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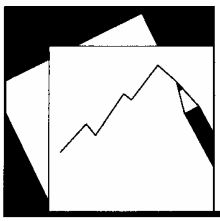

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External Debt, Public Investment, and Growth in Low-Income Countries

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External Debt, Public Investment, and Growth in Low-Income Countries

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Abstract

This paper examines the channels through which external debt affects growth in low-income countries. Our results suggest that the substantial reduction in the stock of external debt projected for highly indebted poor countries (HIPCs) would directly increase per capita income growth by about 1 percentage point per annum. Reductions in external debt service could also provide an indirect boost to growth through their effects on public investment. If half of all debt-service relief were channeled for such purposes without increasing the budget deficit, then growth could accelerate in some HIPCs by an additional 0.5 percentage point per annum.

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Keywords: External Debt, Debt Service, Growth, Public Investment

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I. Introduction

The relationship between external debt and growth continues to attract considerable interest from policymakers and academics alike. A large number of heavily indebted poor countries (HIPCs) are now receiving debt relief under the HIPC and enhanced HIPC Initiatives. This, in turn, has revived the debate over the impact of a high external debt burden on economic growth. Indeed, one of the principal motivations for debt-relief initiatives stems from the presumed deleterious impact of a heavy debt burden on per capita income growth.

Although there is a substantial literature on the impact of external debt on growth, relatively few studies have focused on low-income countries per se. Because most low-income countries do not have access to international capital markets, the impact of external debt on growth can be different in low-income countries than in emerging market countries. Furthermore, the channels through which debt affects growth may differ, given differences in the structure of the economy and the public sector across these two country groups. In addition, low-income countries are usually net recipients of resource transfers from donors, even when debt service is high. Under these circumstances, the adverse effects of debt service on real activity are mitigated.

In light of these considerations, the vast majority of the literature on the debt/growth nexus—developed in the context of emerging market economies—must be interpreted with caution in assessing the debt/growth relationship in a low-income context. These considerations also suggest that empirical estimates of *how much* debt affects growth across these two country groups are likely to differ. A separate empirical analysis of the debt/growth relationship in low-income countries would be especially useful in assessing the growth-enhancing effects of recent debt-relief initiatives.

This paper assesses the impact of external debt on growth in low-income countries and the channels through which these effects are realized. Special attention is given to the indirect effects of external debt on growth via its impact on public investment. The rest of the paper is organized as follows. Section II provides an overview of the theoretical and empirical literature on external debt and growth. Section III presents the results from estimating reduced-form equations for growth and public investment in low-income countries. Section IV concludes and discusses the policy implications of the results.

II. Summary of the Literature on External Debt and Growth

The theoretical literature on the relationship between the stock of external debt and growth has largely focused on the adverse effects of "debt overhang." Krugman (1988) defines debt overhang as a situation in which the expected repayment on external debt falls short of the contractual value of debt. If a country's debt level is expected to exceed the country's repayment ability with some probability in the future, expected debt service is likely to be an increasing function of the country's output level. Thus, some of the returns from investing in the domestic economy are effectively "taxed away" by existing foreign

creditors, and investment by domestic and foreign investors—and thus economic growth—is discouraged. In its original formulation, the debt overhang theory centered on the adverse effects of external debt on investment in physical capital. The scope of the theory is, however, much broader: a high level of external debt can also reduce a government's incentive to carry out structural and fiscal reforms, since any strengthening of the fiscal position (including that generated indirectly through structural reforms) could intensify pressures to repay foreign creditors. These disincentives for reform are of special concern in low-income countries, where an acceleration of structural reforms is needed to sustain higher growth to meet the MDGs.

Debt overhang also depresses investment and growth by increasing uncertainty. As the size of the public debt increases, there is growing uncertainty about actions and policies that the government will resort to in order to meet its debt servicing obligations, with adverse effects on investment. In particular, as the stock of public sector debt increases, there may be expectations that the government's debt service obligations will be financed by distortionary measures (the inflation tax, for example), as in Agénor and Montiel (1996). The extensive literature on uncertainty and investment suggests that in these circumstances, potential private investors will prefer instead to exercise their option of waiting (Serven (1997)). Moreover, any investment that takes place is likely to be diverted to activities with quick returns rather than to long-term, high-risk, irreversible projects. Rapid accumulation of debt can also be accompanied by increasing capital flight if the private sector fears imminent devaluation and/or increases in taxes to service the debt (Oks and Wijnbergen (1995)).

The theoretical literature suggests that foreign borrowing has a positive impact on investment and growth up to a certain threshold level; beyond this level, however, its impact is adverse. As indicated in Cohen (1993), the relationship between the face value of debt and investment can be represented as a kind of "Laffer curve": as outstanding debt increases beyond a threshold level, the expected repayment begins to fall as a consequence of the adverse effects mentioned above. The implication is that an increase in the face value of debt leads to an increase in repayment up to the "threshold" level; along the "wrong" side of the debt Laffer curve, on the other hand, increases in the face value of debt reduce expected payments. Given the postive effects of capital accumulation on economic activity, a similar type of Laffer curve between external debt and growth could also be expected.[2]

The empirical literature has found mixed empirical support for the "debt overhang" hypothesis. Relatively few studies have econometrically assessed the direct effects of the debt stock on investment. In most studies, reduced-form equations for growth are employed, under which the stock of debt is presumed to affect growth both directly (by reducing the

[2] This analysis assumes that the capital stock increases as more debt is incurred, provided that at least part of the debt is used to finance investment. Thus, as external debt increases, so does the capacity to repay, but subject to diminishing returns to capital. Beyond a certain level of debt, repayment capacity declines, owing to these diminishing returns and the debt overhang considerations described in the text.

incentives to undertake structural reforms) and indirectly (via its effects on investment). In middle-income countries, Warner (1992) concludes that the debt crisis did not depress investment, while Greene and Villanueva (1991), Serven and Solimano (1993), Elbadawi, Ndulu, and Ndungu (1997), Deshpande (1997) and Chowdhury (2001), on the other hand, find evidence in support of the debt overhang hypothesis. Fosu (1999), in his empirical study of thirty-five sub-Saharan African countries, also finds support for the debt overhang hypothesis. In contrast, Hansen (2001) finds that in a sample of 54 developing countries (including 14 HIPCs), the inclusion of three additional explanatory variables (the budget balance, inflation, and openness) leads to rejection of any statistically significant negative effect of external debt on growth. In a similar vein, Savvides (1992) finds that the ratio of debt to GNP has no statistically significant effect on growth. Djikstra and Hermes (2001) review a number of studies on the "debt overhang" hypothesis and conclude that the empirical evidence is inconclusive. Furthermore, few studies give a clear idea of the level of the debt-to-GDP ratio at which debt overhang effects come into play.

A recent study finds strong support for a nonlinear, Laffer-type relationship between the stock of external debt and growth. Using a large panel data of 93 developing countries over the period 1969–1998, Pattillo and others (2002) find that the average impact of external debt on per capita GDP growth is negative for net present value of debt levels above 160-170 percent of exports and 35–40 percent of GDP. These results are robust across different estimation methodologies and specifications, and suggest that doubling debt levels slows down annual per capita growth by about half to a full percentage point.

High debt stocks appear to affect growth through their dampening effects on both physical capital accumulation and total factor productivity growth. In a follow-up paper, Pattillo and others (2003) apply a growth accounting framework to a group of 61 developing countries in sub-Saharan Africa, Asia, Latin America, and the Middle East over the period 1969–98. Their results suggest that on average, doubling debt reduces by almost 1 percentage point both growth in per capita physical capital and growth in total factor productivity. Moreover, the policy environment also affects the debt/growth relationship.

External debt service (in contrast to the total debt stock) can also potentially affect growth by crowding out private investment or altering the composition of public spending. Other things being equal, higher debt service can raise the government's interest bill and the budget deficit, reducing public savings; this, in turn, may either raise interest rates or crowd out credit available for the private investment, dampening economic growth. Higher debt service payments can also have adverse effects on the composition of public spending by squeezing the amount of resources available for infrastructure and human capital, with negative effects on growth. Indeed, in the view of some nongovernmental organizations (NGOs), high external debt service is one of the key obstacles to meeting basic human needs in developing countries.[3]

[3] See, for example, Oxfam International (1999).

Relatively few empirical studies have assessed the effects of debt service on private investment or the composition of public spending. Greene and Villanueva (1991) find external debt service dampens private investment, while Serieux and Samy (2001) find a similar link between debt service and total investment. For a large sample of developing countries, including some HIPCs, Savvides (1992) finds that debt service crowds out public investment spending. Using a panel of 24 African HIPCs, Stephens (2001) finds that each additional US$1 in debt service results in: (a) a US$ .33 decrease in education spending; (b) a US$ 0.14–0.23 fall in government wage expenditure; and, surprisingly, (c) a US$ 0.12–0.23 *increase* in health spending. Hence, his results indicate that an increase in debt service may not necessarily lead to a decline in investment in human capital (in this case, health spending). Reduced-form equations have also been employed to assess the impact of debt service on growth, under the presumption that debt service affects growth via its consequences on the composition of spending or the crowding out of private investment. The empirical evidence in this regard is mixed: Elbadawi, Ndulu, and Ndung'u (1997), for example, find a statistically significant relationship between debt service (as a share of exports) and growth in Sub-Saharan Africa, while Fosu (1999) finds no such relationship for countries of that region. Using a broader set of countries, Pattillo and others (2002) also find no statistically signficant relationship between debt service and growth.

In sum, the existing empirical literature provides limited evidence on how the stock of external debt and debt service affect growth, particularly in low-income countries. In particular, there is scope for additional work to clarify the size of these effects, especially for low-income countries that are benefiting from debt relief. Furthermore, more work is needed to explore the channels through which debt affects growth. This study attempts to fill this gap in the literature, with special attention being paid to the effects of external debt service on public investment.

III. Empirical Analysis

A. Overview on Methodology

Our empirical analysis attempts to shed light on the channels through which external debt affects per capita income growth in low-income countries. Following the earlier literature—and to assist in comparing our results with other studies—we begin by estimating reduced-form growth equations for these countries. This does not identify the channels through which external debt affects growth per se, but provides helpful insights into potential channels. We then go on to examine in more detail the potential channels through which external debt might affect growth.

B. The Growth Model

Following earlier studies, the standard growth model is augmented with debt variables to assess the impact of external debt on growth. We use four widely used indicators of the external debt stock burden: The face value of the stock of external debt as a share of GDP;

the net present value (NPV) of the stock of external debt as a share of GDP; the face value of the stock of external debt as a share of exports of goods and services; and the net present value of debt as a share of exports of goods and services. In principle, the net present value of debt should reflect the degree of concessionality of loans, and thus more accurately measure the expected burden of future debt service payments. However, as all four measures have been used in previous studies, we also follow this convention.

The following reduced-form growth model is estimated as follows:

$$GRPCY_{it} = \alpha_r + \alpha_1 LYRPC(-1)_{it} + \alpha_2 TOTGR_{it} + \alpha_3 POPGR_{it} + \alpha_4 GSEC_{it} + \alpha_5 GROINV_{it} + \alpha_6 FISBAL_{it} + \alpha_7 OPEN_{it} + \alpha_8 DEBTSERX_{it} + \alpha_9 EXTDEBT_{it} + \alpha_{10} EXTDEBT^2_{it} + \mu_{it} \quad (1)$$

where

GRPCY = growth of real per capita income (GDP)

LYRPC(-1) = real per capita income (GDP per capita, constant 1995 $U.S.) lagged one period, measured in natural logs

TOTGR = percentage change in the terms of trade

POPGR = population growth rate, in percent

GSEC = gross secondary school enrollment rate

GROINV = gross domestic investment in percent of GDP

FISBAL = central government fiscal balance in percent of GDP

OPEN = openness indicator (exports plus imports as a share of GDP)

DEBTSERX = total debt service in percent of exports of goods and services

EXTDEBT = one of four indicators of the stock of external debt (see below), measured in natural logs

and μ_{it} is the usual error term. The subscript (*it*) for the main explanatory variables refer to country and time period, respectively.

Lagged per capita income is included as an explanatory variable, as in the standard Barro growth model, to test for convergence across countries over time towards a common level of real per capita income. Population growth and gross investment are proxies for the rates of growth of factor inputs (labor and capital) in the production process,

while the secondary school enrollment rate is typically used as a proxy for the quality of human capital. The terms of trade variable is intended to capture external shocks to the economy; many of the countries in our sample are heavily dependent on exports of primary commodities, and are therefore especially vulnerable to these shocks. The central government fiscal balance is included to control for the impact of fiscal balances on growth. The openness indicator takes account of the substantial literature arguing that economies that are more open to trade enjoy higher long-term rates of growth of per capita real income (see Sachs and Warner (1995)). Finally, to distinguish between debt overhang and the crowding out effect mentioned earlier, both contemporaneous debt service and a measure of the stock of external debt are included in the regression analysis.

We estimate the model using both fixed effects and system General Method of Moments (GMM). The advantage of a fixed effects model is that it provides consistent estimates in the presence of country-specific effects that are correlated with the explanatory variables in the model. In a traditional fixed effects formulation, however, the estimate of the lagged income variable may be biased downward. To overcome this problem, we follow Pattillo and others (2002) and also provide estimates based on the system GMM methodology of Blundell and Bond (1998). A further advantage of this method is that it addresses the potential endogeneity of the variables (for example, investment). This method involves the joint estimation of equation (1) in levels and first differences, imposing the restriction that the coefficients in the level and differenced equations are equal. The instruments used in our model in the level equation are lagged first differences of the variables, while the instruments for the differenced equation are the lagged levels of the variables.[4]

C. Data

The empirical analysis in this paper uses data for 55 low-income countries that are classified as eligible for the IMF's Poverty Reduction and Growth Facilitiy (PRGF). The data cover the period 1970–99. To net out the effects of short-term fluctuations, three-year averages have been used for the panel regressions. External debt and gross domestic investment data (total, private, and public) were drawn from the World Bank's *Global Development Network Growth* database. Data on debt service payments as a share of exports and as a share of GDP were taken from the *Global Development Finance* database (World Bank), supplemented with data from the World Bank's *World Development Indicators (WDI)* database. Data on the net present value of debt are taken from the website of William Easterly.[5] The terms of trade and the central government balance as a share of GDP were calculated using data drawn from the *World Economic Outlook* database. All other data came from the WDI.

[4] Data were first demeaned before applying system GMM, rather than directly applying the individual country dummy option for system GMM under the Blundell and Bond routine available in PC-Give.

[5] Data are available at *http://www.nyu.edu/fas/institute/dri/index.html*.

D. Econometric Results

The fixed effects and system GMM estimates yield broadly similar results. In all cases the F-tests reject the null hypothesis of a common intercept term across countries, and the Hausman tests consistently reject random effects in favor of fixed effects. The system GMM estimates all pass the Sargan test for validity of the instrument set. Only in the case where the growth equation is formulated with gross investment and the net present value of external debt as a share of exports do the two methodologies yield notably different results (Table 1).

The empirical estimates provide some support for the debt overhang hypothesis. They suggest that beyond a certain threshold, higher external debt is associated with lower rates of growth of per capita income (independent of any impact it may have on gross domestic investment). Depending on which estimation method is used, the results indicate a threshold level of around 30–37 percent of GDP, or around 115–120 percent of exports.

Debt service has no direct effect on real per capita GDP growth. As argued below, one reason that debt service may be insignificant is that its effect is realized through its impact on investment, which is included as an explanatory variable in the model and is thus held constant.

Both fixed effects and system GMM show that gross investment has a significant positive impact on real per capita GDP growth. [6] Lagged income and the central government fiscal balance are also always statistically significant, with lagged income having a negative coefficient and the fiscal balance having a positive coefficient. This is consistent with recent works showing the positive effects of good fiscal policy on growth (see Gupta and others, forthcoming). The coefficients on population growth and terms of trade growth are, in some cases, statistically significant and negative. Openness is found to be statistically insignificant.

Secondary school enrollment has no statistically significant impact on per capita income growth. This contrasts with the finding of Pattillo and others (2002) for a sample that included middle-income countries.[7] Our results suggest that within the modest range of educational attainment levels in low-income countries, it is not possible to identify a positive relationship between education and growth—although such a relationship may exist for developing countries as a whole. Given the difficulty of identifying an empirical relationship

[6] Pattillo and others (2002) also find that investment has a significant impact on growth. However, their results on the impact of debt on growth were largely unchanged when total investment was excluded from the model; they interpret this as suggesting that it is the impact of debt on the quality (rather than the quantity) of investment that matters.

[7] The same model was estimated using various proxies for human capital, including illiteracy rates and growth rates of secondary school enrollment. In all cases the human capital variables were statistically insignificant, including when measured in logs.

Table 1. Impact of Gross Investment and External Debt on Per Capita Income Growth

	Fixed Effects	SYSGMM	Fixed Effects	SYSGMM	Fixed Effects	SYSGMM	Fixed Effects	SYSGMM
Log (income)$_{-1}$	-13.149 ***	-13.133 ***	-12.733 ***	-12.471 ***	-12.128 ***	-12.883 ***	-11.896 ***	-11.934 ***
	(-8.471)	(-6.750)	(-8.063)	(-5.600)	(-8.159)	(-7.230)	(-7.886)	(-5.710)
Terms of trade growth	-0.009	-0.012	-0.010	-0.010	-0.012*	-0.015*	-0.012*	-0.014
	(-1.331)	(-1.500)	(-1.429)	(-1.210)	(-1.724)	(-1.720)	(-1.706)	(-1.590)
Population growth	-1.178 **	-0.650	-1.366 **	-1.205 **	-0.834	-0.947 *	-1.064 *	-1.091 **
	(-2.133)	(-1.380)	(-2.391)	(-2.480)	(-1.489)	(-1.830)	(-1.885)	(-2.210)
Secondary school enrollment	-0.005	-0.040	0.005	-0.046	0.012	-0.010	0.015	-0.041
	(-0.154)	(-0.947)	(0.146)	(-1.010)	(0.329)	(-0.237)	(0.412)	(-0.911)
Gross investment ratio	0.206 ***	0.176 ***	0.206 ***	0.186 ***	0.223 ***	0.192 ***	0.220 ***	0.189 ***
	(4.644)	(3.580)	(4.561)	(3.630)	(5.031)	(3.720)	(4.839)	(3.810)
Fiscal balance	0.248 ***	0.251 ***	0.238 ***	0.243 ***	0.272 ***	0.241 ***	0.260 ***	0.228 ***
	(4.967)	(3.400)	(4.637)	(3.410)	(5.390)	(3.390)	(4.997)	(3.090)
Openness	-1.069	0.105	-2.148	-1.466	-2.248	-0.270	-2.562	-1.392
	(-0.580)	(0.067)	(-1.206)	(-0.752)	(-1.212)	(-0.168)	(-1.412)	(-0.771)
Debt service/exports	-0.006	0.011	0.004	0.031	-0.018	0.029	-0.006	0.033
	(-0.246)	(0.382)	(0.147)	(0.040)	(-0.726)	(0.871)	(-0.249)	(1.150)
Log (debt/GDP)	3.862 ***	4.26 ***						
	(3.209)	(2.610)						
[Log (debt/GDP)]^2	-0.535 ***	-0.617 ***						
	(-3.375)	(-3.010)						
Log (debt/exports)			3.854 *	4.855 **				
			(1.876)	(2.180)				
[Log (debt/exports)]^2			-0.406 **	-0.508 **				
			(-2.120)	(-2.300)				
Log (NPV(debt)/GDP))					4.292 ***	3.866 **		
					(3.202)	(2.550)		
[Log (NPV(debt)/GDP))]^2					-0.593 ***	-0.699 ***		
					(-2.837)	(-3.220)		
Log (NPV(debt)/exports))							5.023 **	1.219
							(2.285)	(0.478)
[Log (NPV(debt)/exports))]^2							-0.510 **	-0.193
							(-2.261)	(-0.748)
Constant		-0.104		0.050		-4.404		-0.935
		(-0.344)		(0.157)		(-1.570)		(-0.144)
No. of observations	272	261	272	261	272	261	272	261
No. of countries	55	49	55	49	55	49	55	49
Adjusted R-squared 2/	0.526	0.295	0.512	0.260	0.523	0.320	0.512	0.260
Common intercept test (Fixed Effects) 1/	0.000		0.000		0.000		0.000	
Hausman test (Random vs. Fixed Effects) 1/	0.000		0.000		0.000		0.000	

Notes:

(***), (**) and (*) denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

The panels are constructed as averages over three-year periods.

The numbers in parentheses are t-ratios.

1/ p-values.

2/ 1 - RSS/TSS reported for system GMM.

between variables measuring human capital and growth, however, it is not possible to quantify how external debt might depress growth via this channel in low-income countries.

Reestimating the growth equations with gross investment disaggregated into private and public investment suggests that it is the latter which has an impact on growth. This applies for all four debt stock indicators and for both estimation methodologies (Table 2). The results imply that for each 1 percentage point of GDP increase in public investment, annual per capita growth rises by 0.2 percentage point. However, higher public investment that leads to larger budget deficits will not have a salutary effect on growth, given the adverse effects of deficits on economic activity. Changes in the terms of trade, population growth, and openness have no statistically significant effect on growth. As before, the coefficient on the debt service variable is, in all cases but one, statistically insignificant. With respect to the debt stock, the results are once again consistent with the debt overhang hypothesis, and indicate that the marginal impact of debt on growth becomes negative beyond a certain threshold level. This threshold level is estimated at around 50 percent of GDP for the face value of external debt, and at around 20–25 percent of GDP for its estimated net present value. These values are much higher than the estimated ones of 11 percent and 9–14 percent, respectively, in Pattillo and others (2002). One reason for the difference in results could be that our country sample only includes low-income, PRGF-eligible countries, whereas the study by Pattillo and others (2002) includes emerging market countries in their sample. The results with the external debt indicators expressed as a ratio to exports (rather than GDP) are somewhat weaker, but still indicate a statistically significant relationship, with a threshold level for the net present value of external debt at around 100-105 percent of exports.

Various econometric tests were undertaken to assess whether debt affects growth through its effect on the level of private investment. As noted in Pattillo and others (2002), the formulation above understates the potential effect of debt on growth via its effect on investment, given the simultaneous inclusion of investment and debt variables in the reduced form equation. To assess whether debt might be affecting growth via its effect on private investment, we ran the growth regression without the private investment variables for all the model formulations reported in Table 2.[8] The debt variables remained statistically significant, but indicated that a reduction of debt would generally have a *smaller* effect on growth than indicated in Table 2. In addition, Hausman tests under the fixed effects formulation of the model revealed there were no systematic differences in coefficient values whether private sector investment was included or excluded.[9] Finally, we ran the growth equations in Table 2 without the external debt variables, and found that private investment remained statistically

[8] A similar method was used by Pattillo and others (2002) to assess the effect of debt on growth, albeit in a model that included total investment (rather than both private and public investment).

[9] The Hausman test could not be used in the model formulation when the NPV of debt to exports was used. Results are available from the authors upon request. The model was also estimated with an interaction variable, based on the multiple of the NPV of the debt to GDP (or to exports) and the level of private investment to GDP. This variable was also found to be statistically insignificant or incorrectly signed.

Table 2. Impact of Private/Public Investment and External Debt on Per Capita Income Growth

	Fixed Effects	SYSGMM	Fixed Effects	SYSGMM	Fixed Effects	SYSGMM	Fixed Effects	SYSGMM
Log (income)[1]	-12.420 ***	-12.275 ***	-12.726 ***	-11.863 ***	-12.279 ***	-12.865 ***	-12.153 ***	-12.058 ***
	(-7.408)	(-5.910)	(-7.494)	(-5.100)	(-7.566)	(-7.280)	(-7.315)	(-5.350)
Terms of trade growth	-0.002	-0.002	-0.004	-0.003	-0.002	-0.004	-0.003	-0.002
	(-0.254)	(-0.210)	(-0.482)	(-0.399)	(-0.274)	(-0.519)	(-0.374)	(-0.313)
Population growth	-0.594	-0.080	-0.613	-0.279	-0.689	-0.638	-0.741	-0.581
	(-0.909)	(-0.148)	(-0.913)	(-0.446)	(-1.070)	(-1.110)	(-1.103)	(-0.971)
Secondary school enrollment	0.013	-0.031	0.049	0.003	-0.011	0.001	0.022	0.008
	(0.280)	(-0.727)	(1.032)	(0.064)	(-0.243)	(0.004)	(0.488)	(0.198)
Private investment ratio	-0.025	0.008	0.010	0.011	-0.030	-0.001	0.002	0.011
	(-0.410)	(0.247)	(0.164)	(0.269)	(-0.504)	(-0.031)	(0.039)	(0.235)
Public investment ratio	0.207 ***	0.167 **	0.222 ***	0.184 **	0.214 ***	0.181 ***	0.242 ***	0.194 ***
	(2.748)	(2.130)	(3.061)	(2.480)	(2.978)	(2.600)	(3.389)	(2.880)
Fiscal balance	0.211 ***	0.226 ***	0.188 ***	0.190 ***	0.246 ***	0.233 ***	0.226 ***	0.189 ***
	(3.647)	(3.450)	(3.182)	(2.850)	(4.212)	(4.190)	(3.681)	(3.570)
Openness	3.762	0.972	2.665	0.254	3.403	2.509	2.427	0.973
	(1.490)	(0.638)	(1.060)	(0.147)	(1.356)	(1.530)	(0.952)	(0.579)
Debt service/exports	-0.039	-0.037	-0.033	-0.021	-0.044*	-0.017	-0.037	-0.008
	(-1.630)	(-1.380)	(-1.386)	(-0.740)	(-1.755)	(-0.631)	(-1.496)	(-0.279)
Log (debt/GDP)	3.465 *	6.731 ***						
	(1.894)	(3.250)						
[Log (debt/GDP)]^2	-0.458 **	-0.863 ***						
	(-1.972)	(-3.290)						
Log (debt/exports)			3.187	6.872 *				
			(0.966)	(1.840)				
[Log (debt/exports)]^2			-0.344	-0.677 **				
			(-1.157)	(-1.970)				
Log (NPV(debt)/GDP)					6.827 ***	7.804 ***		
					(3.009)	(3.250)		
[Log (NPV(debt)/GDP)]^2					-0.923 ***	-1.250 ***		
					(-2.853)	(-4.200)		
Log (NPV(debt)/exports)							6.888 *	6.550 **
							(1.731)	(2.030)
[Log (NPV(debt)/exports)]^2							-0.674 *	-0.706 **
							(-1.761)	(-2.190)
Constant		-0.121		-0.011		-11.050 **		-14.591 *
		(-0.363)		(-0.034)		(-2.320)		(-1.750)
No. of observations	211	204	211	204	211	204	211	204
No. of countries	40	38	40	38	40	38	40	38
Adjusted R-squared 2/	0.465	0.252	0.461	0.221	0.481	0.258	0.462	0.199
Common intercept test (Fixed Effects) 1/	0.000		0.000		0.000		0.000	
Hausman test (Random vs. Fixed Effects) 1/	0.000		0.000		0.000		0.000	

Notes:

(***), (**), and (*) denote statistical significance at the 1, 5 and 10 percent levels, respectively.

The panels are constructed as averages over three-year periods.

The numbers in parentheses are t-ratios.

1/ p-values.

2/ 1 - RSS/TSS reported for system GMM.

insignificant.[10] In sum, these results suggest that debt affects growth through its impact on the efficiency of resource use, rather than the level of private investment.

The overall results have important implications for the impact of debt relief on growth in the HIPCs. The weighted average NPV of external debt to GDP for the 27 decision point HIPCs is projected to decline from 60 percent prior to debt relief at the decision point to 30 percent by 2005, when most HIPCs are expected to have reached their completion points. Based on our estimates from the second column of Table 2 (the system GMM results), this debt reduction would, ceteris paribus, directly add 0.8–1.1 percent to their annual per capita GDP growth rates.

The results imply a more powerful relationship between debt and growth than recent research focusing on developing countries as a whole. Assuming a reduction in NPV of debt to GDP from 60 percent to 30 percent, and using the quadratic system GMM results presented in Table 6 of Pattillo and others (2002), growth would increase by 0.4 percentage point per annum—about half the figure reported above. Using the quadratic fixed effects results from Table 6 of their paper, however, growth would rise by a figure similar to our estimates noted above.

The effects of debt on growth could be even higher when indirect effects are taken into account. Our results indicate that both the central government balance and public investment influence growth. In what follows below, we explore in greater detail the effect of one of these indirect channels (public investment).

E. The Public Investment Model

There has been relatively little research done on the determinants of *public* investment (as opposed to *total* or *private* investment) in developing countries. Tanzi and Davoodi (1997) model the public investment ratio for a wide range of countries as a function of corruption (proxied by the *International Country Risk Guide* Corruption Index), real per capita income, and the government revenue to GDP ratio. Their empirical results suggest that corruption increases public investment while reducing its productivity. Sturm (2001) focuses on developing countries and models public investment using three sets of explanatory variables: structural variables, such as urbanization and population growth; economic variables, such as real GDP growth, government debt, budget deficits, and foreign aid; and politico-institutional variables, such as political stability and political business cycles. Sturm finds that politico-institutional variables do not seem to be important in explaining public investment in developing economies, in contrast to structural and economic variables.

[10] Relatively few studies have assessed the impact of private investment on growth in developing countries; in most studies, total investment, rather than private investment per se, has been included in the empirical analysis. Two exceptions are Khan and Kumar (1997), and Gupta and others (forthcoming). The weak relationship between private investment and growth merits further research.

In our empirical analysis of public investment we exclude institutional variables for two reasons. The first is that recent work has not found these variables to be of significance in explaining public investment in developing countries. The second—and more important—is that given the lack of available data, inclusion of these variables would significantly reduce the number of observations in our sample.

More specifically we estimate the following public investment equation:

$$PUBINV_{it} = ß_r + ß_1 LYRPC_{it} + ß_2 AIDGNI_{it} + ß_3 URBAN_{it} + ß_4 OPEN_{it} + ß_5 DEBTSERY_{it} + ß_6 EXTDEBT_{it} + ß_7 EXTDEBT^2_{it} + \upsilon_{it} \quad (2)$$

where

PUBINV = public investment in percent of GDP

AIDGNI = foreign aid in percent of gross national income

URBAN = the urbanization ratio

DEBTSERY = total debt service in percent of GDP

LYRPC, OPEN and EXTDEBT are as defined earlier

and υ_{it} is the standard error term. As before, the subscript (*it*) for the main explanatory variables refer to country and time period, respectively. The model is estimated using fixed effects.[11]

The real per capita income variable is used as a proxy for the level of economic development, as in Tanzi and Davoodi (1997). The impact of the urbanization ratio on public investment is ambiguous. On the one hand, it could be argued that as a society becomes urbanized, there is a shift from the family to the government with regard to the provision of services like education and health care; thus, one might expect the coefficient on urbanization to be positive.[12] On the other hand, most public capital spending concerns physical infrastucture, the need for which is relatively greater in rural areas. It is plausible that increasing urbanization leads to less demand for physical infrastructure and perhaps more demand for public consumption spending, giving rise to a negative coefficient. It is also expected that higher foreign aid enables governments to spend more on public investment. The openness

[11] A system GMM approach is not necessary in this context, given that all the explanatory variables are exogenous and the absence of a lagged dependent variable.

[12] Wagner's law also suggests that public investment spending might increase with urbanization. Writing at the end of the 19th century, Wagner posited that the development of an industrialized society would increase pressures to supply public services. For more on Wagner's law, see Wagner (1958).

indicator is included as an explanatory variable because more open economies often compete for foreign direct investment by, among other things, trying to invest more in infrastructure; thus, there is likely to be a positive relationship between openness and the public investment ratio.

We report results using total debt service as a percent of GDP (rather than as a share of exports). This appears to be the most intuitively appealing measure of how debt affects general government decisions regarding the appropropriate level of public investment. These are presented in columns 2 and 6 of Table 3. However, there is no reason to expect a *linear* relationship between debt service and public investment; it is plausible that the crowding-out effect of debt service on public investment becomes increasingly more important as debt service absorbs a growing share of national output. We thus rerun equation (2) replacing the debt service to GDP ratio with the square of its value. These results are presented in columns 3 and 7 of Table 3.

It is also plausible that low levels of debt service payments have no perceptible impact on public investment. Rather, it could be the case that crowding out only occurs after a certain "threshold" of high levels of debt service. To test this, we experimented with various debt service to GDP dummies, which took a value of zero below a specified threshold level and the percent of GDP absorbed by debt service payments beyond this threshold. Separate regressions were also run with the square of this dummy variable to allow for an increasingly stronger crowding-out effect as the ratio of debt service to GDP rises. Since the adjusted R-squared did not vary much across the different specifications, the Schwartz Information Criterion was used to distinguish between the various specifications. The best results were obtained at a threshold level of 5 percent of GDP.[13] These results are presented in columns 4, 5, 8, and 9 of Table 3.

F. Econometric Results

The fixed effects estimates of the public investment equation yield a number of interesting results (Table 3).[14] The overall goodness of fit of the model is satisfactory, as over half of the variation in public investment is explained by the model. With respect to individual coefficients, the openness indicator is always highly significant and positive, while the urbanization ratio is always highly significant and negative, as in Sturm (2001). Foreign aid is statistically significant and positive in most formulations of the model. The coefficient on real per capita income is *positive* and statistically significant, in direct contrast to Tanzi and Davoodi (1997), whose empirical results show a *negative* and statistically significant coefficient. This may be because the Tanzi and Davoodi results cover a wider range of countries, including middle- and high-income countries, and the negative coefficient may

[13] 24 of the 44 countries included in the regressions in Table 2 had debt service to GDP ratios above 5 percent.

[14] As with the growth equations, in all cases the F-tests reject the null hypothesis of a common intercept term across countries, and the Hausman tests consistently reject random effects in favor of fixed effects.

Table 3. Impact of External Debt/Debt Service on Public Investment

	Dependent Variable: Ratio of Public Investment to GDP Estimation Method: Fixed Effects							
Log (income)	4.729 *** (3.355)	4.587 *** (3.331)	4.607 *** (3.270)	4.575 *** (3.323)	5.112 *** (3.774)	4.806 *** (3.607)	4.960 *** (3.667)	4.773 *** (3.584)
Foreign aid as a percentage of GNI	0.085 ** (2.339)	0.091 ** (2.532)	0.082 ** (2.261)	0.090 ** (2.512)	0.056 (1.542)	0.063 * (1.755)	0.052 (1.431)	0.062 * (1.743)
Urbanization ratio	-0.216 *** (-4.589)	-0.222 *** (-4.769)	-0.216 *** (-4.571)	-0.222 *** (-4.764)	-0.209 *** (-4.768)	-0.215 *** (-5.026)	-0.211 *** (-4.802)	-0.215 *** (-5.015)
Openness	7.985 *** (5.020)	7.763 *** (4.946)	7.955 *** (4.990)	7.764 *** (4.947)	13.434 *** (7.116)	12.828 *** (7.024)	13.209 *** (7.031)	12.824 *** (7.025)
Debt service/GDP	-0.167 * (-1.932)				-0.197 ** (-2.526)			
$[\text{Debt service/GDP}]^2$		-0.010*** (-3.345)				-0.011 *** (-3.646)		
Debt service threshold dummy			-0.106 (-1.577)				-0.14 ** (-2.325)	
$[\text{Debt service threshold dummy}]^2$				-0.01 *** (-3.354)				-0.011 *** (-3.677)
Log (NPV(debt)/GDP)	2.297 (1.457)	1.732 (1.109)	2.202 (1.360)	1.630 (1.039)				
$[\text{Log (NPV(debt)/GDP)}]^2$	-0.150 (-0.569)	-0.079 (-0.312)	-0.162 (-0.605)	-0.065 (-0.255)				
Log (NPV(debt)/exports)					1.771 (0.721)	1.272 (0.524)	1.529 (0.622)	1.204 (0.496)
$[\text{Log (NPV(debt)/exports)}]^2$					-0.033 (-0.133)	-0.006 (-0.002)	-0.021 (-0.084)	0.005 (0.022)
No. of observations	338	338	338	338	336	336	336	336
No. of countries	44	44	44	44	44	44	44	44
Adjusted R-squared	0.519	0.531	0.517	0.531	0.540	0.551	0.539	0.551
Schwartz Information Criterion	990.457	986.180	991.183	986.144	978.432	974.493	978.994	974.366
Common intercept test (Fixed Effects) 1/	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hausman test (Random vs. Fixed Effects) 1/	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes:

(***), (**), and (*) denote statistical significance at the 1, 5 and 10 percent levels, respectively.

The panels are constructed as averages over 3-year periods.

The numbers in parentheses are t-ratios.

1/ p-values.

reflect long-run convergence across countries of the public investment to GDP ratio. By contrast, our sample is limited to low-income countries, and the positive coefficient may reflect the fact that, within this sample, countries with higher real per capita income can generate greater tax revenues and can afford higher levels of public investment.

The empirical estimates indicate that the stock of external debt has no significant impact on public investment. This implies that prospective debt servicing payments for the public sector (as indicated by the NPV of debt) do not deter public investment in the short run. This suggests that public investment is driven more by the current fiscal position and the availability of resources, rather than factors that affect fiscal sustainability over the longer term.

The results provide support for the hypothesis that higher debt service "crowds out" public investment, and that this effect becomes stronger as debt service absorbs a growing share of GDP. Under most formulations of the model, debt service has a statistically significant effect on public investment. The relationship is nonlinear, with the crowding-out effect intensifying as the ratio of debt service to GDP rises. The Schwartz Information Criterion suggests that the results with the threshold dummies are marginally better than those using the debt service to GDP ratio or its square. The better performance of the threshold dummies is indicative of the underlying nonlinearity in the relationship between debt service and public investment.

How significant is the "crowding-out" effect? Under the linear formulations of the model, the results indicate that for every one percentage point of GDP increase in debt service, public investment declines by about 0.2 percent of GDP. In some sense, the modest size of this coefficient is surprising, indicating that high debt burdens have not had a very large effect on public investment in low-income countries. More importantly, this implies that, ceteris paribus, debt relief per se cannot be expected to lead to large increases in public investment. Instead, in most cases it either leads to greater public consumption, or—if used for deficit reduction or lower taxes—higher private consumption or investment.

If only a small share of debt relief is channeled into public investment, the corresponding impact on growth will also be modest. For example, assume a reduction in the ratio of debt service to GDP from 8.7 percent (the average in 2000 of the 7 most heavily indebted HIPC countries) to 3.0 percent (roughly the average debt service-to-GDP ratio for all HIPC countries in 2002).[15] Table 4 presents the results of this exercise. The calculations from the best fitting regression results suggest that a reduction in debt service payments from 8.7 to 3.0 percent of GDP would increase public investment by 0.7–0.8 percent of GDP, and

[15] Some caution is needed in interpreting these results, as our debt service variable captures both private and public debt service on long-term debt, while HIPC debt relief is provided for public and publicly guaranteed external debt. Since about three-fourths of the long-term external debt service in low-income countries is public and publicly guaranteed, this is unlikely to have a significant effect on our results.

Table 4. Impact on Public Investment and Indirect Impact on Real Per Capita Income Growth of Reducing the Debt Service-to-GDP Ratio from 8.7 Percent to 3.0 Percent

	Impact on Public Investment (in percent of GDP)	Impact on Annual GDP Growth Rate	
		Fixed Effects	System GMM
Results with net present value of debt in percent of GDP			
Debt service/GDP	0.95	0.20	0.17
[Debt service/GDP]^2	0.70	0.15	0.13
Debt-service threshold dummy	0.92	0.20	0.17
[Debt-service threshold dummy]^2	0.78	0.17	0.14
Results with net present value of debt in percent of exports			
Debt service/GDP	1.12	0.27	0.22
[Debt service/GDP]^2	0.71	0.17	0.14
Debt-service threshold dummy	1.22	0.29	0.24
[Debt-service threshold dummy]^2	0.79	0.19	0.15

indirectly raise real per capita GDP growth by 0.1–0.2 percent annually. While this boost to growth would be small in absolute terms, it is roughly equivalent to the actual growth in per-capita incomes achieved by HIPCs in the 1990s. Morever, if half of this debt service were channeled to higher public investment (instead of one fifth), annual growth would rise quite significantly (about 0.5 percentage point per annum). Under all scenarios, greater public investment only bolsters growth if it is matched by other revenue and expenditure measures that do not lead to higher budget deficits.

IV. CONCLUSIONS

High levels of debt can depress economic growth in low-income countries. Debt appears to affect growth via its effect on the efficiency of resource use, rather than through its depressing effect on private investment. As indicated by the debt-overhang hypothesis, however, debt has a deleterious effect on growth only after it reaches a threshold level. This threshold level is estimated at around 50 percent of GDP for the face value of external debt, and at around 20–25 percent of GDP for its estimated net present value. The results with the

external debt indicators expressed as a ratio to exports are somewhat weaker, but indicate a threshold level for the net present value of external debt at around 100–105 percent of exports. Our results imply that the substantial reduction in external debt projected for the HIPCs by the time most of them reach their completion points in 2005 would, ceteris paribus, directly add 0.8–1.1 percent to their per capita GDP growth rates. Indeed, the positive effects of debt relief may already be reflected in some of the healthier growth experienced by HIPCs in the past few years relative to their poor performance of the 1990s.[16]

External debt also has indirect effects on growth through its effects on public investment. While the stock of public debt does not appear to depress public investment, debt service does. The relationship is nonlinear, with the crowding-out effect intensifying as the ratio of debt service to GDP rises. On average, every 1 percentage point increase in debt service as a share of GDP reduces public investment by about 0.2 percentage point. This implies that a reduction in debt service of about 6 percentage points of GDP would raise investment by 0.75–1 percentage point of GDP, raising growth modestly by about 0.2 percentage point. However, if a more sizeable share of this debt relief were channeled into public investment—say about half—growth could increase by 0.5 percentage point per annum. While the use of debt relief is determined by each country in the context of its poverty reduction strategy paper (PRSP), our results here suggest that one viable option for country authorities to raise growth and combat poverty would be to allocate a substantial share of debt relief for public investment. To reap these positive effects of debt relief on investment and growth, higher spending on capital outlays would need to be matched by spending cuts, higher external grants, or increases in domestic revenues to prevent an increase in the budget deficit.

These results have important implications for the design of adjustment programs in countries receiving debt relief. Reducing the stock of debt alone—rather than an immediate reduction in debt service—is unlikely to induce governments to increase their spending on public investment. And while cutting debt-service obligations can provide breathing space to raise public investment, debt relief per se is likely to lead to just a modest rise in this spending. In practice, most HIPCs have been raising public investment in the context of their PRGF-supported programs; on average, these countries have targeted an increase of 0.5 percentage point of GDP in this spending, relative to the pre-PRGF year.[17]

Additional research could further evaluate other indirect channels through which external debt affects growth. In particular, our reduced-form equation suggests that stronger central government fiscal balances contribute to growth, suggesting that the relationship between debt and public sector deficits merits further examination. These

[16] GDP per capita grew by an average of 1.2 percent per annum in 2000–2002, compared with 0.2 percent during the 1990s.

[17] Drawn from an update on the database on fiscal targets in PRGF-supported countries in Gupta and others (2002).

linkages are complex and beyond the scope of the present paper; from a theoretical standpoint, the impact of aid on both revenues and expenditures is ambiguous (see Gupta and others, 2003). Additional research could also fruitfully assess how debt interfaces with other macroeconomic determinants of growth.

I. List of Countries

Albania	Democratic Republic of Congo	Macedonia, FYR of	Solomon Islands
Angola	Republic of Congo	Madagascar	Sri Lanka
Armenia	Côte d'Ivoire	Malawi	Tanzania
Bangladesh	Djibouti	Mali	Togo
Benin	Eritrea	Mauritania	Uganda
Bhutan	Ethiopia	Mozambique	Vanuatu
Bolivia	Gambia, The	Nepal	Vietnam
Burkina Faso	Ghana	Nicaragua	Yemen
Burundi	Guinea	Niger	Zambia
Cambodia	Haiti	Nigeria	Zimbabwe
Cameroon	Honduras	Pakistan	
Cape Verde	India	Rwanda	
Central African Republic	Kenya	Samoa	
Chad	Kyrgyz Republic	Senegal	
Comoros	Lao PDR	Sierra Leone	

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