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# External Debt and Growth

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**Abstract:** This paper assesses the non linear impact of external debt on growth using panel data for 93 developing countries. The estimates support a non-linear, hump-shaped relationship between debt and growth, especially when the debt burden is measured relative to GDP. For a country with average indebtedness, doubling the debt ratio reduces growth by a third to a half percentage point after controlling for endogeneity. Our findings also suggest that the average impact of debt becomes negative at about 160–170 percent of exports or 35–40 percent of GDP and the marginal impact of debt at about half of these values.

JEL classification: F21, F34, F43, O10, O40
Keywords: growth, external debt, debt relief, HIPC initiative

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# 1 Introduction

The impact of high levels of external debt on economic performance is a topic of recurrent importance for developing countries. In the second half of the 1990s, policymakers around the world began to recognize that very high debt levels were contributing to limit the development of many low-income countries, despite the fact that a sizeable share of the lending to these countries had occurred at concessional rates.[1] High levels of external debt also raised concerns more broadly over whether debt was starting to hit levels at which it might slow economic growth across a broader range of countries, by diverting resources from investment and other productive uses to service the debt.

Conceptually, whether debt reduction could have a positive impact on economic growth depends both on the existence of a "debt overhang" (possible negative impact of external debt on economic growth beyond a threshold) and on the starting level of debt. Indeed, similar to a hypothetical "debt Laffer curve," debt reduction would only be expected to contribute to growth for initial levels of debt well above a particular threshold. There is some support for the existence of empirically estimated turning points, or thresholds above which debt begins to have a negative effect on growth, but it is not robust to the specification and sample used, and limited in scope and methodology. As a result, our understanding of the effect of external indebtedness on economic performance and the related question of the channels through which the impact is likely to occur remains limited.

This study examines the impact of external debt on growth and the differential impact of debt below and above an empirically-estimated threshold using panel data from a broad sample of developing countries in the pre-HIPC period. The paper also provides tentative answers to the question of the channels through which external debt might impact long-term GDP growth. Specifically, we seek to inform the policy debate on the effectiveness of debt reduction initiatives and the existence of a "debt overhang" effect by: (1) using different specifications and methodologies (including quadratic and spline functions) to estimate the posited debt thresholds, and

[1] Responding to these concerns, in 1996, the IMF and the World Bank jointly created the Initiative for the Heavily Indebted Poor Countries (HIPC Initiative) which aimed at reducing external debt of qualifying countries to sustainable levels. The main target level for the net present value of debt was initially set at 200 percent of exports, and then lowered in 1999, in the context of the Enhanced HIPC Initiative, to 150 percent of exports. In 2005, to help free up more room for poverty reducing spending and accelerate progress toward the Millenium Development Goals (MDGs), the HIPC Initiative was supplemented by the Multilateral Debt Relief Initiative (MDRI). The MDRI allows for 100 percent relief on eligible debts by the IMF, the World Bank, and the African Development Fund (In 2007, the Inter-American Development Bank also decided to provide additional debt relief to the five HIPCs in the Western Hemisphere). All countries that complete the HIPC process, as well as other non-HIPCs with per capita income below US $380 and outstanding debt to the IMF at end-2004, are eligible for the MDRI.

(2) quantifying an average, econometrically robust, impact of external debt on growth for countries that are already beyond the threshold.

To this end, we use a variety of debt ratio indicators (both face value and net present value of debt, both relative to GDP and exports) and submit our estimation results to an extensive array of robustness tests. In particular, controlling for country effects and the possible endogeneity of debt ensures that our quantification of the effect of external debt on growth is robust and not affected by omitted variable or simultaneity bias. In terms of methodologies, we rely on fixed effects and system generalized method of moments (GMM). The system GMM technique allows us to control for potential endogeneity of some explanatory variables (such as investment and debt), while also controlling for the presence of unobserved country fixed effects. We also estimate specifications both with and without investment as a control variable to test whether capital accumulation is the sole channel through which debt impacts growth. In addition, we test the robustness of the results, by estimating the regressions both with the full sample and excluding data outliers; both with and without time dummies; and with 3-year and 10-year panel data averages (the latter to further reduce the presence of possible cyclical effects).

We identify a range of values (specific to the type of debt indicator) after which the average impact of debt on growth becomes negative. For the net present value of debt to exports indicator, such a range is very close to the debt target (150 percent of exports) of the Enhanced HIPC Initiative. We also identify ranges of values for the optimal or growth-maximizing level of debt, i.e. the level after which the marginal impact of further debt accumulation becomes negative, which are, as expected, much lower than the ranges in which the average impact of debt turns negative, consistent with a hypothetical "Laffer curve" for the effect of debt on growth. Similar to other studies, we find that the debt threshold estimates vary significantly across specifications and estimation methodologies, making it difficult to precisely identify the turning points.

Relying on the estimated average slope coefficient beyond the turning point, for the specifications that control for endogeneity, we find that for the average country in the sample, the effect of doubling debt is to reduce growth by a third to a half percentage point. This is much lower than the result based on fixed effects estimation, suggesting that studies that fail to control for endogeneity tend to overstate the negative impact of debt accumulation on growth. Nonetheless, the finding that the average impact of debt reduction from initial high levels remains significant - even after controlling for endogeneity - lends support to the argument that the HIPC initiative and a number of other bilateral or multilateral debt relief initiatives launched since then may have contributed not only to enhance debt sustainability but also growth prospects of the benefiting countries. Indeed, over the past decade, the performance of HIPC countries that benefited from debt relief has improved substantially.[2] Finally, and somewhat surprisingly, our results suggest that most of the effect of debt on growth takes place through the quality of investment (productivity) rather than just its level, suggesting that more work is needed both at the theoretical and empirical level to understand the channels through which debt might impact growth.[3]

The remainder of the paper is divided in four sections: Section II provides a survey of the literature; Section III describes the data employed; Section IV outlines the estimation approach; Section V discusses the results; and Section VI draws conclusions.

# 2 Theoretical Considerations and Related Literature

From the literature, what do we know about the effect of debt on growth and why would we expect the effect to be nonlinear? In various theoretical models, under the assumption of perfect capital mobility, reasonable levels of current debt inflows are expected to have a positive effect on growth. The result holds both for traditional neoclassical models and some endogenous growth models (e.g., Eaton, 1993). Even in models with repudiation risk, such as Cohen (1991), low levels of debt are still associated with higher growth than in financial autarky. But why do large levels of accumulated debt stocks lead to lower growth? First, political economy considerations may lead to over borrowing and low growth, often accompanied by capital flight, if the costs of high taxes to service the debt are not internalized (Alesina & Tabellini, 1989, Tornell & Velasco, 1992). Second, and most well known, debt overhang theories posit that if there is some likelihood that in the future debt will be larger than the country's repayment ability, then expected debt service will be an increasing function of the country's output level. The returns from investing in the country therefore face a high marginal tax by the external creditors, and new domestic and foreign investment is discouraged (Krugman, 1988; Sachs, 1989).[4] Although the mod-

[2] After decades of generally low or volatile growth rates, beginning in the late 1990s, low-income countries (LICs), including many of those countries who received HIPC (and later MDRI) debt relief, experienced a decade of strong growth before the 2009 global financial crisis. Favorable external conditions, as well as strengthened macroeconomic policies and institutions, and debt relief, all played a role in this improved performance. However, a number of countries receiving debt relief are also fragile states, characterized by weak governance, limited capacity, persistent social tensions, and a tendency to political instability and conflict. Economic performance, including macro stability, growth, and progress toward the MDGs has been weaker in these countries.

[3] Pattillo, Poirson, & Ricci (2003) further investigate the channels through which external debt affects growth. The results suggest that approximately two-thirds of the effect of debt on growth occurs via total factor productivity growth, and one-third via physical capital accumulation.

[4] Arora (1993) discusses the pros and cons of this argument.

els do not analyze growth explicitly, the implication would be that large debt stocks would lower growth through the channel of reduced investment. There are also a few endogenous growth models that combine both these elements (Cohen & Sachs, 1986; Cohen, 1991; Cohen, 1992). In these models, the channel for nonlinear growth effects of debt is also through investment.

Many authors have argued that the debt overhang theory has broader implications than just lower investment, since any activity that requires incurring costs today for the sake of increased output in the future will be discouraged, as part of the proceeds will be taxed away by creditors (Corden, 1989). For example, one implication may be that the government will have less incentive to undertake difficult reforms such as trade liberalization or fiscal adjustment. This means that the channel for the debt overhang's effect on growth may not only be through the volume of investment, but also through a poorer macroeconomic policy environment which is likely to affect the efficiency of investment. Large accumulated debt stocks may also generate expectations that debt will be restructured and/or that debt service will be financed with particularly distortionary types of taxation, such as the inflation tax, or with cuts in productive public investment (Agenor & Montiel, 1996; see also Calvo, 1998, which argues that high debt is associated with a higher distortionary tax burden on capital). In the former case, the investment under uncertainty literature (Serven, 1997) implies that the induced uncertainty about what portion of the debt will actually be serviced from the country's own resources may affect both the level and the allocation of investment. Facing high uncertainty, investors are likely to favor trading activities with quick returns, rather than long-term, high risk, investment. Again, we infer that the transmission to growth is likely to be through the reduced efficiency of investment as well as lower investment volumes.

Turning to empirics, several studies have found some negative effects of debt on growth. It is important, however, to isolate the channel through which debt affects growth. Most existing studies do not attempt to distinguish the crowding out effect from the debt overhang effect. To isolate the debt overhang effect (which can be captured with a variable representing the burden of future debt service, such as the debt stock), it is important to also control for potential crowding out (proxied by a contemporaneous debt service ratio). In addition, early studies use the face value of debt stocks, rather than the NPV of debt commonly used in more recent studies (including this study). The latter reflects the degree of concessionality of loans and thus more accurately measures the expected burden of future debt service across countries. Several studies allow for non-linearities in the effect of debt, both directly and indirectly.[5] The former have used var-

[5] For an examination of the effect of debt on growth in a linear setting, see for example, Chowdhury (2001) and Lin & Sosin (2001).

ious specifications (including quadratic and spline) to test for the presence of non-linearity. The results, however, are far from conclusive and vary across specification, sample, estimation method, and debt indicator used. In particular, most studies focus on the debt to GDP measure, and evidence on whether the nonlinearity also holds for the debt to exports measure is scant.

A few studies indirectly consider the nonlinear effects of debt. Cohen (1997) does not use the debt stock directly in a growth regression, but rather finds that a variable representing the predicted risk of a debt rescheduling (or debt crisis) significantly lowers growth. Such a probability of rescheduling depends positively on external indebtedness. He uses this method to find debt ratios above which the probability of rescheduling becomes excessive: debt to GDP of 50 percent, and debt to exports of 200 percent. Reinhart, Rogoff, & Savastano (2003) find that "safe" debt-to-GNP thresholds depend on countries' default and inflation history, and can be as low as 15 percent.

Elbadawi, Ndulu, & Ndung'u (1997) directly allows for non-linearities in the effect of debt, using fixed and random effects panel estimates of a growth regression in which debt to GDP enters both in linear and quadratic form. The results imply a growth maximizing debt to GDP ratio of 97 percent, which is quite high considering that the average debt to GDP ratio in our sample is 68 percent. More recent studies (including this study, as discussed below) find significantly lower growth maximizing debt thresholds. Clements, Bhattacharya, & Nguyen (2003) focus on low income countries, and find that the marginal effect of debt becomes negative for a nominal debt-to-GDP ratio of about 50 percent and a NPV of debt-to-GDP ratio of about 20–25 percent. Rubio, Ojeda, & Montes (2003) perform a non-linear estimation for Colombia and find a growth maximizing level of debt close to 27 percent of GDP.

A recent stream of literature aims to ascertain whether and to what extent the relationship between external debt and growth depends on country-specific characteristics, such as the quality of their policies and institutions. Cordella, Ricci, & Ruiz-Arranz (2010) find that the marginal effect of debt for non HIPC countries becomes negative when its face value reaches about 20 percent of GDP, or its NPV reaches about 10 percent of GDP. Countries with good policies are found to have higher debt overhang thresholds, and countries with bad policies have lower thresholds. Using non-parametric methods, Imbs & Ranciere (2005) confirm this result. They find that the marginal effect of debt becomes negative when the face value of debt-to-GDP reaches 60 percent, or the NPV reaches 40 percent, but thresholds are higher for countries with good institutions. Finally, Presbitero (2008) finds evidence of a non-linear (inverted U) relationship between the NPV of external debt and growth with a threshold at around 30 percent of GDP using a quadratic specification, but only in countries with poor policies. In countries with good policies, the impact of debt is found to be linear and negative.

It should be noted that while we will consider whether the evidence supports a negative effect of indebtedness on growth (even after accounting for possible endogeneity of debt to the growth process), Easterly (2001a), for example, contends that the causality runs in the opposite direction. That is, he maintains that the worldwide slowdown in growth after 1975 contributed to the debt crises of the middle income countries in the 1980s and the HIPCs in the 1980s and 1990s. In this view, lower growth lowers tax revenues and primary surpluses, and without adjustment, debt ratios explode. Existing studies (including this one) have generally used system GMM to control for the endogeneity of debt and potential reverse causality.[6] A new method to address endogeneity has recently been developed (Rigobon, 2003) which uses the natural heteroskedasticity in the data (rather than lagged values of the explanatory values as instruments) to solve the identification problem that arises in simultaneous equation models. Unfortunately, however the identification through heteroskedasticity (IH) methodology has not been fully worked out for the case of a nonlinear dynamic model with unobserved country-specific effects and a correction for multiple endogenous variables. However Patillo, Poirson, Ricci (2003) use the IH methodology as an additional check on the negative relationship between high debt (beyond the turning point of the nonlinear function) and growth. They found that the negative relationship between high debt and growth identified for high levels of debt was strongly robust to endogeneity bias.[7]

Unlike recent studies which attempt to shed light on how the debt-growth relationship varies across countries or groups of countries, this study seeks to quantify the size of debt overhang effects in general in a more comprehensive and robust way than the existing literature. In particular, and given the important policy implications, it seeks to estimate robustly the impact of debt accumulation on growth beyond the threshold (i.e., at high debt levels). An important and often overlooked distinction made clear in this paper is that between the *average* impact of debt (the growth differential associated with different indebtedness levels) and the *marginal* impact of debt (the effect on per capita growth of raising debt further from already high levels). In the presence of non-linearity, the two effects are quite distinct: countries with high but moderate indebtedness could still grow on average faster than less indebted ones, but if higher debt has decreasing returns at the margin, the average impact of debt also turns negative eventually.

To ensure robustness, we present a range of regression results using dif-

[6] Using panel causality tests in a linear setting, Chowdhury (2001) provides some supporting evidence that the causality runs from debt to growth. See also Pattillo, Poirson, & Ricci (2003) for a similar result in a non-linear setting.

[7] The IH methodology also allowed a deeper analysis of the simultaneity of debt and growth, suggesting that both the effect of indebtedness on growth (the channel on which Pattillo, Poirson, & Ricci, 2003, focus) and the effect of growth on indebtedness (the channel on which Easterly, 2001a, focuses) are significant when controlling for endogeneity.

ferent specifications, debt measures, and estimation methods, and controlling for country specific effects; moreover, our preferred estimates of the quantitative impact of debt on growth are derived from system GMM regressions which control for the endogeneity of investment, debt, and other explanatory variables. Finally, the findings are robust to the presence of data outliers and cyclical effects, which we net out using both three-year and ten-year averages. Like earlier studies, our findings confirm the presence of non-linearity (inverted U shape) when debt is measured relative to GDP; evidence of a hump-shaped effect is weaker in the case of debt to exports. The empirical results on the impact of doubling debt beyond the estimated threshold based on the regression slope at high debt levels suggest that the *marginal* effect of an increase in debt on annual per capita growth is statistically significant, averaging one third to one half of a percentage point, and this effect is systematically over-estimated in regressions that do not account for endogeneity. Our estimates of the *average* debt overhang effect are based on regressions augmented with debt dummy variables.

# 3 Data Description

The analysis uses panel regressions for 93 developing countries spanning Sub-Saharan Africa, Asia, Latin America, and the Middle East over the period 1969–98. The data are from various sources. Real purchasing power parity GDP is from the World Economic Outlook (WEO) database of the IMF. Population, secondary education, and investment to GDP are from the World Bank databases. Nominal debt to exports and to GDP is from the Global Development Finance dataset (World Bank), complemented with WEO data. NPV of debt data have been kindly provided by William Easterly (see Easterly, 2002). Debt service to exports is from the Global Development Finance dataset (World Bank). The terms of trade, fiscal balance to GDP (central government), and openness as ratio of GDP are from the WEO database.

We calculate three-year averages, to net out the effects of short run fluctuations, while maintaining the ability to utilize the time series dimension of the data. The latter feature of the data is quite important, given that understanding how debt affects growth over time (the within-country variability of the panel data) is at least as important as understanding how countries with different levels of debt experienced different growth patterns (the between-country variability of the panel data). Our complete data set consists of 630 observations for 93 countries over the period 1969–98 (88 countries when using the net present value indicator of debt).[8] Descriptive statistics for all variables are presented in Table 1.

The last two columns of Table 1 (within and between standard devia-

[8] However, the presence of lagged income in the estimation reduces the actual estimation sample to 9 periods, or 1972–98.

***Table 1 - Summary Statistics and List of Countries****

| Variables | Mean | Overall Std. Dev. | Between Std. Dev. | Within Std. Dev. |
|---|---|---|---|---|
| GDP growth | 1.00 | 4.04 | 2.47 | 3.37 |
| Lagged income | 3342.21 | 2930.50 | 3285.89 | 801.57 |
| Terms of trade growth | -0.04 | 9.72 | 2.73 | 9.42 |
| Population growth | 6.96 | 0.96 | 0.96 | 0.36 |
| Debt service to exports | 20.94 | 16.86 | 11.83 | 12.18 |
| Schooling | 35.74 | 22.91 | 22.01 | 8.26 |
| Investment | 20.59 | 8.45 | 6.79 | 5.15 |
| Fiscal balance | -4.68 | 4.96 | 3.55 | 3.56 |
| Openness | 28.27 | 19.57 | 18.35 | 7.69 |
| Debt to exports | 288.75 | 383.27 | 341.20 | 243.48 |
| NPV of debt to exports | 233.62 | 228.06 | 198.08 | 147.16 |
| Debt to GDP | 68.32 | 82.99 | 59.25 | 57.40 |
| NPV of Debt to GDP | 47.65 | 39.14 | 29.52 | 26.23 |

**LIST OF COUNTRIES**

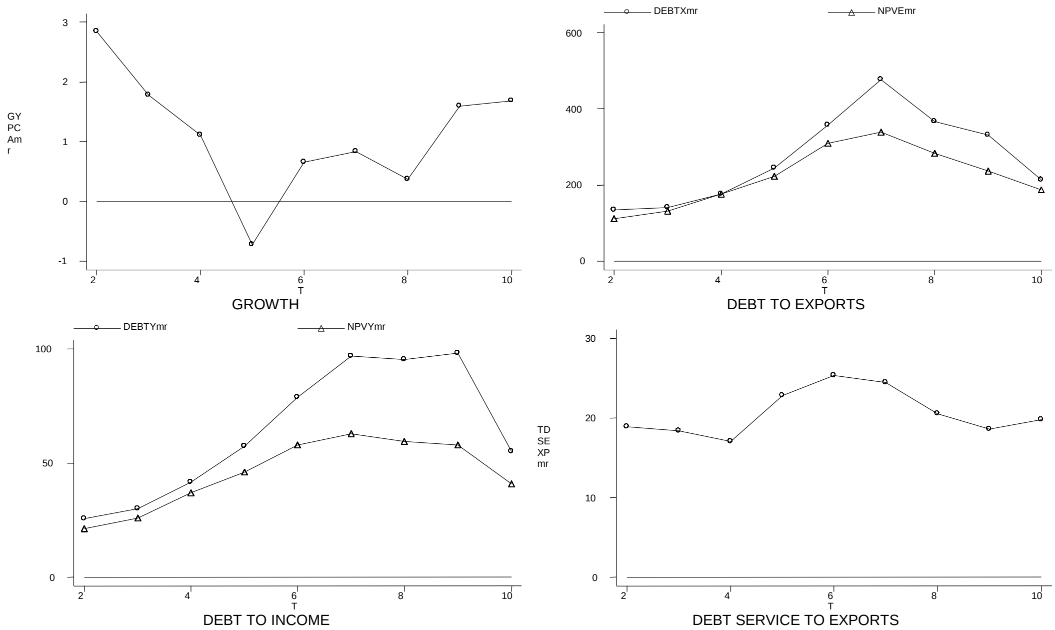
Algeria, Argentina, Bahrain, Bangladesh, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Rep., Chad, Chile, China P.R.: Mainland, Colombia, Comoros, Congo Dem. Rep. of, Congo Republic of, Costa Rica, Côte D'Ivoire, Cyprus, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Fiji, Gambia, Ghana, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iran, Jamaica, Kenya, Korea, Lao People's Dem. Rep, Lebanon, Lesotho, Libya, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Syrian Arab Republic, Tanzania, Thailand, Togo, Trinidad And Tobago, Tunisia, Turkey, Uganda, Uruguay, Venezuela, Vietnam, Yemen Republic of, Zambia, Zimbabwe.

(*) Two observations for Yemen, an extreme outlier with respect to the debt-exports variable, with ratios reaching 20000 percent, were dropped for the computation of sample means.

tions) show that despite the relatively small number of time observations, the time-series standard deviation of the data is substantial for all variables, in some cases (GDP growth, terms of trade growth, debt service to exports, fiscal balance) even greater than the cross-section variation. For the debt variables, the within and between standard deviations are of the same order of magnitude, although somewhat smaller in the within dimension. The use of estimators that rely on both the within- and between-country variability of the data is thus likely to yield more significant results than pure cross-section estimators (in addition to helping address the issues of biases arising from endogeneity of some regressors and unobserved country-specific effects). We also use ten-year averages to check the robustness of our findings, as business cycle effects may not be entirely netted out with only three-year averages.

As a first step in exploring the bivariate relationship between growth and debt, Figure 1 plots the evolutions of the average growth and debt indicators over time.

***Figure 1 - Growth and Debt Indicators Over Time***




Notes: 1. DEBTXmr is Debt/Exports; NPVEmr is NPV of Debt/Exports; DEBTYmr is Debt/GDP; and NPVYmr is NPV of Debt/GDP. 2. The horizontal axis is measured in 3-year period averages starting with the period 1972–74 up to 1996–98. 3. Two observations for Yemen, an extreme outlier with respect to the debt-exports variable, were dropped for the computation of sample means.

The averages were computed for all countries and for a reduced sample excluding outliers (89 countries for the face value indicator sample and 85 countries for the net present value indicator sample).[9] The Figure shows that debt ratios have peaked in the late 1980s, and have since declined, in part owing to traditional and new debt relief mechanisms. NPV of debt begins to be lower than nominal debt towards the early 1980s, due to the growing concessional element of many lending arrangements, especially to the poorest and most indebted countries. Growth appears to be negatively correlated with debt, as it drops during the build-up of debt at the beginning of the sample and it rises during the reduction of debt at the end of the sample. The correlation matrix presented in Table 2 confirms the time-series evidence in Figure 1, suggesting a negative relationship between debt and growth also in the cross-section dimension, as growth is negatively and significantly correlated with all the external debt burden indicators.[10]

[9] For each variable, outliers are defined as observations that deviate from the mean by more than five times the standard deviation.

[10] The cross-section variability dominates the correlations shown in Table 2 as the number of countries is much larger than the number of time-series observations.

***Table 2 - Correlation Matrix***

| | Per capita growth | Log $(Income)_{-1}$ | Terms of trade growth | Log (Population growth) | Debt service /exports | Log (Schooling) | Log (Investment) | Fiscal Balance | Openness | Log (Debt/ Exports) | Log (NPV of debt/ Exports) | Log (Debt/ GDP) | Log (NPV of debt/ GDP) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Per capita growth | 1 | | | | | | | | | | | | |
| Log $(Income)_{-1}$ | 0.0195 | 1 | | | | | | | | | | | |
| Terms of trade growth | 0.1512* | 0.0569 | 1 | | | | | | | | | | |
| Log (Population growth) | -0.1964* | -0.2531* | -0.0257 | 1 | | | | | | | | | |
| Debt service/exports | -0.0992* | 0.0845* | -0.0692* | -0.0167 | 1 | | | | | | | | |
| Log (Schooling) | 0.1523* | 0.7017* | 0.0292 | -0.3361* | 0.0925* | 1 | | | | | | | |
| Log (Investment) | 0.3269* | 0.3149* | -0.0034 | -0.0825* | -0.0786* | 0.3532* | 1 | | | | | | |
| Fiscal Balance | 0.2406* | 0.2306* | 0.1238* | -0.0845* | -0.0157 | 0.0816* | 0.0792* | 1 | | | | | |
| Openness | 0.1166* | 0.3821* | 0.0695* | -0.0602 | -0.2380* | 0.3269* | 0.3519* | 0.0698* | 1 | | | | |
| Log (Debt/Exports) | -0.1880* | -0.4125* | -0.1231* | 0.0711* | 0.4545* | -0.2035* | -0.2808* | -0.2429* | -0.4694* | 1 | | | |
| Log (NPV of debt/Exports) | -0.1672* | -0.3250* | -0.1223* | 0.0038 | 0.4256* | -0.1322* | -0.1480* | -0.2337* | -0.4391* | 0.8601* | 1 | | |
| Log (Debt/GDP) | -0.1812* | -0.1969* | -0.1045* | 0.0708* | 0.2910* | -0.0134 | -0.0408 | -0.2851* | 0.0691* | 0.7213* | 0.6464* | 1 | |
| Log (NPV of debt/GDP) | -0.1134* | -0.0356 | -0.0817* | -0.0023 | 0.3201* | 0.0985* | 0.1287* | -0.2001* | 0.2427* | 0.5386* | 0.6527* | 0.9003* | 1 |

Note: * significant at 10%

Correlations between the different debt indicators are positive and significant, as expected, and relatively high although always less than 85 percent. The debt indicator that is most highly correlated with growth is debt to exports while the indicator with the lowest correlation is debt service to exports (the correlation between growth and net present value of debt to income is also relatively low, albeit higher than between growth and debt service).

# 4 Estimation Approach

Part of the above noted correlation between debt and growth may be spurious, reflecting the effects of third factors (not only traditional growth determinants, but also, as mentioned earlier, the presence of unobserved country effects). The analysis therefore checks whether a debt-growth relationship appears also in multivariate regression analysis. In other words, it seeks to determine whether the debt-growth correlation is robust to including a set of *conditioning* variables, including the usual determinants of growth (investment, human capital, policy variables) and, in certain specifications, time and country effects. The analysis also checks for nonlinearity of the debt-growth relationship, posited by theory, and addresses the issue of causality by using estimation methods that account for the endogeneity of some of the explanatory variables (including debt).

## *4.1 Estimation Methodology*

In order to investigate the impact of external debt on growth we augment a standard growth specification based on conditional convergence by adding several debt variables (see Mankiw, Romer, & Weil, 1992). The dynamic panel data model we estimate therefore has per capita growth as the dependent variable, and on the right-hand side includes, as control variables, lagged income per capita, the investment rate (percent of GDP), the secondary school enrollment rate, the population growth rate (all in logs), a number of other variables to control for differences in total factor productivity (openness, fiscal balance), and exogenous shocks (terms of trade growth).[11] To the extent that we also control for investment, our results are biased toward finding a smaller effect of debt on growth. As discussed in Sections I and II, in fact, part of the effect of debt on growth may occur indirectly through the investment channel rather than directly through the efficiency and productivity channel. We investigate this further using an alternate specification that excludes investment.

Most of the dynamic panel specifications are estimated using: (a) fixed

[11] The dynamic nature of the panel model can be seen by re-arranging equation (1) to make per capita income (in log) the dependent variable. Equation (1) then becomes equivalent to a regression of per capita income on its own lag and on the contemporaneous values of the other control variables.

effects to allow countries to have different intercepts (that may be correlated with the regressors); and (b) system GMM to correct for endogeneity of the schooling, investment, fiscal balance, openness, and debt variables and for the bias introduced by the lagged income variable in the presence of fixed effects. We estimate all three specifications (linear, quadratic, and spline) using both methods and present the range of results for the various debt indicators and specifications to underpin our conclusions, as each model individually has shortcomings.[12] While the system GMM is our preferred specification, we also present the fixed effects estimation results as a baseline for comparison.

To ensure that our results are not driven by time-specific effects or the presence of outliers, we estimate most regressions both with and without time dummies as well as both with the full sample and with a reduced sample where outliers are eliminated.[13] For parsimony, some non linear specifications and the system GMM are run only with the best case, i.e. with time dummies and excluding outliers. Broader robustness analysis is then provided through the use of 10-year panel data regressions to eliminate possible remaining cyclical effects. Estimating the same specifications excluding the investment variable allows us to test whether capital accumulation is the sole channel through which debt impacts growth.

## 4.2 *Control Variables*

The set of control variables encompasses: initial income per capita, population growth rate,[14] investment rates, school enrollment rates (all in log terms), terms of trade growth, fiscal balance to GDP, and openness (exports plus imports over GDP). In the conditional convergence framework, initial income is expected to have a negative coefficient, reflecting the convergence effect, the coefficient on population growth is also expected to be negative, while the coefficients on investment and schooling rates are predicted to be positive. Investment and education reflect the positive impact of physical and human capital accumulation respectively. The terms of trade growth reflects external shocks, and is expected to have a positive coefficient. The fiscal variable should have a positive coefficient, reflecting the positive ef-

[12] Specifically, the quadratic model avoids any sudden change in the slope and thus offers an intrinsically smoother regression line than the spline model. But it also imposes symmetry in the shape of debt-growth curve (inverted-U). By contrast, the spline model implies a sudden break in the regression line, but imposes less structure on the data. The spline model, for example, can detect a non-linear and significantly negative impact of debt on growth at high debt levels, even with no evidence of a statistically significant impact at low debt levels.

[13] For the linear and quadratic specifications, we run the full set of regressions but present only the preferred case i.e. the results with time dummies and without outliers; the full set of results is available in Pattillo, Poirson, & Ricci (2002).

[14] Augmented by the rate of technical progress (2 percent) and by the rate of depreciation (3 percent), as in Mankiw, Romer, & Weil (1992).

fects of macroeconomic sustainability and stability on productivity. Trade openness is also posited to boost productivity through transfers of knowledge and efficiency gains. Table 2 shows unconditional correlations that confirm most of the effects of different growth determinants predicted by theory; notably, the unconditional correlation of growth and initial income per capita is not significant, a result common in the growth literature: the data do not lend support to the notion of unconditional convergence.[15]

Tables 3 to 6 show the estimated coefficients in a growth equation with this set of control variables. They are consistent with those normally presented in the growth literature. All have the expected signs and are generally significant at the 10 percent level at a minimum, with the two exceptions of openness, which is significant only in regressions with fixed effects, and schooling, which is insignificant in all the fixed-effects results.

The set of control variables is complemented with the ratio of debt service to exports, which is expected to have a negative coefficient, as high debt servicing could prevent a country from devoting resources to productive activities (crowding-out hypothesis). However, our focus on this variable is limited as it does not measure the actual payments, but rather the scheduled ones.[16] Notably, this variable is never significant (even in the regressions which do not include investment), although it generally does have the expected negative sign.[17]

# 5 Results: The Relationship Between Debt and Growth

We now present results on the relationship between debt and growth. We begin with a linear specification, then turn to a number of nonlinear specifications, and consider specifications without investment and some additional robustness tests.

## *5.1 Linear Specification*

A first specification assumes a linear relationship between external debt and growth,

$$y_{it} = \alpha_{it} + \beta X_{it} + \gamma D_{it} + \varepsilon_{it} \tag{1}$$

where $y_{it}$ represents per capita growth, $X_{it}$ the control variables, and $D_{it}$ the debt indicator. Table 3 shows that for the debt to exports variable, the coefficient is always negatively signed and significant. Table 4 shows that

[15] However, the notion of conditional convergence is supported by the empirical literature, including in the results presented here.

[16] Data for actual payments are not available for a large sample of countries.

[17] Except in regressions where the point estimate is very close to zero.

***Table 3 - Debt/Exports: Linear and Quadratic Effects on Growth***

| | Debt/exports | | | | Net present value of debt/exports | | | |
|---|---|---|---|---|---|---|---|---|
| | FE | | SYSGMM | | FE | | SYSGMM | |
| | Linear | Quadratic | Linear | Quadratic | Linear | Quadratic | Linear | Quadratic |
| Log (income)$_{-1}$ | -8.70*** | -8.66*** | -3.49*** | -3.42*** | -8.75*** | -8.72*** | -3.77*** | -3.62*** |
| | (7.77) | (7.64) | (4.61) | (5.27) | (8.07) | (7.98) | (6.02) | (5.81) |
| Terms of trade growth | 0.04** | 0.04** | 0.02 | 0.02 | 0.03** | 0.03** | 0.02 | 0.02 |
| | (2.39) | (2.39) | (1.11) | (1.08) | (2.22) | (2.22) | (1.02) | (1.02) |
| Log (population growth) | -4.36 | -4.55 | -3.86*** | -3.85*** | -4.33 | -4.50 | -2.98* | -3.09* |
| | (1.38) | (1.44) | (2.66) | (2.77) | (1.31) | (1.37) | (2.01) | (2.13) |
| Debt service/exports | -0.00 | -0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 |
| | (0.09) | (0.14) | (0.16) | (0.42) | (0.69) | (0.70) | (0.5) | (0.74) |
| Log (schooling) | -0.25 | -0.28 | 2.73*** | 2.77*** | -0.07 | -0.08 | 3.31*** | 3.14*** |
| | (0.36) | (0.41) | (3.12) | (3.84) | (0.09) | (0.11) | (4.33) | (4.13) |
| Log (investment) | 3.74*** | 3.73*** | 1.66* | 1.54* | 3.61*** | 3.63*** | 1.62* | 1.81* |
| | (6.09) | (6.09) | (1.79) | (1.71) | (5.94) | (5.95) | (1.65) | (1.88) |
| Fiscal balance | 0.20*** | 0.20*** | 0.33*** | 0.33*** | 0.18*** | 0.18*** | 0.32*** | 0.33*** |
| | (5.21) | (5.22) | (6.03) | (6.06) | (4.84) | (4.85) | (6.33) | (6.35) |
| Openness | 0.03 | 0.03 | 0.02 | 0.02 | 0.06*** | 0.06*** | 0.03 | 0.03 |
| | (1.48) | (1.50) | (0.8) | (0.88) | (3.03) | (3.02) | (1.36) | (1.41) |
| Log (debt/exports) | -0.97*** | -0.46 | -0.59* | -0.20 | -0.82** | -0.19 | -0.45* | 0.41 |
| | (2.74) | (0.38) | (2.43) | (0.18) | (2.32) | (0.19) | (1.66) | (0.45) |
| [Log (debt/exports)]-squared | -- | -0.04 | -- | -0.02 | -- | -0.06 | -- | -0.07 |
| | | (0.45) | | (0.29) | | (0.69) | | (1.03) |
| Constant | 79.03*** | 77.76*** | 28.01*** | 26.40*** | 78.21*** | 76.75*** | 25.77*** | 22.42*** |
| | (7.16) | (6.60) | (6.26) | (4.58) | (6.85) | (6.34) | (4.98) | (3.73) |
| Number of observations | 630 | 630 | 614 | 614 | 606 | 606 | 592 | 592 |
| R-squared [1/] | 0.52 | 0.52 | 0.23 | 0.23 | 0.51 | 0.51 | 0.17 | 0.19 |

Note: Absolute value of robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. All regressions include time dummies. (1/) 1 - RSS/TSS reported for system GMM.

***Table 4 - Debt/GDP: Linear and Quadratic Effects on Growth***

| | Debt/GDP | | | | Net present value of Debt/GDP | | | |
|---|---|---|---|---|---|---|---|---|
| | FE | | SYSGMM | | FE | | SYSGMM | |
| | Linear | Quadratic | Linear | Quadratic | Linear | Quadratic | Linear | Quadratic |
| Log (income)$_{-1}$ | -8.53*** | -9.32*** | -3.45*** | -3.54*** | -8.59*** | -9.21*** | -3.18*** | -3.41*** |
| | (7.66) | (8.94) | (5.56) | (6.22) | (8.00) | (9.03) | (4.97) | (5.57) |
| Terms of trade growth | 0.04** | 0.04** | 0.02 | 0.02 | 0.04** | 0.03** | 0.02 | 0.02 |
| | (2.46) | (2.34) | (1.07) | (0.98) | (2.29) | (2.17) | (1.09) | (1.06) |
| Log (population growth) | -4.48 | -5.20* | -3.54** | -3.61*** | -3.96 | -4.08 | -3.75*** | -3.67* |
| | (1.45) | (1.73) | (2.49) | (2.67) | (1.22) | (1.28) | (2.66) | (2.32) |
| Debt service/exports | -0.00 | -0.00 | 0.00 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 |
| | (0.38) | (0.27) | (0.14) | (0.37) | (0.75) | (0.46) | (0.69) | (0.25) |
| Log (schooling) | -0.35 | -0.67 | 2.69*** | 2.90*** | -0.11 | -0.22 | 2.48*** | 2.65*** |
| | (0.51) | (1.05) | (3.76) | (4.88) | (0.15) | (0.31) | (3.03) | (3.34) |
| Log (investment) | 3.97*** | 3.92*** | 1.63* | 1.58* | 3.81*** | 3.91*** | 2.12* | 1.94* |
| | (6.56) | (6.30) | (1.73) | (1.74) | (6.20) | (6.27) | (2.25) | (2.12) |
| Fiscal balance | 0.19*** | 0.18*** | 0.32*** | 0.33*** | 0.18*** | 0.17*** | 0.31*** | 0.29*** |
| | (4.96) | (4.76) | (5.43) | (5.84) | (4.93) | (4.68) | (5.67) | (5.35) |
| Openness | 0.05*** | 0.05*** | 0.04 | 0.03 | 0.08*** | 0.09*** | 0.04** | 0.06** |
| | (2.81) | (2.70) | (1.49) | (1.22) | (3.69) | (3.92) | (1.96) | (2.44) |
| Log (Debt/GDP) | -1.22*** | 2.18** | -0.79 | 0.91 | -0.84** | 2.07** | -0.10 | 1.27* |
| | (2.74) | (2.04) | (1.52) | (0.22) | (2.06) | (2.41) | (0.23) | (1.81) |
| Log (Debt/GDP)-squared | -- | -0.48*** | -- | -1.63 | -- | -0.51*** | -- | -0.24* |
| | | (3.47) | | (0.38) | | (3.68) | | (1.74) |
| Constant | 75.75*** | 78.79*** | 26.40*** | 23.98*** | 73.68*** | 74.52*** | 21.74*** | 20.88*** |
| | (7.10) | (7.94) | (5.92) | (3.72) | (6.95) | (7.25) | (4.92) | (4.86) |
| Number of observations | 630 | 630 | 614 | 614 | 606 | 606 | 592 | 592 |
| R-squared [1/] | 0.52 | 0.54 | 0.23 | 0.22 | 0.51 | 0.52 | 0.24 | 0.22 |

Note: Absolute value of robust t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. All regressions include time dummies. (1/) 1 - RSS/TSS reported for system GMM.

the coefficient of the second debt variable (debt to GDP) is also negatively signed in all cases, however it is not significant for the system GMM specification.

As we have noted, there are theoretical reasons suggesting that such a linear specification might be inadequate to identify the impact of debt on growth, as the relation is likely to be non linear (the effect of debt could be positive at low levels of debt and become negative when external indebtedness become excessive), which would explain the lack of robustness of linear specification results. Indeed, the linear estimation would underestimate the impact by failing to capture the non linear relation between debt and growth and therefore imposing a flatter slope even when managing to capture a negative coefficient.

## 5.2 *Non-Linear Specifications*

A non-linear specification allows us to:

- Identify the level of debt at which the overall - or *average* - impact of debt on growth becomes negative, in the sense that an increase in debt would lead to growth that is lower than in the case of no-indebtedness. In a hypothetical plot of growth against debt (once all other growth determinants, including a constant term, are controlled for), this level would correspond to the intercept of the function on the horizontal axis (we later present a stylized visualization of the non-linear relation).

- Identify the level of debt at which the *marginal* impact of debt on growth becomes negative, in the sense that an increase in debt yields a negative marginal contribution to growth, independently of whether growth is higher with respect to the case of no-indebtedness. Again, in a hypothetical plot of growth against debt, this level would correspond to the peak or turning point of the nonlinear function.

- Quantify the impact of debt on growth in each of the cases above. In a hypothetical plot of growth against debt, this would correspond to the slope of the function.

### 5.2.1 The Level of Debt at Which the Overall Impact of Debt on Growth Becomes Negative

In order to address the first issue, we include a set of debt dummies in the regressions:

$$y_{it} = \alpha_{it} + \beta X_{it} + \gamma_2 d_2 + \gamma_3 d_3 + \gamma_4 d_4 + \gamma_5 d_5 + \varepsilon_{it} \tag{2}$$

where $d_2$ to $d_5$ are dummies representing inclusion in the second to the fifth

### *Table 5 - Debt Dummy Thresholds**

| | Debt/Exports | Debt/GDP | NPV of Debt/ Exports | NPV of Debt/GDP |
|---|---|---|---|---|
| **OLS and fixed effects:** | | | | |
| Quintile 1 | 0 | 0 | 0 | 0 |
| Quintile 2 | 100 | 25 | 94 | 21 |
| Quintile 3 | 165 | 40 | 156 | 33 |
| Quintile 4 | 244 | 59 | 225 | 47 |
| Quintile 5 | 367 | 95 | 306 | 67 |
| **Instrumental variables:** | | | | |
| Quintile 1 | 0 | 0 | 0 | 0 |
| Quintile 2 | 98 | 28 | 106 | 25 |
| Quintile 3 | 175 | 43 | 168 | 36 |
| Quintile 4 | 252 | 64 | 233 | 51 |
| Quintile 5 | 376 | 101 | 312 | 70 |

(*)The threshold reported is the lower bound of the respective quintiles.

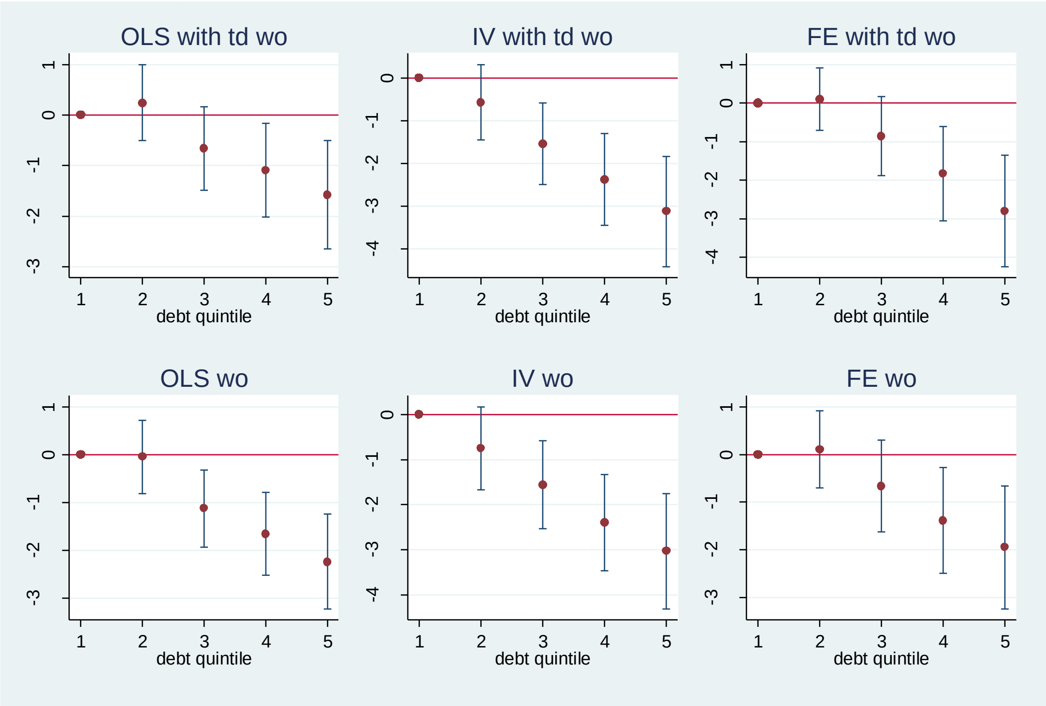
### *Table 6 - Debt Turning Point and Effects of Doubling Debt on Growth*

| | A. Debt Turning Points[1/ 2/ 3/] | | | |
|---|---|---|---|---|
| | **Debt to exports** | **Net present value of debt to exports** | **Debt to GDP** | **Net present value of debt to GDP** |
| | (In percent) | | | |
| Average of significant estimates | 70 | 69 | 28 | 24 |
| [Range] | [45–94] | | [11–45] | [9–49] |
| Percent of significant estimates | 50 | 25 | 50 | 75 |
| | **Both Debt indicators** | | **Both Debt indicators** | |
| Average of significant estimates | 69 | | 26 | |
| [Range] | [45–94] | | [9–49] | |
| Percent of significant estimates | 38 | | 63 | |
| | **B. Effects of Doubling Debt on Growth[1/ 4/ 5/ 6/]** | | | |
| Average of significant estimates | -1.2 | -1.5 | -1.4 | -1.1 |
| [Range] | [-0.4--1.4] | [-0.3--2.6] | [-0.9--1.5] | [-0.4--1.5] |
| Percent of significant estimates | 67 | 67 | 50 | 67 |
| | **Both Debt indicators** | | **Both Debt indicators** | |
| Average of significant estimates | -1.3 | | -1.3 | |
| [Range] | [-0.3--2.6] | | [-0.4--1.5] | |

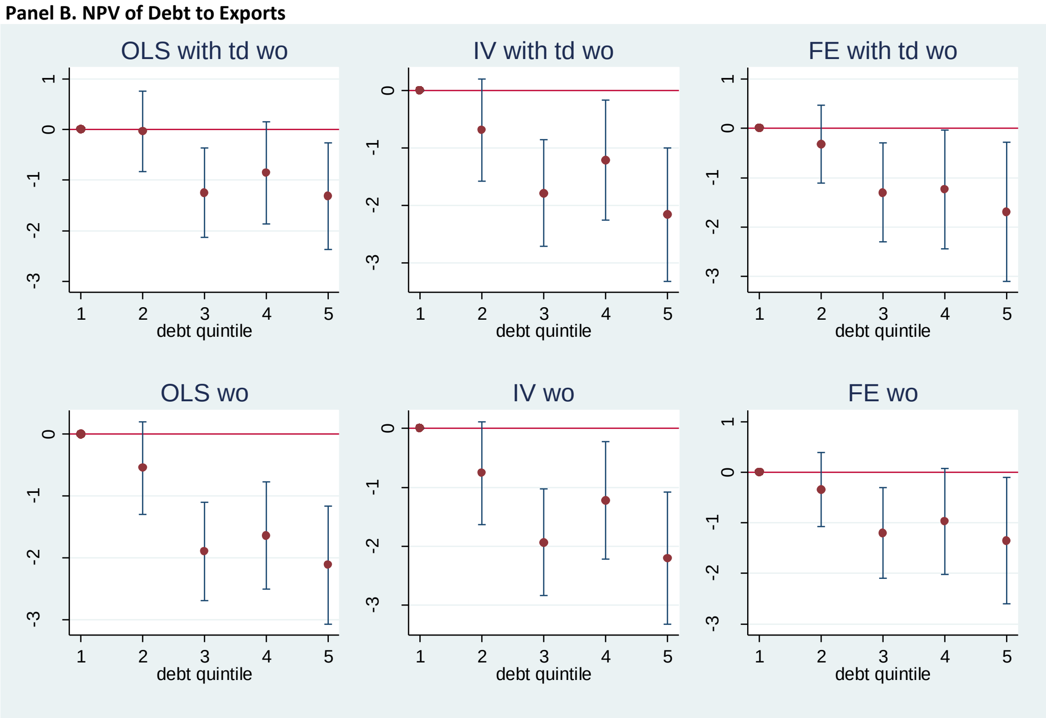
(1)Based on estimation of two models: quadratic and spline (plus linear for panel B), each estimated using two different methods: Fixed effects and System GMM. Each model estimated under the specification with time dummies and without outliers. Average and range of significant estimates is shown when two or more significant turning points were identified.
(2) Quadratic model turning points: let D represent debt variables, (Debt/Exports, Debt/GDP, NPV of Debt/Exports, NPV of Debt/GDP) turning points calculated as $\exp[-\beta_D/(2\beta_{D2})]$.
(3) Spline model: turning points calculated as $\exp[LogD^*]$, where $D^*$ maximizes the $R^2$ in a regression including $[D+(D-D^*)Z]$, where Z = 1 if $D > D^*$, 0 otherwise.
(4) Linear model: Computed as $Log(2)\times\beta_D$, where $D$ represents debt variables.
(5) Quadratic model: Computed at the average, that is, as $Log(2)\times\beta_D+\beta_{D2}\times[Log(2)]^2+2\times Log(2)\times\beta_{D2}\times average\ Log(D)$. The average log of debt was about (once exponentiated): Debt/Exports: 182%; Debt/GDP 46%; NPV of Debt/Exports 170%; NPV of Debt/GDP: 36%.
(6) Spline model: Computed as $Log(2)\times\beta_D\times\beta_{Extra}$, Extra= $[D+(D-D^*)HD]$, where $HD$ = 1 if $D > D^*$, 0 otherwise. Shows impact on growth of doubling debt at the spline threshold.

***Figure 2 - Debt to Exports and NPV of Debt to Exports, Without Outliers, OLS, IV, FE***

**Panel A. Debt to Exports**




**Panel B. NPV of Debt to Exports**

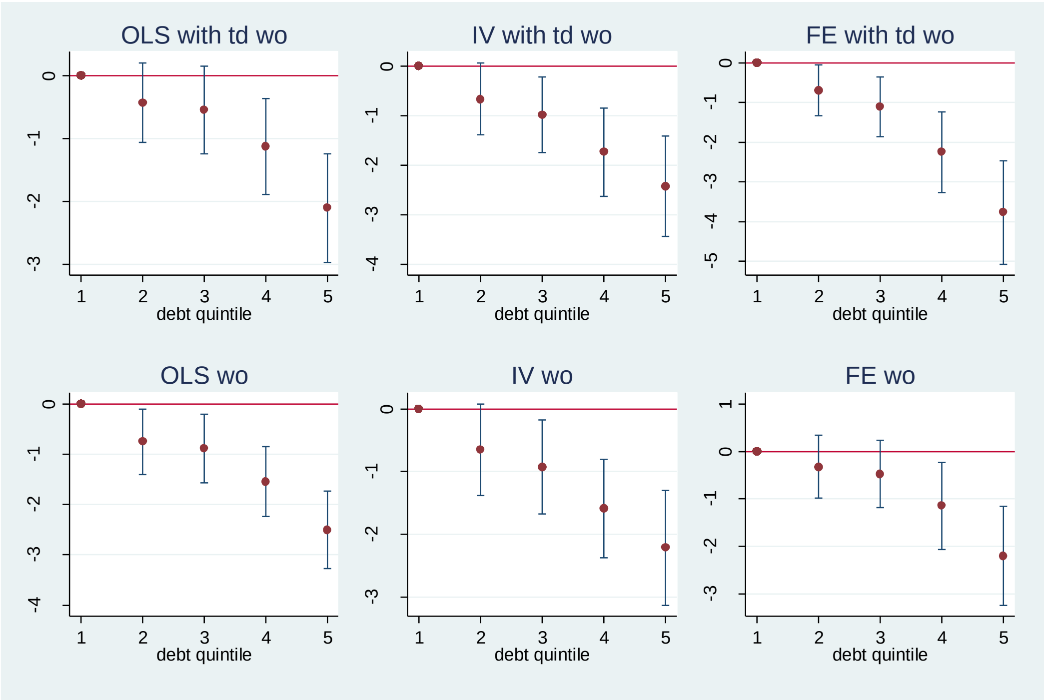



Notes: 1. Each chart plots for the second to fifth debt quintile dummies (horizontal axis) the coefficient estimate of the dummy with its 95 percent confidence interval (vertical axis). The first dummy is excluded from the regression so each coefficient estimate measures the growth differential (ceteris paribus) with respect to the first debt quintile. 2. For each panel, the first row represents estimations with time dummies (td) and without outliers (wo); the second row represents estimations without time dummies and without outliers. 3. The estimations are shown for OLS, IV (Instrumental variables), and FE (Fixed effects) methods.

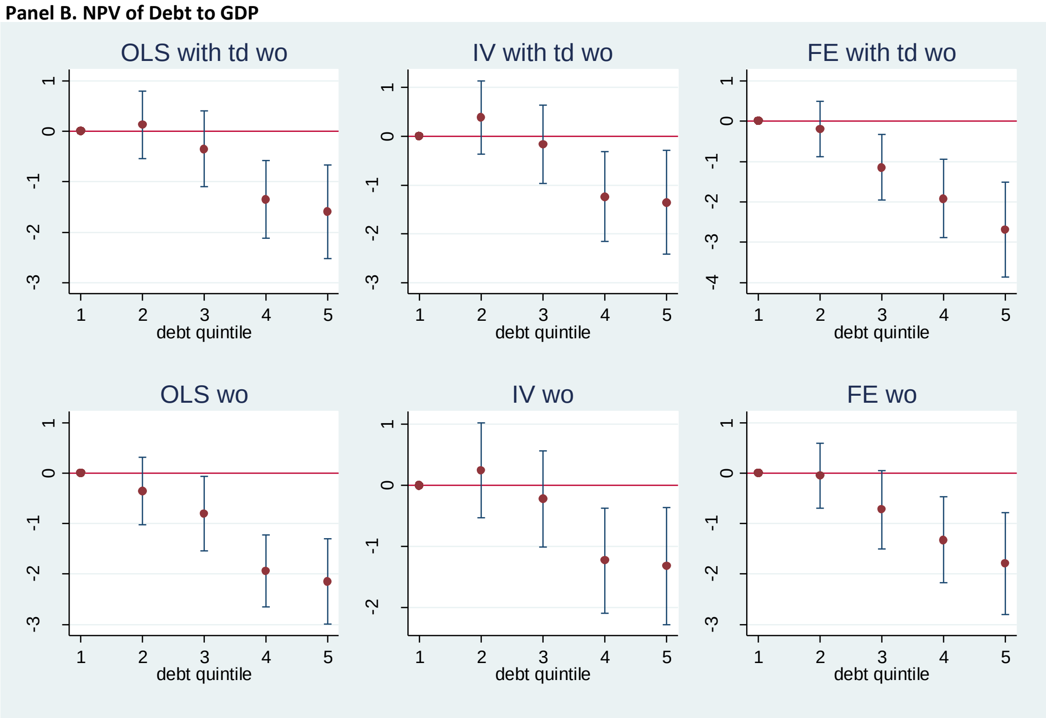
 

***Figure 3 - Debt to GDP and NPV of Debt to GDP, Without Outliers, OLS, IV, FE***

**Panel A. Debt to GDP**



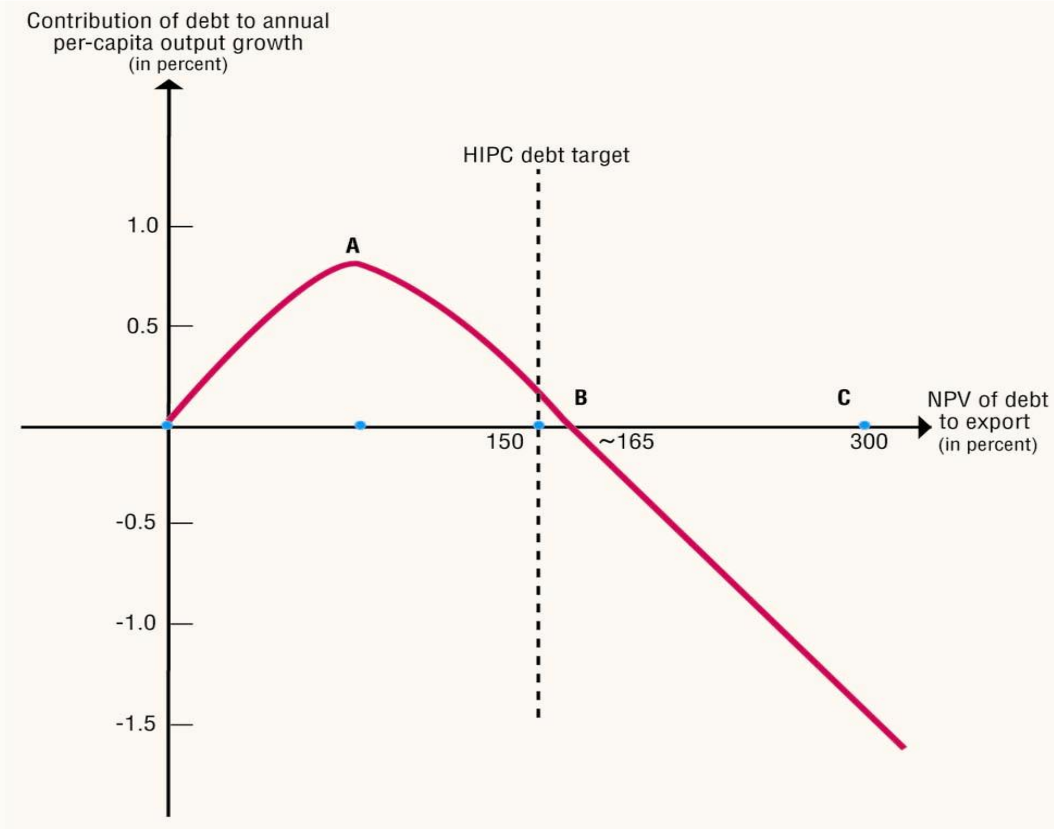

**Panel B. NPV of Debt to GDP**




Notes: 1. Each chart plots for the second to fifth debt quintile dummies (horizontal axis) the coefficient estimate of the dummy with its 95 percent confidence interval (vertical axis). The first dummy is excluded from the regression so each coefficient estimate measures the growth differential (ceteris paribus) with respect to the first debt quintile. 2. For each panel, the first row represents estimations with time dummies (td) and without outliers (wo); the second row represents estimations without time dummies and without outliers. 3. The estimations are shown for OLS, IV (Instrumental variables), and FE (Fixed effects) methods.

quintile of debt (where the quintiles are constructed separately for each debt indicator after ranking all debt observations). Table 5 presents the quintile thresholds for each of the four debt variables. As one can see from the Table, the thresholds are evenly spaced, hence building dummies on the basis of absolute thresholds would yield very similar results to our approach of deriving relative thresholds from ranking exercises. Our methodology, however, avoids the arbitrariness of choosing thresholds. Given the presence of a constant, the first dummy is omitted, implying that the coefficient of each dummy indicates the effect of that range (quintile) of indebtedness with respect to zero or low debt (first quintile).

***Figure 4 - Stylized Shape of the Non linear Relation Between Debt and Growth***




Figures 2 and 3 suggest that debt levels belonging to the third, fourth, or fifth debt dummy tend to significantly reduce growth. The results are robust to the inclusion of country specific fixed effects (in addition to fixed effects, results from simple OLS and instrumental variables methods are also shown for comparison[18]) and suggest that debt levels beyond 160–170 percent of exports, or 35–40 percent of income, might be detrimental to growth

[18] The IV method is two-stage least squares, using as instruments the lagged values of the endogenous regressors (schooling, investment, fiscal balance, openness, and debt variables) and the contemporaneous values of the other variables.

in an absolute sense (see for example point B in Figure 4, which provides a visual summary of the nonlinear relationship between debt and growth posited by theory). The thresholds are similar when debt is measured in nominal or NPV terms, suggesting that concessional lending flows mostly to countries that already have excessive levels of indebtedness. The results also indicate that the per capita growth differential between the countries in the highest and lowest quintile of indebtedness is, on average, in excess of 2 percent (note that 75 percent of the observations in the fifth dummy—i.e. with NPV of debt to export ratios in excess of 300 percent—belong to HIPC countries). However, the exact magnitude may not be accurate as the role of debt cannot be adjusted for endogeneity in this particular method.

This first set of results do suggest that the debt-growth relationship is non-linear, but suggest no evidence of a positive effect of external borrowing at low debt levels. The next section investigates further that issue, using a continuous (quadratic) specification as well as an alternate spline specification. The debt dummies may not perform as well as the quadratic and spline methodologies in addressing the issue of the marginal impact of debt on growth, as it would be necessary to divide the sample into very small debt group dummies.

#### 5.2.2 The Level of Debt at Which the Marginal Impact of Debt on Growth Becomes Negative

To address the second issue we employ a quadratic and a spline specification. The following quadratic specification:

$$y_{it} = \alpha_{(it)} + \beta X_{it} + \gamma D_{it} + \delta D_{it}^2 + \varepsilon_{it} \quad (3)$$

would support a debt and growth Laffer curve relationship if the coefficient of debt is positive and the coefficient of debt squared is negative, which is the case in all regressions for the debt to GDP variable in Table 4, but not for the debt to exports variable in Table 3.[19] While the former result is in line with the findings of other studies, the latter result is somewhat surprising. One possible explanation is that the value of exports is affected by relative price changes that could be substantial in the case of resource-rich countries, and that such countries also tend to be outliers in the data. This explanation seems supported by the empirical evidence, since excluding data outliers helps detect a hump-shaped impact of the debt to exports variable in three out of four cases; however, the coefficients are not significant when debt is measured in net present value terms (Appendix 1, Table A1).[20] A second possibility is that the debt-to-exports ratio affects growth mainly via the in-

[19] The peak of the quadratic function identifies the level of debt at which the marginal impact of debt on growth becomes negative.

[20] Clements, Bhattacharya, & Nguyen (2003) find a similar result for a sample of low income countries.

vestment channel (as suggested by the negative correlation of that variable with investment in Table 2) and thus the regressions which include investment fail to identify a significant impact. However, the results excluding investment are not materially different (Table A1 in the Appendix).

The following spline function:

$$y_{it} = \alpha_{(it)} + \beta X_{it} + \gamma D_{it} + \chi(D_{it} - D^*_{it})Z + \varepsilon_{it} \tag{4}$$

where $D^*$ represents the debt threshold and Z is a dummy equal to 1 if debt is above $D^*$ (and 0 otherwise), allows us to estimate a regression where the impact of debt on growth can have a structural break, in the sense that the impact is different below and above the threshold. In this case, one can determine the best debt threshold $D^*$ by estimating regressions for different thresholds and evaluating which regression produces the highest R-squared.[21]

The threshold for the marginal impact of debt as identified with these two methods is supposedly the growth-maximizing level of external debt. It should be lower, by construction, than the threshold for negative average impact of debt based on the debt dummies approach. Table 6 panel A summarizes the results, by presenting the debt levels at which the marginal impact of debt on growth becomes negative (the full set of estimates with time dummies and without outliers is presented in Table A1 in the Appendix). For each of the four debt variables, the average and the range of estimated significant thresholds is presented for both the quadratic and spline specification and with both the fixed effects and system GMM methodologies. The wide range of estimates in Table 6 underscores the difficulty of estimating a precise debt turning point. Only in half of the sixteen preferred cases in Table A1 in the Appendix (with time dummies and without outliers) do the data support the non-linearity posited by theory. As noted earlier, the presence of non-linearity can be more clearly established for the debt to GDP indicator, especially in NPV terms, but not for the debt to exports variable. For both indicators, the spline specification tends to generate much higher thresholds (about 50 percent of GDP and 95 percent of exports, compared to only 10 percent of GDP and 45 percent of exports when the quadratic specification is used).

Overall, the average threshold (calculated as the average of the significant estimates) is about 70 percent for debt to exports, and about 25 percent for debt to income. Such thresholds correspond approximately to half of those for the overall negative impact of debt on growth (see point A in Figure 4). Note that the estimated thresholds present high variability, suggesting that taking the average may not identify precisely the growth maximizing level of debt. Nevertheless, if we restrict the results to only those

[21] See Sarel (1996) for an application of the spline function to the nonlinear effect of inflation on growth.

implied by the system GMM specification, we are able to identify two significant indebtedness thresholds (in net present value) around 69 percent of exports and 14 percent of income, not noticeably different from those obtained by averaging across the two different methods.[22]

Interestingly, our estimates for the optimal level of debt-to-GDP (beyond which the marginal effect of debt becomes negative) tend to be much lower than the results of early studies (e.g., Cohen, 1997, and Elbadawi, Ndulu, & Ndung'u, 1997) and similar to the results of more recent studies discussed in Section II which find relatively low debt overhang thresholds (e.g., Clements, Bhattacharya, & Nguyen (2003), and Cordella, Ricci, & Ruiz-Arranz, 2010).

### 5.2.3 The Impact of Debt on Growth

To address the third issue we employ the estimates from the quadratic, the spline, and the linear specifications. Table 6 panel B summarizes the implication of the regression analysis for the impact of doubling debt on growth, by presenting the average and range of the significant coefficients (at the 10 percent level) for each of the four debt variables (the full set of estimates is presented in Table A2 in the Appendix). For the quadratic specification, the impact is evaluated at the average level of debt. For the spline specification, the impact is evaluated at the spline threshold, i.e. at the level of debt at which the marginal impact on debt becomes negative. For the linear specification, the estimates indicate the impact for any level of debt.

For the average country in the regression, doubling the extent of indebtedness generally implies a reduction of growth of one third to half a percentage point based on the preferred non-linear specifications estimated with system GMM.[23] Unlike the threshold results, this result is robust across debt ratio indicators. As visible from the Appendix Table A2, and consistent with our expectations (see Section 5.1), the estimates for the linear specification tend to underestimate the negative impact of debt accumulation by imposing a flatter slope than would be consistent with a non linear relation. It is also noteworthy that the estimates for the fixed effects methodology tend to systematically overstate the impact of debt on growth. Hence, we favor the system GMM methodology that controls for endogeneity of the debt variable.

These results can provide an insight on the potential growth implication of the HIPC debt reduction. For countries with a NPV of debt to exports of 300 percent (which is roughly the average level of the HIPC countries that reached the decision point in the year 2000), halving the debt (i.e. bringing

[22] Using the average of all estimates (instead of only the significant ones) would yield thresholds of about 60 percent of exports and 30 percent of GDP.

[23] The average log of debt (once exponentiated) in the sample is approximately: Debt/exports: 182 percent; Debt/GDP: 46 percent; NPV of Debt/exports: 170 percent; NPV of Debt/GDP: 36 percent.

it to the HIPC target) could have contributed to raising per capita growth by about half a percent.[24]

## 5.3 *Channels of Influence*

The previous regression analysis identifies a significantly negative effect of debt on growth (particularly above certain thresholds), when investment is included in the growth regression. This seems to support the hypothesis that the channel of influence for debt's effect on growth may be also through changes in the efficiency of investment, because in the presence of high indebtedness investment expenditure might not be allocated to the most productive activities and/or there might be limited innovation. Estimating specifications where investment is excluded from the regression can provide a limited and indirect assessment of whether the effect of debt on growth operates also via the volume of investment. Quite surprisingly it appears that the impact of debt on growth is not particularly different when we eliminate investment from the regressions, suggesting that the main channel through which large debt negatively influences growth is lower quality of investment (and perhaps lower total factor productivity) rather than the level of investment per se (Table A2 in the Appendix). [25]

Pattillo, Poirson & Ricci (2003) conducted a more in-depth analysis of the channels through which debt affects growth, using a growth accounting decomposition of the sources of growth into factor accumulation and total factor productivity growth. Results indicated that the negative impact of high debt on growth operates both through a strong negative effect on physical capital accumulation and on total factor productivity growth. In terms of the contributions to growth, that paper found that approximately one-third of the effect of debt on growth occurs via physical capital accumulation and two-thirds via total factor productivity growth.

## 5.4 *Additional Robustness Test*

The robustness of the results can already be assessed by comparing the numerous specifications and methodologies described so far. However, one may be concerned that the use of 3-year averages might influence the results, as they could reflect business cycle factors rather than long run effects. We therefore estimate the same regressions for a dynamic panel of 10-year average data. The results obtained are very similar (Table A2 in the Appendix).

[24] Such growth dividend may not occur, however, if other distorsions (of a macroeconomic, structural, institutional, and/or political nature) persist, thus limiting the improvement in investment and productivity.

[25] For the full set of results without investment, see Pattillo, Poirson, & Ricci (2002).

# 6 Conclusions

This paper attempts to provide a thorough analytic answer to an important economic issue that recurrently demands attention from policymakers, lending institutions, international organizations, and citizens around the globe: the impact of external debt and of debt reduction on growth.

Toward this aim, we begin with a standard growth framework and add various indicators of debt in nominal and in net present value terms, measured both as a ratio to exports and to GDP. We use several econometric specifications (quadratic debt terms, a model with debt dummies, a spline function, in addition to a simple linear specification) to investigate the nonlinearity of the relation between debt and growth. The paper also employs several different methodologies (fixed effects and system-GMM) to show how results differ when econometric issues such as endogeneity and dynamic panel biases are taken into account. We use data for 93 developing countries from the period from 1969 to 1998 and construct 3-year averages to retain information on the time dimension of the change in debt. However, the results are checked by using panel regressions with 10-year averages to eliminate any residual business cycle effects. An additional robustness test is provided by estimating regressions which eliminate outliers.

The main results of the paper are interesting and intuitive. Debt appears to have a nonlinear effect on growth, which is depicted in a stylized fashion in Figure 4. The *average* impact of debt on per capita growth appears to become negative for debt levels above 160–170 percent of exports and 35–40 percent of GDP.[26] The *marginal* impact of debt becomes negative at much lower debt levels (growth-maximizing threshold), about half of the above ones, while the effect on growth seems to be positive at even lower levels. However, it is very difficult to accurately estimate the turning point partly because of the limited variation in the data between the growth experiences of countries with low indebtedness and those with low-to-moderate indebtedness and partly because the turning point might vary with country specific characteristics.[27] Our results suggest stronger evidence of a hump-shaped relationship between debt and growth in the case of the debt-to-GDP indicator than in the case of the debt-to-exports variable.

Regarding the quantitative impact of debt on growth, for the average country in the sample the estimates are surprisingly consistent over the various specifications and debt indicators employed, unlike those for the estimated debt thresholds. The results are also robust to endogeneity bias. For the average country, which already has debt levels above the optimal threshold, doubling debt could slow per capita growth by about a third to a

[26] This and the next result are interestingly close to those obtained by Rubio, Ojeda, & Montes (2003) for Colombia, who derive debt thresholds of 50 and 27 percent for the average and marginal impact.

[27] See for example, Cordella, Ricci, & Ruiz-Arranz (2010).

half percentage point. Hence, halving debt from 300 percent of exports (the average level of the HIPC countries that reached the decision point in 2000) to 150 percent of exports (the HIPC target) could have contributed to raising per capita growth by about half a percentage point. The theory of the second best may suggest that such a growth dividend might not arise as these economies are often severely affected by other macroeconomic and structural distortions, as well as by high economic and political risks. Nonetheless, the improvement in economic performance over the past decade in HIPC countries that benefited from debt relief is consistent with our results (see IMF, 2009, and Primo Braga & Dömeland, 2009).

Finally, we find that the level of investment does not appear to be the main channel through which excessive external indebtedness reduces growth. In fact, all the above results hold in regressions where investment is also controlled for. If we exclude investment from the regressions, the results are similar, suggesting that only a small part of the impact of debt on growth is through debt contributing to lower investment levels. The result that most of the impact is via the quality rather than the level of investment is consistent with other empirical studies which find that total factor productivity accounts for most of the variation in output.[28] It can also be reconciled with theoretical arguments suggesting that the prospects of future taxation necessary to repay the debt worsen the investment climate by raising uncertainty and distort the allocation of investment by inducing agents to forego long term projects and choose short run projects with less positive impact on long-run productivity growth.

[28] See Easterly & Levine (2001).

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# Appendix

### *Table A1 - Debt Turning Point*

| | Debt to exports | Debt to GDP | Net present value of debt to exports | Net present value of debt to GDP |
|---|---|---|---|---|
| | | | Quadratic model[1/] | |
| Fixed effects | **45.26** | **10.55** | 19.38 | **9.05** |
| System GMM | 0.01 | 1.32 | 22.41 | **13.57** |
| | | | Spline[2/] | |
| Fixed effects | **94.07** | **44.70** | 665.1[3/] | **49.40** |
| System GMM | 117.21 | 37.49 | **69.30** | 62.93 |

Note: Bold represents significance at least at the 10 percent level. Results based on the preferred specification with time dummies and without outliers.
(1) Quadratic model turning points: let D represent debt variables, (Debt/Exports, Debt/GDP, NPV of Debt/Exports, NPV of Debt/GDP) turning points calculated as $\exp[-\beta_D/(2\beta_{D2})]$.
(2) Spline model: turning points calculated as $\exp[LogD^*]$, where $D^*$ maximizes the $R^2$ in a regression including $[D+(D-D^*)Z]$, where Z = 1 if $D > D^*$, 0 otherwise.
(3)Two other local maxima with similar R-squares were found in this case: 33.1% and 109.9%.

### *Table A2 - Effects of Doubling Debt on Growth*

| | Debt to exports | | Debt to GDP | | Net present value of debt to exports | | Net present value of debt to GDP | |
|---|---|---|---|---|---|---|---|---|
| | Linear[1/] | Quadratic[2/] | Linear | Quadratic | Linear | Quadratic | Linear | Quadratic |
| Fixed effects | | | | | | | | |
| With time dummies and without outliers | **-0.72** | **-1.02** | **-0.92** | **-1.38** | **-0.75** | -0.92 | **-0.86** | **-1.52** |
| Without investment | **-0.54** | **-0.84** | **-0.55** | **-1.04** | **-0.61** | **-0.76** | **-0.43** | **-1.14** |
| With panel decades | **-0.53** | **-0.67** | **-0.61** | **-1.09** | **-0.60** | **-0.92** | **-0.59** | **-1.52** |
| System GMM | **-0.41** | -0.46 | -0.55 | -8.82 | **-0.31** | -0.22 | -0.07 | **-0.44** |
| | | | | Spline[3/] | | | | |
| Fixed effects | **-1.39** | | **-1.51** | | **-2.59** | | **-1.44** | |
| System GMM | -0.54 | | -0.87 | | **-0.33** | | -0.30 | |

Note: Bold represents significance at least at the 10 percent level. Results are based on the preferred specification with time dummies and without outliers. Robustness tests (excluding investment and using decade averages instead of three-year averages) were performed only for the linear and quadratic models estimated with fixed effects.
(1) Computed as $Log(2) \times \beta_D$, where $D$ represents debt variables.
(2) Computed at the average, that is, as $Log(2) \times \beta_D + \beta_{D2} \times [Log(2)]^2 + 2 \times Log(2) \times \beta_{D2} \times average\ Log(D)$. The average log of debt was about (once exponentiated): Debt/Exports: 182%; Debt/GDP 46%; NPV of Debt/Exports 170%; NPV of Debt/GDP: 36%.
(3) Computed as $Log(2) \times \beta_D \times \beta_{Extra}$, Extra= $[D+(D-D^*)HD]$, where $HD$ = 1 if $D > D^*$, 0 otherwise. Shows impact on growth of doubling debt at the spline threshold.

 