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THE PRICE OF LDC DEBT

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ABSTRACT

The Price of LDC Debt*

We study the behaviour of secondary market prices for the debt of seven LDCs for the period March 1986 through November 1989 (monthly data). These prices for long-term debt appear to be driven by a set of 'common factors' across countries. One of these is the interest rate, Libor; we found a unit elasticity w.r.t. Libor for the average (across countries) price and for pooled data. The other 'common factors' are *not* correlated with world macro variables, and we call these factors common only to the indebted countries the 'systemic risk'.

We then study the price of long-term debt relative to that of short-term debt (data for three major countries). The price of short-term debt is influenced neither by 'systemic risk' nor by economic factors specific to the debtor country; we conjecture it is driven by local political risk. The results suggest that *when* it is serviced, long-term debt payments *are* scaled on the country's resources (export prices). The decision to service is contingent upon servicing short-term debt and on 'systemic risk', which appears *not* to be a risk of 'once-for-all' default but rather a milder form that simply alters on a period-by-period basis, but never irrevocably, the incentive of debtors to service their debt.

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NON-TECHNICAL SUMMARY

The secondary market for LDC bank debt has grown dramatically over the last few years. Virtually nil in 1985, transactions are estimated to have exceeded $70 billion in 1989. The analysis of the price of LDC debt on its secondary market is of considerable interest. On the positive side, it is obviously essential to unfold the pattern of risks that the market reveals. On the normative side, it is now well recognized that any attempt to solve the LDC debt crisis must take account of market transactions in debt, which were important in the resolution of sovereign debt problems in the 1930s – 1940s (Eichengreen and Portes, 1990). In this paper, we spell out a first set of conclusions that we obtained by an econometric analysis of the secondary market. They are purely descriptive. We postpone to a future paper the analysis of their normative implications.

We discuss the institutional framework of this market and its operation in a separate paper (Cohen, Portes and Wilson, 1990). The debt of many countries for which prices are quoted is in fact traded only infrequently. In the empirical work reported here, we have focused on the prices of debt for seven countries whose debt is traded extensively. We first analyse the prices of long-term debt. We then analyse, for three countries for which the information is available and reliable, the price of short-term debt and the relationship between the two.

For the long-term debt, we found that the price of the seven countries' debt appears to be essentially driven by a set of 'common factors'. Indeed, more than 85% of the volatility of prices appears to be driven by the same variables. Which are they? Libor is one of them. We found a unit elasticity of the price of debt with respect to Libor for the average price, and for the seven countries, individual elasticities ranging from 0.23 to 1.67 with a mean of 0.74. In pooled time-series data for the seven countries the elasticity was unity. This result suggests that the debt is perceived by the investors to represent the present value of an indefinite sequence of future payments.

The other set of 'common factors' does not appear to be correlated, in any obvious fashion, with world macroeconomic factors. It can therefore be interpreted as a set of factors that are common to the indebted countries only: we call it the 'systemic risk' of LDC debt.

How is this 'systemic risk' to be interpreted? As a risk of 'once-and-for-all' default, or as a milder form that simply alters – on a period-by-period basis, but never irrevocably – the incentive of the debtors to service their debt? The unit elasticity of the price of the debt with respect to Libor points towards the second interpretation. This intuition is confirmed when one decomposes the price of long-term debt into two components: the price of short-term debt and the relative price of long- versus short-term debt.

When one undertakes such a decomposition, one finds that neither the 'systemic risk' nor 'Libor' explains the price of short-term debt well, but that they do explain very well the relative price of long- versus short-term debt. If one accepts that short-term debt is, implicitly, senior to long-term debt (trade credits are always defaulted upon in last resort), this shows that the 'systemic risk' is not one of outright, extended disruption of payments (of both the long- and short-term debt).

This is further confirmed by the analysis of the influence of the price of exports on the price of debt. When analysing the data on long-term debt, we could find little or no correlation between the price of debt and the price of the debtors' exports. As far as countries like Mexico or Venezuela are concerned, it seems difficult to believe that the fluctuations of the price of oil would not cause a fluctuation of the price of their debt! By splitting the price of long-term debt into the two components reported above (short-term debt and relative price of long- versus short-term debt), we did manage to find that in the cases of both Brazil and Mexico (but not for Argentina), the price of the country's exports influenced significantly (with an elasticity superior or equal to 1 the *relative* price of the country's long-term debt (vis-à-vis the price of short-term debt) and did not influence the price of short-term debt. This points towards the following result: the price of the countries' exports matters for the service of the debt, but only conditionally upon the decision to service short-term debt and upon the outcome of the 'systemic risk'.

Putting all these results together, the following picture emerges. The price of short-term debt is influenced neither by a 'systemic risk' nor by an idiosyncratic economic factor. It appears therefore that it must be driven by an idiosyncratic non-economic factor, say a local political risk.

If one assumes that the service of long-term debt is conditional upon the service of short-term debt, one can venture the following hypothesis. When it is serviced, long-term debt's payments are scaled on the country's resources. The decision to service the debt is contingent upon the service of short-term debt (driven by an idiosyncratic political risk) and upon a 'systemic risk'. This 'systemic risk' appears to be rather political but not one of outright default that threatens to break 'once-and-for-all' the service of the debt.

Section I presents the data. Section II analyses the 'common factors'. Section III analyses the idiosyncratic fluctuations. Section IV analyses the relative price of long- vis-à-vis short-term debt. Section V suggests a simple model, in the framework of which we can interpret the results.

I THE DATA

We began with the Salomon Brothers series of data on secondary market prices for LDC debt. We used monthly series beginning in March 1986 and going through November 1989, initially for 24 countries. As reported in Cohen, Portes and Wilson (1990), however, we found that the market could reasonably be characterised as 'liquid' for only seven countries: Argentina, Brazil, Chile, Mexico, Poland, Venezuela and Yugoslavia. These are the countries on which we focus in this paper. Graphs of the average price and those for individual countries are given in Appendix 3. These prices relate to 'benchmark' issues of long-term bank debt.

We were able to obtain from ANZ Merchant Bank prices for short-term debt over the period June 1988 - November 1989, for three countries: Argentina, Brazil and Mexico. We use these in Section IV. The macroeconomic data come from standard sources (IFS, etc.).

II THE ROLE OF COMMON FACTORS

II.1 Principal components analysis was used as an agnostic tool to uncover the joint and specific factors driving the movement of prices. It appears that 86% of the variance is explained by the first component, whose coordinates turn out to be an almost perfect average of all prices. The results are provided in Appendix 2. This points towards the idea that a set of common factors are a key to explaining the fluctuations of prices.

II.2 In order to rank each country with respect to these common factors, we have calculated the covariance of the returns of each specific country with respect to the average return offered by the market. More specifically, we have calculated for each country the value:

$$\beta_i = \frac{\mathrm{cov}[R_i(t), R_m(t)]}{\mathrm{var}\ R_m(t)}$$

in which we simply took $R_i(t) = \frac{p_i(t)-p_i(t-1)}{p_i(t-1)}$.

The results are reported in Table 1 below.

Table 1

	BETA	T
Argentina	1.5508	6.78
Brazil	1.5702	10.07
Chile	0.5380	5.34
Mexico	0.9857	10.55
Venezuela	1.1967	12.01
Poland	0.8636	5.79
Yugoslavia	0.2945	2.30

(Similar calculations were performed taking account of the net transfers paid by the countries, which did not change the results.)

The T-statistics show that there is indeed a significant correlation between each asset and the average portfolio. One sees that Mexico stands as the average risk, with Argentina and Brazil riskier, Chile and Yugoslavia safer. Too short a time horizon and a too small a sample of countries kept us from going further into estimating a CAPM-like model.

II.3 The average price was regressed on a set of worldwide phenomena: Libor, Industrial Production in the industrialised countries, and the fluctuations of the dollar. The only significant factor appears to be Libor (Appendix 1, Table A). In log terms, we found the following regression:

$$(1)\quad \text{Log } p = 5.99 - \underset{(0.17)}{0.96}\ \text{Log (Libor)} - \underset{(0.06)}{0.20}\ \text{Citi}$$

(standard errors in brackets).

Citi is a time dummy that reflects the role of Citibank's decision to set aside $3.0 bn as provisions against LDC debt risk in May 1987. A time dummy for the Brady Plan announcement was not significant.

As one sees, the estimated elasticity of the average price of the debt with respect to Libor is close to one. There is substantial first-order serial correlation in the simple regression; including a lagged dependent variable eliminates it, and this version passes the test for linearity too. The estimated long-run elasticity is now 0.8, still close to unity.

This is a very robust result, indeed one of the most robust results that was uncovered by our research, as we see below. The interpretation of this finding deserves to be spelled out in some detail. On paper, LDC debt is indexed on Libor. If the countries were solvent (i.e. expected to service the debt in full), the market value of the debt should be independent of Libor. At the other extreme, if the debtors are viewed as servicing the debt independently of its face value, then one should indeed expect a unit elasticity of price with respect to Libor. The model of Section V formalizes this argument. With this latter interpretation, which is that suggested by equation (1), the face value of the debt is irrelevant. In Bulow and Rogoff's (1989) terms, the marginal price of the debt is zero. (See Cohen (1989) for a direct estimate of this result.)

III. IDIOSYNCRATIC FLUCTUATIONS

III.1 In order to separate the influence of Libor from the impact of other common factors (whatever they may be), we have proceeded as follows. For each country except Mexico and Venezuela, we have calculated the average price of the other countries' debt. In the case of Mexico and Venezuela (two oil exporters), we have taken the (same) average of the residual countries (which excluded them both). Call p_{-i} the average prices so defined. For each country i, we have regressed the average p_{-i} on Libor and defined the residual of the regression as in equation (2) below:

(2) $\text{Log } p_{-i} = \alpha_i + \beta_i \text{ Log (Libor)} + \gamma_i \text{ Citi} + \text{Res}_i$

We interpret Res_i as the set of "joint phenomena" which may influence country i's debt, when the direct effects of Libor and Citi are controlled for. Citi is the one external event that we have been able to identify as a determinant of 'systemic risk', so we control for it directly.

We have then run for each country the following regression:

(3) $\text{Log } p = \alpha_0 + \alpha_1 \text{ Log Libor} + \alpha_2 \text{ Res} + \alpha_3 \text{ Log } p_x + \alpha_4 \text{ Citi} + \alpha_5 \text{ Brady}$

in which p_x is an index of the country's export prices; Brady is a dummy for the announcement of the Brady Plan, which might be relevant for some individual countries.

The detailed results are shown in Appendix 1, Tables B and summarized in Tables 2 and 3 below. Tables B give detailed results for OLS estimation of equation (3) for each country om the full sample 1986.4 to 1989.11 and on the subsample 1988.1-1989.11. Table 2 in the text summarizes these results. It is evident from Tables B that there is substantial serial correlation in all the OLS estimates except those for Argentina. A shift of parameters (especially α_0 and α_3) across the subsamples might have been thought responsible for the serial correlation, but estimating on this hypothesis did not help. We therefore re-estimated with an AR(1) process estimated by maximum likelihood, and the coefficient estimates are shown in Table 3 of the text for the full sample. The key coefficients are almost all not substantially affected, while the performance in regard to all specification tests is considerably better.

These country-by-country results confirm the importance of Libor in explaining the secondary market price. The only exception is Yugoslavia. Many of the point estimates of the elasticity are not significantly different from one.

<u>Table 2</u>

		Log Libor	Res	Log p_x	Citi	Brady
Argentina	FS	-0.59**	1.46**	-2.37**	-0.31**	-0.15**
	SS	-0.84**	1.06**	-1.11*		-0.19**
Brazil	FS	-1.19**	1.18**	2.03**	-0.27**	-0.19**
	SS	-1.22**	1.89**	1.23**		-0.17**
Chile	FS	-0.30**	0.24*	-0.10	-0.04	0.10**
	SS	0.02	0.05	-0.46**		0.04**
Mexico	FS	-0.73**	0.63**	-0.05	-0.05**	0.03
	SS	-1.01**	0.82**	1.11		0.09**
Venezuela	FS	-1.36**	0.85**	0.06	-0.12**	-0.003
	SS	-1.47**	0.80**	-0.02		0.02
Poland	FS	-0.74**	0.90**	1.66	-0.07	0.03
	SS	-0.83*	1.07**	-0.94		0.13*
Yugoslavia	FS	-0.32	0.32*	-4.62**	-0.06	0.27**
	SS	-0.30*	-0.11	0.50		0.08*

Method of estimation : OLS. Dependent variable: log price.
** : significant at 95% degree of confidence
* : significant at 90% degree of confidence

FS : full sample 1986.04 - 1989.11; SS : sub-sample 1988.01 - 1989.11.
Note: The standard errors for Res are only approximate because of the generated regressor problem, i.e. they do not allow for the fact that Res is constructed using estimated coefficients.

Table 3

	Log (Libor)	Log p_x	DW
Argentina	-0.68 (0.23)	-2.24 (0.29)	2.03
Brazil	-1.67 (0.19)	1.08 (0.38)	1.84
Chile	-0.45 (0.13)	0.05 (0.16)	1.18
Mexico	-0.64 (0.11)	-0.003 (0.08)	2.03
Venezuela	-0.97 (0.12)	-0.01 (0.07)	1.62
Poland	-0.54 (0.24)	1.12 (1.67)	1.22
Yugoslavia	-0.23 (0.18)	-0.34 (0.97)	1.53

Method of estimation: by maximum likelihood AR(1)
Dependent variable: Log price
N = 44 (1986.04 - 1989.11)

Standard errors in brackets.

One also sees the significance of the variable Res (the non-Libor, non-Citi "common factors"). Again the main exception is Yugoslavia. Argentina and Brazil exhibit a strong (larger than one) elasticity. The coefficient on the Brady Plan dummy, however, is not consistently signed.

The main surprising result that is uncovered by Tables 2 and 3 is the absence of a positively significant correlation of the price of debt with the price of the country's exports, except for Brazil. The coefficient is either wrongly signed or insignificant. We investigate this result in more detail below. (It is not due to any significant correlation between export price and Libor.) It is also perhaps surprising that only in the case of Chile does the Brady announcement appear to have a lasting positive effect (the positive coefficient for Yugoslavia vanishes in the AR(1) estimates).

III.2 In order to have an overall view of the results, we have pooled the time series data for all countries for both the full sample 1986.04 - 1989.11 and the sub-sample 1988.01 - 1989.11. The detailed results are shown in Appendix 1, Table C. In Table 4 below we summarize the results for the sub-sample 1988.01 - 1989.11, when a specific dummy variable is added for each country (except Chile which is taken here as the numeraire).

Table 4

Log Libor	Res	Log p_x	Argentina	Brazil
-0.87	0.66	+0.11	-1.07	-0.41
(0.10)	(0.09)	(0.22)	(0.04)	(0.07)

Mexico	Poland	Venezuela	Yugoslavia
-0.29	-0.45	-0.30	-0.21
(0.04)	(0.06)	(0.04)	(0.05)

R^2 = 0.87
(standard errors in brackets)
Dependent variable = Log price. Pooled data 1988.01-1989.11.

Note: The standard error for Res is only approximate because of the generated regressor problem.

The pooled data confirm that the (average) elasticity of the price with respect to Libor is not different from one. The response of the price to the other common factors (Res) shows an elasticity of 0.7. The absence of a significant correlation between the price of the countries' exports with the price of the debt is also confirmed by the pooled data. These results and the absence of any positive role for export prices thus appear consistently in the aggregate estimates, those for individual countries, and the estimates on pooled data. We feel confident, therefore, that despite the serial correlation in some of the estimates, we are not observing spurious relationships.

As far as the dummy variables for each country are concerned, one sees that Chile stands significantly above the other countries. In fact, all other countries but Argentina exhibit discounts with respect to Chile that are not significantly different among themselves (the average discount of these five countries with respect to Chile is 0.33). Argentina, however, is discounted significantly more than all other countries.

III.3 The absence of a significant correlation between the price of the debt and the price of the countries' exports is a puzzling result. Combined with the unit elasticity of the price of the debt with respect to Libor, it seems to suggest that the debt is the present value of future payments which are <u>not</u> significantly correlated with the wealth of the country. We have attempted to test the robustness of this result by analysing the dependency of the price of Mexico and Venezuela's debt with respect to the price of oil. In order to do that, we have taken as an indicator of the market's expectation of future oil prices the relative price of the major oil companies' stock price with respect to the Standard and Poor Index on Wall Street. This does not improve the quality of the results. For the entire sample, it is wrongly signed. The failure to find a correlation between the price of Mexico or Venezuela's debt with the price of oil does not seem to be an artefact of an incorrect measure of Mexico's wealth.

IV - THE RELATIVE PRICE OF LONG VERSUS SHORT TERM DEBT

We have proceeded to extend our analysis as follows. Where it was available (in the case of Argentina, Brazil and Mexico), we have decomposed the (Log of the) price of the debt into two components: the price of the short-term debt, and the relative price of long- versus short-term debt. (The data were available for the sample June 1988 - October 1989 only.) More specifically, call p_1 the price of short-term debt, and p_2 the price of the long-term instrument (which we analysed in the previous sections).

As suggested in the model of Section V, we have written:

$$\text{Log } p_2 = \text{Log } p_1 + \text{Log } p_2/p_1$$

and estimated separately Log p_1 and Log p_2/p_1 following the specification of equation (3). The results are shown in Appendix 1, Tables D and Table 5 below. Again, there is substantial serial correlation in some of the OLS regressions reported in Tables D, so Table 5 gives estimates with an AR(1) process (estimated by maximum likelihood) rather than OLS where the former noticeably improves performance in meeting specification tests. Here too, the estimates of the coefficients are not substantially affected by the estimation method.

Table 5(a)

Sample range: 1988.06 - 1989.11
p_2: secondary market price of long-term debt
p_1: secondary market price of short-term debt

Argentina

$$\underset{}{\text{Log } p_2} = \underset{(6.37)}{2.67} - \underset{(0.51)}{0.98} \text{ Log(Libor)} + \underset{(0.31)}{1.27} \text{ Res} + \underset{(1.32)}{0.51} \text{ Log} p_x$$

Method of estimation: AR(1)
$R^2 = 0.79$ DW = 2.006 $\hat{\sigma} = 3.66\%$

$$\text{Log } p_1 = \underset{(1.37)}{10.13} + \underset{(0.09)}{1.02} \text{ Log(Libor)} - \underset{(0.07)}{0.31} \text{ Res} - \underset{(0.29)}{1.67} \text{ Log } p_x$$

Method of estimation: OLS
$R^2 = 0.94$ DW = 2.53 $\hat{\sigma} = 0.65\%$

$$\text{Log } (p_2/p_1) = \underset{(5.99)}{-6.89} - \underset{(0.50)}{1.86} \text{ Log(Libor)} + \underset{(0.29)}{1.52} \text{ Res} + \underset{(1.25)}{2.01} \text{ Log } p_x$$

Method of estimation: AR(1)
$R^2 = 0.91$ DW = 1.78 $\hat{\sigma} = 7.04\%$

Standard errors in brackets

Table 5(b)

Sample range: 1988.06 - 1989.11
p_2: secondary market price of long-term debt
p_1: secondary market price of short-term debt

Brazil

$$\text{Log } p_2 = \underset{(2.86)}{2.21} - \underset{(0.38)}{1.58}\ \text{Log(Libor)} + \underset{(0.21)}{1.73}\ \text{Res} + \underset{(0.66)}{1.07}\ \text{Log } p_x$$

Method of estimation: AR(1)

$R^2 = 0.96$ DW = 1.98 $\hat{\sigma} = 1.52\%$

$$\text{Log } p_1 = \underset{(2.39)}{7.83} - \underset{(0.29)}{0.57}\ \text{Log(Libor)} + \underset{(0.17)}{0.21}\ \text{Res} - \underset{(0.56)}{0.50}\ \text{Log } p_x$$

Method of estimation: AR(1)
$R^2 = 0.79$ DW = 2.31 $\hat{\sigma} = 1.09\%$

$$\text{Log } (p_2/p_1) = \underset{(2.54)}{-7.60} - \underset{(0.31)}{1.03}\ \text{Log(Libor)} + \underset{(0.20)}{1.97}\ \text{Res} + \underset{(0.65)}{2.02}\ \text{Log } p_x$$

Method of estimation: OLS
$R^2 = 0.91$ DW = 1.61 $\hat{\sigma} = 10.31\%$

Standard errors in brackets

Table 5(c)

Sample range: 1988.06 - 1989.11

p_2: secondary market price of long-term debt

p_1: secondary market price of short-term debt

Mexico

$$\text{Log } p_2 = \underset{(0.42)}{4.95} - \underset{(0.11)}{1.15} \text{ Log(Libor)} + \underset{(0.06)}{0.73} \text{ Res} + \underset{(0.11)}{0.29} \text{ Log } p_x$$

Method of estimation: OLS

$R^2 = 0.95$ DW = 1.68 $\hat{\sigma} = 0.71\%$

$$\text{Log } p_1 = \underset{(0.79)}{6.95} - \underset{(0.21)}{0.45} \text{ Log(Libor)} - \underset{(0.11)}{0.10} \text{ Res} - \underset{(0.21)}{0.40} \text{ Log} p_x$$

Method of estimation: OLS

$R^2 = 0.62$ DW = 1.55 $\hat{\sigma} = 1.23\%$

$$\text{Log } (p_2/p_1) = \underset{(0.93)}{-2.00} - \underset{(0.24)}{0.71} \text{ Log(Libor)} + \underset{(0.13)}{0.83} \text{ Res} + \underset{(0.24)}{0.69} \text{ Log } p_x$$

Method of estimation: OLS

$R^2 = 0.77$ DW = 1.40 $\hat{\sigma} = 19.17\%$

Standard errors in brackets

We first observe that we now find a significant positive (albeit small) correlation between the price of long-term debt and the price of Mexico's exports on the sub-sample 88.6 - 89.11! It is still insignificant, though larger, in the case of Argentina and Brazil.

What is fascinating however, is the decomposition of the effects of the price of exports onto the price of short term debt and the relative price of long-term vis-a-vis short-term debt. For the latter, in both the case of Brazil and Mexico one now does find a large and significant coefficient. Even in the case of Argentina (for which the previous regressions showed a negative, and significant, correlation), one now also finds a large positive coefficient. The point estimate of the elasticity of the price of debt with respect to the price of exports is 0.7 in the case of Mexico and 2.0 in the case of Brazil, not significantly different from 1 in the first case, and significantly above 1 in the latter case. It is also interesting to note that the coefficients of the "common factors" Libor and Res are always significantly larger for the relative price Log p_2/p_1 than for the price of the short-term debt. This is not so surprising as far as Libor is concerned: the short-term debt is implicitly senior to the long-term debt, so that its market value is bound to be less dependent on Libor than that of the long-term debt.

This is more surprising for the case of the variable Res. If this variable were to measure a systemic risk of default, one could expect those risks to be (at least) as important for short-term debt as for long-term debt. What our analysis shows is that this is not so. The market perceives the "systemic risk" as predominantly affecting the service of the long-term debt.

V - INTERPRETATION OF THE RESULTS

We may interpret our results in the following fashion.

Assume that the decision to service long-term debt is conditional upon the decision to service the short-term debt. Call π_1 the probability of the decision to service the short-term debt and π_2 the conditional probability to service the long-term debt. Assume that both decisions (to service the short-term debt and the conditional decision to service the long-term debt) are i.i.d. stochastic processes. Furthermore, assume that the holder of a unit of long-term debt, <u>when</u> it is serviced, is paid:

(4) $P_t = p_x^{\phi}(t) \cdot Z_t$

in which p_x is the price of the country's exports and Z_t is an idiosyncratic factor. Then we can suppose that the price of long-term debt is simply:

(5) $p_2 = E_0 \left[\sum_0^{\infty} \frac{R_t}{(1+i)^t} \right]$

in which $R_t = 0$ if the debt is not serviced, $R_t = P_t$ as in equation (4) otherwise. One then finds:

$$p_2 = \frac{p_x^{\phi} \cdot Z \, \pi_2 \pi_1}{i}$$

which, in long-term debt yields:

$$\text{Log } p_2 = \phi \text{ Log } p_x + \text{Log } \pi_2 + \text{Log } \pi_1 - \text{Log } i + \text{Log } Z.$$

If Res is taken as a proxy proportional to Log π_2, the conditional probability to service long-term debt, if the price of short-term debt is taken to measure the probability π_1 that the short-term debt is serviced, and if Log Z is assumed to be an i.i.d. disturbance, one sees that this is exactly the form that was estimated in Table 5:

(6) $\text{Log } p_2/p_1 = C - \text{Log } i + \text{Res} + \phi \text{ Log } p_x + \epsilon.$

References

Bulow, J, and K Rogoff (1988), The buyback boondoggle, *Brookings Papers on Economic Activity*, 675-698.

Cohen, D (1989), Debt relief and secondary market discount, CEPR Discussion Paper no. 312.

Cohen, D, R Portes and S Wilson (1989), The secondary market for LDC debt, CEPR Discussion Paper, forthcoming.

Eichengreen, B, and R Portes (1990), The interwar debt crisis and its aftermath, *World Bank Research Observer* 5, 69-94.

APPENDIX 1

Table A

$$\text{Log } p_t = 5.99 - \underset{(0.17)}{0.96} \text{ Log (Libor)}_t - \underset{(0.06)}{0.20} \text{ Citi}$$

N = 45 (1986.3 - 1989.11) $R^2 = 0.80$

$\hat{\sigma} = 3\%$ DW = 0.49

Linearity	χ^2 (1) = 6.14
Homoscedasticity	χ^2 (1) = 0.53
Normality	χ^2 (2) = 9.23

Standard errors in brackets

$$\text{Log } p_t = 0.44 - \underset{(0.11)}{0.06} \text{ Log (Libor)}_t - \underset{(0.03)}{0.03} \text{ Citi} + \underset{(0.07)}{0.92} \text{ Log } p_{t-1}$$

N = 44 (1986.4 - 1989.11) $R^2 = 0.96$

$\hat{\sigma} = 1.37\%$ Durbin's $\lambda = 1.42$

Linearity	χ^2 (1) = 0.04
Homoscedasticity	χ^2 (1) = 9.80
Normality	χ^2 (2) = 7.03

Standard errors in brackets

Table B(1)

Argentina

$$\text{Log } p = \underset{(0.88)}{16.04} - \underset{(0.20)}{0.59} \text{ Log(Libor)} + \underset{(0.15)}{1.46} \text{ Res} - \underset{(0.24)}{2.37} \text{ Log } p_x - \underset{(0.04)}{0.31} \text{ Citi} - \underset{(0.05)}{0.15} \text{ Brady}$$

N = 44(1986.04 - 1989.11) $R^2 = 0.98$

$\hat{\sigma} = 2.33\%$ DW = 1.62

Linearity	$\chi^2(1) = 2.95$
Normality	$\chi^2(2) = 0.20$
Homoscedasticity	$\chi^2(1) = 5.86$

$$\text{Log } p = \underset{(2.39)}{10.25} - \underset{(0.27)}{0.84} \text{ Log (Libor)} + \underset{(0.22)}{1.06} \text{ Res} - \underset{(0.58)}{1.11} \text{ Log } p_x - \underset{(0.05)}{0.19} \text{ Brady}$$

N = 23 (1988.01 - 1989.11) $R^2 = 0.90$

$\hat{\sigma} = 2.86\%$ DW = 2.06

Linearity	$\chi^2(1) = 2.63$
Normality	$\chi^2(2) = 0.10$
Homoscedasticity	$\chi^2(1) = 2.99$

Standard errors in brackets

Table B(2)

Brazil

$$\text{Log } p = \underset{(1.75)}{-2.58} - \underset{(0.16)}{1.19} \text{ Log(Libor)} + \underset{(0.13)}{1.18} \text{ Res} + \underset{(0.42)}{2.03} \text{ Log } p_x - \underset{(0.04)}{0.27} \text{ Citi} - \underset{(0.04)}{0.19} \text{ Brady}$$

N = 44 (1986.04 - 1989.11) $R^2 = 0.96$

$\hat{\sigma} = 1.93\%$ DW = 0.62

Linearity	$\chi^2(1) = 6.75$
Normality	$\chi^2(2) = 1.93$
Homoscedasticity	$\chi^2(1) = 1.42$

$$\text{Log } p = \underset{(1.62)}{0.80} - \underset{(0.13)}{1.22} \text{ Log(Libor)} + \underset{(0.15)}{1.89} \text{ Res} + \underset{(0.38)}{1.23} \text{ Log } p_x - \underset{(0.03)}{0.17} \text{ Brady}$$

N = 23 (1988.01 - 1989.11) $R^2 = 0.97$

$\hat{\sigma} = 1.34\%$ DW = 1.46

Linearity	$\chi^2(1) = 0.43$
Normality	$\chi^2(2) = 0.71$
Homoscedasticity	$\chi^2(1) = 0.36$

Standard errors in brackets

<u>Table B(3)</u>

<u>Chile</u>

$$\underset{}{\text{Log p}} = \underset{(0.54)}{5.23} - \underset{(0.12)}{0.30}\,\text{Log(Libor)} + \underset{(0.08)}{0.24}\,\text{Res} - \underset{(0.15)}{0.10}\,\text{Log } p_x - \underset{(0.03)}{0.04}\,\text{Citi} + \underset{(0.03)}{0.10}\,\text{Brady}$$

N = 44(1986.04 - 1989.11) $R^2 = 0.70$

$\hat{\sigma} = 1.07\%$ DW = 0.81

Linearity	$\chi^2(1) = 9.51$
Normality	$\chi^2(2) = 18.19$
Homoscedasticity	$\chi^2(1) = 2.10$

$$\text{Log p} = \underset{(0.77)}{6.34} - \underset{(0.11)}{0.02}\,\text{Log(Libor)} + \underset{(0.07)}{0.05}\,\text{Res} - \underset{(0.19)}{0.46}\,\text{Logp}_x + \underset{(0.02)}{0.04}\,\text{Brady}$$

N = 23(1988.01 - 1989.11) $R^2 = 0.51$

$\hat{\sigma} = 0.74\%$ DW = 1.31

Linearity	$\chi^2(1) = 5.34$
Normality	$\chi^2(2) = 1.51$
Homoscedasticity	$\chi^2(1) = 5.21$

Standard errors in brackets

Table B(4)

Mexico

$$\underset{(0.40)}{\text{Log p} = 5.69} - \underset{(0.07)}{0.73}\ \text{Log(Libor)} + \underset{(0.06)}{0.63}\ \text{Res} - \underset{(0.07)}{0.05}\ \text{Log}\ p_x - \underset{(0.02)}{0.05}\ \text{Citi} + \underset{(0.02)}{0.03}\ \text{Brady}$$

N = 44(1986.04 - 1989.11) $R^2 = 0.95$

$\hat{\sigma} = 0.95\%$ DW = 0.93

Linearity	$\chi^2(1) = 11.46$
Normality	$\chi^2(2) = 1.10$
Homoscedasticity	$\chi^2(1) = 0.31$

$$\underset{(0.47)}{\text{Log p} = 6.48} - \underset{(0.05)}{1.01}\ \text{Log(Libor)} + \underset{(0.05)}{0.82}\ \text{Res} - \underset{(0.10)}{0.11}\ \text{Log}\ p_x + \underset{(0.02)}{0.09}\ \text{Brady}$$

N = 23(1988.01 - 1989.11) $R^2 = 0.97$

$\hat{\sigma} = 0.58\%$ DW = 1.44

Linearity	$\chi^2(1) = 5.22$
Normality	$\chi^2(2) = 0.75$
Homoscedasticity	$\chi^2(1) = 0.14$

Standard errors in brackets

Table B(5)

Venezuela

$$\text{Log } p = \underset{(0.44)}{6.62} - \underset{(0.09)}{1.36} \text{ Log(Libor)} + \underset{(0.07)}{0.85} \text{ Res} + \underset{(0.03)}{0.06} \text{ Log } p_x - \underset{(0.03)}{0.12} \text{ Citi} - \underset{(0.03)}{0.003} \text{ Brady}$$

N = 44(1986.04 - 1989.11) R^2 = 0.97

$\hat{\sigma}$ = 1.20% DW = 0.73

Linearity	$\chi^2(1) = 3.18$
Normality	$\chi^2(2) = 2.70$
Homoscedasticity	$\chi^2(1) = 3.42$

$$\text{Log } p = \underset{(0.92)}{7.06} - \underset{(0.13)}{1.47} \text{ Log(Libor)} + \underset{(0.11)}{0.80} \text{ Res} - \underset{(0.18)}{0.02} \text{ Log } p_x + \underset{(0.04)}{0.02} \text{ Brady}$$

N = 23(1988.01 - 1989.11) R^2 = 0.94

$\hat{\sigma}$ = 1.33% DW = 0.72

Linearity	$\chi^2(1) = 0.49$
Normality	$\chi^2(2) = 2.46$
Homoscedasticity	$\chi^2(1) = 0.02$

Standard errors in brackets

Table B(6)

Poland

$$\text{Log } p = \underset{(7.26)}{-2.45} - \underset{(0.25)}{0.74} \text{ Log(Libor)} + \underset{(0.18)}{0.90} \text{ Res} + \underset{(1.66)}{1.66} \text{ Log } p_x - \underset{(0.06)}{0.07} \text{ Citi} + \underset{(0.04)}{0.03} \text{ Brady}$$

N = 44(1986.04 - 1989.11) $R^2 = 0.74$

$\hat{\sigma} = 1.95\%$ DW = 0.73

Linearity	$\chi^2(1) = 16.38$
Normality	$\chi^2(2) = 14.46$
Homoscedasticity	$\chi^2(1) = 4.03$

$$\text{Log } p = \underset{(16.24)}{9.81} - \underset{(0.41)}{0.83} \text{ Log(Libor)} + \underset{(0.25)}{1.07} \text{ Res} - \underset{(3.65)}{0.94} \text{ Log } p_x + \underset{(0.07)}{0.13} \text{ Brady}$$

N = 23(1988.01 - 1989.11) $R^2 = 0.75$

$\hat{\sigma} = 2.10\%$ DW = 0.97

Linearity	$\chi^2(1) = 8.34$
Normality	$\chi^2(2) = 6.52$
Homoscedasticity	$\chi^2(1) = 5.92$

Standard errors in brackets

Table B(7)

Yugoslavia

$$\text{Log } p = \underset{(5.70)}{26.29} - \underset{(0.24)}{0.32} \text{ Log(Libor)} + \underset{(0.18)}{0.32} \text{ Res} - \underset{(1.30)}{4.62} \text{ Log } p_x - \underset{(0.08)}{0.06} \text{ Citi} + \underset{(0.06)}{0.27} \text{ Brady}$$

N = 44(1986.04 - 1989.11) $R^2 = 0.86$

$\hat{\sigma} = 2.34\%$ DW = 0.50

Linearity	$\chi^2(1) = 0.61$
Normality	$\chi^2(2) = 1.55$
Homoscedasticity	$\chi^2(1) = 0.33$

$$\text{Log } p = \underset{(6.59)}{2.25} - \underset{(0.17)}{0.30} \text{ Log(Libor)} - \underset{(0.12)}{0.11} \text{ Res} + \underset{(1.45)}{0.50} \text{ Log } p_x + \underset{(0.05)}{0.08} \text{ Brady}$$

N = 23(1988.01 - 1989.11) $R^2 = 0.55$

$\hat{\sigma} = 1.37\%$ DW = 0.66

Linearity	$\chi^2(1) = 9.28$
Normality	$\chi^2(2) = 1.01$
Homoscedasticity	$\chi^2(1) = 1.63$

Standard errors in brackets

Table C

$$\underset{(0.66)}{\text{Log } p = 7.1} - \underset{(0.11)}{0.91} \text{ Log(Libor)} + \underset{(0.09)}{0.65} \text{ Res} - \underset{(0.15)}{0.21} \text{ Log } p_x - \underset{(0.04)}{0.16} \text{ Citi}$$

$$- \underset{(0.04)}{0.65} D_A - \underset{(0.05)}{0.29} D_B - \underset{(0.04)}{0.23} D_M - \underset{(0.04)}{0.12} D_V - \underset{(0.04)}{0.47} D_P - \underset{(0.04)}{0.08} D_Y$$

N = 308(1986.04 - 1989.11) $R^2 = 0.74$ $\hat{\sigma} = 4.77\%$

Linearity	$F(2,305) = 43.50$
Normality	$\chi^2(2) = 9.54$
Homoscedasticity	$F(2,305) = 38.17$

$$\underset{(0.97)}{\text{Log } p = 5.48} - \underset{(0.10)}{0.87} \text{ Log(Libor)} + \underset{(0.09)}{0.66} \text{ Res} + \underset{(0.22)}{0.11} \text{ Log } p_x$$

$$- \underset{(0.04)}{1.07} D_A - \underset{(0.07)}{0.41} D_B - \underset{(0.04)}{0.29} D_M - \underset{(0.04)}{0.30} D_V - \underset{(0.06)}{0.45} D_P - \underset{(0.05)}{0.21} D_Y$$

N = 161(1988.01 - 1989.11) $R^2 = 0.87$ $\hat{\sigma} = 3.46\%$

Linearity	$F(2,158) = 6.63$
Normality	$\chi^2(2) = 9.10$
Homoscedasticity	$F(2,158) = 2.85$

Standard errors in brackets

Table D(1)

N = 18(1988.06 - 1989.11), Method of estimation: OLS
Standard errors in brackets

Argentina

$$\text{Log}p_2 = \underset{(5.75)}{6.54} - \underset{(0.38)}{1.04}\ \text{Log(Libor)} + \underset{(0.29)}{1.40}\ \text{Res} - \underset{(1.21)}{0.27}\ \text{Log}\ p_x$$

$R^2 = 0.73$ DW = 1.08 $\hat{\sigma} = 4.03\%$

Linearity $\chi^2(1) = 2.26$, Normality $\chi^2(2) = 1.92$, Homoscedasticity $\chi^2(1) = 1.44$

$$\text{Log}\ p_1 = \underset{(1.37)}{10.13} + \underset{(0.09)}{1.02}\ \text{Log(Libor)} - \underset{(0.07)}{0.31}\ \text{Res} - \underset{(0.29)}{1.67}\ \text{Log}\ p_x$$

$R^2 = 0.94$ DW = 2.53 $\hat{\sigma} = 0.65\%$

Linearity $\chi^2(1) = 3.95$, Normality $\chi^2(2) = 1.11$, Homoscedasticity $\chi^2(1) = 0.02$

$$\text{Log}(p_2/p_1) = \underset{(5.54)}{-3.58} - \underset{(0.37)}{2.06}\ \text{Log(Libor)} + \underset{(0.28)}{1.71}\ \text{Res} + \underset{(1.17)}{1.41}\ \text{Log}\ p_x$$

$R^2 = 0.87$ DW = 0.98 $\hat{\sigma} = 8.05\%$

Linearity $\chi^2(1) = 6.57$, Normality $\chi^2(2) = 1.30$, Homoscedasticity $\chi^2(1) = 1.86$

Table D(2)

N = 18(1988.06 - 1989.11), Method of estimation: OLS
Standard errors in brackets

Brazil

$$\text{Log } p_2 = \underset{(3.38)}{1.01} - \underset{(0.41)}{1.72} \text{ Log(Libor)} + \underset{(0.27)}{2.42} \text{ Res} + \underset{(0.86)}{1.41} \text{ Log } p_x$$

$R^2 = 0.89$ DW = 0.70 $\hat{\sigma} = 2.57\%$

Linearity $\chi^2(1) = 0.02$, Normality $\chi^2(2) = 0.43$, Homoscedasticity $\chi^2(1) = 0.68$

$$\text{Log } p_1 = \underset{(2.08)}{8.61} - \underset{(0.25)}{0.70} \text{ Log(Libor)} + \underset{(0.16)}{0.45} \text{ Res} - \underset{(0.53)}{0.61} \text{ Log } p_x$$

$R^2 = 0.67$ DW = 0.93 $\hat{\sigma} = 1.33\%$

Linearity $\chi^2(1) = 0.95$, Normality $\chi^2(2) = 0.44$, Homoscedasticity $\chi^2(1) = 6.48$

$$\text{Log}(p_2/p_1) = \underset{(2.54)}{-7.60} - \underset{(0.31)}{1.03} \text{ Log(Libor)} + \underset{(0.20)}{1.97} \text{ Res} + \underset{(0.65)}{2.02} \text{ Log } p_x$$

$R^2 = 0.91$ DW = 1.61 $\hat{\sigma} = 10.31\%$

Linearity $\chi^2(1) = 0.05$, Normality $\chi^2(2) = 0.30$, Homoscedasticity $\chi^2(1) = 0.36$

Table D (3)

N = 18(1988.06 - 1989.11), Method of estimation: OLS
Standard errors in brackets

Mexico

$$\text{Log } p_2 = \underset{(0.42)}{4.95} - \underset{(0.11)}{1.15} \text{ Log(Libor)} + \underset{(0.06)}{0.73} \text{ Res} + \underset{(0.11)}{0.29} \text{ Log } p_x$$

$R^2 = 0.95$ DW = 1.68 $\hat{\sigma} = 0.71\%$

Linearity	$\chi^2(1) = 1.99$
Normality	$\chi^2(2) = 1.28$
Homoscedasticity	$\chi^2(1) = 0.08$

$$\text{Log } p_1 = \underset{(0.79)}{6.95} - \underset{(0.21)}{0.45} \text{ Log(Libor)} - \underset{(0.11)}{0.10} \text{ Res} - \underset{(0.21)}{0.40} \text{ Log } p_x$$

$R^2 = 0.62$ DW = 1.55 $\hat{\sigma} = 1.23\%$

Linearity	$\chi^2(1) = 4.19$
Normality	$\chi^2(2) = 0.97$
Homoscedasticity	$\chi^2(1) = 9.91$

$$\text{Log}(p2/p_1) = \underset{(0.93)}{-2.00} - \underset{(0.24)}{0.71} \text{ Log(Libor)} + \underset{(0.13)}{0.83} \text{ Res} + \underset{(0.24)}{0.69} \text{ Log } p_x$$

$R^2 = 0.77$ DW = 1.40 $\hat{\sigma} = 19.17\%$

Linearity	$\chi^2(1) = 0.55$
Normality	$\chi^2(2) = 1.34$
Homoscedasticity	$\chi^2(1) = 0.47$

APPENDIX 2

Principal components were extracted from the seven countries' time-series of monthly debt prices for the period 1986.3 through 1989.11. It will be seen from the Table that the first principle component explains 86% of the variance. We show graphs for it and for the second principle component. It is of interest that a simple regression of the first principle component on Libor gives $R^2 = 0.72$ with $t = -10.4$.

VARIABLES: ARG BRA CHL HEX POL VEN YUG

NUMBER OF OBSERVATIONS: 45

CORRELATION MATRIX

	ARG	BRA	CHL	HEX	POL	VEN	YUG
ARG	1.00000						
BRA	0.94115	1.00000					
CHL	0.76324	0.73740	1.00000				
HEX	0.91337	0.94620	0.72518	1.00000			
POL	0.72495	0.75664	0.56560	0.86474	1.00000		
VEN	0.95781	0.95615	0.73569	0.97147	0.80773	1.00000	
YUG	0.94321	0.83592	0.64606	0.81077	0.63541	0.39123	1.00000

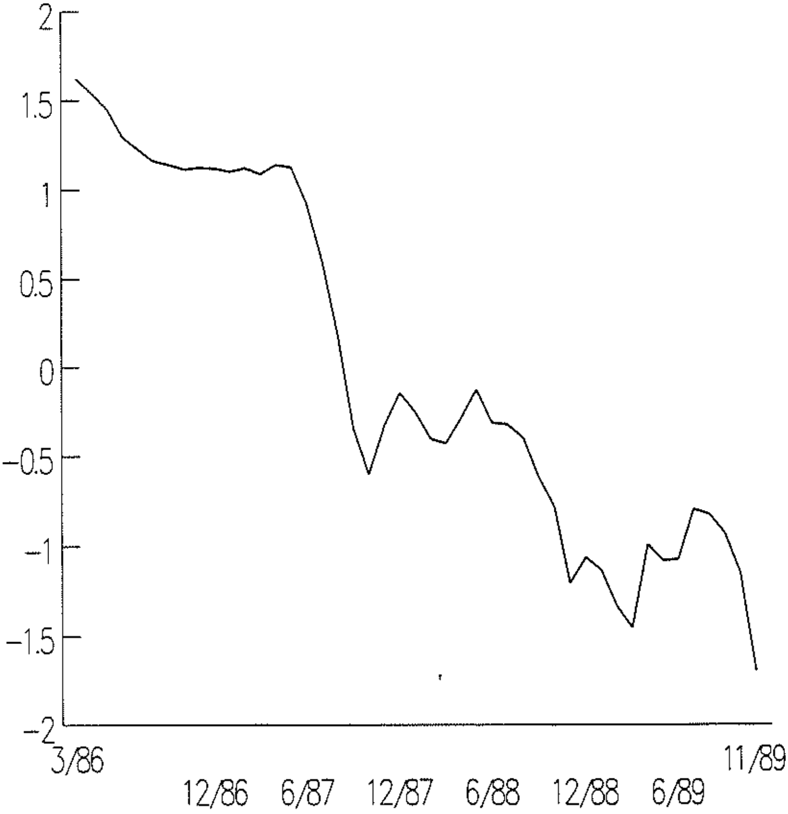
COMPONENT	NAME	ITERATIONS	CHARACTERISTIC ROOT	CUMULATIVE FRACTION OF VARIANCE EXPLAINED
1	P1	6	6.0088136	0.85840195
2	P2	30	0.54590627	0.93638555
3	P3	23	0.24440511	0.97130357
4	P4	17	0.12553331	0.98923697
5	P5	20	0.47606671E-01	0.99603792
6	P6	23	0.17925555E-01	0.99859366
7	P7	3	0.98080135E-02	1.0000000

FACTOR LOADINGS

	1	2	3	4	5	6	7
ARG	0.97156	0.06772	0.13773	0.06053	0.01387	0.07985	-0.05386
BRA	0.96108	-0.08784	0.13876	-0.16006	0.14984	-0.03390	-0.01154
CHL	0.83744	0.42029	-0.33211	-0.10712	0.00647	0.01373	0.00743
HEX	0.96373	-0.19665	0.02678	-0.10296	-0.12733	-0.05983	0.03796
POL	0.82366	-0.47550	-0.25787	0.13645	0.04376	0.01400	-0.00007
VEN	0.93745	-0.04203	0.03426	-0.04321	-0.03226	0.04385	-0.07109
YUG	0.92153	0.29543	0.07276	0.23171	0.00519	-0.06365	-0.01495

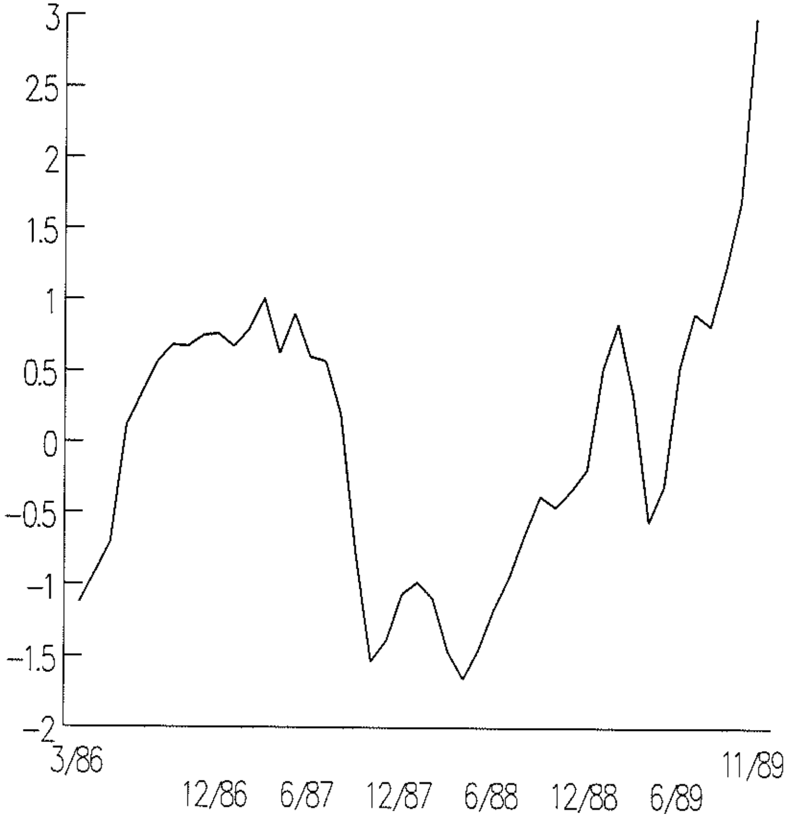
FIRST PRINCIPAL COMPONENT

(7 COUNTRIES)



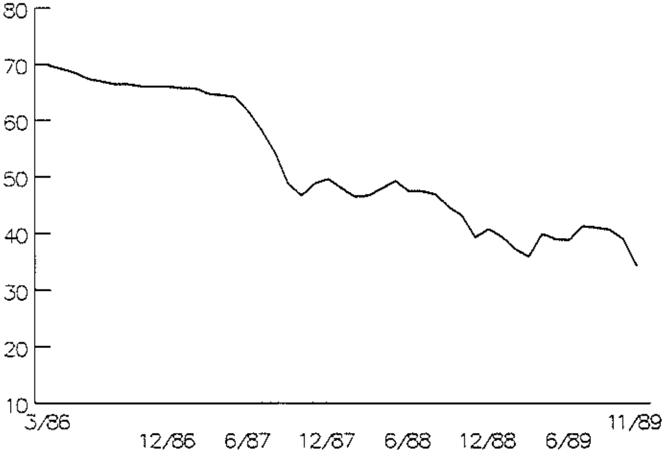
SECOND PRINCIPAL COMPONENT

(7 COUNTRIES)



SECONDARY MARKET DEBT PRICE

UNWEIGHTED MEAN



WEIGHTED MEAN

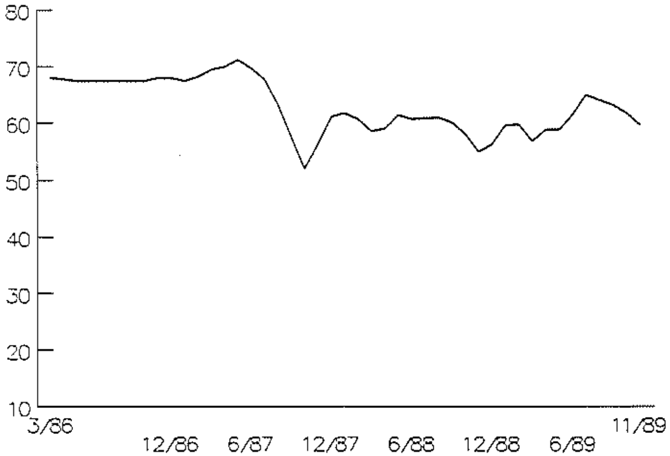
SECONDARY MARKET DEBT PRICE

Argentina

Brazil

SECONDARY MARKET DEBT PRICE

Chile



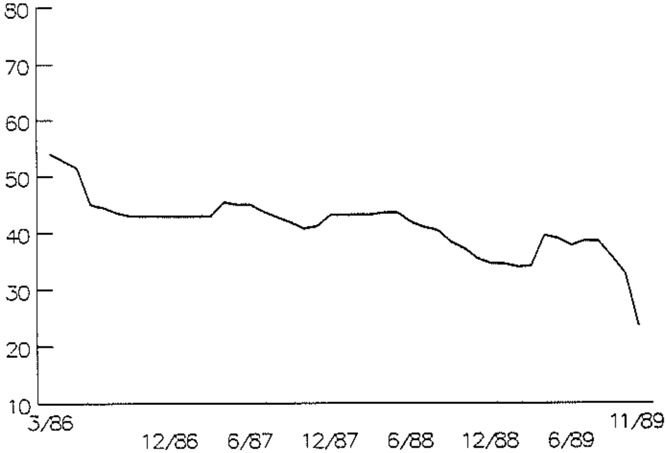
Mexico

SECONDARY MARKET DEBT PRICE

Venezuela

SECONDARY MARKET DEBT PRICE

Poland



Yugoslavia