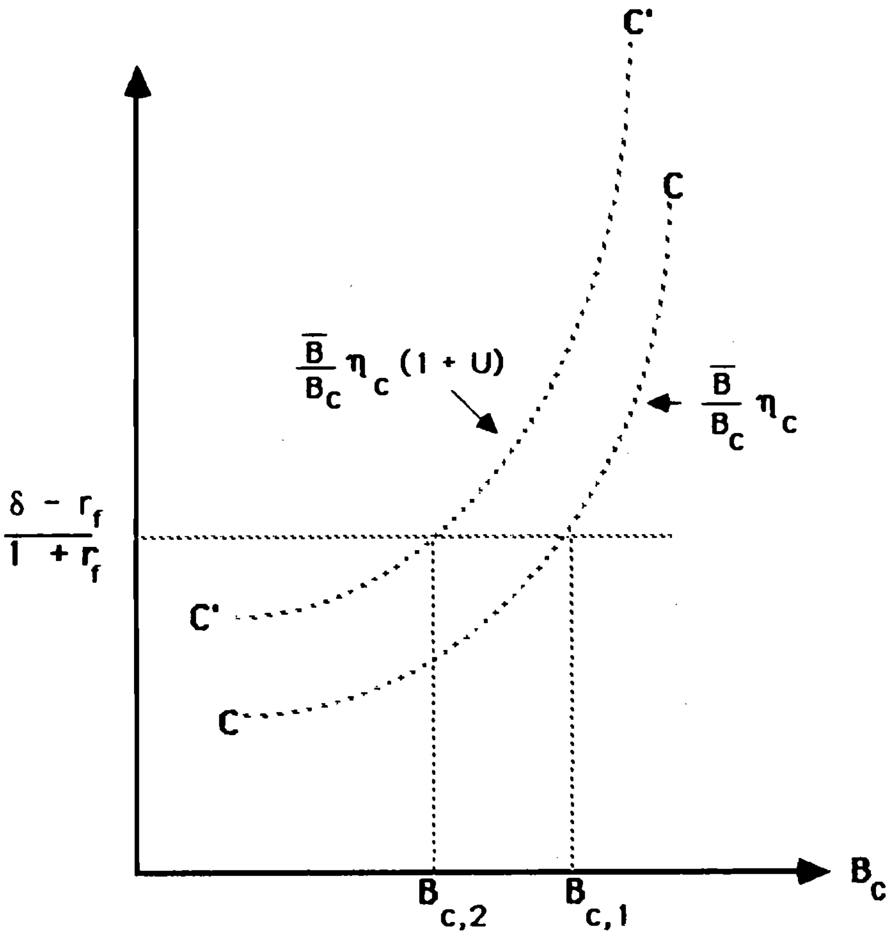
$$(18) \qquad \rho_i = \frac{\bar{B}}{I_i} \eta_i \{ 1 + U\}$$

Inspection of (16) and (18) reveals that two key factors determine the optimal borrowing for consumption and investment in activity i. The first is the elasticity of the interest rate with respect to use of funds (η_c and η_i), and the second is the relative importance of the overdiscounting, as measured by U. As is shown in Appendix A.3, the elasticity of the interest rate with respect to borrowing reflects the marginal contribution of the borrowing to the country risk characteristics of the economy, and is determined by the use of funds (see equations (A15) and (A19)).

In the case of consumption borrowing, the interest elasticity η_c reflects the inverse of the elasticity of supply of credit, and it approaches infinity as we approach the credit ceiling. As is shown in Appendix A.3, in the presence of country risk η_c measures the increase in the probability of default resultant from the increase in indebtedness. Figure one summarizes the factors determining the optimal level of consumption borrowing[16]. In the absence of overdiscounting the consumption borrowing is given by $B_{c,1}$, and with overdiscounting it is given by $B_{c,2}$. A rise in country risk (i.e. a higher η_c) or higher overdiscounting will shift CC (and C'C') leftwards, thus reducing the desired level of consumption borrowing.

---

16. Curves CC and C'C' slop upwards, corresponding to the assumption that due to the presence of country risk we operate on the upper sloping portion of the supply of credit, where higher indebtedness reduces the elasticity of the supply of credit (thereby increasing η_c).



C'
C
$\frac{\overline{B}}{B_c}\eta_c(1+U)$
$\frac{\overline{B}}{B_c}\eta_c$
$\frac{\delta - r_f}{1 + r_f}$
C'
C
B_c
$B_{c,2}$
$B_{c,1}$

FIGURE 1

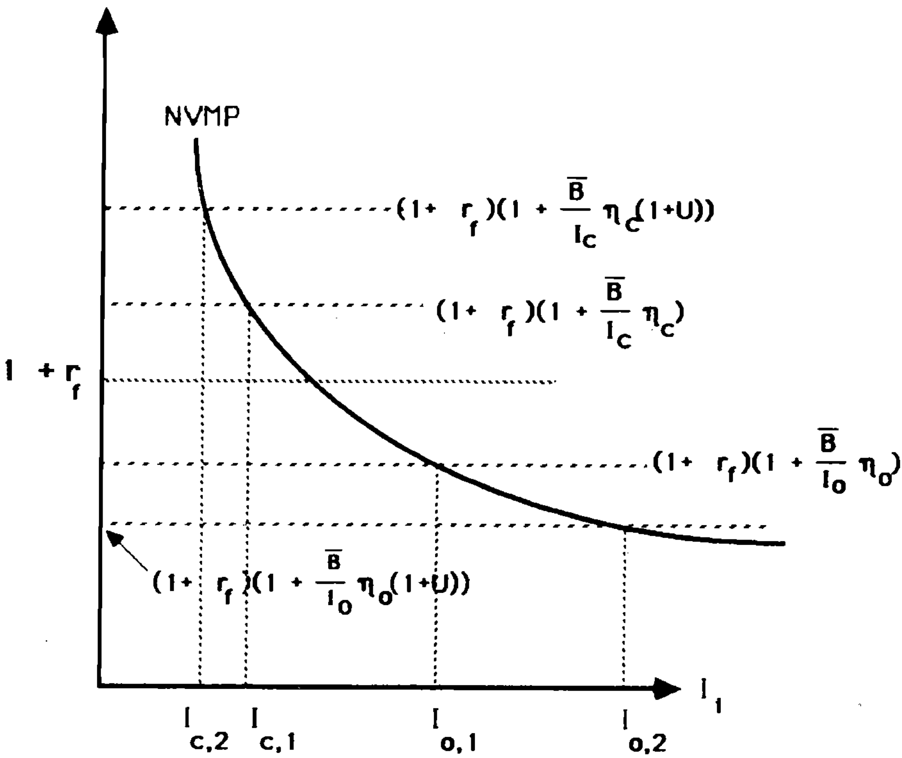
Unlike consumption borrowing, marginal investment borrowing affects the interest rate in two opposite directions (see Appendix A.3 for the derivation of this result). First, marginal borrowing raises total indebtedness, thus increasing the probability of default. This effect is similar to that observed for consumption borrowing. Second, the investment also changes the productive capacity of the economy, thereby affecting the default penalty and the probability of default[17]. We refer to these two effects as the indebtedness and openness effects. The indebtedness effect reflects an upward move on the given supply of credit facing the economy, whereas the openness effect reflects the consequences of the investment on the location of the supply of credit[18]. As is shown in Appendix A.3, the elasticity η_i is the sum of both effects (see (A19)). The optimal borrowing tax balances these two effects. The stronger the openness effect, the lower the optimal investment borrowing tax (18), and if the openness effect dominates, the elasticity η_i and the corresponding borrowing tax will be negative.

Figure 2 describes optimal investment. Curve NVMP depicts the dependency of the expected marginal productivity of capital on the investment. We consider investment in two types of activities, according to their relative openness, as measured by the elasticity η_i. The elasticity η is negative (positive) for a sector biased in favor (against) international trade. This point is developed and justified in Appendix A.3, where we provide the economic interpretation for the bias in favor (or against) trade in terms of the relative importance of the sector in determining the default penalty. In Figure 2 we describe the investment in two activities that differ in terms of their openness as reflected in the value of η. We denote the elasticities of the 'relatively' open and closed

---

17. For example, investment in a sector that depends heavily on international trade raises the default penalty and reduces thereby the probability of default.

18. Note that the location of the supply of credit facing the economy is conditional on the vector of capital $(K_{t,1}, K_{t;2}, ..., K_{t,q})$. Thus, investment will affect its location.



NVMP
(1+ r_f)(1 + B̄/I_c η_c(1+U))
(1+ r_f)(1 + B̄/I_c η_c)
1 + r_f
(1+ r_f)(1 + B̄/I_o η_o)
(1+ r_f)(1 + B̄/I_o η_o(1+U))
I_1
I_c,2
I_c,1
I_o,1
I_o,2

FIGURE 2

activity by η_o and η_c. The level of optimal investment in the open sector is given by $I_{o,1}$ and $I_{o,2}$ for the case where there is no overdiscounting (U = 0) and the case where there is overdiscounting (U > 0) , respectively. Similarly, the level of optimal investment in the relative closed sector is given by $I_{c,1}$ and $I_{c,2}$ for the case where overdiscounting U = 0 and U > 0, respectively[19]. Note that in the absence of investment policies there is a uniform interest rate applied for all activities. Thus, the role of optimal investment policies is to encourage investment in openness, and to discourage investment in activities that reduce openness. As is shown in Appendix A.3, a rise in the openness of an activity reduces the corresponding η_i, shifting down the horizontal schedule in Figure 2[20], thus increasing the optimal investment. The rationale for this effect is that investment in openness generates positive externality: it increases the penalty associated with default, thereby bonding the country to honor its financial obligations, thus shifting rightward the supply schedule facing the country. The economic agent does not have the incentive to internalize this effect, and the role of policies is to induce him to do so by taxing activities that reduce openness, and by subsidizing (relative to the competitive equilibrium) activities that increase openness.

Figure 2 also shows the optimal investment consequence of higher overdiscounting by the policy maker (i.e. an increase in U). It tends to encourage investment in openness, and to discourage investment in activities that are not biased towards openness. In terms of Figure 2, a higher U will shift upwards (downwards) the horizontal line for activities with positive (negative) η, reducing (increasing) the optimal investment. Thus, overdiscounting by the policy maker should increase the optimal

---

19. In Figure 2 we assume that both sectors have the same expected marginal productivity schedule.

20. This is the schedule given by $(1 + r_f)(1 + \frac{\bar{B}}{I_i}\eta_i)$.

investment in sectors biased in favor of trade and reduce the optimal investment in activities not biased in favor of trade. Increasing the relative importance of open activities can be viewed as a way to reduce the harmful consequences of overdiscounting.

Overdiscounting can be viewed as a new distortion: the policy maker understates the future penalty triggered by default. Consequently, the decision maker defaults too frequently relative to the default rate that maximizes the welfare of the representative consumer. This distortion operates in addition to of the distortion introduced by country risk. The role of optimal policies is to mitigate the effect of overdiscounting: increasing the openness of the economy increases the costs of default and reduces the incidence of non-optimal defaults, mitigating thereby the harmful consequences of the distortion generated by the policy maker's short horizon. Optimal policies also call for a further reduction in consumption borrowing; the short-horizon of the policy maker causes too frequent defaults (relative to what is optimal for the representative consumer), and tightening consumption borrowing can be viewed as another way of reducing the frequency of the non-optimal defaults. Note that as long as the policy maker's consumption (or the public sector's consumption) is positively correlated with private consumption, optimal policies in the presence of overdiscounting will call for fiscal contraction[21]. It is noteworthy that the optimal policies have been derived by maximizing the representative consumer's welfare. In the presence of overdiscounting by the policy maker these optimal policies will deviate from those policies viewed as

---

21. This result follows from the observation that part of the borrowing for consumption may be used to increase the public sector's consumption. Consequently, cutting borrowing for consumption also has the consequence of reducing the fiscal deficit.

optimal by the policy maker in the developing country. Overcoming this conflict will require conditionality attached to the provision of credit, and may justify an active role for international institutions in intermediating between the policy maker and the international banking system[22].

5. CONCLUDING REMARKS

Throughout the paper we have assumed the presence of a centralized decision maker, who undertakes the decision regarding the default and who implements policies. We studied the potential consequences of overdiscounting by the policy maker. Our key results are that the consequence of overdiscounting is to shift the supply curve facing the economy leftwards. In the context of desirable credit market policies, overdiscounting by the policy maker increases the tax on borrowing for consumption purposes and for investment in sectors that are not biased towards international trade; it also increases the subsidy for borrowing for investment in sectors heavily biased towards international trade. We conclude with an outline for a possible extension of our analysis and some qualifying remarks.

Our discussion provided a rather narrow interpretation of the optimal policies. We interpreted the optimal polices in the form of borrowing taxes and subsidies that generate the proper wedge between the external interest rate facing the economy and the internal interest rate facing the representative agent. A dual representation of the

22. It can be shown that if the policy maker is confronted with an all-or-nothing option (i.e., borrowing with the attached conditionality or no access to the international credit market) he is better off with the conditionality.

various policies is in the form of corresponding taxes and subsidies applied to sectorial investment and for the saving and borrowing decisions[23].

We concluded that in the presence of overdiscounting the optimal degree of openness (or trade dependency) exceeds the one ·red by the policy maker. It is noteworthy that our discussion overlooked several ...portant factors that are relevant for a more complete determination of the optimal degree of openness. First, openness has the consequence of reducing the exposure to domestic shocks, and increasing the exposure to external shocks. Second, one should recognize that the ability of developing nations to increase openness is conditional on the willingness of the developed nations to tolerate it. Both factors may dampen the optimal degree of openness. Our analysis can be extended to account for these factors by allowing for the presence of domestic and foreign shocks and by considering a more symmetric world where developing nations have a certain market power.

Our analysis should be viewed only as an example intended to highlight a more general point: country risk and overdiscounting by the policy maker generate an environment where the optimal openness form the point of view of private agents may exceed the optimal openne... :orm the point of view of the policy maker, justifying conditionality attached to new credit. This result should apply also to alternative models. We considered the case where the costs of default are the result of trade embargo. If one believes that the default costs are in the form of embargo on future

---

23. According to this interpretation agents are free to borrow in the international capital market but are taxed (or subsidized) according to the domestic activities that they choose to engage in. The duality between the two interpretations of the policies discussed in the paper is similar to the duality between commercial policy and the equivalent set of taxes cum subsidies on domestic activities (like consumption and production).

borrowing and trade credits, then the optimal policies should encourage the activities that are most vulnerable to a credit embargo. We modeled the case where the embargo is in the form of a hike in the effective price of imports. If the embargo reduces the effective price of exportables, then the policies should also encourage exportables.

One important limitation of our discussion is that we treat the overdiscounting and the political infrastructure in the economy as exogenously given. A useful extension of the paper may integrate the logic of the present discussion in a political economy framework, where overdiscounting is endogenously generated. Another limitation of our analysis is with regard to informational assumptions. We treated the case where there is full information on the use of external credit obtained via the central bank, and the structure of optimal policies is conditional on this information. Suppose, instead, that there is no information on the marginal use of credit due to full fungibility, and all that is known is the average use of funds. In such an economy there is room only for one uniform borrowing tax, whose value is determined as a weighted average of the taxes derived in the present paper, where the weights reflect the average use of funds. In general, however, the policy maker has an information set in between these two extreme assumptions: fungibility of funds is feasible for small-scale projects, but may be harder in major projects that can be monitored at a lower cost. In such an environment the key results of our paper will hold, after the proper adjustment for monitoring costs is made.

APPENDIX

The purpose of this Appendix is to provide a detailed discussion on the derivations of the key equation in the text. Appendix A.1 derives the default penalty endogenously. Appendix A.2 studies the welfare consequences of exogenous changes in borrowing. Appendix A.3 determines the linkages between openness and the interest elasticity of consumption and investment borrowing and evaluate the consequence of a raise in overdiscounting on the supply schedule facing the economy. Appendix A.4 extends the discussion to the case of stochastic productivity.

A.1 The Default Penalty

In the paper we considered the case where the default penalty Ω is exogenously given. We start the Appendix by deriving the default penalty endogenously. For simplicity we give an example of a two-sectorial economy. Our analysis applies also to an economy with any number of sectors. Output is produced by domestic and imported inputs. The two sectors differ in terms of their reliance on international trade. A default results in a rise in the price of imported inputs. The various sectors differ in their dependency on importable goods. For example, consider an economy where output in sector i (denoted by X_i) is produced by the following process:

$$\text{(A1)} \qquad X_i = \Psi (K_i)^{\alpha} (M_i)^{\beta_i} \qquad ; \qquad \alpha + \beta_i < 1 ;$$

where K_i and M_i are the capital and the imported inputs used in sector i, and Ψ is a productivity measure. The only difference between the two sectors is that they differ in their dependence on international trade. One of them, sector 1 for example, is more dependent on international trade (i.e. ,$\beta_2 < \beta_1$). Thus, we can refer to β_i as a measure of the "openness", or the reliance on international trade of activity i. In the short run, the stock of capital is exogenously given. We denote the price of the imported input by

P_m, and we assume that P_m is determined by the policies of the country. In the absence of default the country faces the international price of P_m, assumed to be unity. A default will have the consequence of triggering a penalty due to a trade embargo. A simple way to capture the penalty is to assume that the trade embargo will raise the price of imported inputs at a rate of p_m, such that in states of default the effective costs of importables facing the country is exp (p_m), where $p_m > 0$.

Producers in each sector maximize profits in two ways. In the first period, producers will choose the optimal investment which will determine the capital stock in the second and the third period. Within each period the stock of capital is given, and producers will choose the imported input M in order to maximize profits. Short-run profit maximization with respect to the use of importable M yields the following value for output

$$\text{(A2)} \qquad X_i = c_i \left[\frac{\Psi}{(P_m)^{\beta_i}} \right]^{1/(1-\beta_i)} (K_i)^{\alpha/(1-\beta_i)}$$

where $c_i = (\beta_i)^{\beta_i/(1-\beta_i)}$. Thus, a rise of P_m from 1 to exp (p_m) is associated with a change of output at a rate of:

$$\text{(A3)} \qquad \exp(-\{\beta_i/(1-\beta_i)\}p_m) - 1 \approx -\{\beta_i/(1-\beta_i)\}p_m.$$

Note that a portion β_i of output is spent on the imported input. Thus, the value added is:

$$Y_i = (1-\beta_i)X_i,$$

and (A3) implies that the drop in value added in sector i resulting from the default is

$(1 - \beta_i)X_{n,i}\{\beta_i/(1-\beta_i)\}p_m = \beta_i X_{n,i} p_m.$

Aggregating the drop in the value added across sectors gives us:

$$\text{(A4)} \qquad \Omega \approx [\beta_1 X_{n;1} + \beta_2 X_{n;2}]\, p_m ; \qquad \text{where}$$

$$X_{n;i} = c_i (\Psi)^{1/(1-\beta_i)} (K_i)^{\alpha/(1-\beta_i)}$$

for i = 1,2 (c_i are constants).

The default penalty can be approximated by the sum of output in the various sectors in states of no default, weighted by a measure of the reliance on trade (the β_i 's) times the increase in imported inputs prices, p_m. Equivalently, the default penalty equals the increase in the cost of imported inputs resultant from the default. The reliance on international trade (as measured by the importance of the imported input, β_i) plays a key role in determining the relative importance of sector i in the aggregate default penalty. A sector that is shielded from international trade would not play a role in the determination of the aggregate default penalty. These observations will play a key role in determining the elasticity of the interest rate with respect to investment (η_i) and in determining optimal tax on borrowing for investment in sector i. An investment in an activity with a larger "openness" index β_i will cause a greater increase in the the default penalty, causing a larger increase in the probability of no default. Throughout the paper we treat productivity Ψ as a constant. Appendix A.4 extends the discussion to the case where the source of randomness is stochastic productivity.

A.2 The Welfare Consequences Of Exogenous Changes in Borrowing

The purpose of this part is to derive equation (15), determining the consequences of marginal consumption and investment borrowing on the expected welfare position of the representative agent. Direct derivation of (14) shows that

(A5) $\partial V / \partial B_c =$

$$1 + \frac{1}{1+\delta}[(1+r*)\bar{B} - \Omega] f(\varepsilon) \frac{\partial \varepsilon_0}{\partial B_c} - \frac{1}{1+\delta} \int_{\varepsilon_0}^{1} \frac{\partial[(1+r*)\bar{B}]}{\partial B_c} f(\varepsilon)\, d\varepsilon$$

$$- \{\frac{1}{1+\delta}\}^2 \Omega f(\varepsilon) \frac{\partial \varepsilon_0}{\partial B_c} .$$

Note that $\frac{\partial[(1+r*)\bar{B}]}{\partial B_c} = \frac{(1+r*)\bar{B}}{B_c} \eta_c$ and $\int_{\varepsilon_0}^{1} f(\varepsilon)\, d\varepsilon = \Pi$. Thus,

$\frac{1}{1+\delta} \int_{\varepsilon_0}^{1} \frac{\partial[(1+r*)\bar{B}]}{\partial B_c} f(\varepsilon)\, d\varepsilon = \frac{1+r_f}{1+\delta} \frac{\bar{B}}{B_c} \eta_c$. Applying this result to (A5) we get, after collecting terms, that:

(A6) $\partial V / \partial B_c =$

$$1 + \frac{1}{1+\delta}[(1+r*)\bar{B} - \Omega\{1 + \frac{1}{1+\delta}\}] f(\varepsilon) \frac{\partial \varepsilon_0}{\partial B_c} - \frac{1+r_f}{1+\delta} \frac{\bar{B}}{B_c} \eta_c.$$

Applying the default rule (8') we get $(1+r*)\bar{B} - \Omega\{1 + \frac{1}{1+\delta}\} =$

$\Omega \frac{1}{1+\delta}(\varepsilon_0 - 1)$. Consequently,

(A7) $\partial V / \partial B_c =$

$$1 - \frac{1}{1+\delta} \Omega \frac{1}{1+\delta}(1 - \varepsilon_0) f(\varepsilon) \frac{\partial \varepsilon_0}{\partial B_c} - \frac{1+r_f}{1+\delta} \frac{\bar{B}}{B_c} \eta_c.$$

Applying (9) we get

$$\text{(A8)} \qquad f(\varepsilon)\,\frac{\partial \varepsilon_0}{\partial B_c} = \frac{\Pi}{B_c}\,\eta_c \;\; ; \;\; f(\varepsilon)\,\frac{\partial \varepsilon_0}{\partial I_i} = \frac{\Pi}{I_i}\,\eta_c$$

Applying (A8) to (A7), collecting terms and using the definition of U [below (15)] we get

$$\text{(A9)} \qquad \partial V / \partial B_c = 1 - \frac{1+r_f}{1+\delta}\,[\,1 + \frac{\bar{B}}{B_c}\,\eta_c\,\{\,1 + U\}]$$

We turn now to the derivation of $\partial V / \partial I_i$.

Direct derivation of (14) shows that

$$\text{(A10)} \qquad \partial V / \partial I_i =$$

$$\frac{1}{1+\delta}\,[\,(1+r*)\bar{B} - \Omega]\,f(\varepsilon)\,\frac{\partial \varepsilon_0}{\partial I_i} - \{\frac{1}{1+\delta}\}^2\,\Omega\,f(\varepsilon)\,\frac{\partial \varepsilon_0}{\partial I_i}$$

$$- \frac{1}{1+\delta}\int_{\varepsilon_0}^{1} \frac{\partial[(1+r*)\bar{B}]}{\partial I_i}\,f(\varepsilon)\,d\varepsilon + \frac{1}{1+\delta}\,NVMP_i$$

Applying the steps described in the derivations of (A6)-(A9) we get, after collecting terms

$$\text{(A11)} \qquad \partial V / \partial I_i = \frac{1}{1+\delta}\left\{NVMP_i - (1 + r_f)[\,1 + \frac{\bar{B}}{I_i}\,\eta_i\,\{\,1 + U\}]\right\}$$

Note that

$$\text{(A12)} \quad \Delta V = \{\partial V / \partial B_c\} \Delta B_c + \{\partial V / \partial I_i\} \Delta I_i$$

Applying (A9) and (A11) to (A12) we obtain equation (15).

A.3 Openness and the Interest Elasticity of Consumption and Investment Borrowing

We now turn to the derivation of the value of the interest rate elasticities with respect to consumption and investment borrowing, η_c and η_i. Equation (8') implies that for ΔB_c, assuming $\Delta I_i = 0$ for all activities

$$\text{(A13)} \quad \bar{B}\,\Delta(1 + r*) + (1 + r*)\,\Delta B_c = \frac{\Omega}{1+\delta}\,\Delta\varepsilon_0$$

Applying equations (9) and (9') we get

$$\text{(A14)} \quad \Delta\varepsilon_0 = \frac{\Pi}{f(\varepsilon_0)(1+r*)}\,\Delta(1 + r*)$$

Solving (A13) and (A14) simultaneously we infer that

$$\text{(A15)} \qquad \eta_c = \frac{B_c f(\varepsilon_0)(1+r*)}{\frac{\Omega\Pi}{(1+\delta)} - f(\varepsilon_0)\bar{B}(1+r*)}$$

The interest rate elasticity with respect to consumption borrowing is zero for small borrowing, and initially it grows with the volume of borrowing. We reach the credit ceiling for $\bar{B} = \frac{\Omega\Pi}{f(\varepsilon_0)(1+r*)(1+\delta)}$.

We now turn to the derivation of the interest rate elasticity with respect to investment borrowing. Applying (8') we infer that for ΔI_i , assuming $\Delta B_c = 0$ and $\Delta I_j = 0$ for $i \neq j$:

$$\text{(A16)} \quad \bar{B}\,\Delta(1 + r*) + (1 + r*)\,\Delta I_i = \frac{\Omega}{1+\delta}\,\Delta\varepsilon_0 + (1 + \frac{\varepsilon_0}{1+\delta})\,\Delta\Omega$$

Applying (A4) we infer that

$$\text{(A17)} \qquad \Delta\Omega = \beta_i\, MPK_{n,i}\; p_m\;\Delta I_i$$

where $MPK_{n,i}$ is the marginal product of capital in sector i (in the absence of default). Applying (A2) we infer:

$$\text{(A18)} \quad MPK_{n;i} = \frac{\alpha}{1-\beta_i}\frac{X_{n;i}}{K_i}$$

Note that equation (A14) continues to hold. Solving (A16)-(A18) simultaneously, applying (A14), we get that

$$\text{(A19)} \qquad \eta_i = \eta_c\,[1 - s_i\frac{\alpha}{1-\beta_i}\frac{\bar{B}}{K_i}]\,\frac{I_i}{B_c}$$

where s_i is the i's sector share in the aggregate penalty

$$s_i = \frac{\beta_i X_{n;i}}{\beta_1 X_{n;1} + \beta_2 X_{n;2}}$$

We can define the openness of a given activity by its contribution to the default penalty (s_i). It is determined by the reliance on imported inputs, β_i. A sector that does not

import goods has $\beta = 0$, and consequently its share in the penalty is zero ($s_i = 0$). As (A19) reveals, for such a sector the interest elasticity with respect to investment borrowing in that activity is positive and equals $\eta_c \frac{I_i}{B_c}$. A higher openness is associated with a higher β_i and s_i. Inspection of (A19) shows that a higher openness of an activity i will reduce the interest rate elasticity with respect to investment in that activity. For high enough openness this elasticity may be even negative (for
$K_i < s_i \frac{\alpha}{1-\beta_i} \bar{B}$).

Note that we can rewrite (A19) as

$$\text{(A19')} \qquad \eta_i = \eta_c \frac{I_i}{B_c} - s_i \frac{\alpha}{1-\beta_i} \frac{\bar{B}}{K_i} \eta_c \frac{I_i}{B_c}$$

The elasticity η_i is the sum of two terms. The first reflect the move on the given supply curve. We refer to this move as the indebtedness effect (it is obtained from (A16) for $\Delta\Omega = 0$). The second term reflect the shift of the supply schedule associated with the investment. We refer to this shift as the indebtedness effect (it is obtained from (A16) for $\Delta(1 + r^*) = 0$).

Note that our analysis considered the case where the default penalty stems from e increase in the prices of imported inputs. A similar analysis can be made for the case where the default reduces the price of exports.

We now turn to evaluate the consequence of a raise in overdiscounting on the supply schedule facing the economy. The overdiscounting is summarized by the distribution $f(\varepsilon)$. We will refer to distribution f' as representing a higher overdiscounting relative to f if for all ε ($0 < \varepsilon < 1$) the cumulative density of f' is above the cumulative density of f, or formally if

$$\text{(A20)} \qquad \text{for all} \quad 0 < \varepsilon < 1 \qquad \int_{\varepsilon}^{1} f'(\varepsilon)\, d\varepsilon < \int_{\varepsilon}^{1} f(\varepsilon)\, d\varepsilon.$$

We define a distribution f^h for $0 < h < 1$ by $f^h = f + h(f' - f)$. We will refer to a rise in the overdiscounting as a rise in h, shifting f^h closer to f'. We will derive the consequences of higher overdiscounting on the supply of credit, or $\Delta r^*/\Delta h$ for a given $\bar{B}$. The supply schedule corresponding to f^h is defined by equations (8'), (9) and (9') (replacing f with f^h). Applying these equations we can infer that a higher h changes the interest rate (for a given borrowing) by

$$\text{(A21)} \quad \frac{\Delta r*}{\Delta h}\Big|_{\text{given borrowing}} = \eta_c \frac{\Omega}{B_c(1+\delta) f h} \int_{\varepsilon_0}^{1} [f(\varepsilon) - f'(\varepsilon)] d\varepsilon$$

Note that from the definition (A20) it follows that $\int_{\varepsilon_0}^{1} [f(\varepsilon) - f'(\varepsilon)] d\varepsilon > 0$, thus the sign of (A21) is determined by η_c, implying that a rise in overdiscounting will shift the supply curve facing the economy leftward.

A.4 Stochastic Productivity

Throughout the paper we assumed that the only source of randomness is the uncertainty regarding the time preference of the decision maker. This assumption was made to simplify the discussion. We close our discussion by extending our analysis to the case where the source of uncertainty is a stochastic future productivity. We assume that the rate of time preference of the future policy maker equals $\varepsilon'/(1+\delta)$, and, for simplicity, we consider now the case where ε' is known with certainty.

Equations (1)-(5) continue to hold. We now modify the output equation by allowing for stochastic productivity. Consequently, output is given by:

$$(6') \quad Y_{t;i} = \begin{cases} Y_{t;i}\,(\Psi, n, K_{t;i}) & \text{if no default occurs} \\ Y_{t;i}\,(\Psi, d, K_{t;i}) & \text{if default occurs} \end{cases}$$

where Ψ is a stochastic productivity term whose density function is given by g, and we assume that $\Delta Y_{t;i}/\Delta\Psi > 0$ and $\Delta\Omega/\Delta\Psi > 0$. An example of such an economy is provided in part A.1 of this Appendix. While equation (7) continues to apply, we modify the default rule (8) to reflect the new source of uncertainty. Default will occur if

$$\text{(A22)} \qquad (1 + r*)\bar{B} \; > \; \Omega(1 + \varepsilon' \frac{1}{1+\delta})$$

The source of uncertainty is the future default penalty, which will be determined in our case by the realization of Ψ. Let us define the marginal value of the productivity shock associated with default by Ψ_0:

$$\text{(A23)} \qquad (1 + r*)\bar{B} \; = \; \Omega(\Psi_0)\,(1 + \varepsilon' \frac{1}{1+\delta}).$$

The interest rate is determined by the equality of the expected yield to the risk-free yield:

$$\text{(A24)} \quad 1 + r_f = (1 + r*) \int_{\Psi_0}^{\infty} g(\Psi)\, d\Psi$$

The expected utility of the representative agent is:

$$\text{(A25)} \qquad Y_1 + B_c + \frac{1}{1+\delta} \int_0^{\Psi_0} \{Y_{2,n} - \Omega\}\{1 + \frac{1}{1+\delta}\}\, g(\Psi)\, d\Psi +$$

$$\frac{1}{1+\delta} \int_{\Psi_0}^{\infty} [Y_{2,n} + R - \{B_c(1 + r) + \sum_{i=1}^{q} I_i(1+r_i)\} + \frac{1}{1+\delta} Y_{2,n}]\, g(\Psi)\, d\Psi$$

The source of uncertainty is now stochastic productivity and not uncertainty regarding the future discount rate. Nevertheless, it can be verified that all the results regarding policies continue to hold. Specifically, Equations (11')-(13) and (15)-(18) continue to hold subject to the following replacements: ε_0 is replaced by ε'; Ω is replaced by Ω evaluated at Ψ_0 ($\Omega(\Psi_0)$); and $NVMP_i$ is replaced by the expected value of $NVMP_i$ (denoted by $E\{NVMP_i\}$). It can be shown that

$$\text{(15')} \qquad \Delta V = \quad \left\{1 - \frac{1+r_f}{1+\delta} [\, 1 + \frac{\bar{B}}{B_c} \eta_c \{ 1 + U\}]\right\} \Delta B_c +$$

$$\sum_{i=1}^{q} \frac{1}{1+\delta} \left\{E\{NVMP_i\} - (1 + r_f)[\, 1 + \frac{\bar{B}}{I_i} \eta_i \{ 1 + U\}]\right\} \Delta I_i$$

where $U = \dfrac{\Omega/(1+\delta)}{\bar{B}(1+r*)} (1 - \varepsilon')$.

Applying (15') we can show that all the key results regarding the consequences of overdiscounting and the role of policies (Sections 3-4) continue to hold if the source of uncertainty is future productivity instead of the future discount factor[24]. Note that the interpretation of productivity shocks is broad, and that one can implement our analysis to the case where the productivity uncertainty stems from uncertainty regarding future terms of trade or regarding future input prices.

24. For example, a drop in underdiscounting shifts the supply schedule to the right. Formally, it can be shown that for a given interest rate $\frac{d \log \overline{B}}{d \log \varepsilon'} = U \frac{\varepsilon'}{1-\varepsilon'} > 0$. It can be also shown that the characteristics of optimal conditionality (equations (16)-(18)) continue to hold for the case where uncertainty is due to stochastic productivity.

REFERENCES

Aizenman, Joshua. "Country Risk, Incomplete Information and Taxes on International Borrowing," manuscript, 1986.

__________ and Eduardo R. Borensztein. "Debt and Conditionality under Endogenous Terms of Trade Adjustment," manuscript, The International Monetary Fund, 1988.

Alesina Alberto and Guido Tabellini. "External Debt, Capital Flight and Political Risk", manuscript, 1987.

Blanchard, Olivier J. "Debt, Deficits, and Finite Horizon", **Journal of Political Economy** 93, 1985.

Bulow I. Jeremy and Kenneth Rogoff. "A Constant Recontracting Model of Sovereign Debt," manuscript ,1986.

Calvo, Gulliermo. "Debt Repudiation: The Role of Expectations, "manuscript ,1987.

Dooley, Michael P. "Country-Specific Risk Premiums, Capital Flight and Net Investment Income Payments In Selected Developing Countries", manuscript, the International Monetary Fund, 1986.

Dornbusch, Rudiger. "External Debt, Budget Deficits and Disequilibrium Exchange rates," NBER Working Paper No. 1336, 1984.

Eaton, Jonathan and Mark Gersovitz. "Debt with Potential Repudiation Theoretical and Empirical Analysis," **Review of Economic Studies** 48, 1981.

Edwards, Sebastian. "Country Risk, Foreign Borrowing and the Social Discount Rate in an Open Developing Economy," NBER Working Paper Series No. 1651, 1985.

Folkerst-Landau David. " The Changing Role of International Bank Lending in Development Finance" **The I. M. F. Staff Papers** 32, 1985.

Frenkel, Jacob A. and Assaf Razin. "Fiscal Deficits in the World Economy, " **Journal of Political Economy** 94, 1986.

Harberger, Arnold C. "On Country Risk and the Social Cost of Foreign Borrowing by Developing Countries," manuscript, 1976.

Helpman, Elhanan. "The Simple Analytics of Debt-Equity Swaps", manuscript, 1987.

Kharas, Homi, J. "Constrained Optimal Foreign Borrowing by L.D.C. 's" Domestic Finance Study No. 75, **The World Bank**, Washington, D.C., 1981.

Kletzer, Kenneth M. "Asymmetries of Information and LDC borrowing with Sovereign Risk," **Economic Journal** 94, 1984.

Krugman, Paul. "International Debt Strategies in an Uncertain World," in Smith, W.G. and Cuddington, J. T., eds., "International Debt and the Developing Countries", A World Bank Symposium, **The World Bank**, Washington, D.C., 1985.

Sachs, Jeffery D. "Theoretical Issues in International Borrowing," **Princeton Studies in International Finance** 54, 1984.

Smith, Gordon, W. and John T. Cuddington. "International Debt and the Developing Countries," A World Bank Symposium, **The World Bank**, Washington, D.C., 1985.