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THE UNIVERSITY OF WOLLONGONG
DEPARTMENT OF ECONOMICS

THE ANALYSIS OF THE POTENTIAL
EXTERNALITIES AFFECTING THE
BORROWING BEHAVIOUR OF
DEVELOPING COUNTRIES

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Abstract

This paper deals with the externalities associated with the individual developing country's cost of credit and borrowing level. As long as the supply curve of credit is positively sloped, the interest rate charged on credit extended to a particular developing country is affected by the aggregate borrowing level of the rest of the countries. Moreover, the relatively high level of indebtedness of big developing countries and their problems to service their external debts, might adversely affect the reputation of the developing countries as a whole and reduce their financial credibility. The estimation of the interest rate equations confirms the significant role of these externalities in explaining the cost of credit to individual countries in the three distinct developing regions of Latin America, sub-Saharan Africa, and Asia-Pacific. Furthermore, since the individual country's information about the borrowing of the other debtor countries is not perfect, this country perceives the interest rate on loans taken as a random variable, and hence might suffer from substantial costs of risk bearing. The implications of this type of externality on the borrowing behaviour of developing countries are analyzed within the context of a stochastic framework in which countries borrowing large amount of money behave like Stackelberg leaders. The estimation of the derived borrowing equations are found to be statistically significant in the cases of Latin America and Asia-Pacific.

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1. INTRODUCTION

While capital accumulation, per-capita income, and income inequality were the predominant issues of development economics in the post-world war II era, it is the external debts of the less developed countries that have captured the attention of development economists as well as the attention of main stream economists in the last decade. During the 1970's and the 1980's the aggregate indebtedness of developing countries grew very rapidly leading to a heightened concern about their ability to repay their debts. The growing debts also led to an increase in income inequality and poverty levels caused by the cuts in subsidies and wages prescribed by debt-relief programmes. According to Berg and Sachs' (1988) estimation results, this increase in the income inequality and poverty levels might raise the probability of insolvency and the need for debt rescheduling and discount; and hence intensifies the already mounting tension between the developing countries and the industrialized countries even further.

Furthermore, the large external debts accumulated by the LDCs tended further to adversely affect their growth prospects. Thus, Krugman (1989) and Sachs (1988, 1989) argue that high governmental debt-service payments require high tax rates that discourage capital formation and repatriation of flight capital. Similarly, Dornbusch (1988) argues that the fact that the government is the main maker of debt-service payments in most of the heavily indebted countries moderates the improving effect of devaluation on the trade balance. The underlying reason is that a devaluation raises the domestic-currency costs of servicing the foreign-currency debt. Thus in turn, increases the budget deficit, raises the inflation rate, and reduces the competitiveness of the country's export. As a result, most of the LDCs have seen their growth rates slow, and many have seen living standards that were often already pitifully low fall even further.

The major sources of continuous and rapid accumulation of external debts by the LDCs are: (1) inefficient allocation of resources stemming from inward-looking trade policy supported by tariffs and licences; (2) domestic instability and inflation; (3) the dramatic increase of oil prices in the 1970s followed by the rapid decline of these prices in the 1980s; and (4) the rise of the inflation rate in the U.S. and Western Europe in the

early 1980s, that led to a hike of the interest rate. The present paper is concerned with the externalities affecting the later factor.

In addition to the inflation in the creditors' countries, the interest rate charged on the individual developing country's liabilities might also reflect this country's financial position in the credit market. However, there might be other factors, that are external to the individual developing country, affecting the cost of credit and providing further explanation of the rapid growth of the country's level of indebtedness. As long as the supply curve of credit is positively sloped, the interest rate charged on credit extended to a particular country should be affected by the aggregate borrowing level of the rest of the countries. Moreover, the relatively high level of indebtedness of large developing countries, such as Brazil and Mexico in Latin America and Nigeria and Zaire in Sub-Saharan Africa, and their problems to service their external debts, might adversely affect the reputation of the developing countries as a whole and reduce their financial credibility.

The purpose of this paper is to explore, test, and quantify the effects of the aforementioned external factors on the cost of credit for the individual developing country and its level of borrowing. The assessment of the role of these external factors is carried out in the following sections. Section 2 presents a statistical summary of the external debt, external debt burden, and interest rate for three developing regions — Latin America, Sub-Saharan Africa, and Asia-Pacific-- in the period 1975-1986. Section 2 also compares the time trajectories of the interest rate and tests whether the differences in interest rates charged on credit extended to these regions are statistically significant. Confirmation of this hypothesis might indicate the existence of fundamental differences among the three developing regions with regard to access to credit suppliers and level of indebtedness and hence support the classification of the developing countries by regional affiliation. Section 3 takes into account credit-supply's considerations, and estimates the external effects of the regions' level of indebtedness and borrowing on the interest rate charged on credit extended to each individual country.

Furthermore, since the individual country does not have full information about the borrowing of its counterpart debtors, it perceives the interest rate on loans taken as a random variable, and hence might suffer from substantial costs of risk bearing. Section 4

analyzes the implications of this type of externality, as well as the implications of the aforementioned externalities associated with the cost of credit, on the borrowing behaviour of developing countries within the context of a stochastic framework, in which countries borrowing large amounts of money behave like Stackelberg leaders — maximizes expected utility from consumption subject to their resource constraint while taking into account the reaction of the following smaller borrowing countries. The parameters of the resultant Stackelberg equilibrium borrowing equations for leading and following developing countries are estimated for each region, and the existence of external effects on their borrowing behaviours is tested in Section 5.

Finally, a conceptual analysis of a jointly co-ordinated credit system, which takes into account global welfare considerations as well as the individual country's welfare, and which is capable of moderating the potential adverse effects of the aforementioned externalities, is briefly described in Section 6.

2. THE BURDEN OF THE EXTERNAL DEBT AND INTEREST RATES

Developing countries are often affiliated to regional reference groups such as Latin America, Sub-Saharan Africa, and Asia-Pacific. The underlying rationale is that greater geographical affinity facilitates transfer of both positive and negative externalities between countries. It is therefore possible that the well-being of an individual country is affected by the overall performances of its reference group.

A statistical summary of the aggregate level of indebtedness of the aforementioned regional groups and the interest rates paid on their external liabilities is given in Table 1 below for the period 1975-1986 that encompasses the aftermath of the first oil shock, the second oil shock, the oil glut and the fall of the oil prices, and the rise of the interest rates. This table presents the evolution of the absolute external debt level (in billions of 1985 U.S. Dollars) of each regional group as a whole (ΣD), as well as the proportions of these levels of external debts of the regional groups' aggregate output (d) which can be viewed as indicators of the regional groups' average abilities to service their debts. The average annual real interest rates (r) are proxied by the ratios of interest payments (public plus

private) made by the regional groups during each year to the aggregate external debt levels at the beginning of the year. It is important to note that in many incidences the actual interest payments were smaller than the due ones. In these incidences, the ratio of interest payments to external debt level understates the interest rates agreed upon. It is assumed that such downward biased effective interest rates were a-priori expected by the creditors and were incorporated into their decisions about the supply of credit to various countries.

Table 1. The total external debt (in Billions of U.S. 1985 dollars), average debt burden, and average real interest rates for Latin America, Sub-Saharan Africa, and Asia-Pacific*

	Latin America			Sub-Saharan Africa			Asia-Pacific		
Year	ΣD	d	r	ΣD	d	r	ΣD	d	r
1975	93.691	0.1497	0.0618	25.203	0.2698	0.0299	57.567	0.1587	0.0242
1976	111.664	0.1531	0.0658	28.052	0.3065	0.0266	62.436	0.1732	0.0276
1977	129.187	0.1537	0.0569	31.309	0.3193	0.0281	67.597	0.1741	0.0298
1978	155.800	0.2080	0.0657	37.161	0.2674	0.0278	71.193	0.1746	0.0316
1979	168.957	0.2062	0.0821	41.259	0.3084	0.0328	68.568	0.1668	0.0404
1980	171.044	0.1888	0.1027	43.930	0.3011	0.0445	72.835	0.1623	0.0398
1981	182.673	0.1892	0.1039	45.930	0.3429	0.0371	74.053	0.1643	0.0404
1982	194.586	0.2451	0.1079	47.970	0.3843	0.0364	83.130	0.1858	0.0407
1983	240.062	0.3486	0.0899	52.006	0.4456	0.0356	91.839	0.2128	0.0410
1984	259.680	0.4045	0.0819	50.152	0.5539	0.0413	95.168	0.2285	0.0434
1985	270.968	0.4252	0.0865	55.294	0.6157	0.0390	109.004	0.2598	0.0404
1986	288.880		0.0745	67.539		0.0201	99.513		0.0415
Average r			0.0816				0.0333		
Stand. Dev. r			0.0165				0.0067		

Table 1 reveals that the external debts and debt burden of the three regional groups increased substantially during the inspected period. On the average the Latin American countries had larger external debts than the Asia-Pacific and African countries. The Latin American and African groups' debt-burden indices rose dramatically during the 1980s due to the increase in the absolute level of indebtedness as well as to the decline in the aggregate product. In contrast, the Asia-Pacific's debt burden rose very moderately due to a lower rate of increase in the absolute level of indebtedness and a lower rate of decline in the aggregate product. While the interest rate on credit extended to the Latin American countries rose substantially and steadily to a peak of 10.79 percent in 1982, it varied very moderately for the Sub-Saharan African and Asia-Pacific countries. Furthermore, the average annual real interest rate for the Latin American group was substantially higher than that of the other reference groups. During the inspected period, the average annual real interest rate differentials between the Latin American group and the Sub-Saharan African and Asia-Pacific groups were 4.83 percent and 4.49 percent, respectively. These differentials are statistically significant at the 5 percent level of confidence. The statistical test reveals further that the interest rate differential between the Asia-Pacific group and the Sub-Saharan African group is insignificant. These interest rate differentials suggest that there are fundamental differences among the three developing regions with regard to access to credit suppliers and level of indebtedness, and hence support the classification of the developing countries by regional affiliation.

3. EXTERNALITIES, CREDIT SUPPLY'S CONSIDERATIONS, AND THE ESTIMATION OF THE INTEREST RATE EQUATION

Under the assumption that a greater geographical affinity tends to facilitate the transfer of both positive and negative externalities between countries, it seems reasonable to hypothesize that the cost of credit for any country might be directly related to the current borrowing and initial levels of indebtedness of the group of countries with which it is associated, as well as to its own current borrowing and initial level of indebtedness. There are two ways by which developing countries belonging to a common regional group inflict such external effects on one another:

1. Given that the credit supply curve is positively sloped, the greater the group's aggregate borrowing, the higher the cost of credit to the individual country.
2. The greater the indebtedness level of the rest of the countries, the greater their incentive to repudiate and hence the lower the expected debt repayment. The decrease in the group's overall credibility leads creditors to charge higher interest rates on new loans extended to the country in order to accommodate the excessive risk.

In view of the aforementioned externalities and credit supply's considerations, it is suggested that the average interest rate (r) charged on the i -th country's borrowing at period t can be expressed in mathematical notations by the following ad-hock equation:

$$r_i = r_1 D_{i,t-1} + r_2 \frac{1}{N-1} \sum_{j \neq i}^N D_{j,t-1} + r_3 B_{it} + r_4 \sum_{j \neq i}^N B_{jt} \quad (1)$$

where, $j=1,...,N$ denotes the countries belonging to the regional group which the i -th country is affiliated to; $D_{i,t-1}$ and $D_{j,t-1}$ are the i -th and the j -th countries' external debts at the end of the previous period, respectively; B_{it} is the i -th country's borrowing at period t ; B_{jt} is the j -th country's borrowing at period t ; and r_1, r_2, r_3 , and r_4 are parameters representing the effects of these factors, respectively, on the i -th country's assessment of the average cost of its new borrowing.

The purpose of this section is to estimate the unknown parameters of equation 1 in order to provide a preliminary assessment of the external effect of the regional reference group's aggregate level of indebtedness and borrowing on the cost of credit for the individual country member. The estimation of the interest rate equation is carried out with annual observations on countries listed in Table 1 and classified to the aforementioned regional groups for the period 1975 - 1986. All of the explanatory variables are expressed in millions of 1985 U.S. dollars. The estimation results are summarized in Table 2. An alternative specification of the interest-rate equation, in which the debt-

product ratios of the regional group and the individual country replace the respective absolute levels of debts, leads to significantly less satisfactory estimation results.

Table 2. The estimated interest rate equation; coefficients for Latin America, Sub-Saharan Africa and Asia-Pacific*

Explanatory variables	Estimated parameters for three reference groups		
	Latin America	Sub-Saharan Africa	Asia-Pacific
D_i	0.9991398E-06 (6.579)	0.4317022E-05 (5.476)	0.1771181E-06 (0.764)
$\frac{1}{N-1} \sum_{j \neq i}^N D_j$	0.2764420E-06 (14.038)	0.6253893E-06 (10.898)	0.5774115E-06 (15.470)
B_i	-0.8877093E-06 (0.784)	-0.4906530E-05 (1.954)	0.3498145E-05 (1.474)
$\sum_{j \neq i}^N B_j$	0.4149293E-06 (2.405)	-0.2749078E-06 (0.657)	0.2003761E-06 (0.498)
R^2	0.250	0.017	0.022
F-test	293.201	138.354	121.854
d.f.	260	314	122

*The t-ratios are indicated in the parentheses.

As indicated by the F-test values, the estimation results of the interest rate equation's parameters as a whole are statistically significant for the three regional groups of developing countries. Most particularly, the t-ratios show that for all of the three regional groups the initial level of indebtedness of a country as well as the initial level of indebtedness of the regional group to which the country is affiliated have, as expected, significant positive effects on the interest rate on that country's current borrowing. Only in the case of Asia-Pacific this effect of the individual country's level of indebtedness is statistically insignificant. Moreover, in the case of Asia-Pacific, the effect of an infinitesimal increase in the affiliation group's level of indebtedness on the interest rate on

the individual country's liabilities exceeds the effect of an infinitesimal increase in that country's own liabilities. If the likelihood of repudiation increases with the level of indebtedness, these findings imply that an increase in the level of indebtedness of a country and/or an increase in the level of indebtedness of the rest of the countries affiliated to the same regional group reduce that country's reputation in the credit market and hence raise the cost of its current borrowing.

A further indication of negative external effects among countries belonging to a regional group is that in the case of Latin America the aggregate current borrowing level of the rest of the countries significantly increases the cost of credit for the individual country member. The existence of this source of external effect was not confirmed for Sub-Saharan Africa and Asia-Pacific. A possible explanation to this variation in the estimation results is that, due to their low levels of per-capita income, a major part of the African and Asia-Pacific countries' credit is provided by non-profit international funds, whereas the medium-income countries of Latin America rely more heavily on credit supplied by commercial banks. This distinction may also explain the significantly negative effect of the country's current borrowing on the interest rate for sub-Saharan African countries. The existence of structural differences in the credit supply across the three regional groups is indicated further by Chow tests.

4. UNCERTAINTY, RISK AVERSION, AND THE BORROWING BEHAVIOUR OF LDCs IN A STACKELBERG EQUILIBRIUM

While the previous section's empirical ad-hock analysis of the supply of credit lends support to the hypothesis that the greater the reference group's aggregate borrowing and level of indebtedness, the higher the cost credit to the individual country; this section considers the implications of these external factors with a broader and more elaborate framework that also takes into account credit-demand's considerations. In this framework, each individual country maximizes expected utility from consumption and investment and takes into account the external effect inflicted by the rest of the countries' financial position and borrowing behaviour on its consumption possibilities. Moreover, it is assumed that the individual country does not have full information about the borrowing

of its counterpart debtor countries. Instead, it perceives the interest rate on loans taken during the present period as a random variable, and thus might suffer from substantial costs of risk bearing.

The following analysis is based on the assumption that the i -th country forms its expectations about the interest rate (r_{it}^e) rationally by incorporating the credit-supply's considerations according to equation 1 and its assessment of the borrowing level of the rest of the countries. It is postulated that the i -th country's borrowing at t is chosen to maximize the country's (or the representative agent's) expected utility from private consumption and investment and government spendings (C) subject to its perceived resource constraint:

$$C_{it} = \alpha_i B_{it} y_{it} + NIM_{it} - RPM_{it} - IPL_{it} - r_{it}^e B_{it}. \quad (2)$$

In this formulation y_i denotes the average productivity of a borrowed dollar directed to a production activity, and α_i is the proportion of the borrowing abroad serves to finance domestic production activities. The rest, $(1 - \alpha_i)B_{it}$, helps to finance the net import of consumption and investment goods (NIM), repayments of principal that matured (RPM), interest payments on liabilities accumulated previously (IPL) and on current borrowing.

The model refers to two Sub-groups of countries in a given reference group distinguished by the scale of their borrowing abroad — the big borrowers vis-a-vis the smaller borrowers. In which case it seems reasonable to say that the Sub-group of the big borrowers is behaving as a leader (L) in a Stackelberg setting and the Sub-group of the smaller borrowers is behaving as a follower (F). The Stackelberg equilibrium is found by computing the follower's reaction to a given borrowing level of the leader. This reaction is incorporated, in turn, into the leader's decision about the optimal borrowing level.

The computation of the follower's reaction function assumes that the follower does not have full information about the leader's borrowing level, but that the follower's expectations about the leader's borrowing level are unbiased and normally distributed with finite variances σ_{Lt}^2 :

$$B_{Lt}^e \sim N(B_{Lt}, \sigma_{Lt}^2). \quad (3)$$

This assumption and equations 1 and 2 imply that the follower's private and public consumption and investment (C_{Ft}) is normally distributed with mean and variance equal to:

$$E(C_{Ft}) = \alpha_F B_{Ft} y_{Ft} + NIM_{Ft} - RPM_{Ft} - IPL_{Ft} - [r_1 D_{Ft-1} + r_2 D_{Lt-1} + r_3 B_{Ft} + r_4 B_{Lt}] B_{Ft} \quad (4)$$

$$VAR(C_{Ft}) = r_4^2 \sigma_{Lt}^2 B_{Ft}^2. \quad (5)$$

Assuming for tractability that the follower's preferences over C_{Ft} can be represented by a negative exponential utility function reflecting constant absolute risk aversion, the follower's current borrowing is found by maximizing the difference between the mean of C_{Ft} and the costs of risk-bearing that are equal to half the product of the variance of C_{Ft} and the follower's degree of absolute risk aversion (R_F):

$$\max_{B_{Ft}} [E(C_{Ft}) - 0.5 R_F VAR(C_{Ft})] \quad (6)$$

(See Freund, 1956, for a rigorous development of the mean-variance expected utility function, and Hammond, 1974, and Meyer, 1987, for a discussion of the generality of this framework.)

The first-order condition for maximum implies that the expected increase in the Follower's private and public consumption and investment from an additional dollar borrowed abroad (i.e., the marginal product of credit minus the marginal interest payment on credit) is offset by the increase in its costs of risk bearing stemming from the uncertainty about the leader's borrowing level :

$$\alpha_F y_{Ft} - [r_1 D_{Ft-1} + r_2 D_{Lt-1} + 2r_3 B_{Ft} + r_4 B_{Lt}] = R_F r_4^2 \sigma_{Lt}^2 B_{Ft}. \quad (7)$$

The second-order condition for maximum

$$-2r_3 - R_F r_4^2 \sigma_{L_t}^2 < 0 \quad (8)$$

is satisfied as long as the marginal costs of credit for the follower are increasing.

The necessary condition for maximum implies that the reaction of the follower's borrowing to the leader's borrowing is given by:

$$B_{F_t} = \beta(\alpha_F y_F - r_1 D_{F_{t-1}} - r_2 D_{L_{t-1}} - r_4 B_{L_t}) \quad (9)$$

where

$$\beta = 1/(2r_3 + R_F r_4^2 \sigma_{L_t}^2) \quad (10)$$

is by the second-order condition for maximum a positive term. Equations 9 and 10 imply that for any given leader's borrowing level, the follower's demand for credit is equal to the difference between the marginal product of a dollar borrowed abroad and the marginal cost stemming from the follower's and leader's initial levels of indebtedness and the leader's current borrowing, divided by twice the marginal cost stemming from the follower's own borrowing and risk bearing.

The computation of the leader's borrowing level assumes that the leader maximizes utility from private and public consumption and investment subject to the follower's reaction function specified above. Given that the parameters of the follower's reaction function and the follower's initial level of indebtedness are known to the leader, the leader's costs of risk bearing are nil. This implies in turn that, in view of the mean-variance expected utility specification and equations 1, 2 and 9, the leader's decision problem can be rendered as:

$$\begin{aligned} \max_{B_{L_t}} \{ & \alpha_L B_{L_t} y_{L_t} + MIN_{L_t} - RPM_{L_t} - IPL_{L_t} \\ & - [r_1 D_{L_{t-1}} + r_2 D_{F_{t-1}} + r_3 B_{L_t} + r_4 \beta(\alpha_F y_F - r_1 D_{F_{t-1}} - r_2 D_{L_{t-1}} - r_4 B_{L_t})] B_{L_t} \}. \end{aligned} \quad (11)$$

The resultant necessary condition for maximum implies that the leader's borrowing in a Stackelberg equilibrium ($B_{L_t}^*$) is given by:

$$B_{Lt}^* = \gamma[(\alpha_L y_{Lt} - r_4 \beta \alpha_F y_{Ft}) - (r_1 - r_2 r_4 \beta) D_{Lt-1} - (r_2 - r_1 r_4 \beta) D_{Ft-1}] \quad (12)$$

where

$$\gamma = 1/(2r_3 - 2r_4^2 \beta). \quad (13)$$

Correspondingly, the follower's borrowing level in a Stackelberg equilibrium (B_{Ft}^*) is found by substituting equation 12 for B_{Lt} in equation 9:

$$\begin{aligned} B_{Ft}^* &= \beta(1 - r_4^2 \beta \gamma) \alpha_F y_{Ft} - r_4 \beta \gamma \alpha_L y_{Lt} - \beta[(r_1 - r_2 r_4 \gamma + r_1 r_4^2 \beta \gamma)] D_{Ft-1} \\ &\quad - \beta[(r_2 - r_1 r_4 \gamma + r_2 r_4^2 \beta \gamma)] D_{Lt-1} \end{aligned} \quad (14)$$

Equations 12 and 14 implies the following propositions about the leading and following Sub-groups' borrowing behaviour in a Stackelberg equilibrium.

Proposition 1 (the effect of D_{Lt-1} on B_{Lt}^*):

$$\frac{dB_{Lt}^*}{dD_{Lt-1}} \begin{matrix} \geq \\ < \end{matrix} 0$$

$$\text{as } \frac{r_1}{r_2} \begin{matrix} \geq \\ < \end{matrix} \frac{r_4}{2r_3 + R_F r_4^2 \sigma_{Lt}^2}$$

Proposition 1 implies that the likelihood that the leader's initial debt level deters its borrowing at present:

- rises with the follower's costs of risk bearing stemming from the uncertainty about the leader's borrowing at present ($R_F \sigma_{Lt}^2$),
- rises with the effect of the leader's initial debt level on the interest rate charged on its own borrowing at present (r_1),
- declines with the effect of the follower's initial debt level on the interest rate charged on the leader's borrowing at present (r_2) through a decline in the credibility of the reference group to which the leader and the follower are affiliated.

Proposition 2 (the effect of D_{Ft-1} on B_{Lt}^*):

$$\frac{dB_{Lt}^*}{dD_{Ft-1}} \gtrless 0$$

$$\text{as } \frac{r_2}{r_1} \gtrless \frac{r_4}{2r_3 + R_F r_4^2 \sigma_{Lt}^2}$$

Proposition 2 implies that the likelihood that the follower's initial debt level deters the leader's borrowing at present:

- rises with the follower's costs of risk bearing stemming from the uncertainty about the leader's borrowing at present ($R_F \sigma_{Lt}^2$),
- declines with the effect of the leader's initial debt level on the interest rate charged on its own borrowing at present (r_1),
- rises with the effect of the follower's initial debt level on the interest rate charged on the leader's borrowing at present (r_2) through a decline in the credibility of the reference group to which the leader and the follower are affiliated.

Proposition 3 (the effect of D_{Ft-1} on B_{Ft}^*): If $\gamma > 0$, then :

$$\frac{dB_{Ft}^*}{dD_{Ft-1}} \gtrless 0$$

$$\text{as } \frac{r_2}{r_1} \gtrless \frac{r_4(1-2r_4)}{2r_3 + R_F r_4^2 \sigma_{Lt}^2} + \frac{2r_3}{r_4}.$$

(A proof is provided in the Appendix.)

Proposition 3 implies that, given that $\gamma > 0$, the likelihood that the follower's initial debt level deters its borrowing at present:

- declines with the follower's costs of risk bearing stemming from the uncertainty about the leader's borrowing at present ($R_F \sigma_{Lt}^2$), as long as $r_4 < 0.5$,

- b. rises with the effect of the follower's initial debt level on the interest rate charged on its own borrowing at present (r_1),
- c. declines with the effect of the leader's initial debt level on the interest rate charged on the follower's borrowing at present (r_2) through a decline in the credibility of the reference group to which the leader and the follower are affiliated.

Proposition 4 (the effect of D_{Lt-1} on B_{Ft}^*): If $\gamma > 0$, then $\therefore$

$$\frac{dB_{Ft}^*}{dD_{Lt-1}} \begin{matrix} > \\ < \end{matrix} 0$$

$$\text{as } \frac{r_1}{r_2} \begin{matrix} > \\ < \end{matrix} \frac{r_4(1-2r_4)}{2r_3 + R_F r_4^2 \sigma_{Lt}^2} + \frac{2r_3}{r_4}$$

Proposition 4 implies that, given that $\gamma > 0$, the likelihood that the leader's initial debt level deters the follower's borrowing at present:

- a. declines with the follower's costs of risk bearing stemming from the uncertainty about the leader's borrowing at present ($R_F \sigma_{Lt}^2$), as long as $r_4 < 0.5$,
- b. declines with the effect of the follower's initial debt level on the interest rate on its own borrowing at present (r_1),
- c. rises with the effect of the leader's initial debt level on the interest rate charged on the follower's borrowing at present (r_2) through a decline in the credibility of the reference group to which the leader and the follower are affiliated.

Propositions 1 to 4 indicate that the leader's and follower's initial levels of indebtedness affect the leader's and follower's current borrowing levels in several ways and directions, and hence their total effects are not clear a priori. It is important to note that if $\gamma < 0$, the inequalities indicated by propositions 3 and 4 are reversed. However, equations 10 and 13 indicate that the greater the followers' degree of absolute risk aversion and level of uncertainty about the leaders borrowing level, the greater the likelihood that γ is positive.

5. LEADERS AND FOLLOWERS' ESTIMATED BORROWING EQUATIONS

The leaders and followers' borrowing equations developed above are estimated in this section in order to quantify and test further the hypothesized financial interdependencies between developing countries affiliated to a common reference group summarized by propositions 1 to 4. The estimation utilizes annual observations on the external debts and borrowing of developing countries in millions of U.S. dollars at 1985 prices for the period 1975 to 1986. The countries included in the empirical analysis are classified according to regional affiliation into three general groups — Latin America, Sub-Saharan Africa, and Asia-Pacific. The data source and the countries affiliated to any of these groups are indicated in the comment to Table 1. The leaders in each of the regional groups are identified by their outstanding high level of annual borrowing: Brazil and Mexico in Latin America; Nigeria, Sudan, and Zaire in Sub-Saharan Africa; and India and Indonesia in Asia-Pacific. The rest of the countries are classified as followers. The estimation is performed with annual observations on the aggregate borrowing and initial indebtedness levels of the two types of countries in each of the regional groups. The estimation results are obtained by the Cochrane-Orcutt iterative procedure that minimizes the sum of squares of the transformed residuals, and are summarized in Table 3.

Table 3. The estimated borrowing equations coefficients for leaders and followers in Latin America, Sub-Saharan Africa and Asia-Pacific 1975-1986*

Explanatory variables	Latin America	Sub-Saharan Africa	Asia-Pacific
<u>Leaders' Borrowing Equation</u>			
constant	463.5705 (0.124)	-999.55998 (0.402)	19341.38 (2.602)
The leaders' aggregate level of indebtedness (D_L)	0.7994862 (3.361)	-0.06111733 (0.281)	-0.5722540 (2.412)
The followers' aggregate level of indebtedness (D_F)	0.6445407 (1.549)	0.1729466 (0.738)	0.1653956 (1.748)
R^2	0.964	0.163	0.319
F-test statistic	681.6729	4.970476	2.926900
Durbin-Watson test statistic	1.736	1.596	1.955
<u>Followers' Borrowing Equation</u>			
constant	23272.287 (4.031)	3089.440 (0.847)	31261.98 (2.354)
The leaders' aggregate level of indebtedness (D_L)	-0.1244822 (2.895)	0.1127531 (0.390)	-0.8408428 (2.294)
The followers' aggregate level of indebtedness (D_F)	0.2554852 (3.494)	-0.1365340 (0.420)	0.1941243 (1.274)
R^2	0.461	0.135	0.226
F-test statistic	51.54835	2.508637	2.356048
Durbin-Watson test statistic	2.035	1.884	2.188

*The t-ratios are indicated in the parentheses.

In general, the estimation results of the leaders and followers' borrowing equations are statistically significant in the cases of Latin America and Asia-Pacific, but are not significant in the case of Sub-Saharan Africa. The lack of statistically significant estimation results in the later case is probably due to the fact that the predominant share of credit to the African countries was provided by non-profit international funds. The significant findings are as follows.

While the effect of the leading countries' absolute initial level of indebtedness on their current annual borrowing is significantly positive in the case of Latin America, it is

significantly negative in the case of Asia-Pacific and deterring further borrowing. Recalling proposition 1, these findings might indicate that while the underlying factor "c" dominates factors "a" and "b" in the former case, the underlying factors "a" and "b" dominate factor "c" in the later.

In both the Latin American and Asia-Pacific cases the effect of the following countries aggregate initial level of indebtedness on the leading countries borrowing is significantly positive. In view of proposition 2, this finding might indicate that the underlying factor "b" dominates the underlying factors "a" and "c".

In contrast, in both the Latin American and the Asia-Pacific cases the leading countries' aggregate level of indebtedness significantly deter the following countries' aggregate borrowing. Recalling proposition 4, this finding might indicate that the underlying factor "c" dominates factors "a" and "b".

In both the Latin American and the Asia-Pacific cases the following countries initial aggregate level of indebtedness does not deter their current borrowing. Moreover, in the case of Latin America, the following countries level of borrowing significantly increases with their initial level of indebtedness. In view of proposition 3, this finding might indicate that the underlying factors "a" and "c" dominate factor "b".

6. GLOBAL WELFARE CONSIDERATIONS AND A JOINTLY COORDINATED CREDIT SYSTEM

The adverse effects of the externalities described and assessed in the previous sections on the global welfare level of the developing countries can be moderated by a jointly coordinated borrowing. The general framework of a jointly coordinated borrowing is based on the maximization of a Bergson-Samuelson global welfare function defined on the individual countries' utilities from consumption, where each country's consumption possibilities depend upon its borrowing level, and where the global borrowing level is constrained:

$$\max_{B_{1t} \dots B_{Nt}} W[U^1(C_{1t}), \dots, U^N(C_{Nt})] \quad (15)$$

subject to

$$C_{it} = \alpha_i B_{it} y_{it} + NIM_{it} - RPM_{it} - IPL_{it} - [r_1 D_{it-1} + r_2 \frac{1}{N-1} \sum_{j=1}^N D_{jt-1} + r_3 B_{it} + r_4 \sum_{j \neq i}^N B_{jt}] B_{it} \quad (16)$$

$$r_{it}$$

for every $i = 1, \dots, N$, and

$$\sum_{j=1}^N B_{jt} = \bar{B}. \quad (17)$$

The necessary condition for maximum global welfare implies

$$\frac{\partial W}{\partial U^i} \frac{\partial U^i}{\partial C_i} [\alpha_i y_i - (r_1 + r_3 B_i)] = \mu \quad (18)$$

for every country $i=1, \dots, N$; where μ is the shadow value of the global credit constraint. As can be seen from the necessary condition for maximum, such a coordinated credit system leads to the following globally desired properties:

1. The net marginal benefits from extending credit to either country $i=1, \dots, N$; i.e., the marginal product of credit minus the marginal factor cost of credit; are the same in terms of global welfare units.
2. The uncertainty about the borrowing levels of the rest of the countries and the accompanying costs of risk bearing for the individual country are eliminated.

Although from a global welfare perspective there is a need for a higher degree of co-ordination in view of the externalities existing in the credit market and the segmentation of this market, the design and application of such co-ordination is very difficult. The Bergson-Samuelson welfare function is nothing but a very general way to describe global welfare and hence it is not much use in deciding what kind of ethical judgment might be reasonable in allocating credit to developing countries. This problem is, of course, the major obstacle in establishing a jointly co-ordinated credit system.

7. CONCLUDING REMARKS

This paper was concerned with the potential transfer of externalities among highly indebted developing countries that might affect the cost of credit to the individual debtor country. These externalities stem from the free-rider problem characteristic to price pooling: as long as the supply curve of credit is positively sloped, the interest rate charged on credit extended to a particular country is affected by the aggregate borrowing level of the rest of the countries. Moreover, the relatively high level of indebtedness of big developing countries and their problems to service their external debts, might adversely affect the reputation of the developing countries as a whole and reduce their financial credibility. The estimation of the interest rate equations confirmed the significant role of these externalities in explaining the cost of credit to individual countries in the three distinct developing regions of Latin America, Sub-Saharan Africa, and Asia-Pacific.

This paper considered further the external effect on the individual country's cost of credit imposed by uncertainty about the rest of the countries' borrowing behaviour. Since the individual country does not have full information about the borrowing of its counterparts debtors, it perceives the interest rate on loans taken during the present period as a random variable, and hence might suffer from substantial costs of risk bearing. The implications of this type of externality on the borrowing behaviour of developing countries were analyzed within the context of a stochastic Stackelberg-type model, in which big borrowing countries maximizes expected utility from consumption subject to their resource constraint while taking into account the reaction of the following smaller borrowing countries. The estimation results of the derived borrowing equations were found to be statistically significant in the cases of Latin America and Asia-Pacific. The empirical findings indicate that in the Latin American and Asia-Pacific cases the initial levels of indebtedness of the relatively small-borrowing countries raise the borrowing levels of the big-borrowing countries. In contrast, the small-borrowing countries demand for credit is deterred by the big-borrowing countries initial level of indebtedness. In terms of the conceptual model, this small-borrowing countries reduced demand for credit corresponds to the increase in the interest rate arising from the adverse effect of the big-borrowing countries initial level of indebtedness on the credibility of the regional group as

a whole. It is also aimed at lowering the small-borrowing countries costs of risk bearing stemming from the uncertainty about the big-borrowing countries demand for credit. This empirically indicated asymmetry reveals the role that the externalities inherent in the international credit market play to the disadvantage of the small-borrowing developing countries.

APPENDIX

PROOF OF PROPOSITION 3

The differentiation of equation 14 with respect to D_{Ft-1} implies

$$\frac{dB_{Ft}^*}{dD_{Ft-1}} = -\beta(r_1 - r_2 r_4 \gamma + r_1 r_4^2 \beta \gamma) \gtrless 0$$

$$\text{as } r_4^2 \beta \gamma - r_2 r_4 \gamma / r_1 \gtrless -1. \text{ And given that } \gamma > 0,$$

$$\frac{dB_{Ft}^*}{dD_{Ft-1}} \gtrless 0 \text{ as } r_4(r_2/r_1 - r_4 \beta) \gtrless 1/\beta.$$

By substituting equations 10 and 13 for β and γ , respectively

$$\frac{dB_{Ft}^*}{dD_{Ft-1}} \gtrless 0$$

$$\text{as } \frac{r_2}{r_1} \gtrless \frac{r_4(1-2r_4)}{2r_3 + R_F r_4^2 \sigma_{Lt}^2} + \frac{2r_3}{r_4}. \text{ QED}$$

PROOF OF PROPOSITION 4

Proof: The differentiation of equation 14 with respect to D_{Lt-1} implies

$$\frac{dB_{Ft}^*}{dD_{Lt-1}} = -\beta(r_2 - r_1 r_4 \gamma + r_2 r_4^2 \beta \gamma) \gtrless 0$$

$$\text{as } r_4^2 \beta \gamma - r_1 r_4 \gamma / r_2 \gtrless -1.$$

Given that $\gamma > 0$,

$$\frac{dB_{Ft}^*}{dD_{Lt-1}} \gtrless 0$$

$$\text{as } r_4 (r_1/r_2 - r_4\beta) \geq 1/\beta.$$

By substitution equations 10 and 13 for β and γ , respectively,

$$\frac{dB_{Ft}^*}{dD_{Lt-1}} \geq 0$$

$$\text{as } \frac{r_1}{r_2} \geq \frac{r_4(1-2r_4^2)}{2r_3 + R_F r_4^2 \sigma_{Lt}^2} + \frac{2r_3}{r_4}. \text{ QED}$$

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