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INTERNATIONAL MONETARY FUND

Research Department

An Examination of the Contagion Effect in the International Loan Market

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I. Introduction

The rapid growth of commercial bank loans to sovereign borrowers in the last decade has at times caused considerable concern among regulators, politicians and academics. One aspect of this concern has been a fear that the international banking system could collapse if a default by a single major borrower triggered other defaults, resulting in a wild scramble among banks to disengage themselves from the international loan market. This disengagement process itself could exacerbate the crisis and increase the pace of sovereign defaults and bank failures.

In this paper the causes of, and potential for, a debt crisis encompassing all sovereign borrowers is examined and tested. Elsewhere this potential for an interlinked crisis between borrowing groups has been called a contagion effect (see Aharony and Swary (1982), Carron (1982), and Guttentag and Herring (1982)). A high degree of contagion implies a high level of systematic, or undiversifiable risk in international lending, and therefore, considerable exposure of the international banking system to a major collapse. Conversely, a low level of contagion suggests that sovereign defaults are basically independent or unsystematic events and that these risks can be minimized by holding a geographically diversified portfolio of sovereign loans.

In Section II a simple analytical framework is specified to examine the underlying causes of contagion or systematic risk in international lending. It is argued that contagion is caused by a shift in lenders' subjective perceptions regarding borrower repayment probabilities, and that this shift is induced by changes in either the lenders' information set and/or changes in real economic or financial factors linking countries. It is shown that such shifts imply increases in both the average interest spreads on international loans and a greater degree of co-movement or correlation in the spreads charged to different borrowing groups. More-

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over, it is also demonstrated that under certain circumstances, profit maximizing behavior by lenders can involve rationing credit and that contagion can increase the aggregate degree of credit rationing in the international loan market.

In Section III the predicted effects of contagion on (international loan) interest spreads are investigated using data published by Euromoney. The results suggest a clear trend over time towards rising spreads on average as well as a greater degree of co-movement among spreads, especially during periods of adverse information, such as requests for reschedulings of principal and/or interest; characteristics which support the presence of contagion effects as defined in Section II. In Section IV the evidence on loan flows between borrowing groups is examined using data reported by the Bank for International Settlements (BIS). It appears that up until the end of 1982, loan flows have been positively and systematically related, suggesting that the potential for a long-range and comprehensive contraction of loans across all borrowing groups following a shock to any one group, was probably quite high at the time. Finally in Section V, these results are summarized and some conclusions are drawn.

II. Analysis of the Contagion Effects

The basic framework for analyzing contagion effects is the risk-premium model developed by Bierman and Hass (1975), Yawitz (1977, 1978), and John and Saunders (1983), and extensively reviewed in Saunders (1983). Consider a competitive banking system with risk neutral lender(s). 1/ For simplicity, it is assumed that if a sovereign debtor declares default, expropriable collateral will be zero. 2/ Let k be the equilibrium interest rate (return) on the loan, R_F be the interest rate on a safe-loan (the risk-free rate), ϕ be the risk-premium or spread on the loan and p be the lenders' subjective probability of repayment. Then a profit-maximizing risk-neutral lender would charge a loan rate such that the expected return on a risky loan just equals the return on a safe or risk-free loan. That is,

$$0(1 - p) + (1 + k)p = 1 + R_F \qquad (1)$$

Solving for k, the required rate on the risky loan:

1/ The risk-averse case is also considered in Saunders (1983).

2/ For example, default by domestic borrowers can usually be met by recourse to local bankruptcy courts, while no similar set of institutions exists to deal with cross-border defaults. As discussed elsewhere (Saunders (1983)), this is not an unreasonable assumption given the jurisdictional and legal powers which distinguish sovereign borrowers (and risks) from corporate or domestic borrowers.)

$$k = [(1 + R_F)/p] - 1 \quad (2)$$

with a risk premium, ϕ, equal to:

$$\phi = [(1 + R_F)/p] - (1 + R_F) \quad (3)$$

From equations (1) - (3) it is clear that given R_F (the rate on risk-free loans), both k and ϕ are driven by lenders' perceived probability of loan repayment (p).

Recent theoretical research, in the area of corporate and international borrowing (see, for example, Merton (1974), Ross (1977), and Myers (1977) for corporate borrowing; and Eaton and Gersovitz (1981), Sachs and Cohen (1982), and Freeman (1979) for international borrowing) 1/ has viewed default as a wealth maximizing decision or option which can be exercised by the borrower. This option or investment decision has a well-defined stream of costs and benefits. Within this rather narrow paradigm the economic benefits of default are viewed as the expropriation of outstanding debt and nonpayment of interest on that debt by the borrower. This expropriation results in a once-and-for-all gain (or windfall increase) in the domestic captial stock or equity of the defaulting country. Against this a sovereign borrower would weigh the expected economic costs of default. These include the effects of trade disruption on imports and exports as well as the costs of being excluded from the international loan market in the future. 2/ The latter is likely to be more costly, the greater the country's profitable investment opportunities or future growth options (see Myers (1977) and Freeman (1979)). Clearly the larger these costs are, relative to the benefits, the less likely a country is to default on its existing loans (i.e., to exercise its default option).

If we define C_i as the lenders' perception of the net costs/benefits to the ith borrower of declaring default and repudiating its debt obligations, then

$$p = Pr[1 + k > 0] = f(C_i) \quad (4)$$

where $f' > 0$ and C_i may be viewed as the country-specific or unsystematic default risk of the ith borrower.

1/ The literature is critically reviewed in Saunders (1983).

2/ Here we ignore political and legal costs, although obviously they will be an important factor.

Following Guttentag and Herring (1982) a crisis state or period may be defined as one in which lenders perceive that the probability of systematic default or default contagion is nonzero. Further, in such a disaster state the probability of repayment is zero for all loans. Thus while in normal periods lenders may base their subjective probabilities of repayment of a given loan on $f(C_i)$ as in (4) above, in crisis periods p is determined by equation (5) below:

$$p = Pr[1 + k > 0] = (1 - \pi)f(C_i) + \pi(0) \qquad (5)$$

where π is the lenders' perceived probability of the disaster state occurring. Implicitly, in normal periods $\pi = 0$ while in crisis periods $\pi > 0$. 1/ Note that this perception of systematic risk or contagion can be based on either actual real and financial linkages (e.g., through trade, inflation, money supply, etc.) or it can be purely informational, i.e., the debt repayment problems of one sovereign borrower sends adverse signals to lenders regarding the repayment probabilities of all countries, thereby changing lenders' prior expectations as to π.

In the context of equations (1) - (5) an increase in the systematic or contagion probability (π) will reduce p, the perceived probability of repayment, even if country-specific risk, $f(C_i)$, remains unchanged. Moreover, the larger is π, the more the systematic or contagion risk component will dominate country-specific risk, so that the perception of repayment probabilities for different countries will tend to become increasingly isomorphic. Thus the presence of a perceived contagion risk should not only result in increasing risk premiums or spreads on international loans, or ϕ in equation (3), but also in a greater correlation or co-movement in the spreads charged to different borrowing groups (countries). 2/ These characteristics are tested for in Section III below.

Country risk and contagion risk not only may have well-defined effects on interest rates (k) and spreads (ϕ), but also may have important effects on the quantity of loans the lender is willing to make. The possibility of credit-rationing as a profit-maximizing response by lenders making risky loans, has gained increasing attention in the literature (see Sachs and Cohen (1982), Eaton and Gersovitz (1981), and Stiglitz and Weiss (1981), among others). This is because it has been noted that increasing interest rates on loans to borrowers may be counterproductive, since raising rates (e.g., on loan roll-overs) may produce increased incentives for borrowers to default rather than repay. In the context of the wealth-maximizing or cost-benefit default paradigm, increasing rates raise the benefits to the borrower from defaulting ex-post (i.e., after the loan

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1/ This idea of systematic and unsystematic risks of loans in the international market is similar to that also found in portfolio theory (see Goodman (1981) and Walter (1981) for analyses along these lines).

2/ See Carron (1982) for a similar argument.

is made). Moreover, rising rates also reduce the incentives against default provided by the opportunity set of potentially profitable future investment (or growth) options, since higher rates eliminate many of these options (see Myers (1977)) making default more probable, i.e., less costly to the borrower. Thus the expected return on the loan (E(r)) and the interest rate charged on the loan (k) may be non-linearly related over some range.

Similar to Stiglitz and Weiss (1981), the relationship between the E(r) on the loan and the contractual interest rate (k) can be shown in Figure 1. In this figure, as the interest rate charged to a sovereign borrower rises from zero, the lender's expected return may initially rise, since over the relatively low interest rate range ($k < k_0^*$) the lender's expected return from higher interest rate charges will tend to offset any greater risk due to the borrower's increased incentive to default after the loan is made. Eventually, however, the increased risk due to the default incentives generated by higher rates, may come to outweigh the increased returns due to higher interest rate charges, so that at some point beyond (k_0^*) the lender's expected return on the loan will actually start to fall. Of course the logic of this argument is that extremely high interest rates, such as k_3 in Figure 1, will simply result in lower expected returns to the lender (r_3). Hence an important implication of Figure 1 is that at any moment in time there is an equilibrium rate on a risky loan which maximizes a lender's expected return, and that this rate, or associated spread over the risk-free rate, is not necessarily large. In Figure 1 the optimal rate is k_0^*.

To see how credit rationing can occur, assume that there are two observationally distinguishable borrowing groups 1/: A and B. Group A might be thought of as the industrialized group of countries and Group B as developing countries. Suppose the interest rate-expected return loci for these two groups take the forms characterized in Figure 2. Here, k_A is the optimal, expected-return maximizing, rate to be charged to Group A lenders and k_B is the optimal rate to be charged to Group B lenders such that $k_B > k_A$. Now suppose that the bank's cost of funds (assumed, for simplicity, to equal the risk-free rate) is designated by R_{f0} in Figure 2. At this cost of funds, all borrowers in Group A, who are willing to pay k_A, will receive loans. Indeed, even at rate k_A', loans to this group of borrowers will be just profitable. However, because of the higher default risk of Group B borrowers, the whole expected return-interest rate locus for this group lies below R_{f0} and no bank loans to Group B borrowers are profitable at any finite interest rate (or spread). Hence all type B borrowers will be rationed out of the international loan market. There are two ways that type B borrowers might regain access to the loan market. The first is if the cost of funds falls from R_{f0} to R_{f1} or below. The second is if lenders' subjective perceptions of Group B default risk is reduced, perhaps by some favorable shift in the investment opportunity

1/ Observationally distinguishable in the sense of country-risk(s) as defined in the wealth-maximizing default framework (see above).

set of future growth or investment options available to the borrowing country 1/ (in Figure 2, the locus B would shift upwards).

A contagion effect on the supply of loans can also be analyzed within this framework. Suppose Group B loans were initially credit-rationed because of some perceived adverse shift in its future investment/growth opportunities. In the absence of contagion Group A and B borrowers are, by definition, mutually distinguishable and only B's locus would be affected. However, contagion implies that lenders, due to informational or real linkages, no longer perfectly distinguish between borrowing groups. Hence an increase in the default risk of Group B's loans, due to a shift in its opportunity investment set for example, will also be viewed as increasing the default risk of all other groups: Group A, Group C, etc. As a result the expected return-interest rate loci will be revised downward for all groups even though the cost of funds remains the same for lenders at R_{f0}. This effect is shown in Figure 3 for the three borrowing groups A, B and C.

Initially all three groups have access to the credit market (with $k_B^* > k_C^* > k_A^* > R_{f0}$), although lenders prefer borrowers in Group A to those in Group B, and those in Group B to those in Group C. An increase in the default risk of Group B borrowers, when borrowers are mutually distinguishable, simply results in locus B shifting to B' and all borrowers in that group being rationed out of the market, while Group A and C retain access to the market at unchanged interest rates. When contagion is present a perceived shift in the riskiness of Group B's investment opportunity set is also viewed as an increase in the riskiness of the rest of the world's opportunity set, so that borrowers become less distinguishable and the expected return interest rate loci of both Group A and C borrowers shift downwards as in Figure 3. The result is that now all Group C borrowers are rationed out as well as Group B, while Group A borrowers still have access only if they are willing to pay a higher interest rate, i.e., $k_A' > k_A$.

The implication of the above analysis is that contagion should result in (increased) credit rationing, characterized by a falling quantity of loans in aggregate. These effects are examined in Section IV.

III. Contagion and Interest Spreads on International Loans

In Section II a period of crisis or contagion was defined as having the following effects on interest spreads:

(1) rising spreads or risk premiums (on average) on new international loans, and

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1/ Suppose the country invests mainly in primary commodity-producing investments. Then a favorable change in the terms of trade could produce such a shift.

Figure 1

The Relationship between the Expected Return and Interest Rate on the Loan

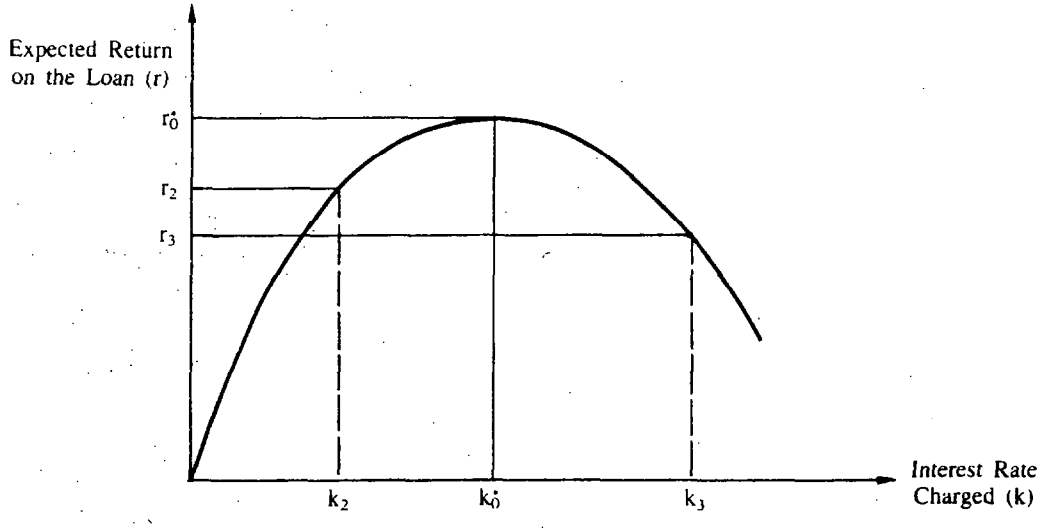


Figure 2. Expected Return - Interest Rate Loci for Groups A and B

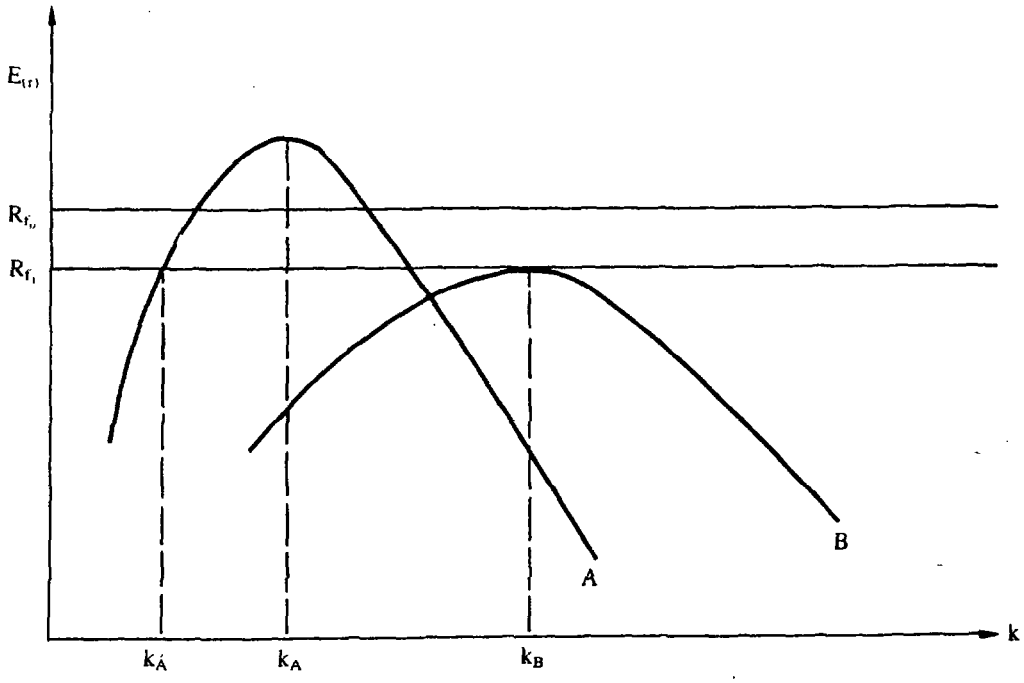
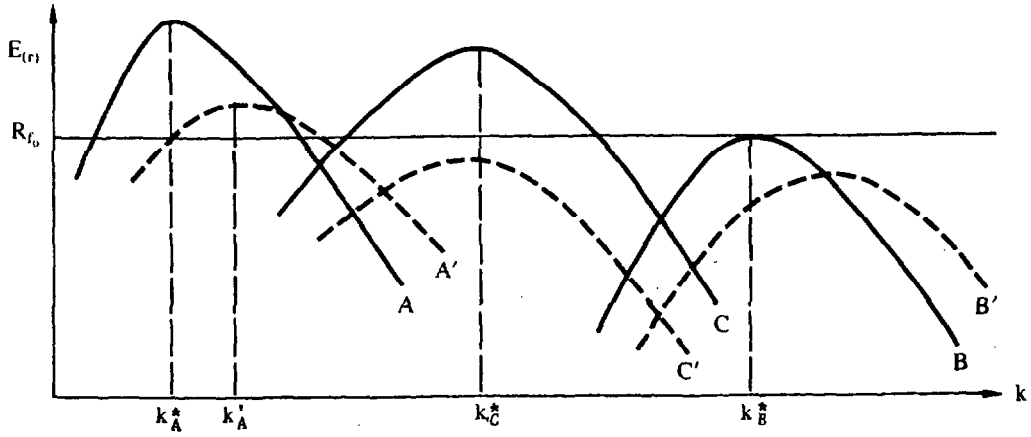


Figure 3. Contagion and Credit Rationing



(2) an increase in the covariance (or co-movement) in the spreads charged to different borrowing groups.

The data used in this section to examine these effects are indices on spreads published by Euromoney. These indices include a general spread index based in a weighted average of all borrowers' (interest) costs, 1/ and sub-indices that reflect the interest conditions facing individual borrowing groups. In particular, the behavior of three country group sub-indices will be analyzed here: (1) the industrialized group, (2) the high, upper middle-income group and (3) the intermediate, lower income group. 2/ The industrialized group includes all the borrowers we might view as prime: the United States, United Kingdom, Canada, etc. The high, upper middle-income group includes a number of countries currently in debt difficulties, e.g., Yugoslavia, Brazil and Argentina, as does the third group of intermediate, lower income countries which includes Mexico, Chile, and Costa Rica. 3/

Before analyzing the data it might be worth noting again the problem of credit rationing. As has already been discussed in Section II, one rational response by lenders to an increase in the perceived default risk of a borrowing country is to ration it out of the loan market completely. That is, there may be no finite interest spread which makes the loan worth making. If this is so, then new loan requests would be turned down and the published spreads will not reflect the required spread (infinite) on these loans. However, since we are examining the "contagion" effect, this provides no significant problems, as any adverse information regarding existing borrowers, even if they no longer have access to new loans, would have a contagious effect on the interest conditions facing all other borrowers--including those that still have direct access to the loan market and might otherwise, in normal times, be viewed as low risk countries. Thus the characteristics defined above as a period of debt crisis still pertain, i.e., rising spreads on average and a greater co-movement in the spreads across borrowing groups.

1/ This series does not include fees and hence may imperfectly reflect "true" loan costs. However, as constructed, changes in the terms of the loan by shortening or lengthening the maturity are reflected, respectively, by rising and falling index values. This series is quite different from the spreads used in a recent study by Williams et al. (1983) based on data reported by the OECD. The OECD data includes only medium-term (i.e., over three-year) commitments rather than all loans, as covered by Euromoney. Moreover, the OECD series is unadjusted for non-price terms such as maturity, which is used in the Euromoney index. Hence the two series are not directly comparable.

2/ A fourth sub-index was published, this was for centrally planned economies. However, as a number of observations are not available (as quoted by Euromoney) this is not included in the study.

3/ For a full list of the countries which comprise each group see Euromoney, October 1980. These roughly accord with the World Bank's classification or grouping of countries by per capita income.

The monthly Euromoney index is plotted for the period January 1978 to April 1983 in Figure 4. To get a better idea of trends the three-month (centered) moving average of the index is also plotted in Figure 5. Visual impression suggests that spreads were falling on average until the end of 1979 and then started to rise, although not uniformly, throughout the 1980's. Moreover, the upward trend in spreads post-1981 seems more pronounced than during 1980-81.

To get a better idea of the underlying behavior in the spread or risk premium index (I_t), simple time trend regressions were run for the whole sample period and two equal subperiods: January 1978 to August 1980 and September 1980 to April 1983. The results are presented below (standard-errors in parentheses, and * indicates that the coefficient is significantly different from zero at the 5 percent level or more).

January 1978 - April 1982

$$I_t = \underset{(6.234)}{111.457^*} + \underset{(0.167)}{0.198t} \qquad (6)$$

$R^2 = 0.022 \qquad n = 64 \qquad t = 1 \ldots n$

January 1978 - August 1980

$$I_t = \underset{(5.235)}{140.265^*} - \underset{(0.276)}{1.700^*t} \qquad (7)$$

$R^2 = 0.556 \qquad n = 32 \qquad t = 1 \ldots n$

September 1980 - April 1983

$$I_t = \underset{(23.576)}{67.623^*} + \underset{(0.478)}{1.153^*t} \qquad (8)$$

$R^2 = 0.163 \qquad n = 32 \qquad t = 1 \ldots n$

These simple time trend regressions confirm the visual impression of Figures 4 and 5. Specifically, that there was a significant downward trend in spreads over the more normal period January 1978 to August 1980 (the only "major" debt rescheduling problem was for Turkey) whereas in the most recent sub-period, when the number of sovereign countries with debt problems increased significantly, there has been an upward trend in the index. Hence the first characteristic of a crisis or contagion effect, an upward trend in spreads (on average), appears to have some empirical support in the post-September 1980 period.

Further insights into the persistence of the spread such as cumulative or non-cumulative behavior, can be gained by examining whether a

Figure 4

Euromoney (Monthly) Index of Interest Spreads

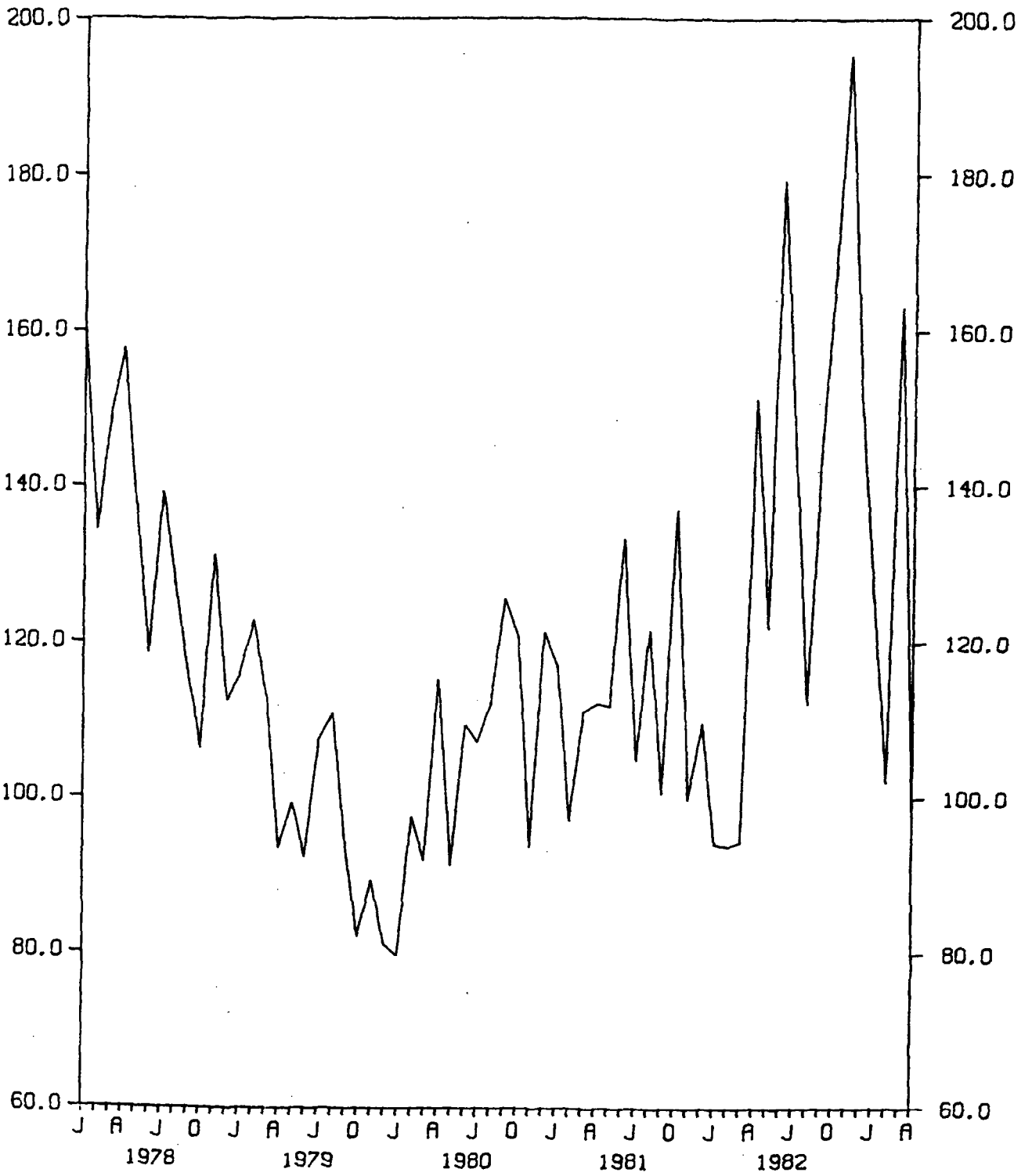
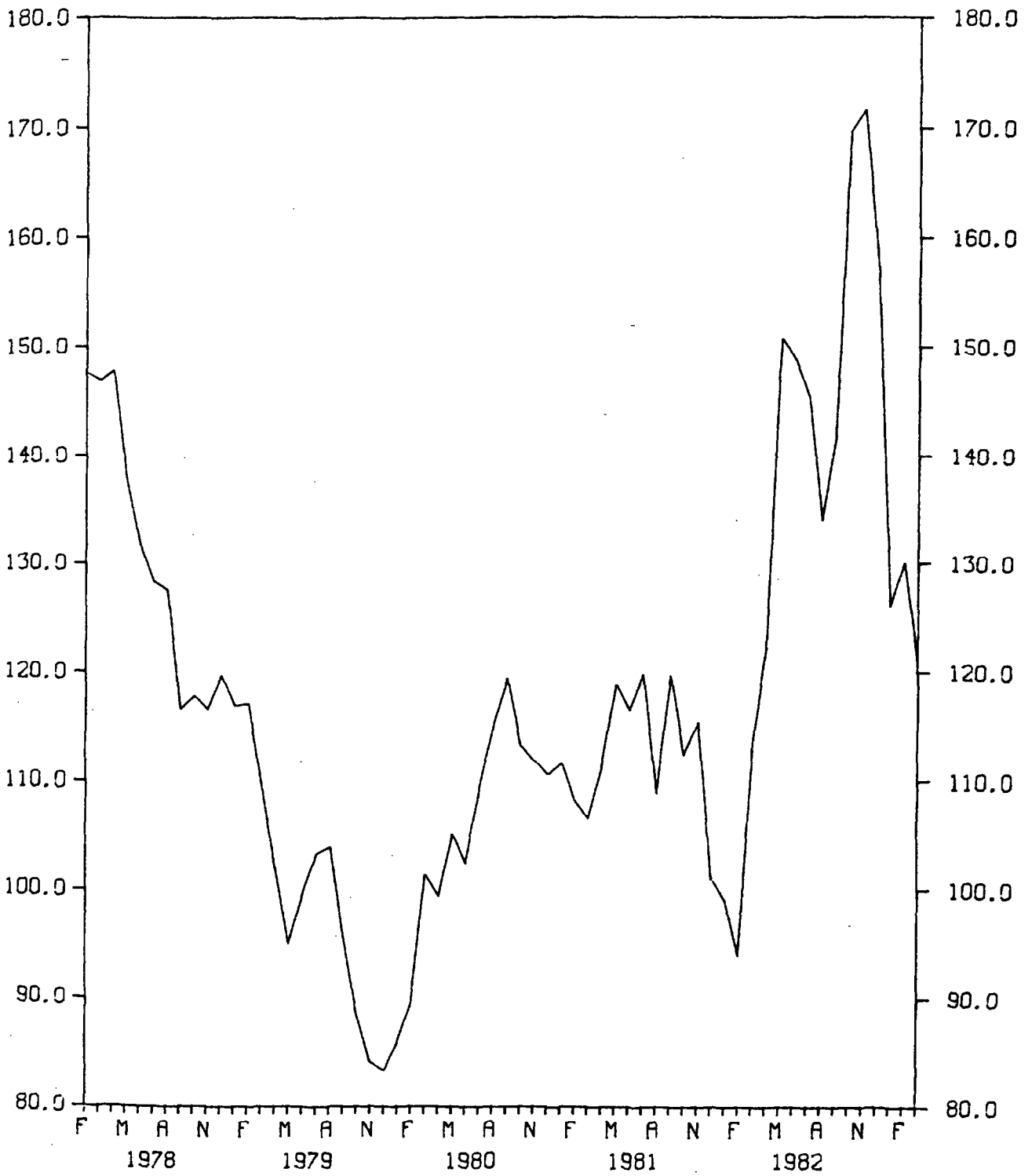


Figure 5

Euromoney Index - Three-month (Centered) Moving Average



simple random walk model holds for interest-spreads over the time period. If directional persistence has been important, as in a crisis, then the data should reject the random-walk model for the spread-index. The necessary conditions (restrictions) for the spread index to follow a random walk are that $\alpha = 0$ and $\beta = 1$ in the equations below 1/ (** denotes β significantly different from unity, and * denotes α significantly different from zero).

Whole Period

$$I_t = \underset{(13.142)}{59.097^*} + \underset{(0.109)}{0.492}\ I_{t-1}^{**} \qquad (9)$$

$R^2 = 0.251$ n = 63 h = -2.31

Sub-Period 1

$$I_t = \underset{(12.880)}{34.006^*} + \underset{(0.113)}{0.683}\ I_{t-1}^{**} \qquad (10)$$

$R^2 = 0.558$ n = 31 h = -1.616

Sub-Period 2

$$I_t = \underset{(22.337)}{83.372^*} + \underset{(0.176)}{0.306}\ I_{t-1}^{**} \qquad (11)$$

$R^2 = 0.091$ n = 32 h = -4.879

As can be seen, equations (9) - (11) clearly reject the notion that the spread over LIBOR behaved in a random-walk fashion over the sample period since both $\alpha \neq 0$ and $\beta \neq 1$ in all cases.

In summary, it appears that risk premiums tend to persist from month to month, and that over the first half of the sample period the trend was negative and over the second half, positive.

The next step is to examine the time-series behavior of different country groups (sub-indices) to see if they also displayed similar upward trends on average in the more recent time period. Monthly indices for the three subgroups: (1) industrialized countries, (2) the high, upper middle-income group (middle income developing countries) and (3) the

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1/ Assuming an underlying regression model of the form:

$$I_t = \alpha + \beta I_{t-1} + \varepsilon_t, \quad \text{where } \varepsilon_t \sim N(0, \sigma_\varepsilon^2).$$

intermediate, lower income group (poor developing countries), are available in published form for the period June 1980 to March 1983 only. These indices are plotted in raw form and as three-month (centered) moving averages in Figures 6 and 7, while the time trends for each sub-index and two equal subperiods, June 1980 to October 1981 and November 1981 to March 1983, are estimated in regressions (12) - (20) below.

(1) Industrialized Group

June 1980 - March 1983

$$I_t = \underset{(3.104)}{73.179^*} + \underset{(0.154)}{0.261t} \qquad (12)$$

$R^2 = 0.082$ $\quad n = 34$

June 1980 - October 1981

$$I_t = \underset{(4.275)}{80.302^*} - \underset{(0.417)}{0.458t} \qquad (13)$$

$R^2 = 0.074$ $\quad n = 17$

November 1981 - March 1983

$$I_t = \underset{(8.596)}{41.7901^*} + \underset{(0.325)}{1.443^*t} \qquad (14)$$

$R^2 = 0.568$ $\quad n = 17$

(2) High, Upper Middle Income Group

June 1980 - March 1983

$$I_t = \underset{(8.167)}{124.817^*} + \underset{(0.407)}{2.862^*t} \qquad (15)$$

$R^2 = 0.607$ $\quad n = 34$

June 1980 - October 1981

$$I_t = \underset{(7.737)}{130.517^*} + \underset{(0.755)}{2.214^*t} \qquad (16)$$

$R^2 = 0.364$ $\quad n = 17$

Figure 6

Euromoney Country Group Sub-indices

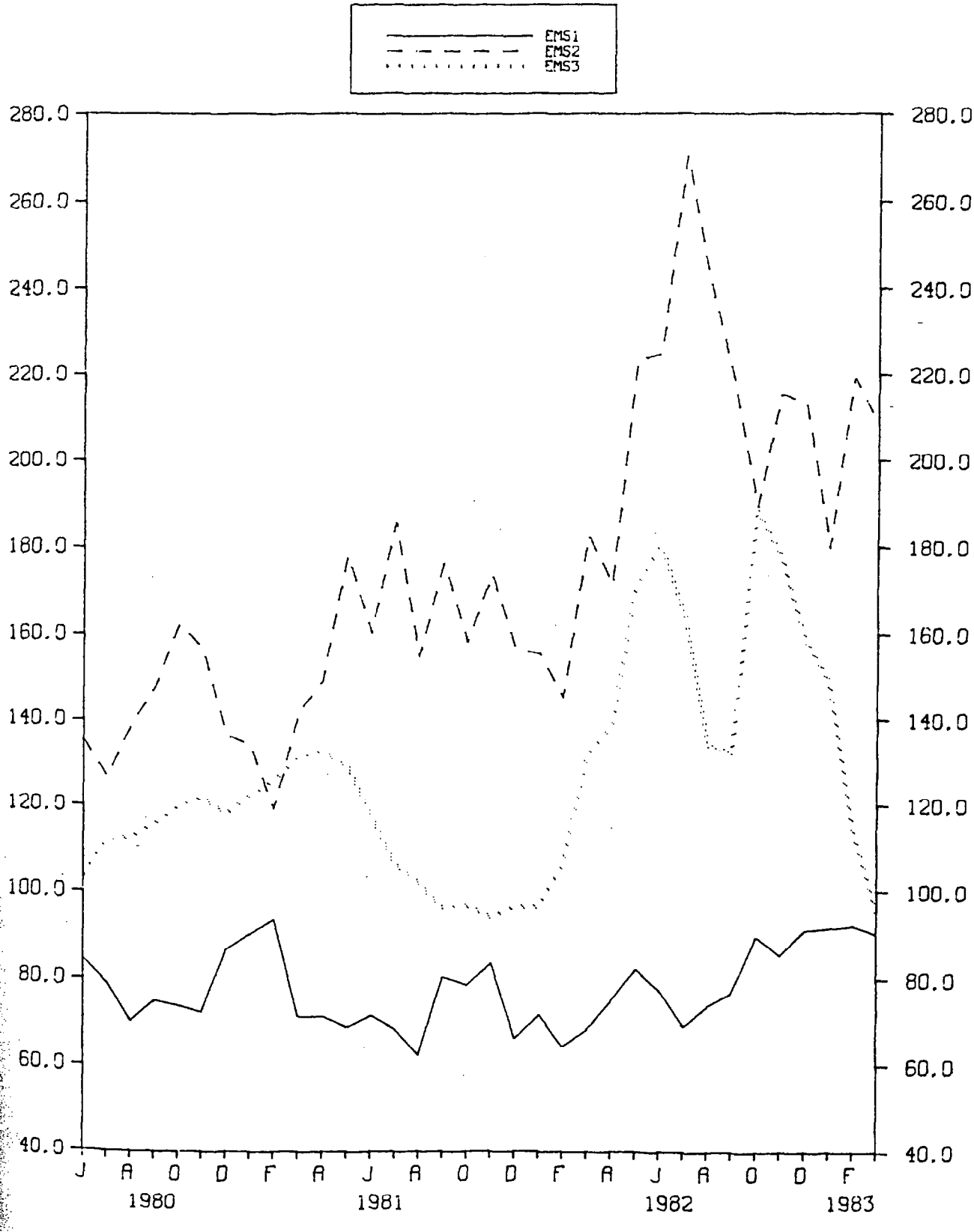
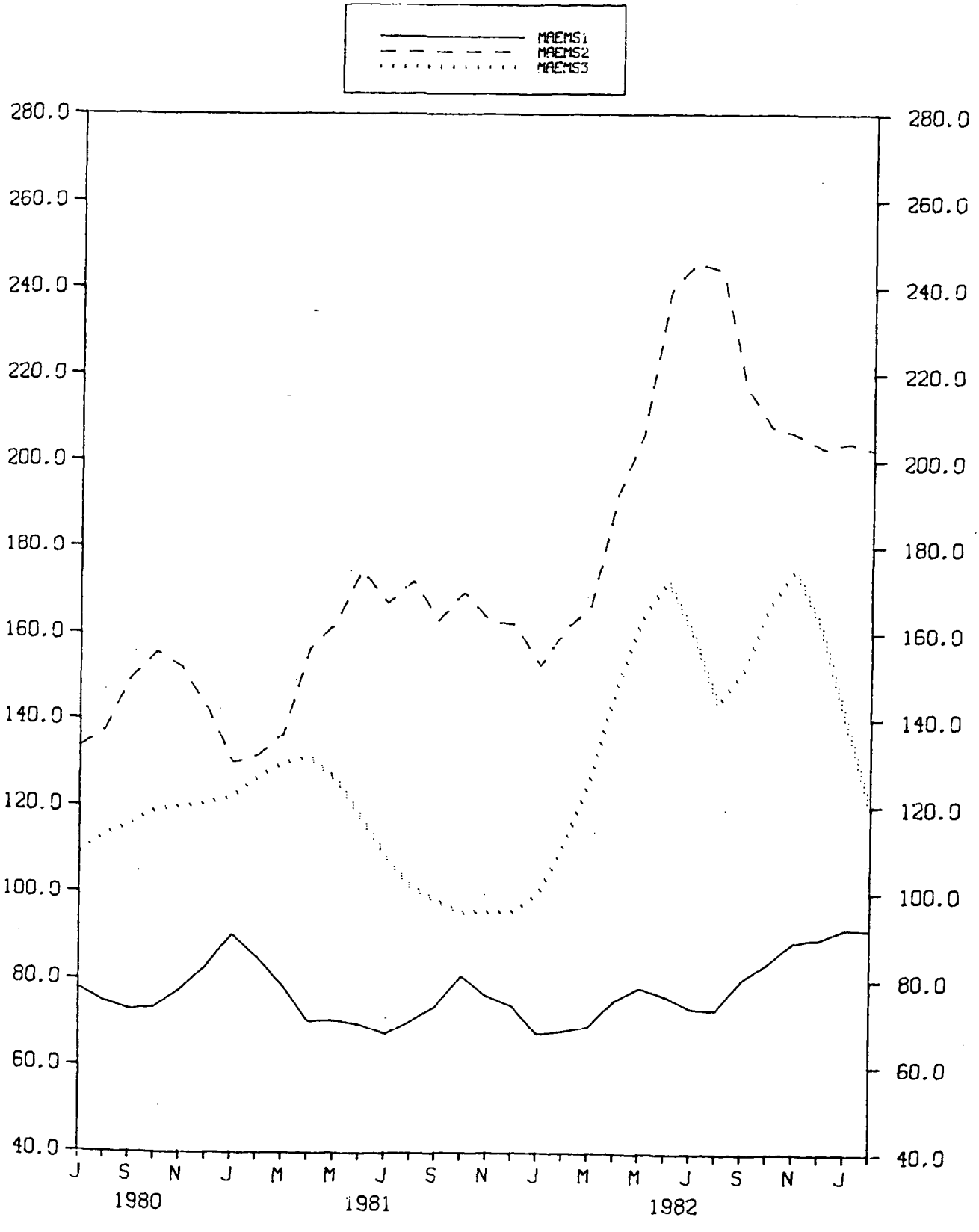


Figure 7

Euromoney Country Group Sub-indices - Three-month Moving Average



November 1981 - March 1983

$$I_t = 110.555^* + 3.416^*t \quad (17)$$
$$(39.392) \quad (1.489)$$

$R^2 = 0.259 \qquad n = 17$

(3) Intermediate, Lower Income Group

June 1980 - March 1983

$$I_t = 105.721^* + 1.165^*t \quad (18)$$
$$(8.510) \quad (0.424)$$

$R^2 = 0.191 \qquad n = 34$

June 1980 - October 1981

$$I_t = 120.351^* - 0.562t \quad (19)$$
$$(5.839) \quad (0.569)$$

$R^2 = 0.061 \qquad n = 17$

November 1981 - March 1981

$$I_t = 78.627 + 2.242t \quad (20)$$
$$(41.608) \quad (1.572)$$

$R^2 = 0.119 \qquad n = 17$

The results of regressions (12) - (20) show there is also some support for an increasingly upward trend in subgroup spread indices over time. In the first subperiod (June 1980 to October 1981), little common pattern is apparent; the only positive trend is for the Middle Income Group of developing countries, while the slope coefficients for the Industrialized and Lower Income Groups are negative and insignificant. However, in the second subperiod (November 1981 to March 1983), the time trends of two of the three groups are (significantly) positive and the coefficient on the time-trend for the Middle Income Group is larger, in absolute value, than in the first subperiod. 1/

1/ The exception appears to have been the Intermediate, Lower Income Group, whose trend is positive but not statistically significant in the second subperiod. The major reason for this result is a considerable drop in the index after Mexico was excluded from the market while trying to reschedule its existing debt so that other developing countries, especially Asian developing countries, gained a greater weight, and thereby importance, in determining average spreads for this group.

To examine the second aspect of contagion effects on spreads, namely an increase in the co-movement in spreads over the more recent time period as the debt problems of sovereigns have unfolded, correlation matrices for two equal subperiods were estimated. The results are presented in Table 1 below.

Table 1. Correlations Between Spreads for Different Country Groups

	Group 1	Group 2	Group 3
(a) June 1980 - October 1981			
Group 1	1		
Group 2	-0.597*	1	
Group 3	0.027	-0.258	1
(b) November 1981 - March 1983			
Group 1	1		
Group 2	0.226	1	
Group 3	0.269	0.530*	1

* Is significantly different from zero at the 5 percent level for test $Z = (\rho-0)/(1/\sqrt{n-1})$.

From Table 1(a), the spreads of the middle income developing countries (Group 2) appear to have been negatively correlated with those of both the industrialized countries (Group 1) and lower income countries (Group 3) over the June 1980 to October 1981 period, while the spreads for the poor developing countries and the industrialized countries were basically unrelated. By comparison, in the most recent subperiod the spreads of all three groups are positively (i.e., systematically) correlated, with ρ_{12} increasing from -0.597 to +0.226, ρ_{23} from -0.258 to +0.530 and ρ_{13} from +0.027 to +0.269.

To test the statistical significance of these increased correlations a bi-variate test using the standard Fisher ρ to Z transformation was performed. 1/ This test take the form:

$$Z_{12} = (Z_1 - Z_2)/\sqrt{(1/N_1-3) + (1/N_2-3)}$$

1/ Because of the limited number of observations, the results of the Z test should be interpreted with caution.

where

$$Z_i = 1/2 \ln [(1+\rho_i)/(1-\rho_i)] \qquad i = 1,2.$$

such that ρ_i are the estimated correlations and N_i are the number of observations in each subsample (i.e., 17 observations in each subsample).

The estimated Z_{ij} value for the Group 1 and Group 2 correlations (ρ_{12}) is 2.432, for the Group 2 and Group 3 correlations (ρ_{23}), 2.226, and for the Group 1 and Group 3 correlations (ρ_{13}), 0.659. Thus two out of three correlations, those for ρ_{12} and ρ_{23}, showed significant increases in a positive direction between the first and second subperiods.

An even clearer impression of the increased co-movement in spreads or contagion effect on spreads can be gained by viewing Figures 8 - 10. In these figures the correlation coefficients are estimated using a moving window procedure. That is, each correlation coefficient is initially estimated over the first 17 months of the sample period and then the estimation period is shifted forward one month and the first observation is deleted. Thus the second estimate would be for months 2 through 18, and so on. The advantage of this approach is that the impact of any new information (such as the announcement of a request for loan rescheduling or adverse reports on a given sovereign borrower's creditworthiness) can be more readily identified. As can be seen from these figures, there is quite a dramatic increase in all three subgroup spread correlations over the period January 1982 (month 20) to November 1982 (month 30) followed by a plateauing and general decrease in correlations in the first few months of 1983. It should be noted that this period of quite dramatic increase in correlations encompasses a worsening of Poland's debt problems as well as the announcements of the Mexican and Brazilian requests for loan reschedulings. Thus these figures quite strongly suggest a contagion effect of spreads for most of 1982.

One possible criticism of this type of bi-variate analysis is that there is inadequate control for the correlations between correlations. For example, there might be interdependence between ρ_{ij} and ρ_{kj} over time (see Elston (1975)) so that the bi-variate analysis would only be indicative of changes in the underlying foctors or interrelationships between these group indices. An alternative, multi-variate approach which may be useful in identifying common factors such as the systematic default risk inherent in the time series of the spreads for each group is principal components analysis. This type of analysis has been widely used to analyze relationships among international stock market returns (see, for example, Ripley (1973)).

Principal components analysis consists of calculating the eigen-values and eigen-vectors of the correlation matrix formed from the original data (variables). These eigen-vectors are then used to transform the original variables into a new co-ordinate space such that the principal components

are orthogonal to each other. The first principal component (largest eigen-value) is the linear combination of original variables which has maximum variance. The second principal component has maximum variance among all linear combinations after the effects of the first principal component has been removed, and so on for the third component.

Below in Table 2 the three principal components are presented for the sub-indices over the whole period June 1980 to March 1983. Unfortunately, the limited number of observations prevents a splitting into subperiods as well.

Table 2. Principal Components Analysis of Country Group Spreads, June 1980 to March 1983

	Eigen Vectors		
Group 1 (industrialized countries)	0.993	-0.114	-0.036
Group 2 (middle income developing countries)	0.026	0.495	-0.868
Group 3 (poor developing countries)	-0.116	-0.861	-0.495
Eigen-values	1642.322	407.973	76.433
Percent variance explained	77.22%	19.18%	3.60%

As can be seen from Table 2, the first component (factor) explains 77.22 percent of the time-series behavior of spreads while the second and third factors explain only 19.18 percent and 3.6 percent, respectively. One problem with principal components analysis is that it is left to the researcher to interpret what the first, second and third factors are. Specifically, if the first factor is viewed as the systematic, or in our case, the contagion component of risk inherent in the group (spread) indices, which is a common interpretation of stock market return studies using principal components analysis to test the Arbitrage Pricing Model 1/ (see Roll and Ross (1981) and Ross (1976)), then the multi-variate results imply that the degree of systematic risk has been rather high, since it

1/ The arbitrage pricing model (or APT) argues that the expected returns on stocks are linear combinations of some common (observable) factors, the first factor being the market or systematic risk factor (beta) of the stock and the second factor the industry specific factor.

Figure 8. Moving Estimates of the Correlations between the Spreads Charged to the Industrialized Group and the Higher, Upper Middle Income Group (ρ_{12})

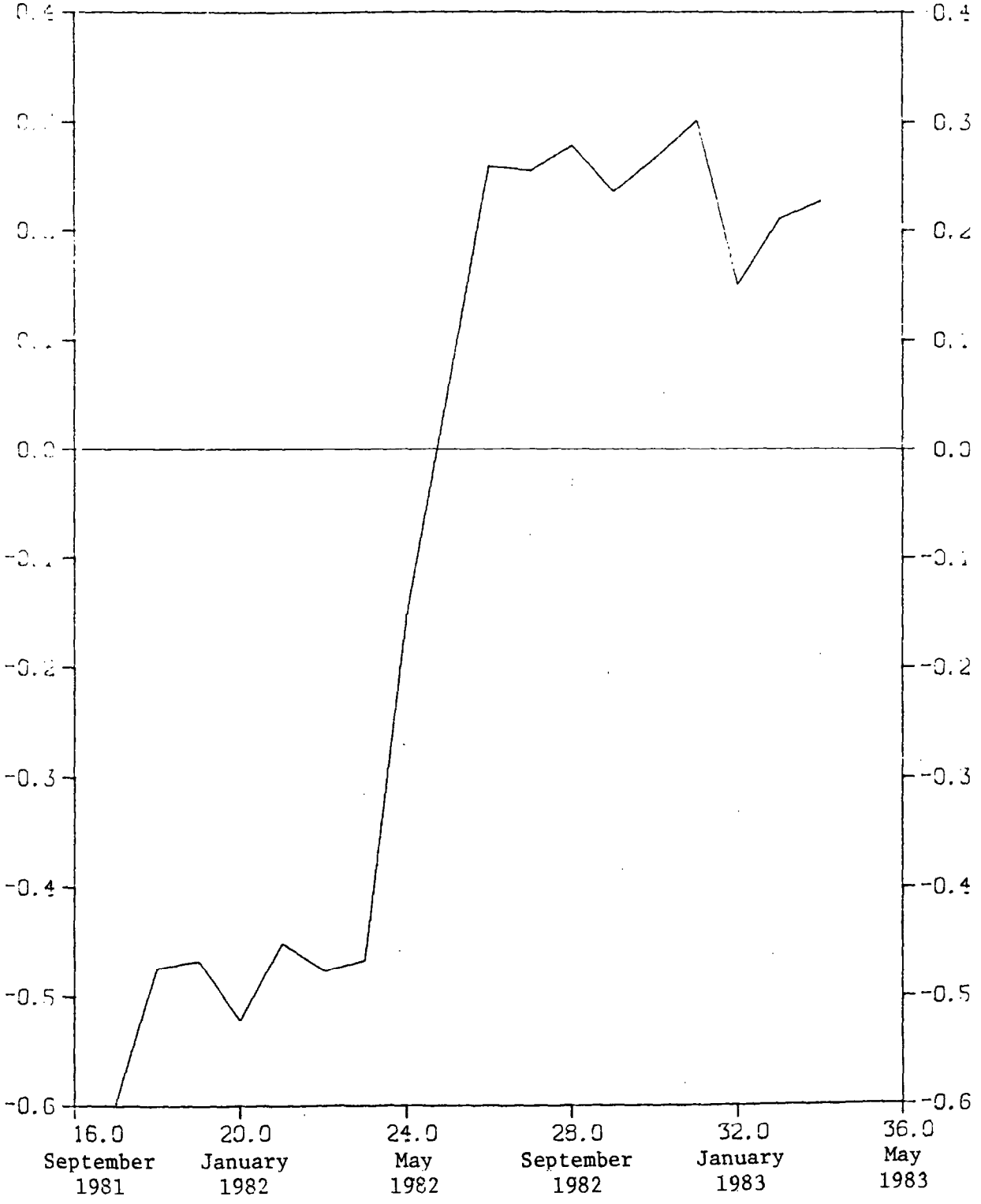


Figure 9. Moving Estimates of the Correlations between the Spreads Charged to the Industrialized Group and the Intermediate, Lower Income Group (ρ_{13})

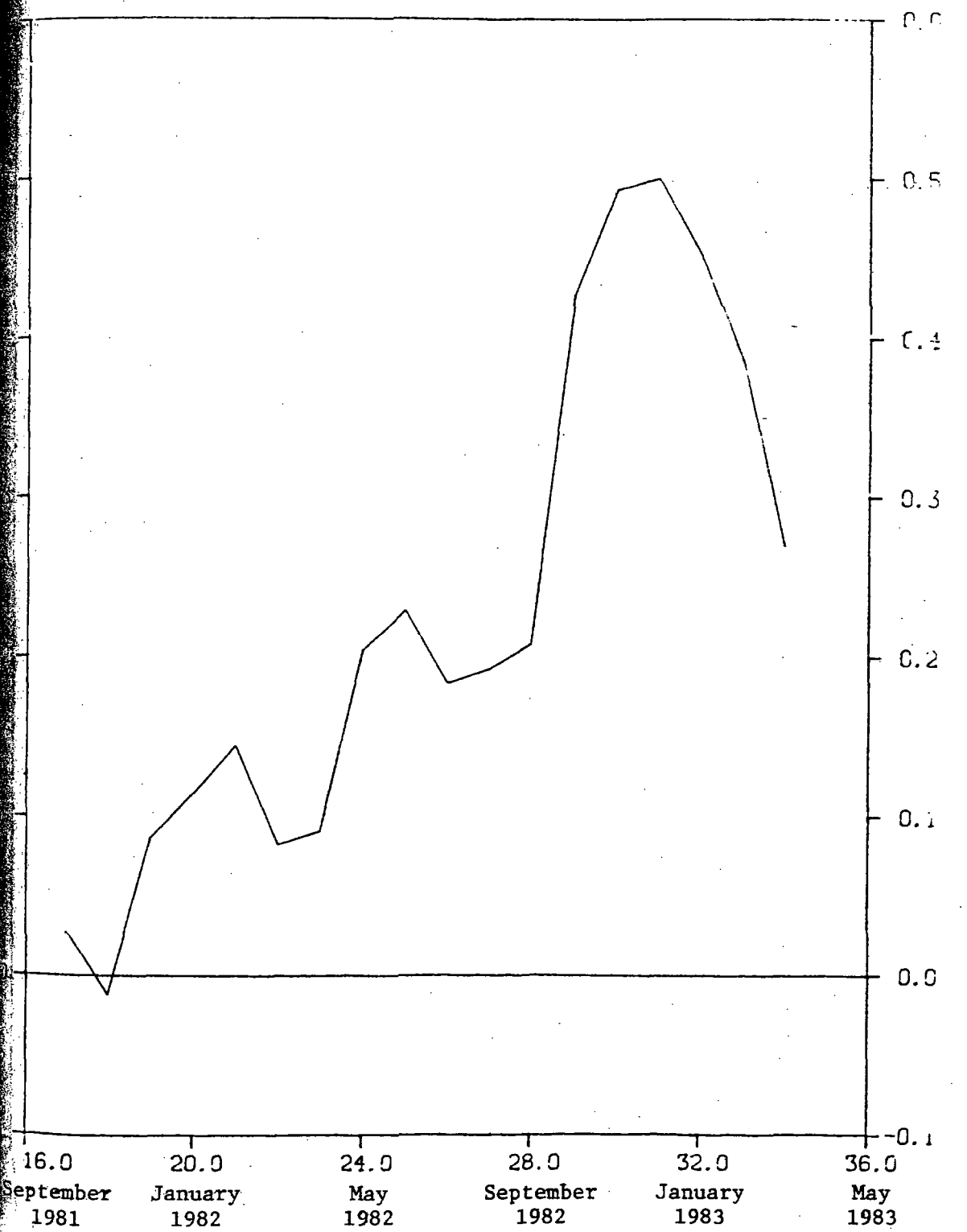
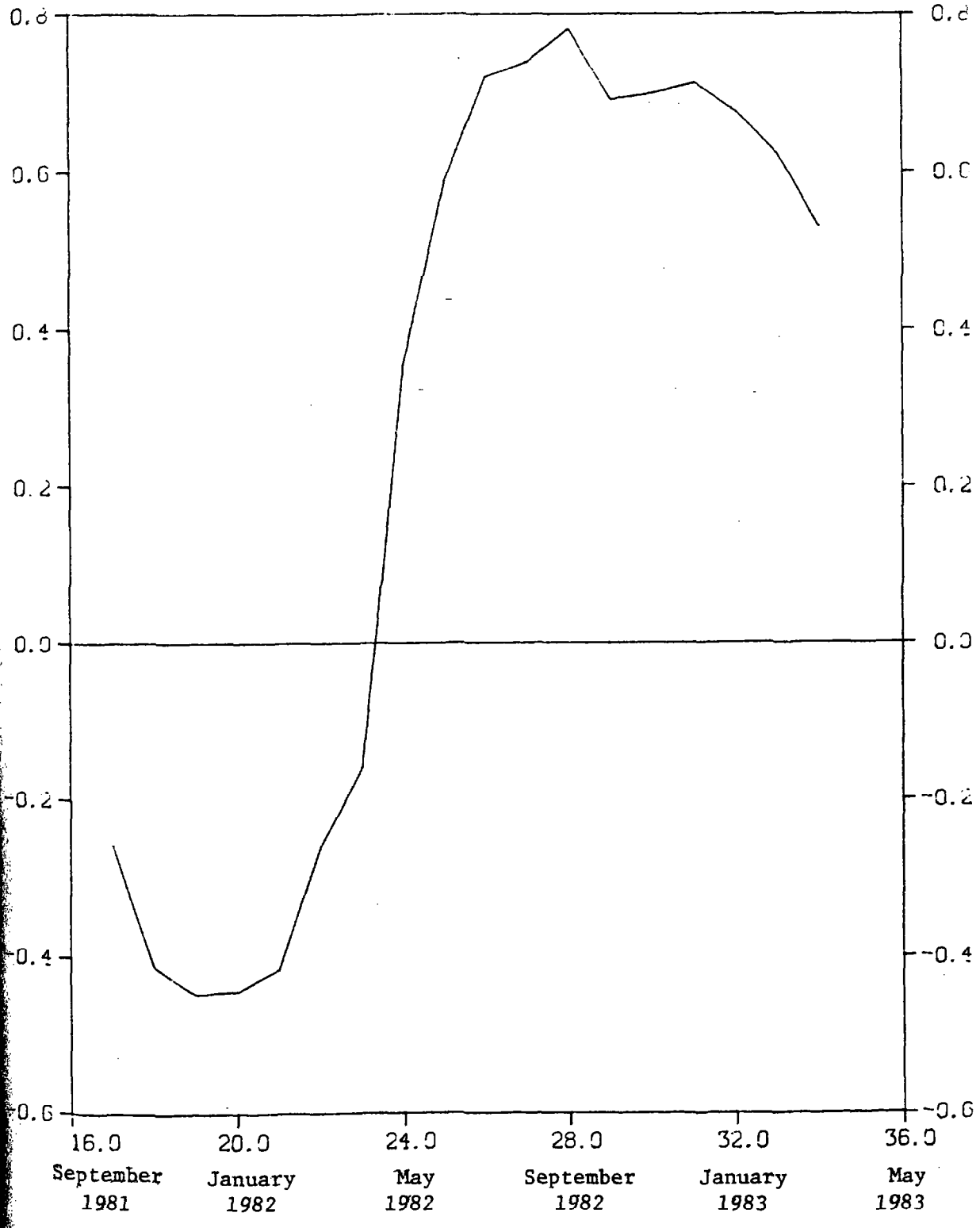


Figure 10. Moving Estimates of the Correlations between the Spreads Charged to the Higher, Upper Middle Income Group and the Intermediate, Lower Income Group (ρ_{23})



explains over 77 percent of the movement in spreads over the sample period. 1/

In summary, the bi-variate and multi-variate tests appear to be consistent with the view that significant systematic or contagion risk factors were impounded in movements or changes in interest-spreads (risk-premiums) at least during part of 1982.

IV. Contagion and the Supply of Loans

To examine whether there has been a significant or systematic contagion effect on the supply of international loans, data on international loans reported by the Bank of International Settlements were analyzed for the period 1977-IV to 1982-IV. These data reflect the outstanding external lending positions (exchange-rate adjusted) in domestic and foreign currencies, of banks in the BIS reporting area and for certain offshore branches of U.S. banks. While these data are not the most comprehensive aggregates of loans, they have the advantage of being published quarterly and over a longer historic time period than data reported in the World Bank's Borrowing in International Capital Markets. 2/ The growth in the aggregate stock of loans (excluding unallocated loans) is shown in Figure 11, while in Figure 12 this stock figure is broken down into loans to seven subgroups: (S1) the BIS reporting area, (S2) offshore banking centers, (S3) other developed countries (Australia, New Zealand, South Africa, etc.), (S4) Eastern Europe, (S5) Organization of Petroleum Exporting Countries (OPEC), (S6) Latin America, and (S7) other developing countries. Figure 11 demonstrates that the growth in the stock of loans outstanding has been considerable, growing from $680 billion in 1977-IV to over $1,653 billion in 1982-IV. Figure 12 shows that the largest borrowers (as at the end of the sample period) have been the reporting countries, offshore banking centers and Latin American countries followed by other developed countries, OPEC, other developing countries and the Eastern bloc. However, while stock figures demonstrate upward long-term trends in borrowing, contagion is really concerned with changes in the outstanding stock of loans, i.e., in the flow of loans, and in the correlation of loan flows between different borrowing groups. In Table 3 the quarterly changes in the stock of loans outstanding (or flows) in aggregate and for each subgroup are displayed.

As can be seen from Table 3, the flow of new loans in 1982 (over all four quarters) was only $134.4 billion, compared to $216.6 billion in 1981. Moreover, new loans in 1982 were lower than in all years from 1978-81.

1/ In studies of the APT the second factor is usually viewed as industry-specific risk. This might be analogous to country-specific risk in the case under consideration here.

2/ These BIS data are also preferable to the data published by the OECD, which are based on loan commitments. The major problem with loan commitments is that they are imperfectly binding and may not be fully exercised (see Ho and Saunders (1983)).

Table 3. Flows of Loans from BIS Reporting Banks to Various Borrowing Groups, 1978-I to 1982-IV

(In billions of dollars)

	BIS Reporting Area (1)	Offshore Banking Centers (2)	Other Developed Countries (3)	Eastern Europe (4)	OPEC (5)	Latin America (6)	Other Developing Countries (7)	Total (8)
1978								
Q1	5.5	4.7	2.0	2.0	3.0	2.4	0.9	20.5
Q2	12.2	2.1	10.6	1.9	2.6	2.9	1.5	33.8
Q3	38.4	9.9	-7.3	3.9	2.2	4.0	2.6	53.7
Q4	66.7	8.2	3.7	1.5	10.3	5.6	4.8	100.8
1979								
Q1	-15.5	-2.2	-1.9	-0.6	-1.7	2.0	1.7	-18.2
Q2	33.0	11.3	13.6	2.5	2.2	5.6	3.1	71.3
Q3	56.5	14.8	-6.2	3.3	4.8	6.3	3.3	82.8
Q4	41.6	9.4	2.4	3.1	1.6	7.8	2.4	68.3
1980								
Q1	11.4	1.7	-0.6	-2.6	-4.2	1.9	-0.6	7.0
Q2	45.4	11.7	8.1	4.3	3.3	8.6	4.9	86.3
Q3	14.0	10.5	2.0	0.5	2.7	8.5	3.2	41.4
Q4	45.3	7.8	3.8	1.7	4.1	7.7	3.5	73.9
1981								
Q1	11.2	13.6	1.8	-1.0	-3.7	3.7	-1.0	24.6
Q2	-12.8	8.4	1.1	-1.6	-0.4	3.9	1.5	0.1
Q3	71.5	15.0	4.2	1.5	2.6	9.2	2.0	106.0
Q4	45.2	12.2	5.9	1.9	3.4	12.3	5.0	85.9
1982								
Q1	8.9	5.1	2.7	-4.8	0.4	3.1	-3.0	12.4
Q2	-7.6	6.2	2.9	-1.7	2.7	7.1	4.8	14.4
Q3	30.3	20.4	2.0	-2.0	2.2	0.7	-2.5	51.1
Q4	42.7	-1.3	5.7	1.2	1.4	-0.2	7.0	56.5

Figure 11

Stock of International Loans Outstanding (BIS), 1977-IV to 1982-IV

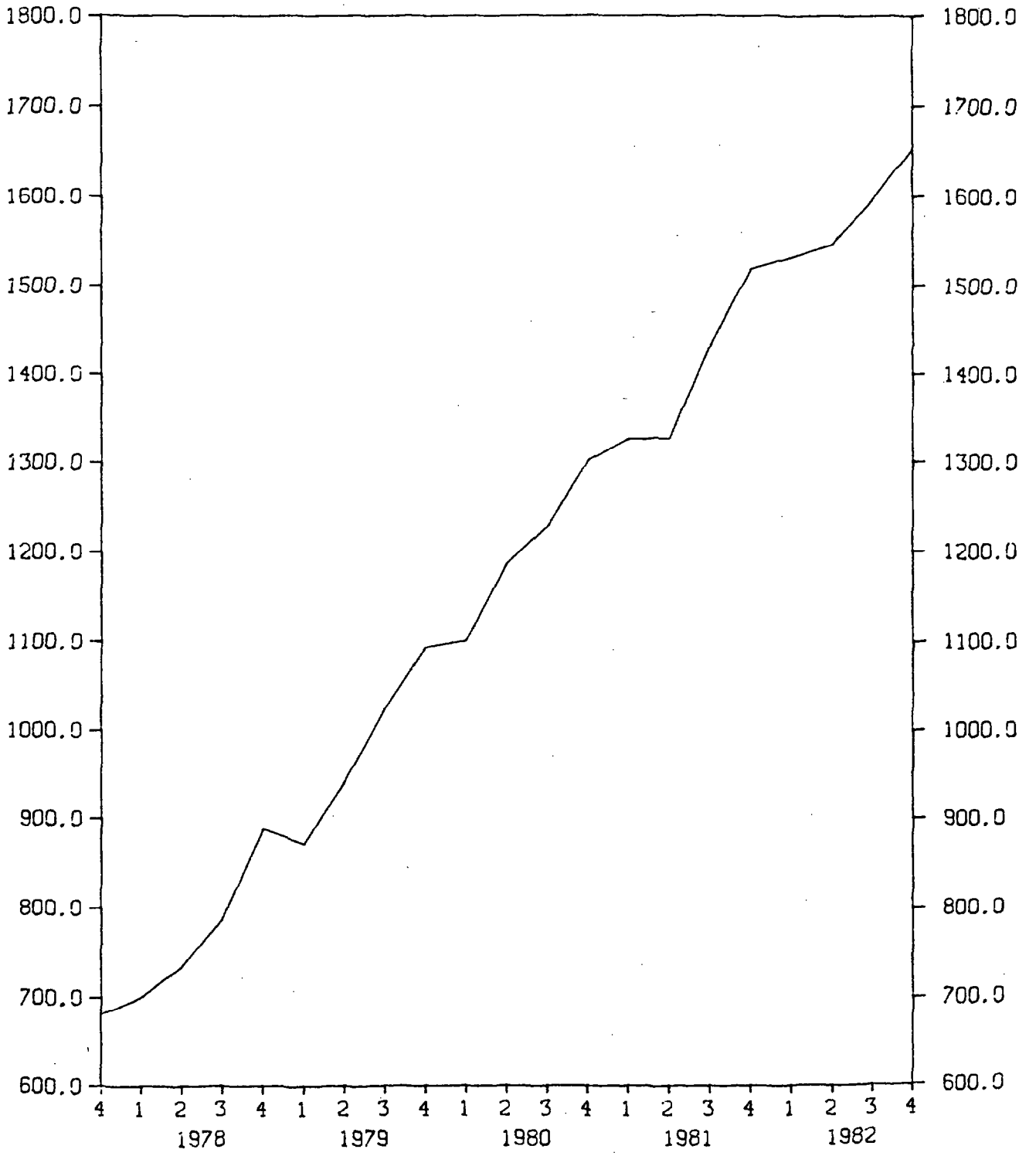
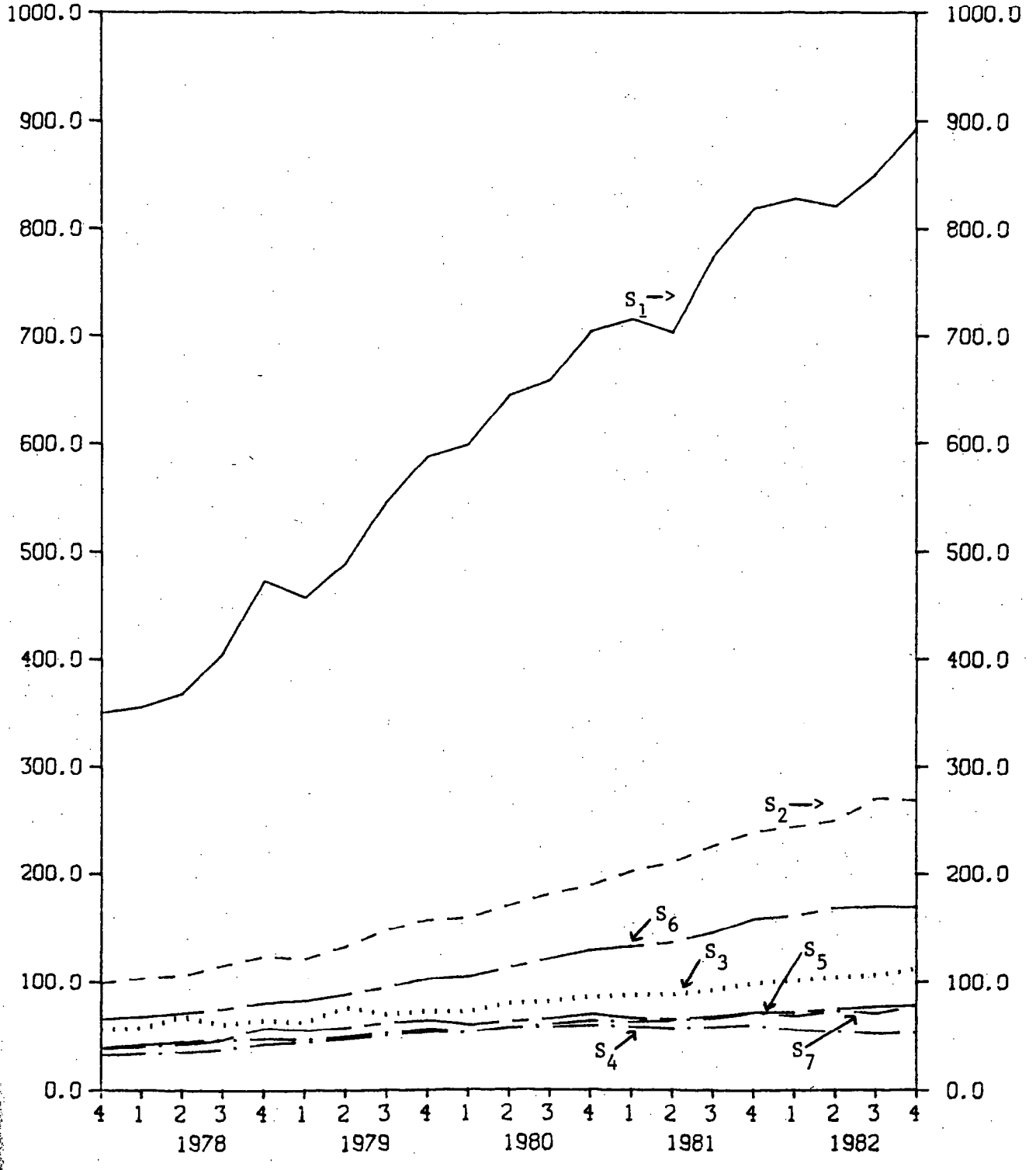


Figure 12

Stock of Loans Outstanding for Different Subgroups, 1977-IV to 1982-IV



S_1 = Reporting area
S_2 = Offshore centers
S_3 = Other developed countries
S_4 = Eastern Europe
S_5 = OPEC
S_6 = Latin America
S_7 = Other developing countries

This would tend to support the view that aggregate credit rationing has started to be imposed by banks in the last year or so. As to whether lenders have chosen to ration credit sectorally, Table 3 yields few, if any, clear impressions of such behavior. It is clear that after the problems with Poland, Hungary and Romania in 1981, net lending to Eastern Europe was negative in the first three quarters of 1982. Similarly, the announcement of Mexican debt difficulties in August 1982, followed soon after by Brazil's debt problems, dampened the flow of loans to Latin America in the third quarter of 1982, with loan flows becoming negative in the fourth quarter of 1982. Nevertheless, it is not obvious that these funds sought a safe haven with "prime" borrowers. For example, while loans to the reporting area (industrialized countries) expanded quite fast in the third and fourth quarters of 1982, new loans were relatively small in the first quarter and even negative in the second. Moreover, while loans to offshore banking centers actually declined in the fourth quarter of 1982, those to other developing countries (i.e., non-Latin American developing countries) recorded their largest ever increase.

To get a more precise idea of the interrelationships between borrowing group loan flows, correlation matrices were calculated for the seven subgroups for the whole sample period and two equal subperiods. These results are shown in Table 4. Note that if sectoral credit rationing is important we might expect to find negative, or at the very least, low positive, correlations between the loan flows to borrowing groups (i.e., between a priori high risk and low risk or prime borrowing groups), whereas if systematic credit rationing or contagion effects dominate, large and significant positive correlations between loan flows should be apparent between all borrowing groups.

The major impression gained from comparing the loan flow correlation matrices is the high degree of positive correlation between borrowing groups. Indeed, there is not a single significant negative correlation between loan flows either for the whole or the two subperiods. Another quite surprising result is the often strong positive correlations of Latin American, other developing country and Eastern European loan flows with those of the BIS reporting area and offshore banking centers. 1/ Thus the overall impression is one of the systematic movements in credit flows across all borrowing groups, i.e., creditworthy and less creditworthy. However, it should be noted that the subperiod correlation matrices suggest that there is some evidence of a trend towards less strongly positive correlations in the most recent subperiod (1980-III to 1982-IV). For example, the correlation (ρ_{16}) of Latin American loan flows with BIS area flows fell from +0.775 to +0.279 and with offshore banking centers (ρ_{26}) from +0.809 to +0.206 between the first and second subperiods. The bi-variate Fisher test (see Section III) shows that the reduction in

1/ This positive correlation could also be associated with the effects of other systematic factors such as inflation and real growth as well as credit rationing.

Table 4. Loan Flows Correlation Matrices

Whole Period							
(1) BIS Area	1.0						
(2) Offshore Banking Centers	0.465*	1.0					
(3) Other Developed Countries	0.101	-0.042	1.0				
(4) Eastern Europe	0.597*	0.193	0.106	1.0			
(5) OPEC	0.616*	0.257	0.163	0.507*	1.0		
(6) Latin America	0.431**	0.436**	0.180	0.423**	0.401	1.0	
(7) Other Developing Countries	0.397**	-0.162	0.216	0.628*	0.527*	0.441	1.0
Subperiod 1: 1978-I to 1980-II							
(1) BIS Area	1.0						
(2) Offshore Banking Centers	0.854*	1.0					
(3) Other Developed Countries	-0.016	-0.007	1.0				
(4) Eastern Europe	0.593*	0.780*	0.097	1.0			
(5) OPEC	0.742*	0.541	0.142	0.565	1.0		
(6) Latin America	0.775*	0.809*	0.218	0.719*	0.477	1.0	
(7) Other Developing Countries	0.759*	0.677*	0.198	0.689*	0.771*	0.787*	1.0
Subperiod 2: 1980-III to 1982-IV							
(1) BIS Area	1.0						
(2) Offshore Banking Centers	0.205	1.0					
(3) Other Developed Countries	0.710*	-0.334	1.0				
(4) Eastern Europe	0.683*	0.159	0.628**	1.0			
(5) OPEC	0.463	-0.015	0.413	0.460	1.0		
(6) Latin America	0.279	0.216	0.302	0.516	0.494	1.0	
(7) Other Developing Countries	0.240	-0.530	0.654**	0.726*	0.479	0.359	1.0

* Denotes significantly different from zero at 5 percent level.
** Denotes significantly different from zero at 10 percent level.

the ρ_{16} and ρ_{26} correlations were significant at the 5 percent level. This trend also holds true for the other developing country group (non-Latin American developing countries) and the BIS area and offshore banking centers. Again bi-variate tests confirm significant changes (falls) in the correlations of developing country loan flows with the prime borrowing areas, 1/ with both ρ_{17} and ρ_{27} showing decreases that are significant at the 5 percent level. Hence to the extent that any market separation or sectoral rationing is taking place, between high and low default risk groups, it is being reflected in lower positive rather than negative, correlations in loan flows between different borrowing groups.

To gain further insights into the systematic nature of loan flows between borrowing groups, a principal components test was also conducted. As can bee seen from the second from last row in Table 5, the first principal component explains over 90 percent of the changes in loan flows over the whole 1978-I to 1982-IV sample period. 2/ If the first component is viewed as the common "market" factor underlying loan flows, then the results confirm that there has been a considerable systematic element in the movements of loan flows to borrowing groups on the international market. As can also be seen from Table 5, the other components offer little explanatory power, with the second component (which might be viewed as the country group or sectoral component) explaining only 3.9 percent of the variation in loan flows over the whole sample period.

In summary, the above results suggest that over the sample period as a whole loan flows to borrowing countries have, on average, been quite strongly positively related. However, there is some evidence that this degree of positive correlation is weakening over time (comparing the two subperiods discussed above) which may indicate the beginning of a trend by lenders towards rationing loans to some borrowers (e.g., Latin America, Eastern Europe) more severely than others (e.g., the industrialized countries).

V. Summary and Conclusions

This paper has examined the causes and effects of contagion in the market for international loans. The evidence, both for interest spreads and loan flows, is consistent with the existence of contagion being present in the market for international loans during certain periods in 1982. Since contagion appears to be caused by shifts in lenders' perceptions regarding the probability of a disaster state occurring, and these shifts emanate either from adverse information regarding one borrowing group contaminating risk perceptions regarding other borrowing groups

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1/ Note that by comparison the correlation of developing country loan flows with those of other developed countries, increased significantly in the second subperiod.

2/ Because of the limited degrees of freedom, only the results for the whole sample period are shown in Table 5.

Table 5. Principal Components Analysis of Loan Flows

		Eigen Vectors						
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	BIS Area	0.00731235	0.02832926	-0.05176723	0.09794612	0.08946169	0.06449096	0.98727312
(2)	Offshore Banking Centers	0.17144474	-0.18946518	0.14694680	0.01435016	-0.46667839	-0.82687733	0.10674977
(3)	Other Developed Countries	-0.01126972	-0.03745691	0.00958038	0.25799320	-0.83398462	0.48568603	0.01991077
(4)	Eastern Europe	-0.55424865	-0.76027417	0.03982337	-0.32284387	-0.01265834	0.07516979	0.05627458
(5)	OPEC	-0.16950208	0.34498982	0.82864021	-0.38496579	-0.07526970	0.07850953	0.07468963
(6)	Latin America	-0.21578476	0.40477693	-0.53531110	-0.64808558	-0.26970813	-0.08439745	0.05616296
(7)	Other Developing Countries	0.76677287	-0.31783365	0.02909539	-0.50119696	-0.01045491	0.23934641	0.04000230
	Eigen Values	655.103	28.772	22.879	10.747	5.068	3.316	1.566
	Percent of Variance Explained	90.191	3.901	3.102	1.457	0.687	0.449	0.211

and/or perceived increases in real or financial linkages between borrowing groups (exports, imports, money supply, inflation, etc.), then contagion can only be reduced by minimizing these effects. One way to reduce contagion would be for the high borrowing groups to undertake self-constraining actions which send favorable information signals to lenders regarding default probabilities. An alternative method for reducing the degree of contagion in the international loan market may be to make the granting of new loans contingent on the existence of IMF stand-by programs.

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