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DEBT OVERHANG, LIQUIDITY CONSTRAINTS AND ADJUSTMENT INCENTIVES

by

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RÉSUMÉ

Dans la plupart des pays lourdement endettés, l'investissement, depuis 1982, s'est caractérisé par une grande faiblesse. Selon la thèse généralement admise de la "dette trop élevée", la chute de l'investissement relève d'une problématique d'ordre psychologique : le fardeau de la dette stimule la consommation, parce que le bénéfice marginal de tout investissement semble devoir échapper aux bailleurs de fonds. Cet ouvrage présente plusieurs hypothèses relatives aux réactions les mieux adaptées, de la part des pays débiteurs victimes de limitations de crédits, dans les cas d'une augmentation de la dette, de modifications des limitations de crédit, d'une variation des taux d'intérêt. Cette étude compare également ces hypothèses aux prévisions découlant de la thèse de la "dette trop élevée".

Les caractéristiques empiriques des fonctions conventionnelles d'investissements et de consommation (selon l'hypothèse du revenu permanent -- Permanent Income Hypothesis) invalident la thèse de la "dette trop élevée". Elles permettent, en revanche, de montrer que, pour des pays endettés, le passage d'un solde positif de transferts financiers extérieurs à un solde négatif de ces mêmes transferts constitue une explication importante de la chute de leurs investissements. Du point de vue politique, la principale conclusion que le changement de 1989 dans la gestion de la dette internationale (le Plan Brady), plus soucieux d'alléger la dette que de multiplier les crédits de restructuration, ne donnera guère un coup de fouet à l'investissement dans les pays endettés. Ces pays ont surtout besoin d'une injection de fonds nouveaux pour profiter des opportunités d'investissements productifs.

SUMMARY

Investment in most heavily indebted countries has been weak since 1982. The widely accepted debt overhang proposition interprets the investment drop as a moral hazard problem: a heavy debt burden raises the incentive to consume, because the marginal benefit of investment would go to the creditor. This paper develops several hypotheses on optimal reactions of a credit-constrained debtor country on an increase in debt, on variations in the credit constraint, on changes in interest rates, and contrasts these with the predictions stemming from the debt overhang proposition.

Empirical specifications of conventional investment functions and consumption functions (along the Permanent Income Hypothesis) lead to reject the debt overhang proposition, but find that the switch from positive to negative external transfers to the debtor countries is an important explanation for their investment drop. The major policy conclusion is that the 1989 shift in international debt management (the Brady initiative), emphasising debt relief rather than new money, will not spur investment in debtor countries. These countries rather need infusion of new funds to take advantage of profitable investment opportunities.

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PREFACE

While an important part of the world economy has experienced economic growth in the 1980s, much of Africa and Latin America has suffered from hyperstagnation and/or hyperinflation. Poor economic performance, notably depressed levels of investment, has generally gone along with high foreign debt. The 1990-92 research at the Development Centre on Financial Policies for the Global Dissemination of Economic Growth thus aims at finding efficient ways to achieve debt relief and simultaneously to enhance new capital flows.

The present paper addresses a question which has important implications for the international debt strategy: whether the drop in problem debtors' investment is due to a debt overhang rather than to the switch in net external transfers. It is shown that the many developing countries which are constrained by external liquidity need infusion of new funds to take advantage of profitable investment opportunities. Cutting debt stocks and debt service with no or little new lending, a trend which seems to have emerged in current international debt management, will not spur investment in heavily indebted countries.

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I. INTRODUCTION*

Investment in most heavily indebted countries has been weak since 1982. Several papers (Krugman, 1988; Corden, 1988; Sachs, 1989) have subsequently established the debt overhang proposition: the existence of a heavy debt burden reduces the incentive to invest[1]. This proposition has given an important rationale for the 1989 shift in international debt management, emphasizing debt relief rather than new money for problem debtors.

Some preliminary analysis by the IMF (1989) has concluded that the debt overhang plays a large part in explaining the slump in investment in problem debtor countries. The IMF bases its support of the debt overhang proposition on two pieces of evidence. First, the savings ratio in the so-called Baker-15 countries[2] has fallen, rather than increased, when external finance dried up. The necessary squeeze in domestic demand relative to output was therefore more than fully reflected in lower investment. Second, a comparison of the country group of problem debtors with a group of other heavily-indebted countries which did not experience debt-servicing problems shows that investment and savings ratios dropped in the former group but not in the latter. This evidence supposedly confirms the debt overhang hypothesis which attributes disincentive effects to the fact that debt service becomes linked to economic performance in problem debtors, thus weakening the incentive to invest.

A closer inspection of the IMF analysis reveals several shortcomings, however.

-- First, the base period 1975-81, against which the IMF compares events after 1981, is highly exceptional because it includes the years when the build-up of foreign debt was overshooting at an unsustainable pace. Especially during 1978-81, foreign savings financed exceptional levels of investment in problem debtor countries. A standard investment model easily explains why investment ratios peaked in that period and dropped thereafter (Dornbusch, 1985). The increasing anticipation of future depreciation of the real exchange rate acts as a temporary investment stimulus in developing countries, since imports form an important part of inputs in the production of investment. While anticipated depreciation means an immediate jump in the real price of assets, real capital costs start only to rise once real depreciation sets in. Then disinvestment takes place.

-- Second, the IMF analysis selects a control group of middle-income non-problem debtors which is highly arbitrary. Non-problem debtors are defined as indebted countries that have not confronted serious debt-servicing difficulties. The IMF sample picks only high-investment countries (Indonesia, Korea, Malaysia, Thailand and Turkey). We have added Algeria, Greece, Israel, and Portugal which also belong to the group of non-problem debtors to extend the control group[3] for a covariance test on investment and savings ratios.

A covariance test is presented in Table 1 for savings ratios, in Table 2 for investment ratios. The test reveals that the change in savings ratios (comparing the periods 1982-87 and 1971-81) was not significant at a 95 per cent confidence level, regardless of whether the IMF sample or the extended sample was chosen as a control group. There has indeed been an important drop in savings ratios and investment ratios in problem debtor countries during the 1980s. But the variance of national savings ratios within the country groups was too big and the variance between country groups too small to confirm the debt overhang proposition along these lines. The only difference which is significant at a 95 per cent confidence level is found for the changes in investment ratios between problem debtors and the IMF sample of non-problem debtors.

The fact that investment behavior changed more markedly than savings behavior between problem and non-problem debtors, suggests that net financial flows to the debtor countries are at least as important in explaining this behaviour as are debt stock related disincentives. Table 3 illustrates this point for the Latin American countries: investment in the 1980s has fallen on average by 6.8 per cent of GDP compared with the 1970s, almost exactly equal to the increase in the non-interest external surplus (which roughly measures the reduction in liquidity).

While investment ratios in Latin America dropped immediately in 1983 to accommodate the switch in net financial transfers (net new debt minus interest), they have stabilized thereafter on a modest upward trend (IDB, 1989, table II-4). Table 3 shows also, contrary to what is often maintained, that investment ratios in Latin America are not low by historical standards. Investment ratios and the non-interest current account look now as they looked in the 1960s. Given this *prima facie* evidence, assessing debt incentives in isolation from the credit regime to which a country is subject, seems a serious flaw. The principle aim of this paper is to assess the impact of both liquidity and debt on investment and consumption in problem debtor countries, and to provide empirical evidence on the relative importance of these factors.

The remainder of this paper is structured as follows: Section 2 will put the debt overhang proposition into perspective; it will present Corden's (1988) debt incentives for a country in financial autarky; it then develop the analysis for a country with free access to international capital markets, as well as for a country which is credit contrained. Factors affecting investment and consumption under various credit regimes will be integrated in econometric specifications of investment and consumption functions. The results of the econometric test are presented in section 3. No significant negative effect of debt stocks on investment in the average problem debtor country could be detected, but liquidity variables seem to have had a pervasive role in the weak investment activity in those countries over the 1980s. Section 4 draws the immediate conclusions for international debt management. Cutting the debt burden without new lending will not spur investment in heavily indebted countries.

II. EXTERNAL DEBT, CONSUMPTION, AND INVESTMENT

1. The Debt Overhang Proposition

The "debt overhang" proposition belongs to the group of moral hazard interpretations of the current debt crisis. Their advocates argue that a "debt overhang" provides a disincentive for adjustment. Both concepts have been put into a specific context. "Adjustment" (which can be thought of as economic reform) refers to the debtor's decision to invest or to consume in a two-period model. The economy "inherits" a given stock of debt in the first period which must be serviced in the second period. The decision in period one is to consume or to invest, the latter yielding a return in period two, which serves to pay back the debt and to consume. This decision is presumed to be biased towards consumption in the presence of a "debt overhang". The "debt overhang" is defined as the difference between the face value of debt outstanding and its market value -- the expected present value of future resource transfers (debt service minus new debt) from the borrower to the lender. The "debt overhang" may act like a tax on the debtor's consumption in period two. This is because for over-indebted countries, debt service does not depend on scheduled interest and amortization anymore, but is linked to their economic performance via arrears and involuntary lending. If a debtor is only servicing part of his debt, reduced consumption in period one is not offset by higher consumption in the future, because the creditor would reap all or most of the benefits of that adjustment effort. Consequently, it does not pay to invest. The country will instead consume its resources in period one, and will then (have to) default upon its debt. Hence the conclusion, that debt relief would increase the incentive of a debtor country to make an adjustment effort (to invest), because it would leave a larger share of the benefits from investment to the debtor. Debt relief would be in the interest of both debtor and creditor, since now at least part of the debt is repaid.

Following Corden's (1988) presentation of an economy without acces to international financial markets, debt incentives can be illustrated as in Figure 1[4].

In Figure 1, the horizontal axis measures -predetermined- output, A, net of debt obligations in period 1. Consumption in period 1 is measured from the origin to the right, and period 1 investment is measured leftwards, starting from A. Investment yields output in period 2 along AB, assuming decreasing returns of investment. Without inherited debt, AB is the consumption possibility curve, and the country would choose S_0, the point of tangency of this curve with the utility curve U_0; it will invest AJ_0, and consume OJ_0 in period 1. A small inherited debt D_1 shifts consumption possibilities downwards to C_1C_1, and the optimum now yields higher investment AJ_1, and lower consumption OJ_1. At low levels of debt, therefore, debt and investments are positively correlated. However, if the inherited debt is very large, say D2, the country has a debt overhang. With D_2, choosing point A would be optimal, yielding U_2, and implying the consumption of all resources in period one, no investment and default (or "endogenous debt relief") on the debt in period 2. If the inherited debt D_2 would be paid back, C_2C_2 would be the relevant consumption possibility curve, which were to yield utility lower than U_2. The debt overhang position therefore predicts the association of high debt, low investments and high consumption, which the IMF finds in the data. If indeed point A in Figure 1 applies to the problem debtor countries, debt relief in period one (or "exogenous debt relief") would be rational for the creditors. Forgiving the amount R would induce the country to choose S_2, thus investing AJ_2, and paying back (D_2-R). Debt relief would be Pareto improving.

2. Debt and Liquidity Constraints

The positive effect of a small debt on investment, as described by Corden, applies in the case of financial autarky, but equally, if the debtor is credit constrained, as will be shown below. With free access to capital markets, no pro-investment incentive effect of a small debt exists, as is shown by Callier (1989)[5], and will be repeated here. Then the case of a credit constrained debtor will be analyzed, and factors which explain investment and consumption behavior will be identified. Throughout, it is assumed that the consumption and investment decisions are under control of a social planner, thus substitution effects are neglected[6].

If a country has unrestricted access to the international capital market, i.e., is only limited by its intertemporal budget constraint, investment and consumption decisions are separated. The country will invest until the marginal productivity of capital is equal to the world interest rate (see Appendix I, case I for a formal exposition), and it will borrow up to the point where marginal utility is equated in each period. The capital market is used to allocate wealth over time and the country will consume according to its wealth constraint (see, for example, Sachs 1984, p.6 ff). The equilibrium of a debtor without a liquidity constraint is depicted as point S_3 in Figure 2.

In Figure 2, consumption possibilities with a debt D_1 are not restricted to C_1C_1, as in Corden's financial autarky case, but can be extended along the capital market line HH, with slope $-1/(1 + r)$, where r is the world interest rate. In the unconstrained case, r represents the opportunity costs of borrowing. The borrower will invest until the capital market line is tangent to the C_1C_1 schedule, i.e. AJ_3. It will subsequently borrow J_3D in order to attain the preferred consumption point S_3, where the utility curve is tangent to HH. An increase in inherited debt[7] from D_1 to D_3 would shift the C_1C_1 curve downwards to C_3C_3, but would leave investment unaffected at AJ_3, since both marginal productivity of capital and the opportunity costs of capital are unaffected. The loss in wealth from W_0 to W_1 caused by the increase in debt burden is spread over consumption in period 1 and 2, as can be seen in the new consumption point S_4. Borrowing is reduced, and period 1 consumption as a percentage of -- predetermined -- output A falls. However, if the utility function is homothetic, consumption as a percentage of wealth remains constant. Corden's (1988) pro-incentive effect of an increase in debt therefore does not apply if access to capital markets exists. Investments are only determined by marginal productivity and world market interest rates, not by the level of debt.

Unrestricted access to capital markets seems hardly a relevant case for most LDC borrowers, and especially for the problem debtors over the 1980s. The inability to borrow as much as desired, or indeed the net lender position enforced upon these countries, affects the optimal investment-consumption choice, since these entities are now interrelated.

Suppose a country can only borrow the amount B_c (see Figure 3), and suppose this constraint is binding. Investing AJ_3 would imply consuming in point S_5, since only B_c can be borrowed. This is no longer optimal: a higher utility level could be reached by reducing investments, and increasing consumption. Due to the credit constraint, the shadow price of capital now exceeds the world discount rate (Sachs, 1984, p.20), yielding a steeper opportunity costs of capital line, H_cH_c (see Appendix 1, case II). The opportunity costs of capital are a function of borrowing possibilities and marginal utility of consumption. The optimal investment is now AJ_6, where H_cH_c is tangent with the C_1C_1 curve[8]. Optimal consumption is determined by the amount which can be borrowed on the international capital market, B_c, which gives S_6, where $C_1=A-AJ_6+Bc$, and $C_2=f(AJ_6)-D_1-(1+r)B_c$[9]. Note that in the consumption point

the utility curve is tangent to a line parallel to the H_cH_c line, and thus the marginal rate of substitution is still equal to the marginal rate of transformation.

The lower B_c is, the more the opportunity costs of capital will differ from the world interest rate, and the less will be invested, and the less is consumed in period one, both absolute, and in terms of output in period one. However, due to reduced investments, the credit constraint reduces the country's wealth as well, and the change in consumption as a percentage of the latter is ambiguous. The credit constraint also has several other implications (formally derived in Appendix I, case II). The lower discounted period 2 marginal utility is relative to period 1 marginal utility --in other words, the lower the propensity to save -- the lower investments will be. Savings, being a source of capital, become an argument in the investment function.

An increase in inherited debt now again has a positive effect on investment: since more old debt has to be repaid in period two, the country is less willing to borrow in period one. This means, however, that the the credit constraint becomes less binding, the shadow price of capital falls, and investment and consumption in period one are increased. Corden's (1988) case of financial autarky, in which a small debt equally stimulates investments, can thus be considered as a special case of a credit constrained borrower.

For a net borrower who is credit constrained, an increase in the interest rate has equally a **positive** effect on investment. The increase in the costs of borrowing reduces the propensity to do so, and therefore relaxes the borrowing constraint, which reduces the shadow price of capital, hence investments are increased. However, most problem debtors have delivered net transfers abroad over the 1980s, by repaying old obligations, without receiving new loans. In that case, a rise in interest rates makes it more profitable to repay, but this tightens the credit constraint (less capital is available for domestic purposes), and thus investments are reduced.

An interesting special case arises when the credit limit is a function of the inherited debt (see appendix I, case III). Now, the positive direct effect of an increase in inherited debt, as described above, is counteracted by the reduced borrowing possibilities due to this increase, and the total effect might result in reduced investments. Simple bivariate correlations could therefore yield the rather misleading result that debt reduces investments, whereas the crucial point would be the credit constraint.

3. Empirical Specification

The conceptual discussion of the previous section has identified a number of variables influencing consumption and investment in debtor countries, the effects of which may vary with the credit regime the country is subject to. To discriminate between the various hypotheses discussed above, debt and liquidity constraints will be integrated into standard empirical specifications of consumption and investment.

3.1 The Investment Function

The effect of debt on investment is estimated in the context of an investment equation, containing the variables discussed in the previous two sections:

$$(2.1) \quad I = \alpha_0 + \alpha_1 r + \alpha_2 S + \alpha_3 (dF/dK) + \alpha_4 NTR + \alpha_5 D + \mu$$
where I = investment
      r = real interest rate
      S = savings

dF/dK   = marginal productivity of capital

NTR = net transfer to the debtor country

D   = debt burden

μ = error term

The expected signs of the coefficients differ with the various hypotheses discussed and are summarized in Table 4.

In order to estimate equation (2.1) a number of proxies for the variables had to be taken of which the most important one is that of debt burden. The debt burden, D, can be measured in a number of ways. In the empirical research concerning the determinants of repayment problems, usually a measure of debt/exports, debt/GDP or debt service is used. Neither of these variables is a perfect measure of the real burden, and all of them are endogenous variables to a certain extent: rational creditors would only allow a country to build up a high debt or debt service level (compared to GDP or exports) if they ascribe a high creditworthiness to this country, or in other words, if the debt burden for the country is manageable. Besides, the correct measure for debt burden depends upon the nature of the problem: if the debt crisis is basically seen as an internal transfer problem, debt to GDP is more accurate than debt to exports or debt service to exports, whereas the latter is more accurate if the problem is the external transfer. Debt service depends, to a large extent, on the maturity distribution of the debt, and is rather a measure of liquidity than of debt burden. As such, it is already included in the transfer variable of equation (2.1). Differences in timing of repayments and levels of interest for different countries would make the discounted present value of future debt service a better indicator, but if liquidity is constrained, not only present values count, but also the timing of debt service. Finally, without any change in debt, debt service, or any other conventional measure, the **real** burden may increase, e.g. due to terms of trade movements, a rise in interest rates, if the debt is floating rate debt, etc.

Given these qualifications, one can expect to find the conventional measures to have only a weak relation with debt burden. However, this relation may become stronger, if we add *a priori* information: **given** that a country has debt servicing problems, an increase in the debt to GDP-ratio will more likely indicate an increase in the debt burden than a reduction of it. A more direct measure of debt problems is equally tested as a proxy for debt burden: interest arrears. Again, this is not an undisputed measure of debt burden, but it does track the debt overhang proposition.

As a proxy for world market real interest rates, the US government bond yield deflated by the percentage change in the U.S. GDP deflator was taken. Productivity of investments was proxied by GDP growth. For the savings variable, domestic savings as a percentage of GDP were taken. Net transfers were calculated as net long term capital disbursements minus long term interest payments. Short term capital movements were excluded, due to lack of data over the 1970s.

3.2 The Consumption Function

As discussed in the previous section, the unconstrained borrower will divide his wealth over consumption now and in the future. Debt and credit constraints have influence on the marginal propensity to consume, as well as on wealth itself. In order to distinguish empirically between these effects, we will test the hypotheses on consumption in the context of the Permanent Income Hypothesis, the specification of consumption behaviour which has received the best empirical support in developing countries (see IDB, 1989). Following this hypothesis, permanent consumption C_p is a function of permanent income Y_p:

(2.2) $C_p = k\, Y_p$

where k is the marginal propensity to consume out of permanent income. Assuming that adaptive expectations are a reasonable approximation of expectations formation in developing countries, equation (2.2) can be readily operationalized. Permanent income is then proxied by a weighted average of present and past current income[10]. Taking into account a trend factor in income, and using a Koyck transformation, then yields (see for a full derivation, König, 1978):

(2.3) $C_t = k\beta Y_t + (1 + \alpha - \beta)C_{t-1} + \mu_t$
        with C_i = consumption in period i
        Y_t = income in period t
        α = trend in income
         β = coefficient of expectations adjustment
         μ_t = error term

k can now be identified from the coefficients of C_{t-1} and Y_t, if either α is neglected, or if this is estimated directly.

        In case of a debt overhang, one would expect k to be higher, than in the case of normal credit relations. If a country is constrained on the capital market, one would expect k to be lower than in the case of free access to the capital market, due to imperfect smoothing of consumption (see section 2.2).

The problem with the hypotheses on k is, of course, to find the normal k. If we accept the IMF criterion of rescheduling as a sign of disrupted capital market relations, the 1970s can be considered as a reasonable counterfactual. We will therefore take the change in marginal propensity to consume out of permanent income between 1971-81 and 1982-87 as an indicator of presence or absence of debt overhang.

The consumption function was estimated with total per capita consumption and per capita gross national product, using 1980 prices. This assumes that government consumption is equally valued as private consumption, but avoids the problem of defining disposable income for each country

III. EMPIRICAL RESULTS

Equations (2.1) and (2.3) were estimated for the period 1971-87 and the two subperiods, 1971-81 and 1982-87 using pooled time series cross section data for problem debtor countries, in order to gain the necessary degrees of freedom. For the consumption function, the Instrumental Variable method was used, since shocks on income are likely to affect consumption as well. Dummy variables allowed for different intercepts in both investment and consumption estimations. The results can thus only be interpreted for an "average" problem debtor. This precludes detecting presence or absence of debt incentives for an individual country. The estimation results are presented in Tables 5 and 6.

1. The Investment Function

The estimated investment equations in table 5 perform rather well in terms of R^2 and F statistics, but this is due to the lagged investment terms, which were included to suppress autocorrelation of the residual. Inclusion of a time trend suppressed heteroscedasticity[11]. Investment behaviour showed a structural change between the two subperiods[12].

The evidence on debt-related variables would reject the debt overhang hypothesis for the average problem debtor, in the sense that no negative correlation of debt and investments could be detected. On the contrary, in the 1982-87 period, both Debt/GDP and Debt/Exports are significantly positive at the 5 per cent level. This is in line with the theoretical findings for a liquidity constrained country. Arrears do not seem to influence investment behavior in the 1982-87 period, which would occur under the debt overhang hypothesis. The coefficient for Net Transfers is significantly positive in both periods, and in each specification. Estimations were equally performed with Net Transfers split up on Long Term Debt Service and Long Term Capital Disbursements, using further the specification of equations (1) and (3). In 1971-81, the values were respectively (t-values in parenthesis) -0.39 (2.25) and 0.24 (2.12). For the 1982-87 period, the same values were -0.52 (3.28) and 0.49 (3.66). For both periods, the null hypothesis that the absolute value of the coefficients was equal could not be rejected[13]. This indicates that debt service had no other effects than liquidity effects; possible negative effects, due to taxation for financing the debt service, could not be detected in this way.

The second liquidity variable, Savings, is only significantly positive in the 1980s (equations 3 and 5). A joint test of the significance of both the Net Transfers and the Savings variable accepts the null hypothesis of no significant difference from zero in equation (1), but rejects the same hypothesis for equation (3)[14]. This would indicate that over the latter period, the problem debtors have become more constrained in their access to the international capital market.

The negative correlation of interest and investment in the 1982-87 period is compatible with the credit constraint hypothesis, given that the problem debtors were net lenders over this period. Given the joint insignificance of the Net Transfer and Savings variables over the 1971-1981 period, one might conclude that the negative correlation of interest and investments indicates unconstrained capital market access for this period.

Although more formal tests for the pooling procedure followed in the estimations were rejected -- or could not be performed, due to lack of degrees of freedom -- the equations estimated for the whole sample performed quite well for

individual countries, as can be seen in Table 6. (For a similar procedure of testing the pooling procedure, see Pastor, 1989).

2. The Consumption Function

The marginal propensity to consume out of permanent income, k, shows a fall in the 1980s as compared to the 1970s. This holds equally for the marginal propensity to consume corrected for a trend factor, k_g[15]. We conclude therefore that it is more likely that the marginal propensity to consume was lower in the 1980s compared to the 1970s, for the problem debtors, than the reverse, thus contradicting the debt overhang proposition, and the evidence quoted in IMF (1989). The fall in k is predicted by the credit constraint hypothesis as presented in section 2.2. The results from the estimations of table 7 should, however, be interpreted with caution. Apart from the specification of the Permanent Income Hypothesis, the estimated coefficients are not very stable over time, and the observed heterosedasticity indicates omitted variables. An F-test for the sub-periods refutes the hypothesis of no structural change between the 1970s and 1980s[16]. Moreover, the causes of the movement in k are not analyzed, and might be other than debt and liquidity variables. Integrating these in the Permanent Income set-up would be necessary to derive firmer conclusions[17]. This is left for further research.

Although a formal F-test would again reject the method of pooling chosen, the correlation of the predicted values from the estimated equations and the actual values observed for the individual countries is generally high. Exceptions to this are Colombia, Brazil and Peru in the period 1971-81.

IV. CONCLUSIONS

Whether the drop in problem debtors' investment is due to a debt overhang rather than to the switch in net transfers, has important implications for policy. If a debt overhang was to blame for weak investment, the provision of liquidity alone would leave the problem of debt-stock-related disincentives unresolved. Debt reduction would give investment a bigger boost than interest reduction or new foreign money. On the other hand, countries that are constrained only by liquidity need infusion of new funds to take advantage of profitable investment opportunities. Cutting the debt stock without new lending would not spur investment there.

This paper has developed hypotheses on optimal reactions of a credit constrained debtor on an increase in debt, variations in the credit constraint, and changes in interest rates, and contrasted these with the predictions stemming from the debt overhang hypothesis. The empirical evidence presented seems to reject the debt overhang hypothesis, and is in line with the credit constraint hypotheses.

The rejection of the debt overhang hypothesis for the average problem debtor confirms previous alternative empirical attempts to show the existence of a debt overhang. These have measured the elasticity of the secondary market price of the debt with respect to its nominal value (see, notably, Cohen 1989a). They have systematically found a low estimate. While these results cannot reject the existence of a debt overhang, they imply that debt relief cannot be Pareto improving (Froot, 1988) except for very few countries such as Bolivia, Peru, Nicaragua and Sudan. The findings of this paper are equally in line with Borensztein's (1990) simulation results which show the dominance of the credit constraint over the debt overhang in explaining investment behaviour, even at high levels of debt, and add to Cohen's (1989b) results for estimates on the influence of debt and liquidity variables on growth and investments[18].

This is bad news for the new international debt strategy which relies on "voluntary, market-based" debt reduction. For the available evidence, presented here and elsewhere, implies that it is unlikely that banks will gain (increase the market value of their claims) by granting debt reduction. Their claims could be better protected by the provision of new loans.

NOTES AND REFERENCES

1. The concept of investment stands here for the broader concept of "economic reform", like trade liberalization, privatization, or tax reform. Both investment and "economic reform" are expected to increase future output and the capacity to service debt.

2. Another term often used for the countries is "problem debtors". They include Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Côte d'Ivoire, Mexico, Morocco, Nigeria, Peru, Philippines, Uruguay, Venezuela, and Yugoslavia.

3. The sample of non-problem countries could be further extended according to the selection criteria used by the IMF if some small island economies were added for which, however, investment and savings data were not readily available.

4. Without loss of generality, Corden's "minimum consumption" can be set to zero (see Sachs, 1989).

5. Callier equally extends Corden's analysis with acces to international capital markets, but he does not discuss the case of credit rationing. Instead he discusses debt overhang in the context of free acces to the capital market, which seems a rather odd case.

6. Corden (1988) devotes some analysis to these substitution effects. In the case of debt overhang, debt relief would, due to substitution effects, lead to more investments since individuals expect lower taxes in the future. He neglects, however, these substitution effects when discussing the pro-incentive effect of debt. The substitution effects of an *increase* in debt as a fraction of taxes would then lead to less investment, and will thus counter the pro-incentive effect. The analysis is complicated by the possibility of substitution of investments *abroad*. Capital flight might be a rational response to future tax obligation. If no effective control exists, an increase in debt might only affect the decision to invest abroad or at home, without affecting the consumption (or savings) decision. A social planner could counter these effects by taxing consumption, equally affecting income from domestic and foreign sources. Intertemporal substitution effects could be countered by equalizing tax rates over time, e.g., by supplying investment credits once an increase in debt occurs. For a discussion of the effect of debt on capital flight, see for example, Ize and Ortiz, 1987.

7. An increase in inherited debt can, for example, be caused by an increase in world interest rates, if the obligations have variable interest rates. In order not to complicate the analysis, however, we consider the increase as purely exogenous.

8. This liquidity effect would be mitigated if creditworthiness is a function of investments, and if the country could credibly commit itself to a high level of investments. We abstract from this possibility here.

9. This consumption point is reached if the receipts from charging a higher interest rate internally are distributed in a lump sum matter. In this, the analysis is comparable to that of a quota on an imported good.

10. This concept of permanent income is valid if current and past income provide a reasonable indicator for future income streams. This concept is not undisputed

(see for example, Hall, 1978).

11. This time trend may capture the effect of omitted variables equally trended, but candidates for this, like the terms of trade and the real exchange rate either showed insignificant signs, or deteriorated the estimation results due to high correlation with other explanatory variables.

12. An F-tests for structural changes in the investment equations (H_0: no structural change) gave the following results:

Equations	F value	accept/reject at 95% level
(1) and (3)	$F_{23,188} = 2.04$	reject
(2) and (4)	$F_{23,201} = 1.63$	reject

13. Test for difference in absolute values of the coefficients of Debt Service and Long Term Capital disbursements. The unrestricted equation includes these variables separately; the restricted equations are (1) and (3) in table 5. H_0: no difference in absolute value.

	Sum of Squared Residuals		
Unrestricted Equation	Restricted Equation	F value	Accept/Reject at 95% level
595.7	(1)	$F_{1,123} = 1.18$	accept
157.9	(3)	$F_{1,63} = 0.06$	accept

14. Tests for joint significance of the Savings and Net Transfer variables (H_0: not significantly different from zero)

Equations	F value	accept/reject at 95% level
(1)	$F_{2,124} = 2.85$	accept
(3)	$F_{2,64} = 14.52$	reject

15. The trend factor was found by regressing the logarithm of per capita GNP on time: $\ln(GNP/CAP) = a + bt + e$. The trends, α, for the debtor groups and the two periods, are then found by:

$\alpha = $ antilog(b) -1 (See World Bank, 1988).

The values found for α are;

1971-81	1982-87
0.022	-0.006

It should be noted that the coefficient for time was not always significant. Furthermore, the value of -0.006 for the problem debtors is unlikely to be the expected trend. A higher value for α would imply a lower value for the problem debtors' trend-corrected marginal propensity to consume over the 1980s.

16. Test for structural change in the Consumption Function.
    H_0: no structural change

Equations	F value	accept/reject at 95% level
(1) and (2)	$F_{17,221}=3.79$	reject

17. Adding debt and net transfer variables to the consumption equation in an ad-hoc manner yields positive signs for both in the 1971-81 period, with only net transfers significantly different from 0. In the 1980s, both variables have a significantly negative sign.

18. Cohen (1989b) finds a positive, significant relation between debt and growth; and a positive, but insignificant relation between debt and investments. He equally shows that net transfers from the rescheduling debtors crowded out investments.

Table 1

SAVINGS RATIOS: A COVARIANCE TEST

	1971-81	1982-87	1982-87 vs 1971-81
I. Savings Ratios			
* Problem Debtors	19.4	14.5	- 4.9
* Non-Problem Debtors			
-- IMF Sample	22.7	23.5	0.8
-- Ext'd Sample	24.1	21.9	- 2.3
II. Variance Within Country Groups			
* Problem Debtors	48.2	97.6	52.0
* Non-Problem Debtors			
-- IMF Sample	7.0	11.9	9.2
-- Ext'd Sample	40.9	48.1	24.6
III. Variance Among Country Groups			
* IMF Sample	2.1	15.2	6.0
* Ext'd Sample	5.3	12.9	1.6
IV. F-Statistics			
* IMF Sample	1.0	3.6	2.4 (< 4.4)
* Ext'd Sample	2.4	3.3	0.7 (< 4.3)

Note: Savings Ratios are defined as Gross National Savings as a percentage of Gross National Product, at current prices. For the definition of country groups, see text. Figures in brackets for F-Statistics show the critical values at the 95 per cent confidence level.

Source: World Bank, World Tables 1988-1989, Tape Documentation.

Table 2

INVESTMENT RATIOS: A COVARIANCE TEST

		1971-81	1982-87	1971-81
I.	Investment Ratios			
	* Problem Debtors	23.3	17.8	- 5.5
	* Non-Problem Debtors			
	-- IMF Sample	25.1	26.4	1.3
	-- Ext'd Sample	27.9	25.8	- 2.0
II.	Variance Within Country Groups			
	* Problem Debtors	25.5	51.1	33.8
	* Non-Problem Debtors			
	-- IMF Sample	6.2	10.0	3.9
	-- Ext'd Sample	28.7	21.8	17.7
III.	Variance Among Country Groups			
	* IMF Sample	0.6	14.0	8.8
	* Ext'd Sample	4.8	15.1	2.9
IV.	F-Statistics			
	* IMF Sample	0.5	6.2	6.0 (> 4.4)
	* Ext'd Sample	3.6	7.6	2.1 (< 4.3)

Note: Investment Ratios are defined as Gross Domestic Investment as a percentage of Gross Domestic Product, at current prices. For the definition of country groups, see text. Figures in brackets for F-Statistics show the critical values at the 95 percent confidence level.

Source: World Bank, World Tables 1988-1989, Tape Documentation

Table 3

**LATIN AMERICA: INVESTMENT AND THE NON-INTEREST
CURRENT ACCOUNT**

(percent of GDP)

	1960-69	1970-82	1983-88
Investment	18.6	23.2	16.4
Non-Interest Current Account	5.3	-0.4	6.1

Change 1983-88 against

	1960-69	1970-82
Investment	-1.8	-6.8
Non-Interest Current Account	0.8	6.5

Source: IDB, Economic and Social Progress in Latin America, 1989 Report.

Table 4

EXPECTED SIGNS OF COEFFICIENTS IN THE INVESTMENT FUNCTION UNDER VARIOUS HYPOTHESES

	Unrestricted Borrower	Liquidity Constraint Borrower	Debt Overhang*	
			Borrower	Lender
α_1	-	+	-	0
α_2	0	+	+	0
α^3	+	+	+	0
α_4	0	+	+	0
α^5	0	-	+	-

- = negative
+ = positive
0 = no influence

*   Assuming that the "debt overhang" remains after the change in the respective variables.

Table 5

INVESTMENT IN PROBLEM DEBTOR COUNTRIES 1971-87

		1971-81			1982-87		1971-87
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	8.95	7.34	16.13	18.85	9.58	2.54	3.76
	(3.58)	(3.70)	(3.44)	(3.58)	(1.21)	(1.75)	(3.42)
Investments(-1)	0.70	0.75	0.5	0.55	0.59	0.80	0.81
	(8.66)	(9.48)	(5.28)	(5.03)	(4.85)	(12.89)	(13.32)
Investments(-2)	-0.28	-0.30	-0.35	-0.30	-0.43	-0.28	-0.28
	(3.34)	(3.67)	(3.24)	(2.56)	(3.56)	(4.72)	(4.68)
Real Interest	-0.51	-0.48	-0.57	-0.56	-0.17	-0.43	-0.42
	(2.64)	(2.69)	(2.31)	(2.66)	(0.55)	(4.17)	(4.33)
Growth	0.11	0.10	0.16	0.23	0.09	0.12	0.12
	(1.56)	(1.33)	(2.29)	(2.96)	(1.00)	(2.44)	(2.54)
Savings	0.12	0.11	0.28	0.14	0.24	0.20	0.16
	(1.80)	(1.64)	(3.65)	(1.68)	(2.66)	(4.96)	(4.64)
Net Transfers	0.25	0.23	0.50	0.53	0.62	0.29	0.23
	(2.16)	(2.07)	(4.29)	(4.39)	(4.46)	(3.65)	(3.09)
Debt/GDP			-0.03		0.05		-0.00
			(1.05)		(2.01)		(0.49)
Debt/Exports		-0.01		0.01		0.00	
		(1.92)		(2.92)		(0.87)	
Arrears				0.02			
				(0.97)			
Time	0.39	0.32	-0.60	-0.59	-0.06	0.21	0.21
	(3.88)	(3.75)	(2.80)	(2.40)	(0.20)	(3.08)	(3.65)
R^2	0.84	0.83	0.91	0.91	0.90	0.87	0.87
F	35.4	37.4	41.0	38.3	30.2	73.7	76.4
Observations	147	147	87	87	72	234	247
Sum of Squared Residuals	601.4	674.2	158.0	168.5	120.7	949.2	1000.3
ϕ	0.00	-0.04	-0.12	0.07	-0.12	0.03	0.01
	(0.03)	(0.44)	(1.03)	(0.59)	(0.99)	(0.30)	(0.18)
B (χ^2_{23})	12.5	9.8	7.9	2.4	7.4	7.9	7.9

Investments(-1):Fixed investment as a percentage of GDP, lagged one period.
Investments(-2):Fixed investment as a percentage of GDP, lagged two periods.
Real interest rate:Yield on US government bonds corrected for depreciation: REALRA = RUS - (INFL) with RUS
= Yield on US governmentbonds, INFL = percentage change in US GDP-deflator.
Savings:Gross Domestic Savings as a percentage of GDP.
Growth:Percentage growth in GDP measured as 100 x d log (constant GDP).
Net Transfers:Long term capital disbursements minus long term capital repayments minus long term interest payments as a percentage of GDP.
Debt/GDP:Public and private long term external debt minus international reserves as a percentage of GDP.
Debt/Exports:Public and Private long term external debt minus international reserves as a percentage of Exports and Non-Factor Services.
Time: Time variable, with 1968 = 1 ..... 1987 = 20.
Arrears:Interest arrears outstanding as a percentage of total debt service due.
ϕ :Estimated first order correlation of the residuals.
B:Breusch Pagan Test statistic for heteroscedasticity.
                    All variables, except the investment terms, are averages of period t and (t-1).
(Absolute value of t-statistics in parenthesis)

*Source:*World Bank, World Tables, 1988-89, Tape Documentation; IMF, International Financial Statistics Yearbook 1988 (for Yield on US government bonds and US inflation); Institute of International Finance (Arrear data); own calculations.

Table 6

**CORRELATION COEFFICIENTS BETWEEN ACTUAL AND PREDICTED
VALUES OF INVESTMENTS FROM REPORTED REGRESSIONS**

Equation

	(1)	**(3)**	**(6)**
Argentina	0.82	0.92	0.93
Bolivia	0.65	0.93	0.91
Brazil	0.01	0.92	0.88
Chile	0.69	0.84	0.81
Colombia	0.21	0.31	0.21
Côte d'Ivoire	0.81	0.97	0.95
Ecuador	0.65	0.83	0.73
Mexico	0.82	0.82	0.87
Morocco	0.88	0.64	0.85
Nigeria	0.18	0.95	0.72
Peru	0.88	0.73	0.83
Philippines	0.96	0.96	0.95
Uruguay	0.98	0.89	0.96
Venezuela	0.80	0.94	0.88
Yugoslavia	0.87	0.97	0.93

Note: Equations refer to the estimations reported in Table 5.

Table 7

CONSUMPTION IN PROBLEM DEBTOR COUNTRIES 1971-87
(DEPENDENT VARIABLE: CONSUMPTION)

	1971-81	1982-87	1971-87
	(1)	(2)	(3)
Lagged Consumption	0.556 (8.34)	0.143 (2.93)	0.576 (11.05)
Income	0.328	0.553	0.257
k	0.74	0.64	0.60
k_g	0.70	0.57	..
R^2	1.00	1.00	1.00
F-statistic	2 738	1 046	4 815
Sum of Squared Residuals	$1.8*10^9$	$7.9*10^8$	$2.4*10^9$
ϕ	0.06	-0.13	0.10
# Observations	165	90	255
$B(Chi^2_{16})$	15.5	17.5	14.8

Note: Estimation Method: Instrumental variables, fixed effect model. Instruments: Lagged Consumption, lagged income and country intercept dummies. The constant term, in all but one case insignificant, is not reported. The variables used in the regressions were expressed in local currency per capita, using 1980 prices.

Consumption is private plus government consumption. Lagged Consumption is private plus government consumption lagged one period; Income is Gross National Product.
k is the marginal propensity to consume from permanent income (see text); k_g is the marginal propensity to consume from permanent, corrected for a trend factor. ϕ denotes estimates first order auto correlation. B is the Breusch Pagan test statistic for heteroscedasticity. Population was calculated using 1968 data, and extrapolated using population growth rates from the World Development Report, 1989. (Absolute value of t-statistics are in parentheses).

Source: World Bank, World Tables, 1988-89, Tape Documentation; World Bank, World Development Report, 1989; own calculations.

Table 8

**CORRELATION COEFFICIENTS BETWEEN ACTUAL AND PREDICTED
VALUES OF CONSUMPTION FROM REPORTED REGRESSIONS**

	Equation		
	(1)	**(2)**	**(3)**
Argentina	0.69	0.72	0.67
Bolivia	0.92	0.95	0.85
Brazil	0.98	0.97	0.98
Chile	0.89	0.39	0.86
Colombia	0.99	0.97	0.99
Côte d'Ivoire	0.83	0.96	0.83
Ecuador	0.99	0.85	0.88
Mexico	0.99	0.93	0.97
Morocco	0.98	0.87	0.96
Nigeria	0.37	0.97	0.64
Peru	0.79	0.99	0.88
Philippines	0.98	0.94	0.95
Uruguay	0.97	0.97	0.88
Venezuela	0.93	0.69	0.91
Yugoslavia	0.92	0.92	0.91

Note: Equations refer to the estimations reported in table 6.

BIBLIOGRAPHICAL REFERENCES

Borensztein, Eduardo,
"Debt Overhang, Credit Rationing and Investments", *Journal of Development Economics*, vol. 32 (1990), pp.315-335.

Callier, Philippe,
"Debt Relief and Adjustment Incentives in a Financially Open Economy; Comment on Corden", *IMF Staff Papers*, Vol. 36, No. 2 (June 1989), pp.514-522.

Claessens, Stijn, and Ishac Diwan,
"Liquidity, Debt Relief, and Conditionality", in I. Husain and I. Diwan (eds.), *Dealing with the Debt Crisis* (Washington, D.C.: The World Bank, 1989), pp.213-225.

Cohen, Daniel,
"How to Cope with a Debt Overhang: Cut Flows Rather Than Stocks", in I. Hussain and I. Diwan (eds.), *Dealing with the Debt Crisis*, op.cit., 1989a, pp.229-235.

Cohen, Daniel,
"Slow Growth and Large LDC Debt in the Eighties: an Empirical Analysis" Mimeo, C.E.P.R.E.M.A.P., November 1989b.

Corden, W. Max,
"Debt Relief and Adjustment Incentives", *IMF Staff Papers*, Vol. 35, No. 4 (December 1988), pp.628-643.

Dornbusch, Rudiger,
"External Debt, Budget Deficits, and Disequilibrium Exchange Rates", in G.W. Smith and J.T. Cuddington (eds.), *International Debt and the Developing Countries* (Washington, D.C.: The World Bank, 1985), pp.213-235.

Froot, Kenneth A.,
"Buybacks, Exit Bonds, and the Optimality of Debt and Liquidity Relief", *NBER Working Paper No. 2675* (Cambridge, Mass.: National Bureau of Economic Research, August 1988).

Gajdeczka, Przemyslaw,
"Measurement of Capital Flight and Developing Country Foreign Assets". Paper presented at the Workshop "Net External Asset Positions" (Kiel March 1990).

Hall, Robert E.,
    "Stochastic Implications of the Life Cycle - Permanent Income Hypothesis: Theory and Evidence", *Journal of Political Economy*, Vol 86 (1978), No. 6, pp. 71-87.

Inter-American Development Bank (IDB),
    Economic and Social Progress in Latin America, 1989 Report, (Washington, D.C., IDB, 1989).

International Monetary Fund (IMF),
    "IMF World Economic Outlook", Supplementary Note 1 (Washington, D.C., IMF, 1989).

Ize, Alain and Guillermo Ortiz,
    "Fiscal Rigidities, Public Debt and Capital Flight", *IMF Staff Papers*, Vol. 37, No. 2 (June 1987), pp. 311-332.

Krugman, Paul R.,
    "Market-Based Debt Reduction Schemes", *NBER Working Paper No. 2587* (Cambridge, Mass.: National Bureau of Economic Research, May 1988).

Pastor, Manuel jr.,
    "Curret Account Deficits and Debt Accummulation in Latin America", *Journal of Development Economics*, Vol. 31 (1981), pp. 77-97.

Reisen, Helmut,
    "Public Debt, North and South", in I. Hussain and I. Diwan (eds.), *Dealing with the Debt Crisis*, op.cit., pp.116-127.

Sachs, Jeffrey,
    "Theoretical Issues in International Borrowing", *Princeton Studies in International Finance* No. 54 (Princeton, N.J.: Princeton University, July 1984).

    "Conditionality, Debt Relief, and the Developing Country Debt Crisis", in: Jeffrey D. Sachs (ed.), *Developing Country Debt and Economic Performance*, Vol. 1: The International Financial System (Chicago: University of Chicago Press, 1989), pp.255-295.

World Bank,
    World Development Report 1988 (Washington, D.C., Oxford: World Bank/Oxford University Press, 1988).

APPENDIX I

The social planner's problem is:

$$\text{Max! } U(C_1;C_2)$$

subject to:

$$C_1 = A+B-I$$
$$C_2 = f(I)-D-(1+r)B$$
$$B \leq B_{max}$$

where

C_i = Consumption in period i

A = Period 1 output

I = Investments in period 1

f(I) = Output in period 2

D = Inherited debt, to be repaid in period 2

B = Period 1 Borrowing

B_{max} = Credit constraint

r = World interest rate

Assuming a simple, time separable utility function, the Lagrangian becomes:

(1) $\quad Z = U(C_1) + \delta U(C_{2)} + \mu_1[A+B-I-C_1] + \mu_2[f(I)-D-(1+r)B-C_2]$
$$+\mu_3[B_{max}-B]$$

where μ_i' are Lagrangian multipliers

First order conditions, with subscripts indicating partial derivatives yield:

(2) $\quad U_1-\mu_1 = 0$

(3) $\quad \delta U_2-\mu_2 = 0$

(4) $\quad -\mu_1+\mu_2 f_I = 0$

(5) $\mu_1 - \mu_2(1+r) - \mu_3 = 0$

(6) $B_{max} - B \geq 0$ and $\mu_3 \geq 0$ and $\mu_3[B_{max} - B] = 0$

and the two definitions for consumption.

Case I: Unconstrained borrowing

If B<Bmax, condition (6) implies that $\mu_3 = 0$, and combining (4)and (5) then gives the usual condition

(7) $f_{I=} (1+r)$

i.e. investment takes place until marginal returns equal the world discount rate, and consequently

(8) $dI = dr/f_{II} < 0$

dI/dD equals zero: a change in inherited debt leaves investments unaffected.

Case II: Constrained Borrowing

If $B_{max} - B = 0$, $\mu_3 > 0$, and combining (4) and (5) yields the first order conditions for investment:

(9) $f_I = (1+r) + \mu_3/(\delta U_2)$

In the optimum, marginal productivity of investments is therefore larger then the world discount rate.

Taking the total differential of (9) yields:

(10) $f_{II} dI = dr + (d\mu_3/\delta U_2) - (\mu_3 dC_2/\delta U_{22})$

Inserting equations (2),(3),(5) and their total differentials into (10) and rearranging gives:

(11) $f_{II}dI = (U_{11}/\delta U_2)dC_1 + \{(U_2(1+r)/U_{22}) - (U_{22}(1+r)/U_2) - (U_1/\delta U_{22})dC_2$

Realizing that $dC_1=(dB-dI)$ and $dC_2=(f_I dI-D-(1+r)dB-Bdr)$, the partial derivatives can be determined as:

$$\frac{dI}{dD} = \frac{-\Gamma}{f_{II}+(U_{11}/\delta U_2)-\Gamma} \quad >0 \text{ if } \Gamma>0$$

$$\frac{dI}{dB} = \frac{(U_{11}/\delta U_2)-\Gamma}{f_{II}+(U_{11}/\delta U_2)-\Gamma} \quad >0 \text{ if } \Gamma>0$$

$$\frac{dI}{dr} = \frac{-B\Gamma}{f_{II}+(U_{11}/\delta U_2)-\Gamma} \quad >0 \ (<0) \text{ if } B>0 \ (<0), \text{ and } \Gamma>0$$

where $\Gamma = \{(U_2(1+r)/U_{22}) - (U_{22}(1+r)/U_2) -(U_1/\delta U_{22})\}$

For Γ to be larger then zero, it is sufficient to assume that the preferences are homothetic (i.e. the functional form of the Utility function is the same in period 1 and 2) and that the country, if unconstrained would be a net borrower, implying that $\delta<1/(1+r)$, since then the last term of the definition of Γ is larger then the first term in absolute terms, and the whole becomes positive.

Case III: debt and credit constraint interrelated

If the credit constraint depends upon the inherited debt, and if the credit constraint is binding, dB becomes a function of dD.

Suppose, for simplicity, that under this assumption the credit constraint becomes:

(12) $B \leq B_{max}-D$

and therefore dB/dD=-1. Inserting this in equation (11), the partial derivative of investments towards debt now becomes:

$$\frac{dI}{dD} = \frac{-(U_{11}/\delta U_1)}{f_{II}+(U_{11}/\delta U_2)-\Gamma} \quad <0$$

This could be the reason why in bivariate correlations, a negative relation between

debt and investments is found.