UNIVERSITY OF ALBERTA

External Public Debt, Economic Growth, and Welfare Gains from Debt Relief for HIPCs

By

Ergete Assefa Ferede ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Department of Economics

Edmonton, Alberta, Canada

Fall 2005

0-494-08638-6

Your file Votre référence
ISBN:
Our file Notre reference
ISBN:

DEDICATION

To Etenesh, Frena, and Sarah.

ABSTRACT

We undertake theoretical and empirical investigations of the impact of external public debt on economic growth and welfare of the Heavily Indebted Poor Countries (HIPCs). The theoretical model shows that at a lower level of external public debt ratio, the relationship between the long run growth rate and external public debt ratio is positive. However, if external public debt ratio exceeds a certain critical value, then it has a deleterious effect on growth. This implies that the critical external public debt ratio is the growth maximizing level. Calculations used to calibrate the average growth performance of the HIPCs reveal that the growth maximizing external public debt to GDP ratio is about 28 percent. We also investigate the impacts of external public debt on welfare and growth maximizing fiscal policies.

Using panel data from HIPCs and other non-HIPC developing countries, we empirically examine the implication of the simple theoretical model that external public debt has a non-linear effect on growth. The recent threshold estimation method employed in this dissertation demonstrates that the threshold external public debt-to-GDP ratios for the HIPCs and full sample of developing countries are 22 and 31 percent, respectively. We find that while low external public debt (below the threshold value) has a positive effect on the growth rate, excessive external pubic debt (above the threshold value) hinders growth. The empirical result also suggests that high external public debt ratio affects the growth rate adversely through the productivity and investment channels.

We also conduct a simulation analysis of the effects of the current debt relief initiative on the HIPCs' growth and welfare. The simulation results suggest that the proposed two-third reduction in the external debt of HIPCs increases their per capita GDP growth rate, on average, by about 1.6 percentage points. This significant growth gain is the result of both the direct and indirect effects of debt relief on growth. The results also show that debt relief has a substantial welfare gain for debtor countries.

ACKNOWLEDGEMENTS

Many people have contributed to the completion of this dissertation in a variety of important ways. I would like to express my greatest gratitude to my supervisor Dr. Bev Dahlby for his support, guidance, and career advice. I am also highly indebted to my supervising committee members, Dr. Todd Smith and Dr. Maxim Nikitin for all their comments and assistance. I wish to thank Dr. Stuart Landon, Dr. Talan Iscan, and Dr. Barry Scholnick for their suggestions and contributions to this dissertation. I am also thankful to Dr. Andre Plourde and Dr. David Ryan for their support and encouragement.

I am grateful to the Department of Economics for the financial support throughout my study. I am also very grateful to African Economic Research Consortium (AERC) for financing my dissertation. I would be remiss if I did not thank the administrative staff of the Department of Economics at the University of Alberta: Louis Edwards, Theresa Everest, Audrey Jackson, Charlene Hill, and Margaret Howell for their kind support during my stay in the Department. They were always willing to go the extra mile to help out.

I owe an immeasurable debt of gratitude to my family for their moral support throughout my study. I view the years of graduate study as a family collective effort and the outcome as a shared achievement. I am greatly indebted to my beloved wife, Frena. My mother, Etenesh Ayele, has been my constant source of encouragement and inspiration. Habteab Wolde Sillassie, Hawa Hussien, Gedefaw Amsalu, Ayalew Tadesse, Gashe Hagos, Zinabu Belete, and others have also contributed greatly for my academic success.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 INTRODUCTION

The external debt problem of poor developing countries has once again become a topic of hot discussion. Many poor developing countries have accumulated a large amount of external debt. The lion's share of the external debt of developing countries is generally either public or publicly guaranteed. This is particularly true in the case of the Heavily Indebted Poor Countries (HIPCs). In the literature, many authors argue that external debt is one of the main reasons for the weak economic performance of these countries. In this regard, the debt overhang hypothesis of Krugman (1988) and Sachs (1989) is the most commonly used argument to establish a negative relationship between external debt and growth. According to the debt overhang hypothesis, when countries accumulate external debt, investors anticipate a higher future tax to finance the foreign debt service payments. This reduces investment and hence growth will be adversely affected. However, if the external public debt is used for productive purposes, some level of external debt accumulation may be good for growth. In fact, the experience of some developed countries show that external debt may be helpful at some stage of the growth process.

This dissertation examines the impact of external public debt on economic growth and welfare of developing countries. In this regard, we present a simple theoretical model that shows a non-linear relationship between external public debt and the long run growth rate. The theoretical model builds on analytical frameworks presented in previous studies such as Arrow and Kurz (1970), Barro (1990), Turnovsky (1997), Calvo (1998), and Aschauer (2000). We also test the predictions of the simple model using data from 70 developing countries (30 HIPCs and 40 non-HIPCs) for the period 1970 to 1999. It is worth noting right from the outset that even though in our empirical analysis we use data from non-HIPC developing countries, the focus of this study is the poor developing countries that have accumulated a huge external public debt and are eligible for the current IMF and World Bank supported debt relief initiative.

We focus on the HIPCs for the following reasons. First, although there are many studies that examine the impact of external debt on growth, to my knowledge, there are no studies on the HIPCs exclusively. As Claessens et al. (1996) and Pattillo et al. (2002) pointed out, analyzing the HIPCs separately is important since the political and economic environment in these countries is different from other developing countries. Second, in the light of the current debt relief initiative, studying HIPCs separately is very important in order to examine the likely effects of the debt relief initiative. Moreover, while previous studies generally used total external debt in their analysis, we focus on external public debt that has a significant effect on domestic fiscal policy. The need to focus on external public debt arises mainly because a substantial part of the developing countries' debt in general and of the HIPCs' in particular is either public or public guaranteed.

With the above background, this dissertation examines the following key issues. First, many developing countries heavily rely on external borrowing not only to finance temporary consumption falls but also long-term investment projects that are deemed essential in their development endeavors. If the flow of external public borrowing is used to finance investment, it will help boost the borrowing countries economic growth.

However, since the external debt must be paid back, the debt service payments take resources away from domestic use. In the case of external public debt, the debt service payments require an increase in taxes or a reduction in government expenditures. Recent endogenous growth models *a la* Barro (1990) show that an increase in distortionary taxes and/or a reduction in productive public spending reduce growth. This suggests that the effect of external public debt on economic growth depends on the relative strength of the two opposite effects. That is, the impact of external public debt on growth depends on the magnitude of the external public debt itself. Thus, the first issue that this dissertation examines is the effect of external public debt on economic growth. Moreover, we want to investigate the channels through which external public debt affects growth.

In order to investigate the relationship between external public debt and growth, we present an endogenous growth model. The main feature of the model is that the government spends on public investment financed through external public borrowing. The model predicts that external public debt has a non-linear effect on the long-run growth rate. More specifically, while low external public debt supports economic growth, excessive external public debt affects the long run growth rate adversely. Another important issue that we investigate is the impact of external public debt on growth and welfare maximizing fiscal policies. That is, we analyze how the presence of external public debt affects growth and welfare maximizing public capital ratio and income tax rate.

We conduct an empirical analysis of the implication of the model that there is a non-linear relationship between external public debt and economic growth. We employ the recent threshold estimation method of Hansen (1999, 2000) to investigate whether external public debt has a threshold effect on growth and investment. Unlike the simple quadratic empirical specification that is usually used in the literature, the threshold method is very powerful and does not impose an a priori functional specification. We run the threshold estimation for HIPCs and the full sample of developing countries separately. The empirical results show that for the growth regression, for HIPCs and full sample the threshold external public debt-to-GDP ratios are 22 and 31 percent, respectively. Similarly, in the case of investment regressions, the threshold external public debt ratio is found to be 26 percent for both HIPCs and full sample. When the external public debt to GDP ratio exceeds the threshold values, it reduces investment and adversely affects the growth rate.

The threshold estimation method only provides us with the turning points or threshold external public debt to GDP ratios. However, we also want to see whether low (below the threshold value) and high (above the threshold value) external public debt-to-GDP ratios have different effects on the growth rate. This is important because if low external public debt affects growth positively, but high external public debt ratio affects growth negatively, then the threshold value represents the growth maximizing external public debt to GDP ratio. This is of paramount importance for developing countries' policy makers as it shows what level of external public debt these countries should accumulate. Unlike previous studies, we estimate both growth and investment regressions, and identify the channels through which external public debt affects growth. We find that in both HIPCs and full sample of developing countries, while low external public debt to GDP ratio affects growth positively, high external public debt ratio has a significant negative effect on the long-run growth rate. Thus, the empirical result lends support for the implication of the theoretical model that external public debt has a non-linear effect on growth.

Over the years, many poor developing countries have accumulated a large amount of external public debt. The economic performance of these countries, however, has generally been very weak showing little or no improvement for a long time. The high external debt stock and the associated debt service payments of these countries while a large part of their population is living in absolute poverty attracted a lot of attention in the 1990s. Consequently, there has been a world wide concerted effort in support of debt relief for these countries. On the premise that the large external debt of these countries contributed to their poor economic performance, in 1996 the World Bank and the IMF jointly launched a comprehensive debt relief initiative. Thus in this dissertation, using the theoretical model and the empirical estimates, we conduct a simulation exercise to shed some light on the possible growth and welfare gains from the debt relief. We also discuss the objectives, eligibility conditions and possible shortcomings of the current HIPC initiative.

Simulation results based on the theoretical and empirical models suggest that the current debt relief effort will have a significant impact on growth and welfare. Under the current enhanced HIPC initiative (E-HIPC), eligible countries will see a two-third reduction in their external debt when they reach the completion point. The simulation results based on our empirical estimates show that the proposed two-third reduction in the external public debt of the HIPCs would increase the growth rate of the HIPCs, on average, by about 1.6 percentage points. Remarkably, the simulation of the theoretical model provides a similar result: a two-third reduction in the external public debt of the HIPCs would increase their per capita GDP growth, on average by about 1.57 percentage points. We thus conclude that debt relief provides a substantial welfare gain to the debtor countries.

The remaining part of the dissertation is organized as follows. In the second chapter, we present a simple theoretical model that shows the relationship between external public debt and economic growth. We also analytically examine the impact of external public debt on welfare and growth maximizing fiscal policies. The implication of the simple theoretical model is empirically tested using data from HIPCs and other non-HIPC developing countries in the third chapter. The fourth chapter presents a simulation analysis of the impact of the current debt relief initiative on the economic growth and welfare of the HIPCs using both the simple theoretical model and numerical estimates of the empirical model. The fifth chapter concludes.

1-1. References

Arrow, K., Kurz, M., 1970. Public Investment, the Rate of Return and Optimal Fiscal Policy. Baltimore: The John Hopkins Press.

Aschauer, D. A., 2000. Do states optimize? Public capital and economic growth. Annals of Regional Science 34, 343-363.

Barro, R., 1990. Government spending in a simple model of endogenous growth. Journal of Political Economy 98,1 03-126.

Calvo, G.A., 1998. Growth, debt and economic transformation: the capital flight problem, in: Coricelli, F., Matteo, M., Hahn, F. (Eds.), New Theories in Growth and Development, St. Martin's Press Ltd., New York, pp. 251-269.

Claessens, S., Detragiache, E., Kanbur, R., Wickham, P., 1996. Analytical aspects of the debt problems of heavily indebted poor countries. The World Bank Policy Research Working Paper No.1618.

Hansen, B., 1999. Threshold effects in non-dynamic panels: estimation, testing and inference. Journal of Econometrics 93, 345-368.

Hansen, B., 2000. Sample splitting and threshold estimation. Econometrica 68, 575-603.

Krugman, P., 1988. Financing vs. forgiving a debt overhang: some analytical notes. Journal of Development Economics 29, 253-268.

Pattillo, C., Poirson, H., Ricci, L., 2002. External debt and growth. IMF Working Paper WP/02.

Sachs, J., 1989. The debt overhang of developing countries, in: Calvo, G., Findlay, R., Kouri, P., Braga de Macedo, J., (Eds.), Debt, Stabilization and Development, Basil Blackwell, Oxford, pp. 80-102.

Turnovsky, S.J., 1997. Equilibrium growth in a small economy facing an imperfect world capital market. Review of Development Economics 1, 1-22

CHAPTER 2 EXTERNAL PUBLIC DEBT, GROWTH, AND FISCAL POLICY

2-1. Introduction

The importance of foreign borrowing in the economic development of developing countries has long been a hot topic of discussion in the literature. Countries borrow from abroad either to accumulate physical capital or to smooth domestic consumption levels. If the flow of foreign borrowing is channeled towards capital accumulation it enables the borrowing countries to expand their productive capacity and assist their development endeavor. The foreign debt service payments, on the other hand, require countries to divert scarce domestic resources and may act as drain on their economies. Thus, as Glick and Kharas (1986) suggest, the costs and benefits of external borrowing should be weighed when countries decide to accumulate a certain level of external debt. In fact, previous studies on optimal external borrowing such as Hamada (1969), Pitchford (1970), Sachs (1984), and Cooper and Sachs (1985), among others, show that countries should borrow until the marginal cost of external borrowing is equated to the marginal benefit of external borrowing.

By now there is ample theoretical and empirical evidence that public capital enhances economic growth. In the case of external public debt, therefore, the benefit is that the debt can be used to finance public investment without the need to immediately raise the tax rate. The cost associated with external public debt, on the other hand, is that servicing a large foreign public debt requires raising future taxes or reducing government expenditure. A higher tax rate and lower productive government spending in turn adversely affect economic growth. Thus, if external borrowing is used for productive purposes, it may initially affect growth favorably. However, as a country accumulates more and more foreign debt, servicing the foreign debt becomes more burdensome. Consequently, the relationship between external public debt and growth may not be monotonic.

In this chapter we analyze the impact of external public debt on economic growth. In contrast to previous studies, the possibility that low external public debt may be growth enhancing is explored. Using an endogenous growth model similar to Barro (1990) and Futagami et al. (1993), we examine the effect of external public debt on optimal fiscal policy and economic growth. The model allows only governments to borrow from abroad. Governments invest on public infrastructures and impose a flat rate income tax. We derive the growth maximizing tax rate and public capital to private capital ratio. We find that both the growth maximizing tax rate and the public to private capital ratio increase with the external public debt to capital ratio.

In order to investigate how external public debt affects the growth rate, we assume that a certain fraction of the inflow of external public borrowing is used to finance public investment. The model predicts that there is a non-linear relationship between external public debt and growth. We derive the growth maximizing external public debt to capital ratio. External public debt affects the growth rate through two channels. The first channel is the public capital ratio. The external public debt that is used to accumulate public capital affects the growth rate positively. The second channel is the tax rate. Financing external public debt requires the government to raise the tax rate that in turn affects the growth rate adversely. Thus the net effect of external public debt on the growth rate depends on the relative strength of the two opposite effects.

The model is designed mainly to explain the impact of external public debt on the growth rate of developing countries such as the Heavily Indebted Poor Countries (HIPCs) that have accumulated a large amount of external pubic debt. Consequently, we parameterize the model using average data for the HIPCs. Calculations based on the model reveal that the growth maximizing external public debt to capital ratio is about 20 percent. Or alternatively, the growth maximizing external public debt to GDP ratio is about 28 percent. This implies that the marginal impact of the external public debt to capital ratio on the growth rate is positive below the growth maximizing level but negative when the external public debt ratio exceeds this level. This has also an important implication for the current debt relief initiative. Since external public debt above 28 percent has an adverse effect on growth, reducing external public debt has a significant positive effect on the economic performance of the HIPCs.

The remaining part of the chapter is organized as follows. In the second section, a brief review of the literature is presented. In the third section, an analytical framework is specified. Using the endogenous growth model, we examine the impact of external public debt on economic growth and optimal fiscal policy. In particular, we show that the relationship between external public debt and economic growth is non-monotonic. We also derive the growth maximizing external public debt ratio. The fourth section concludes.

2-2. Literature review

One basic feature of poor developing countries is their low saving and investment rates. This is mainly due to scarcity of domestic resources. In such economies foreign inflow of resources like foreign direct investment, foreign aid and foreign borrowing can help finance investment and support economic growth. The theoretical foundation for the role of external finance in helping economic growth of developing countries is based on the famous Harrod-Domar growth model. According to this model, as the economic growth rate depends solely on investment, the key to enhance economic growth is to invest more. Developing countries, however, may not be able to save enough to finance the desired level of investment. Essentially, there will be a gap between domestic saving and the desired level of investment. In such circumstances, external finance fills the gap between saving and investment. The increase in investment financed by external resources can ultimately boost economic growth in the recipient economy.

In many developing countries, the flow of external aid and foreign direct investment is not sufficient to fill the gap between domestic saving and investment. In such economies, therefore, external borrowing may be of great help to finance investment; see Seiber (1982). The importance of foreign borrowing in helping the development endeavors of developing countries is also emphasized in the recent theoretical studies of Burguet and

Fernandez-Ruiz (1998). They argue that if governments are constrained to run a balanced budget, then economies may not be able to move from low-income to high-income levels. In such cases, the authors argue, foreign borrowing is the only way out of a "development trap."

In the literature, a lot of emphasis has been on the adverse effects of high external debt on the economic performance of borrowing countries. Glick (1986) and Glick and Kharas (1986) are two excellent surveys of earlier studies on external debt and growth. Interest in the impact of external debt was particularly strong during the debt crisis of the 1980's. During this period, many studies tried to examine the link between foreign indebtedness and growth. One major hypothesis in the literature is the debt overhang hypothesis suggested by Krugman (1988) and Sachs (1989). The basic idea behind the debt overhang hypothesis is that when countries accumulate large foreign debt, potential investors anticipate a higher tax rate in the future that is required to finance the foreign debt. This discourages investors and reduces the level of investment. The decline in investment caused by anticipation of higher future taxes, in turn, reduces economic growth. Thus according to the debt overhang hypothesis, outstanding foreign debt affects growth adversely through its disincentive effect on investment.

In an overlapping generations and endogenous growth framework, Van der Ploeg (1996) analyzes the impact of foreign indebtedness on economic growth. From the current account identity, he derives an expression that relates foreign debt and the growth rate. In particular, he shows that the ratio of foreign debt to output and the growth rate are negatively related provided that the growth rate is less than the marginal cost of foreign borrowing. Farzin (1988) and Forslid (1998) also find a similar result. However, these studies are based on a mere identity and thus do not tell much about how foreign debt affects growth.

In a representative agent framework with endogenous growth, Turnovsky (1997a) also examines the effect of foreign debt on economic growth. Unlike van der Ploeg (1996), Turnovsky assumed that the government provides productive expenditure in an endogenous growth model similar to Barro (1990). Turnovsky assumes that private agents borrow internationally and the cost of borrowing rises with the debt to capital ratio. The basic finding of the study is that along a balanced growth path the growth rate depends entirely on internal factors with external borrowing costs playing no role.

All the previously discussed studies focus on the idea that the relationship between foreign debt and growth is linear. Sachs (1984), on the other hand, indicates the possibility of a non-linear relationship between foreign borrowing and growth. Calvo (1998, 2001) also shows that the impact of debt on growth depends on the magnitude of the initial debt stock. In particular, he shows that the economy will exhibit a high growth equilibrium for a lower debt to GDP ratio and a low growth equilibrium for a higher debt to GDP ratio. This is because the higher the initial debt, the higher will be the debt service payments. This requires a higher tax rate and affects growth adversely. Note that Calvo (1998, 2001) does not allow for productive government expenditures. Thus, the only channel through which debt affects growth is changes in the tax rate that are required to finance debt service payments. Calvo does not explicitly show how debt-creating inflows are used to enhance the economic performance of the borrowing countries. Moreover, the relationship between external debt and growth is not clearly spelled out; the author just assumes a given constant growth rate. Nevertheless, the simple model used shows the possibility that the relationship between foreign debt and growth is non-linear.

2-3. Analytical framework

In the empirical literature a growing number of studies have found that the relationship between economic growth and foreign debt is non-linear. Initially, foreign debt affects growth positively and then, after a certain threshold level, increasing foreign debt affects growth adversely; see for instance Elbadawi et al. (1997) and Pattillo et al. (2002). That is, initially foreign debt increases the growth rate of the economy, reaches a maximum, then beyond a certain threshold foreign debt level, foreign debt affects growth adversely as the negative effect of the debt service payments and the disincentive effect of debt overhang dominate. Thus the key issue is to find the threshold foreign debt level that maximizes the growth rate. However, this issue has been generally ignored in the theoretical literature.

2-3.1. Production Function

Government spends on infrastructure that enhances the productivity of private capital. As in Futagami et al. (1993) we introduce public capital as an external input to the firms' production function. The output of the single domestic good depends on domestic private capital and public capital. Thus the production function is specified as:

$$Y = AK^{1-\alpha}K_G^{\alpha}, \tag{1}$$

$0<\alpha<1$ and $A>0$.

In the above specification, Y is output, K is the private capital stock, and K_G is public capital. The production function exhibits diminishing returns with respect to each of the inputs but exhibits constant returns to scale over the two inputs jointly. Thus public capital enhances the productivity of private capital. We assume that there is no depreciation or adjustment cost in both private and public capital. Labor is not included in the model and we can think of private capital as being a composite of both physical and human capital. Suppose the public capital to private capital ratio is denoted by p, equation (1) can also be rewritten as $Y = Ap^{\alpha}K$. Note that for a given public capital to private capital ratio, unlike in the neoclassical growth model, the marginal product of private capital is constant. Thus, if the public capital to private capital ratio is constant, the production function reduces to the familiar AK model.[1]

2-3.2. *Private agents*

We assume that the economy is inhabited by a continuum of infinitely lived identical agents whose preferences over infinite sequences of consumption (C), is represented by the following utility function:

$$U = \int_0^{\infty} \frac{\sigma}{\sigma - 1} C_t^{\frac{\sigma-1}{\sigma}} e^{-\rho t} dt. \tag{2}$$

[1] The AK model is an endogenous growth model; see chapter 4 of Barro and Sala-i-Martin (1995).

There is no population growth. $\rho>0$ and $\sigma>0$ are the consumer's rate of time preference and the elasticity of intertemporal substitution, respectively. When $\sigma = 1$, equation (2) corresponds to the logarithmic utility function. Since the emphasis is on foreign public debt, domestic public debt is ignored. Moreover, private agents have no access to the international financial market. It is only the government that can borrow from the world market. This is a reasonable assumption for developing countries with relatively higher external public debt ratios. For instance, in 1999, about 95 percent of the HIPCs foreign debt was public and public guaranteed. Thus the representative agent's instantaneous budget constraint is given by:

$$\dot{K} = (1-\tau)Y - C, \tag{3}$$

where Y is output and τ is the income tax rate as defined below.

2-3.3. Government sector

The government in our basic model collects taxes from income or output, borrows internationally, and invests in productive capital. Thus the budget constraint of the government is given as:

$$\dot{F} = r(z)F + I_G - \tau Y. \tag{4a}$$

In the above expression τ is the tax rate, I_G is public investment, F is the stock of foreign public debt, z is the foreign public debt to private capital ratio, and $r(z)$ is the interest rate. Public investment is given as:

$$\dot{K}_G = I_G. \tag{4b}$$

The interest rate that the small country under consideration faces in the international market is given by:

$$r(z) = r^* + \psi(z) \tag{5}$$

$$\psi'(z) > 0, \quad \psi''(z) > 0, \; z = F/K, \; F > 0,$$

where r^* is the exogenous constant world interest rate, $\psi(z)$ is a country specific risk premium over the world interest rate and it is assumed to be an increasing function of foreign debt to capital ratio, z. That is $\psi'(z) > 0$, the higher the foreign debt to capital ratio, the higher is the risk premium and hence the cost of borrowing.[2] This specification implicitly assumes that lenders associate a higher foreign public debt to capital ratio with a higher risk of default. In effect, the small economy faces an upward sloping supply of foreign borrowing and this assumption also implies that the interest rate is endogenously determined. The dependence of the interest rate on the foreign public debt to capital ratio also implies that the marginal cost of foreign borrowing rises as the country accumulates more and more foreign debt and hence discourages excessive foreign borrowing; see Hamada (1969) and Hanson (1974).

Along the balanced growth path C, F, K, K_G, and Y all grow at the rate γ that will be determined later. Thus corresponding to equation (4a), the intertemporal budget constraint of the government can be written as:

$$\tau A p^{\alpha} - p\gamma = (r(z) - \gamma)z. \tag{6}$$

[2] The choice of the foreign debt to capital ratio as a measure of the debt servicing capacity of a country is common in the literature. See Turnovsky (1997a).

A condition for dynamic stability requires that the interest rate exceeds the growth rate of the economy. If the interest rate is equal to the growth rate of the economy, additional debt issuance covers just the debt service payments. In this case, the intertemporal budget constraint of the government shows that the tax rate will be sufficient to finance public investment and the economy behaves like a closed economy.

2-3.4. Decentralized economy

Taking the tax rate and public capital as given, for an initial value of capital, $K_0 > 0$, the representative agent chooses C and K to maximize the utility function (equation (2)) with respect to the instantaneous budget constraint of equation (3) and taking K_G as given. Thus, the Hamiltonian of the optimization problem in the decentralized economy is given as:

$$H = \frac{\sigma}{\sigma - 1}\left[C^{\frac{\sigma-1}{\sigma}}\right] + \lambda\left[(1-\tau)AK^{1-\alpha}K_G^{\alpha} - C\right]. \tag{7}$$

The first order conditions of the Hamiltonian with respect to C and K are, respectively given by:

$$C^{\frac{-1}{\sigma}} = \lambda, \tag{8a}$$

$$\rho - \frac{\dot{\lambda}}{\lambda} = \left\{(1-\tau)(1-\alpha)A\left(\frac{K_G}{K}\right)^{\alpha}\right\}. \tag{8b}$$

For the decentralized equilibrium, the transversality condition is:

$$\lim_{t \to \infty} \lambda K(t) e^{-\rho t} = 0. \tag{8c}$$

The costate variable λ can be viewed as the shadow value of capital measured in utility terms. Thus equation (8a) implies that in equilibrium, the marginal utility of consumption equals the marginal utility of wealth or the shadow value of capital. Taking the time derivative of (8a) and using (8b), the growth rate of consumption can be expressed as:

$$\gamma = \frac{\dot{C}}{C} = \sigma\left[(1-\tau)(1-\alpha)A\left(\frac{K_G}{K}\right)^{\alpha} - \rho\right]. \tag{9}$$

Suppose we denote the public to private capital ratio by p, i.e., $p = K_G/K$, then the growth rate expression of equation (9) can also be rewritten as:

$$\gamma = \sigma\left((1-\tau)(1-\alpha)Ap^{\alpha} - \rho\right). \tag{10}$$

Along the balanced growth path C, K, K_G, and Y all grow at the rate γ shown in equation (10). This is a standard result in endogenous growth models of *a la* Barro (1990). The growth rate depends on the two fiscal instruments: the tax rate and the public capital to private capital ratio. From the above growth rate expression, we can see that while the income tax rate reduces the growth rate, the public to private capital ratio increases the growth rate. Specifically differentiating the growth rate with respect to τ and p we obtain:

$$\frac{\partial \gamma}{\partial \tau} = -(1-\alpha)\sigma A p^{\alpha} < 0, \tag{11a}$$

$$\frac{\partial \gamma}{\partial p} = \alpha\sigma(1-\tau)(1-\alpha)Ap^{\alpha-1} > 0. \tag{11b}$$

Equation (11a) shows that for a given public capital ratio, an increase in the distortionary tax rate reduces the long run growth rate. Thus, an increase in debt service payments, for a given public capital ratio, requires raising the tax rate and hence affects the growth rate adversely. Equation (11b), on the other hand, implies that for a given tax rate, an increase in the public capital ratio increases the growth rate. That is, the model suggests that a foreign borrowing financed increase in the public capital ratio increases the growth rate.

Suppose that g denotes the public investment to output ratio. Then equation (4b) can be rewritten as $\dot{K}_G = I_G = gY$. Combining the budget constraint of the representative agent (equation (3)) and the government budget constraint of equation (4a) and noting equation (4b), for a given external public debt to capital ratio (z), we can express the aggregate resource constraint of the economy as:

$$\dot{K} = \frac{1}{1-z}\left[(1-g)AK^{1-\alpha}K_G^{\alpha} - r(z)zK - C\right]. \tag{12}$$

In order to discuss the steady state and the transitional dynamics associated with the decentralized economy, it is convenient to express the relevant variables as a ratio of private capital. Thus, we denote the consumption to private capital ratio by c. The equilibrium dynamics of the decentralized economy can be expressed as:

$$\frac{\dot{c}}{c} = \frac{\dot{C}}{C} - \frac{\dot{K}}{K} = \sigma\left[(1-\tau)(1-\alpha)Ap^{\alpha} - \rho\right] - \frac{1}{1-z}\left((1-g)Ap^{\alpha} - r(z)z - c\right), \tag{13a}$$

$$\frac{\dot{p}}{p} = \frac{\dot{K}_G}{K_G} - \frac{\dot{K}}{K} = gAp^{\alpha-1} - \frac{1}{1-z}\left((1-g)Ap^{\alpha} - r(z)z - c\right). \tag{13b}$$

Equation (13a) shows the growth rate of the consumption to private capital ratio and is obtained from equations (9) and (12). The growth rate of public capital from equation (4b) (and noting that g denotes the public investment to output ratio) along with the aggregate resource constraint of equation (12) gives equation (13b).

In the steady state, consumption, private capital and public capital all grow at the same rate. This implies that in the steady state $\dot{c} = \dot{p} = 0$. Thus, from equations (13a) and (13b), the steady state equilibrium in the decentralized economy is given by the following two equations (where asterisks denote steady state values of the variables)

$$\sigma(1-z)\left((1-\alpha)(1-\tau)A\left(\overset{\bullet}{p}\right)^{\alpha} - \rho\right) = \left((1-g)A\left(\overset{\bullet}{p}\right)^{\alpha} - r(z)z - \overset{\bullet}{c}\right), \tag{14a}$$

$$(1-z)gA\left(\overset{\bullet}{p}\right)^{\alpha-1} = \left((1-g)A\left(\overset{\bullet}{p}\right)^{\alpha} - r(z)z - \overset{\bullet}{c}\right). \tag{14b}$$

The above two equations determine the steady state values of the public capital to private capital ratio and the consumption to private capital ratio. One can analyze the transitional dynamics of the decentralized economy by linearizing equations (13a) and (13b) around the steady state values c^* and p^*. However, as a detailed examination of the transitional dynamics of a similar model is found in the literature, we will not discuss this issue in detail here; see for instance Futagami et al. (1993), Turnovsky (1997c), and Gomez (2004).

In the above decentralized equilibrium, all government variables were taken as given. In order to see how external public debt affects the economy, we need to discuss the central planner's problem. Consequently, in the following sections we characterize the centrally planned economy. In particular, for a given external public debt to private capital ratio (z), we analyze the central planner's problem. Moreover, taking z as exogenous, we analyze the impact of external public debt on welfare and growth maximizing fiscal policies. By identifying the channels through which external public debt affects the economy, we examine the impact of external public on the long-run growth rate. We also derive the growth maximizing external public debt to private capital ratio.

2-3.5. *Centrally planned economy*

We now turn to analyzing the centrally planned economy to see how external public debt affects the economy. For a given value of external public debt to private capital ratio, z, using equations (3) and (4a) the aggregate resource constraint of the economy shown in equation (12) can also be rewritten as:

$$\dot{K} = \frac{1}{1-z}\left[AK^{1-\alpha}K_G^{\alpha} - r(z)zK - I_G - C\right]. \tag{15}$$

The central planner's problem involves the maximization of the utility function of equation (2) subject to the resource constraint of equation (15) and the public capital accumulation equation (4b). The central planner chooses C, K, I_G, and K_G directly for a given value of z. The Hamiltonian of the central planner is given as:

$$H = \frac{\sigma}{\sigma-1}C^{\frac{\sigma-1}{\sigma}} + \lambda\left\{\frac{1}{1-z}\left[AK^{1-\alpha}K_G^{\alpha} - r(z)zK - I_G - C\right] - \dot{K}\right\} + \mu(I_G - \dot{K}_G). \quad (16)$$

The first order conditions with respect to C, I_G, K, and K_G are respectively given as:

$$C^{\frac{-1}{\sigma}} = \frac{\lambda}{1-z}, \quad (17a)$$

$$\frac{\lambda}{1-z} = \mu, \quad (17b)$$

$$\rho - \frac{\dot{\lambda}}{\lambda} = \frac{1}{1-z}\left\{(1-\alpha)A\left(\frac{K_G}{K}\right)^{\alpha} - r(z)z\right\}, \quad (17c)$$

$$\rho - \frac{\dot{\mu}}{\mu} = \frac{\lambda}{\mu(1-z)}\left\{\alpha A\left(\frac{K_G}{K}\right)^{\alpha-1}\right\}. \quad (17d)$$

The relevant transversality conditions in the centrally planned economy are:

$$\lim_{t\to\infty} \lambda K(t)e^{-\rho t} = 0, \quad \lim_{t\to\infty} \mu K_G(t)e^{-\rho t} = 0. \quad (17e)$$

Moreover, the government is not allowed to play Ponzi-games. That is,

$$\lim_{t\to\infty} F(t)e^{-rt} = 0. \quad (17f)$$

In the above optimization problem, λ and μ are the costate variables associated with private and public capital, respectively. Equation (17a) says that marginal utility of consumption and the shadow value of private capital divided by (1-z) are equal. Equation

(17b) on the other hand shows that when the central planner chooses the level of public investment optimally the ratio of the shadow values of public and private capital is equal to *1/(1-z)*. Thus for a given external public debt to private capital ratio, the ratio of the shadow values of public and private capital is constant.

Equation (17c) characterizes the marginal return to private investment. Note that this expression comprises two elements. The first element in the curly brackets is the (gross) marginal product of private capital. The second element, on the other hand, is the external public debt service payments as a ratio of private capital. This shows that external public debt service payments reduce the return to private investment. This is in fact broadly consistent with the debt overhang hypothesis of Krugman (1988) and Sachs (1989). Equation (17c) shows that high external debt reduces the return to private investment and discourages investment. The right hand side of equation (17d) simply describes the marginal product of public capital. Equation (17f) rules out Ponzi schemes in public borrowing. This condition implies that the interest rate exceeds the growth rate of the economy. We have seen previously that this is also a condition for dynamic stability.

From the above first order conditions, using equations (17a) and (17c) we obtain the growth rate of consumption in the centrally planned economy as:

$$\gamma = \frac{\dot{C}}{C} = \sigma\left[\frac{1}{1-z}\left((1-\alpha)Ap^{\alpha} - r(z)z\right) - \rho\right]. \tag{18}$$

Using a similar procedure as in the decentralized economy, the equilibrium dynamics in centrally planned economy can be represented by the following two differential equations:

$$\frac{\dot{c}}{c} = \sigma\left[\frac{1}{1-z}\left((1-\alpha)Ap^{\alpha} - r(z)z\right) - \rho\right] - \frac{1}{1-z}\left((1-g)Ap^{\alpha} - r(z)z - c\right), \qquad (19a)$$

$$\frac{\dot{p}}{p} = \frac{\dot{K}_G}{K_G} - \frac{\dot{K}}{K} = gAp^{\alpha-1} - \frac{1}{1-z}\left((1-g)Ap^{\alpha} - r(z)z - c\right). \qquad (19b)$$

Equation (19a) shows the differential growth rate between consumption and private capital and it is obtained by using equations (18) and (15). Likewise, equation (19b) is obtained from equations (4b) and (15) and it shows the growth rate of the public to private capital ratio. Notice that the growth rate of private capital is obtained by dividing the aggregate resource constraint of the economy given in equation (15) by private capital. Recall that we denote the public investment to output ratio by g. In the central planner's problem, optimization with respect to public investment as given in equation (17b) implicitly implies that the public investment to output ratio is also optimally chosen.

In the long run, private capital, public capital, and consumption all grow at the same rate. As we have seen before, this simply means that in the steady state of the centrally planned economy, $\dot{c} = \dot{p} = 0$. Thus, from equations (19a) and (19b), the steady state equilibrium in the centrally planned economy is given by (where tilde denotes steady state values of the variables):

$$\sigma\left((1-\alpha)A\left(\tilde{p}\right)^{\alpha}-r(z)z-(1-z)\rho\right)=\left((1-g)A\left(\tilde{p}\right)^{\alpha}-r(z)z-\tilde{c}\right), \tag{20a}$$

$$(1-z)gA\left(\tilde{p}\right)^{\alpha-1}=\left((1-g)A\left(\tilde{p}\right)^{\alpha}-r(z)z-\tilde{c}\right). \tag{20b}$$

The above two equations simultaneously determine the steady state values of the public capital to private capital ratio and the consumption to private capital ratio. Notice that since the central planner chooses public investment optimally, the optimal public capital ratio can be obtained using equations (17b) to (17d). As we will see later, for a given external public debt to private capital ratio, the associated optimal public capital to private capital ratio will be constant. Thus, the economy stays in the steady state. If, on the other hand, the public investment to output ratio is arbitrarily fixed then the centrally planned economy involves transitional dynamics. For a closed economy, this issue is explored in detail in the literature; see for instance, Turnovsky (1997c, 2000) and Gomez (2004).

2-3.6. External public debt and optimal fiscal policy

In this section, we examine how the presence of external public debt affects optimal (welfare maximizing) fiscal policy. In particular we analyze how the optimal public-to-private capital ratio and tax rate behave in our simple model that includes external public debt. From the above central planner problem, suppose q denotes the ratio of the two costate variables, μ/λ, from equation (17b) we obtain that

$$q = \mu/\lambda = 1/(1-z). \tag{21}$$

Since z is assumed to be constant, q is also constant. Recall that we denote the ratio of public capital to private capital ratio by p. Thus using the first order conditions of equations (17c) and (17d) along with equation (21) we obtain:

$$\alpha(1-z)A\hat{p}^{\alpha-1} = (1-\alpha)A\hat{p}^{\alpha} - r(z)z. \tag{22}$$

The above equation provides the first best or optimal public capital to private capital ratio, $\hat{p}$. In the absence of external public debt (i.e., z = 0), equation (22) yields the familiar optimal public capital ratio as $\hat{p} = \alpha/(1-\alpha)$. From equation (22) above, it can be shown that the optimal public capital ratio in our model is higher or lower than the corresponding closed economy optimal public capital ratio depending on whether the interest rate is higher or lower than the marginal product of public capital.

We now examine how the presence of external public debt affects the optimal tax rate. In order to derive the optimal income tax rate, we follow the procedure outlined in Turnovsky (1997c, 2000), who argues that the optimal tax rate enables the decentralized equilibrium to replicate the first best outcome of the central planner. Accordingly, for the decentralized equilibrium to mimic the first best equilibrium of the central planner, among other things, the growth rates in the two cases must be equal. Thus equating equations (10) and (18) we see that the steady state optimal tax rate is given by

$$\hat{\tau} = \frac{\left(r(z) - (1-\alpha)A\left(\hat{p}\right)^{\alpha} \right) z}{(1-\alpha)(1-z)A\left(\hat{p}\right)^{\alpha}}. \tag{23}$$

In a closed economy model, if there is no congestion (and hence no externality) in public capital, the optimal income tax rate is zero; see Turnovsky (1997c) and Gomez (2004). Equation (23) shows that in our model as long as the interest rate is different from the marginal product of private capital, the steady state optimal tax rate is non-zero. In the absence of external public debt, equation (23) yields the familiar closed economy result that the optimal tax rate is zero. Notice that setting the tax rate according to equation (23) will enable the steady state equilibrium of the decentralized equilibrium to mimic the steady state equilibrium of the centrally planned economy. However, if the tax rate is held at $\hat{\tau}$ the adjustment path towards equilibrium followed by the decentralized equilibrium and the centrally planned equilibrium will be different. As Turnovsky (1997c) argues, during transition, for the adjustment path followed by the decentralized equilibrium to mimic that of the centrally planned economy, the optimal tax rate should be time varying. This is generally true if the central planner arbitrarily fixes the public investment to output ratio. However, if public investment is optimally chosen, as is the case in this chapter, then the central planner problem does not involve transitional dynamics and hence it suffices to replicate the steady state of the centrally planned economy and the decentralized equilibrium.

2-3.7. External public debt and growth-maximizing fiscal policy

In the previous section we examined how the presence of external public debt affects welfare maximizing fiscal policy. Since the decentralized equilibrium involves transitional dynamics, growth-maximizing fiscal policies are generally different from welfare-maximizing fiscal policies; Turnovsky (1997c) and Gomez (2004). Thus, it may be also interesting to see how external public debt affects growth maximizing fiscal policies. We assume that the government (or central planner) is interested in growth maximization. Thus the planner chooses the tax rate, τ, and public capital ratio, p, to maximize the growth rate of the decentralized equilibrium subject to the intertemporal budget constraint of the government. That is the growth maximizing tax rate and public capital ratio can be obtained by maximizing the growth rate of the economy (equation (10)) with respect to τ and p subject to the intertemporal budget constraint of the government (equation (6)) and holding z constant. The Lagrangian of the optimization problem is given as:

$$L = \gamma(\tau, p) + \lambda(\tau A p^{\alpha} - p\gamma - (r(z) - \gamma)z) . \tag{24}$$

where λ is the Lagrangian multiplier associated with the intertemporal budget constraint of the government. The first order conditions of the maximization problem are:

$$\frac{\partial \gamma}{\partial \tau} + \lambda\left(Ap^{\alpha} - (p - z)\frac{\partial \gamma}{\partial \tau}\right) = 0 , \tag{25a}$$

$$\frac{\partial \gamma}{\partial p} + \lambda\left(\alpha\tau A \ p^{\alpha - 1} - \gamma - (p - z)\frac{\partial \gamma}{\partial p}\right) = 0 . \tag{25b}$$

Plugging equations (11a) and (11b) into equations (25a) and (25b), and solving for p yields:

$$p=\left(\frac{\alpha A}{\gamma}\right)^{\frac{1}{1-\alpha}}. \tag{26a}$$

Furthermore, plugging equation (10) into equation (26a) we obtain the following,

$$\alpha A p^{\alpha-1}=(1-\tau)\sigma(1-\alpha)Ap^{\alpha}-\sigma\rho\ . \tag{26b}$$

Equation (26b) provides a public capital to private capital ratio that is consistent with the growth maximizing condition. However, the equation also includes the tax rate. Thus in order to obtain the growth maximizing public capital ratio, we need to eliminate the tax rate from the equation. As the growth maximizing public capital ratio should satisfy the government's intertemporal budget constraint, we can eliminate the tax rate from equation (26b) using this constraint. More specifically, if we use the growth rate expression of equation (10) in the intertemporal budget constraint of equation (6) we can obtain the tax rate in terms of the structural parameters and the public capital ratio. Then using this tax rate expression in place of τ in equation (26b) yields an expression for the growth maximizing public capital ratio as (where asterisks denote growth maximizing level):

$$\sigma(1-\alpha)^2Ap^{*\alpha}-\alpha Ap^{*\alpha-1}-\sigma\rho=\sigma(1-\alpha)z[r(z)-\alpha Ap^{*\alpha-1}]. \tag{27}$$

As equation (27) is non-linear in p^*, a closed form solution for the growth maximizing public capital ratio cannot be obtained. This is also true even in a closed economy framework where z is equal to zero. However, for given values of z and the structural parameters (A, r, ρ, α, and σ), the value of the growth maximizing public capital ratio p^* can be solved numerically from equation (27).

In the absence of external public debt (i.e., $z = 0$), equation (27) shows that the growth maximizing public capital ratio is given by the following equation:

$$\sigma(1-\alpha)^2 Ap^{*\alpha-1}\left[p^* - \frac{1}{\sigma(1-\alpha)}.\frac{\alpha}{(1-\alpha)}\right] = \sigma\rho\,. \qquad (28)$$

As we discussed previously, in a closed economy, the first best optimal (welfare maximizing) public capital ratio is given by $p = \alpha/(1-\alpha)$. Notice that the right hand side of equation (28) is positive. Thus for the equality to hold, the left hand side must be positive. This implies that the expression in the square bracket is positive. That is the growth maximizing public capital ratio, $p^* > \alpha / \sigma(1-\alpha)^2$. Since σ and α are less than one, this also implies that p^* is greater than $\alpha/(1-\alpha)$. Thus from equation (28) we get an interesting result: *in the absence of external public debt (or in a closed economy) the growth maximizing public capital ratio is higher than the welfare maximizing public capital ratio.*

We can use equation (27) to analyze the impact of external public debt on the growth maximizing public capital ratio, p^*. Implicit differentiation of equation (27) with respect to z, yields

$$\frac{dp^*}{dz} = \frac{\sigma\left[r(z) + r'(z)z - \alpha A p^{*\alpha-1}\right]}{\alpha A p^{*\alpha-2}\left[1 + \sigma(1-\alpha)(p^* - z)\right]}. \tag{29}$$

Since z is generally less than one, the denominator of the above equation is positive. Thus equation (29) is positive as long as the marginal cost of foreign borrowing (i.e., $r(z)+r'(z)z$) is greater than the marginal product of public capital ($\alpha A p^{*\alpha-1}$) at the growth maximizing public capital ratio. If the marginal cost of foreign borrowing is equal to the marginal product of public capital, on the other hand, external public debt will not affect the growth maximizing public capital ratio. As shown in equation (26a), at the growth maximizing public capital ratio, the marginal product of public capital is equal to the growth rate. We also argued previously that for dynamic stability to hold, the interest rate must exceed the growth rate. Consequently, since the growth rate and the marginal product of public capital are equal, the condition for dynamic stability also implies that the interest rate is greater than the marginal product of public capital. Hence, the numerator in equation (29) is positive, implying that external pubic debt has a positive impact on the growth maximizing public capital ratio. This is not surprising since in our model, apart from foreign interest payments, government revenues (both tax and external public borrowing) finance public capital accumulation.

We now turn to examining how external public debt affects the growth maximizing income tax rate. In order to derive the growth maximizing tax rate, we use the growth maximizing public capital ratio expression given in equation (27) along with the intertemporal budget constraint of the government and noting the growth rate of the economy given in equation (10). More specifically, at the growth maximizing public capital ratio p^*, equation (26b) can be rewritten as:

$$-\sigma(1-\alpha)Ap^{*\alpha}\,\tau = \alpha Ap^{*\alpha-1} - \sigma(1-\alpha)Ap^{*\alpha} + \sigma\rho . \tag{30}$$

Similarly, equation (27) can be rewritten as:

$$\sigma(1-\alpha)z[\alpha Ap^{*\alpha-1} - r(z)] - \alpha\sigma(1-\alpha)Ap^{*\alpha} = \alpha Ap^{*\alpha-1} - \sigma(1-\alpha)Ap^{*\alpha} + \sigma\rho . \tag{31}$$

Since the right hand sides of equations (30) and (31) are equal, the left hand side expressions of the two equations must be also equal. Thus equating the left hand sides of equations (30) and (31) and solving for the tax rate, τ, yields the growth maximizing income tax rate as:

$$\tau^* = \frac{\alpha Ap^{*\alpha} + [r(z) - \alpha Ap^{*\alpha-1}]z}{Ap^{*\alpha}} . \tag{32}$$

Equations (26b) and (32) show that p^* and τ^* are not explicitly expressed in terms of the structural parameters. However, the model can determine the growth maximizing tax rate and public capital to private capital ratio recursively. First, note that for given values of the structural parameters and external public debt ratio, equation (26b) determines p^*. Then using the value of p^* and the structural parameters in equation (32), we can solve for the value of τ^*.

It is worth noting the following regarding the growth maximizing tax rate. First, it depends on the external public debt ratio. In particular, as long as the condition for dynamic stability is satisfied, the growth maximizing tax rate is higher than the corresponding closed economy value. This is because in our model a higher external public debt ratio implies higher foreign debt service payments that necessitate a higher tax rate. Other things being equal, an increase in the interest rate increases the growth maximizing tax rate. Second, for a given external public debt ratio, the growth maximizing tax rate is constant. This is true as we are concerned only with maximization of the growth rate along the balanced growth path. The growth maximizing tax rate is consistent with the intertemporal budget constraint of the government but it is different from the corresponding closed economy values obtained in Barro (1990) and Futagami et al. (1993) due to the presence of external public debt. In the absence of external public debt, i.e., $z = 0$, equation (32) implies that $\tau^* = \alpha$ and hence the usual Barro (1990) and Futagami et al. (1993) result holds.

The impact of external public debt on the growth maximizing tax rate can be assessed by differentiating equation (32) with respect to z and noting equation (29). Thus, using equations (29) and (32) we obtain

$$\frac{d\tau^*}{dz} = \frac{\Psi\left[r(z) + r'(z)z - \alpha A p^{*\alpha-1}\right]}{A^2 p^{*2\alpha-1}\left[1 + \sigma(1-\alpha)(p^* - z)\right]}, \tag{33}$$

where $\Psi = Ap^{*\alpha-1} + \sigma\big((1-\alpha)(p-z)Ap^{\alpha-1} + zAp^{\alpha-1} - r(z)z\big)$.

Because p and z are generally less than one, the denominator in equation (33) is positive. From equation (18), for the growth rate to be positive, the marginal product of private capital must be higher than the interest payment, implying that Ψ is positive. Thus like the case of the growth maximizing external public capital ratio, the impact of external public debt on the growth maximizing tax rate is positive as long as the marginal cost of external public borrowing is greater than the marginal product of public capital (at the growth maximizing level of public capital ratio, p^*).[3]

2-3.8. External public debt and economic growth

In the previous section, we examined how the presence of external public debt affects growth and welfare maximizing fiscal polices. Thus taking the external public debt to capital ratio as given, we have shown that external public debt ratio has an impact on both growth and welfare maximizing fiscal policies. In this section, on the other hand, we are interested in analyzing how external public debt affects the long run growth rate. Consequently, we investigate what kind of relationship exists between external public debt and the long run growth rate. Moreover, the possible channels through which external public debt affects the growth rate will be explored. To this end, unlike in the previous sections, we explicitly take into account how the flow of external borrowing is used to finance public investment. This will help us analyze how changes in the external public debt ratio affect the growth rate. The analysis will also guide us what kind of specification would be appropriate in empirical studies that focus on the relationship between external public debt and growth.

Glick and Kharas (1986) have suggested that in multi-period models, the production function should be specified to describe how new foreign borrowing leads to increased output through financing investment. Thus, following Pitchford (1970), Bade (1972),

---

[3] In a somewhat similar analysis, Zee (1994) has shown that the optimal wage tax rate is increasing with external public debt.

Aizenman and Borensztein (1989), we assume that the government provides public capital that is financed with foreign borrowing.[4] This is a reasonable assumption as low-income countries rely to finance a significant part of their public investment using a flow of external public borrowing. For instance, in Sub-Saharan Africa, the use of foreign borrowing in financing public investment is documented in Green (1989).

The government in this simple model is assumed to finance public investment through foreign capital inflow. The assumption that foreign borrowing finances public investment implies that:

$$\dot{K}_G = \theta \dot{F}, \qquad 0<\theta\leq 1, \tag{34}$$

where θ is the proportion of the flow of foreign borrowing that is used to finance public investment.[5] If $\theta=1$, a unit increase in the inflow of foreign public borrowing leads to an equivalent increase in public investment. If $\theta<1$, on the other hand, the government can use part of the inflow of foreign borrowing to reduce taxes or finance outstanding foreign debt service payments.

Previously, we have seen that the tax rate and public capital ratio affect the growth rate. Thus external public debt affects the growth rate if it affects these fiscal policy instruments. Indeed, a closer look at the government budget constraint and equation (10) reveals that external public debt ratio affects the growth rate through its effects on the tax

---

[4] For a similar set up as how public capital is financed in a closed economy framework, see chapter 6 in Arrow and Kurz (1970).

[5] For instance for private foreign borrowing Barro et al. (1995) assume that private capital equals to foreign debt, i.e., $K=F$. See also Cohen and Sachs (1986) for a similar assumption.

rate and public capital accumulation. From equation (10), we can see that the impact of external public debt ratio on the long run growth rate is given as:

$$\frac{d\gamma}{dz} = (1-\alpha)\sigma A p^{\alpha}\left(\frac{-d\tau}{dz} + \frac{\alpha(1-\tau)}{p}.\frac{dp}{dz}\right). \tag{35}$$

Notice that as we will show below, both our model and the debt overhang hypothesis show that excessive external public debt affects growth adversely. However, there are differences in the transmission mechanisms. According to the debt overhang hypothesis, when governments accumulate high external public debt, investors anticipate an increase in future taxes. Because higher tax rates generally reduce the return to private investment, the expectation of higher taxes discourages investment. The fall in investment in turn reduces the growth rate. Thus according to the debt overhang hypothesis, investors' anticipation of higher future taxes is the channel through which excessive external debt affects growth.

In our model, on the other hand, higher external public debt implies higher debt service payments. Financing external public debt service payments require higher current tax rates or lower productive government expenditure. A higher tax rate and/or lower productive government expenditure reduce the growth rate. Thus in our model the transmission mechanisms are current taxes and productive government expenditure.

A direct link between the external public debt ratio and the growth rate can be established by explicitly taking into account how the government finances the public investment.

Note that for a given θ, equation (34) implies that $K_G = \theta F$. Substituting this into equation (10) and noting that $z = F/K$, we get:

$$\gamma = \sigma\left((1-\tau)(1-\alpha)A\theta^{\alpha}z^{\alpha} - \rho\right). \tag{36}$$

In equation (36), the growth rate depends on the tax rate and the external public debt ratio. For a given tax rate, a higher external public debt ratio affects the growth rate positively. This is because the public debt is used to accumulate public capital that enhances productivity. However, the government budget constraint shows that we cannot increase public capital by just accumulating more external public debt without increasing the tax rate because of rising risk premium on outstanding debt, and the solvency condition.

The tax rate depends on the external public debt ratio. A higher external public debt ratio implies more external public debt service payments. For the government to remain solvent, this requires a higher tax rate. Or, a larger part of the flow of foreign borrowing will be channeled to financing debt service payments and the rate of public capital accumulation will be lower. However, for a given proportion of external public borrowing channeled to public investment (θ), higher external public debt always results in a higher tax rate. This in turn affects the growth rate adversely.

Thus for given values of r, z, A, α, θ, σ, and ρ the model can be summarized with the following equations:

$$p = \theta z\ , \tag{37a}$$

$$\tau = \frac{r(z)z - \sigma(1-\theta)z[(1-\alpha)A\theta^{\alpha}z^{\alpha} - \rho]}{A\theta^{\alpha}z^{\alpha}[1-\sigma(1-\alpha)(1-\theta)z]}, \tag{37b}$$

$$\gamma = \frac{\sigma[(1-\alpha)A\theta^{\alpha}z^{\alpha} - (1-\alpha)r(z)z - \rho]}{[1-\sigma(1-\alpha)(1-\theta)z]}. \tag{37c}$$

Equations (37a) to (37c) express the public capital ratio, the tax rate, and the growth rate in terms of external public debt ratio (z) and the structural parameters. Notice that equation (37a) is simply the result of our assumption as to how the government uses the flow of external borrowing and is obtained from equation (34) for a given level of θ. Plugging equation (37a) into the growth rate expression of equation (10) and substituting the resulting growth rate expression into the government's intertemporal budget constraint of equation (6) yields equation (37b). And finally, we obtain equation (37c) by substituting equation (37b) into equation (36). Thus equations (37b) and (37c) summarize the implication of the assumption about public investment financing on the simple model.

We have seen previously that the tax rate affects the growth rate adversely while the public capital affects positively. Equations (37a) and (37b) on the other hand show that external public debt affects both the tax rate and the public capital ratio. Thus external public debt ratio affects the growth rate through its effect on the tax rate and the public capital ratio. That is in so far as the resources obtained through external public debt accumulation are invested productively, external public debt has both a contractionary and a stimulating effect on the economy. Indeed, equation (37c) shows that external public debt has two opposite effects on the growth rate. While the interest payment affects the growth rate adversely, the accumulation of public capital financed by foreign public debt creating inflows affects the growth rate positively. Thus, the net effect of external public debt on the long run growth rate depends on the relative strength of the two opposite effects. In fact, equation (37c) shows that the relationship between external public debt and the growth rate is non-monotonic. Along the balanced growth path differentiating equation (37c) with respect to the external public debt ratio we obtain:

$$\frac{d\gamma}{dz} = \frac{\sigma(1-\alpha)}{\pi^2}\left\{A\theta^{\alpha}z^{\alpha-1}(\alpha\pi+\eta z)-r(z)-\pi r'(z)z-\sigma(1-\theta)\rho\right\}, \qquad (38)$$

where $\eta = \sigma(1\text{-}\theta)(1\text{-}\alpha)$ and $\pi = 1\text{-}\eta z$.

Notice that in equations (37a) to (37c) the tax rate and the growth rate are functions of the interest rate which itself is assumed to be a function of the external public debt ratio. Thus we need to specify the functional form of the interest rate that is given in general terms in equation (5). Following Harberger (1985), Glenn (1997), and Schmitt-Grohe and Uribe (2003) suppose that the world interest rate takes the following form:

$$r(z) = r_w + \beta z^2, \qquad (39)$$

where $0 \leq \beta \leq 1$ is the risk premium facing the country in the international market and r_w is the exogenous world interest rate.

The growth maximizing external public debt ratio is obtained by setting equation (38) equals to zero. Using equation (39) into equation (38) and setting the result equal to zero gives the following equation:

$$2\beta z^{*3}\eta - 3\beta z^{*2} + (1-\alpha)\eta A\theta^{\alpha} z^{*\alpha} + \alpha A\theta^{\alpha} z^{*\alpha-1} = r_w + \sigma(1-\theta)\rho, \tag{40}$$

where $\eta = \sigma(1\text{-}\theta)(1\text{-}\alpha)$.

Equation (40) is non-linear in z^* and it is not possible to obtain a general closed-form solution for the growth maximizing z^*. However, a closed form solution for the growth maximizing external public debt ratio can be obtained if we make certain simplifying assumptions. Suppose the country does not face the risk premium in international borrowing (i.e.,$\beta = 0$) and all the flow of external borrowing is used to finance public investment (i.e., $\theta = 1$), then from equation (40) the optimal external public debt ratio is given by:[6]

$$z^* = \left(\frac{\alpha A}{r_w}\right)^{\frac{1}{1-\alpha}}. \tag{41}$$

The growth maximizing external public debt ratio depends on the elasticity of output with respect to public capital (α), the interest rate and the technology parameter. The growth maximizing external public debt ratio will be high if the interest rate is lower or if the elasticity of output with respect to public capital is higher. In this model, as the external public debt creating-inflows finance public capital accumulation, it is not surprising to see that the growth maximizing external public debt ratio depends on the interest rate (which is the cost) and the elasticity of output with respect to public capital.

[6] Such simplifying assumption is not uncommon in the literature. For instance, Pitchford (1970) and Bade (1972) also assume that all foreign borrowing is used for productive purposes.

The finding of a positive growth maximizing external public debt to capital ratio has an important implication for the relationship between external public debt and economic growth. The existence of a growth maximizing external public debt ratio implies that the relationship between external public debt and the long run growth rate depends on whether the external public debt to capital ratio is above or below the critical value, z^*. Specifically, the marginal effect of external public debt on the growth rate is positive below z^* but negative above z^*. Thus, if *a certain fraction of the inflow of external public borrowing is used to finance public investment, then there is a critical level of external public debt to capital ratio beyond which the marginal impact of external public debt on the growth rate becomes negative.*

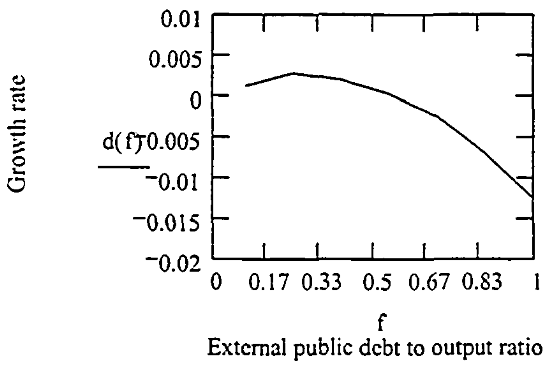
The growth-maximizing external public debt ratio of equation (41) is obtained by imposing some restrictive assumptions on θ and β. However, for given values of the structural parameters, the growth-maximizing external public debt ratio, z^*, can be obtained numerically from equation (40) without imposing restriction on the parameters. In order to obtain the growth-maximizing external public debt ratio, we choose the structural parameters to match the average economic growth rate of the HIPCs for the period 1970-99. Over this period, the average annual real per capita GDP growth rate of the HIPCs was –0.2 percent. During the same period, their average external public debt to GDP ratio was about 67 percent. According to King and Levine (1994) the capital to output ratio during 1970-1989 for most of the countries in the HIPCs was about 1.3. Thus for the period 1970-1999, we assumed a capital to output ratio of 1.4. This implies that during the same period the average external public debt to capital ratio was 48 percent, i.e., $z = 0.48$.

Empirical evidence on the value of the various structural parameters in developing countries is generally scarce. But as much as possible we assign values for the structural parameters in accordance with previous theoretical studies on developing countries. We assign a value of $\alpha = 0.15$. The choice of $\alpha = 0.15$ implies that the productive elasticity of public capital is 0.15. In their analysis of volatility and growth in developing countries, Turnovsky and Chattopadhyay (2003) assumed a coefficient of relative risk aversion of 2.5. This is equivalent to assigning a value of 0.4 for the intertemporal elasticity of substitution. Thus following these authors, we assumed a value of 0.4 for the intertemporal elasticity of substitution (i.e., $\sigma = 0.4$). The rate of time preference (ρ) is assumed to be 0.05 (as in Ortigueira (1998)). We have also assumed an exogenous world interest rate of 5 percent ($r^* = 0.05$), as in Osang and Turnovsky (2000), and risk premium of 10 percent ($\beta = 0.1$).

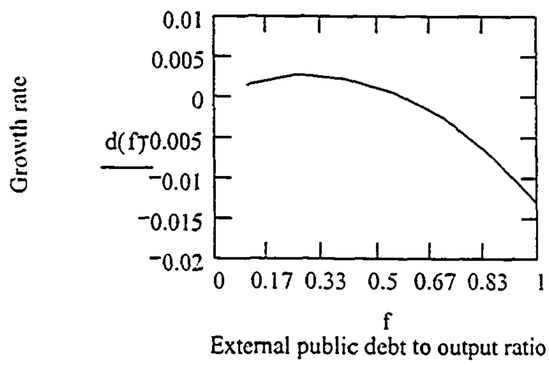
There is no evidence on how much of the flow of external borrowing is channeled towards productive public investment. But we assumed that 75 percent of the flow of foreign borrowing is used to finance public investment (i.e., $\theta = 0.75$). However, the qualitative result of the model would not change much even if we assume that a smaller portion of the flow of external public borrowing is used to finance public investment.

Thus given $z = 0.48$, $\gamma = -0.002$, $r^* = 0.05$, $\beta = 0.1$, $\theta = 0.75$, $\rho = 0.05$, $\sigma = 0.4$, and $\alpha = 0.15$, the technology parameter, A, is calculated from equation (37c) as 0.103. When we use the above parameter values in equation (40), we obtain that the growth maximizing external public debt to capital ratio is about 20 percent. Or equivalently, using average capital-output ratio of 1.4 for the period, the growth maximizing external public debt to output ratio is about 28 percent. Thus the marginal impact of external public debt to output ratio on the long growth rate is positive below this growth maximizing level but negative when the external public debt ratio exceeds this critical level.

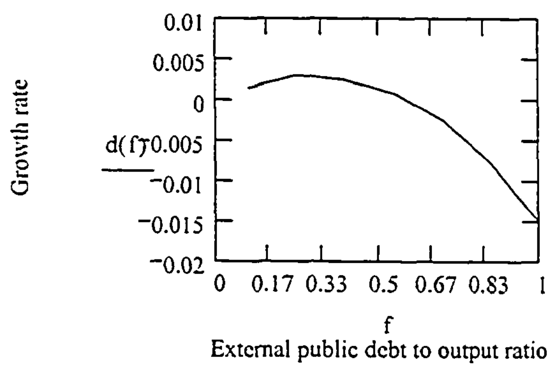
The following figures plot the growth rate against the external public debt to output ratio for different values of θ. We can see from the figures that the relationship between the growth rate and external public debt ratio is indeed non-monotonic.



(a) When θ=1



(b) When $\theta = 0.75$



(c) When $\theta = 0.25$
Figure 2-1a Growth rate and external public debt-to-output ratio.

Figure 2-1a indicates that at a low level of external public debt ratio, the relationship between external public debt and the growth rate is positive. But as the external public debt ratio rises, the relationship between the two variables becomes negative. This implies that excessive external public debt is an impediment to economic growth.

It is important to note that in our model the interest rate depends on the external public debt to capital ratio. More specifically, consistent with most studies in the literature we assume that the interest rate increases with the external public debt to private capital ratio. Thus the impact of external pubic debt on the interest rate depends on the interest rate specification assumed. That is the model in itself is not capable of answering the effect of external public debt on the interest rate without using the ad hoc functional specification that is commonly used in the literature. For the quadratic relationship between external public debt ratio and interest rate, it is easy to show that the interest rate increases as the external public debt increases. Figure 2-1b shows the relationship between external public debt to output ratio (*f*) and the interest rate (*r*) for our base-case parameter values.

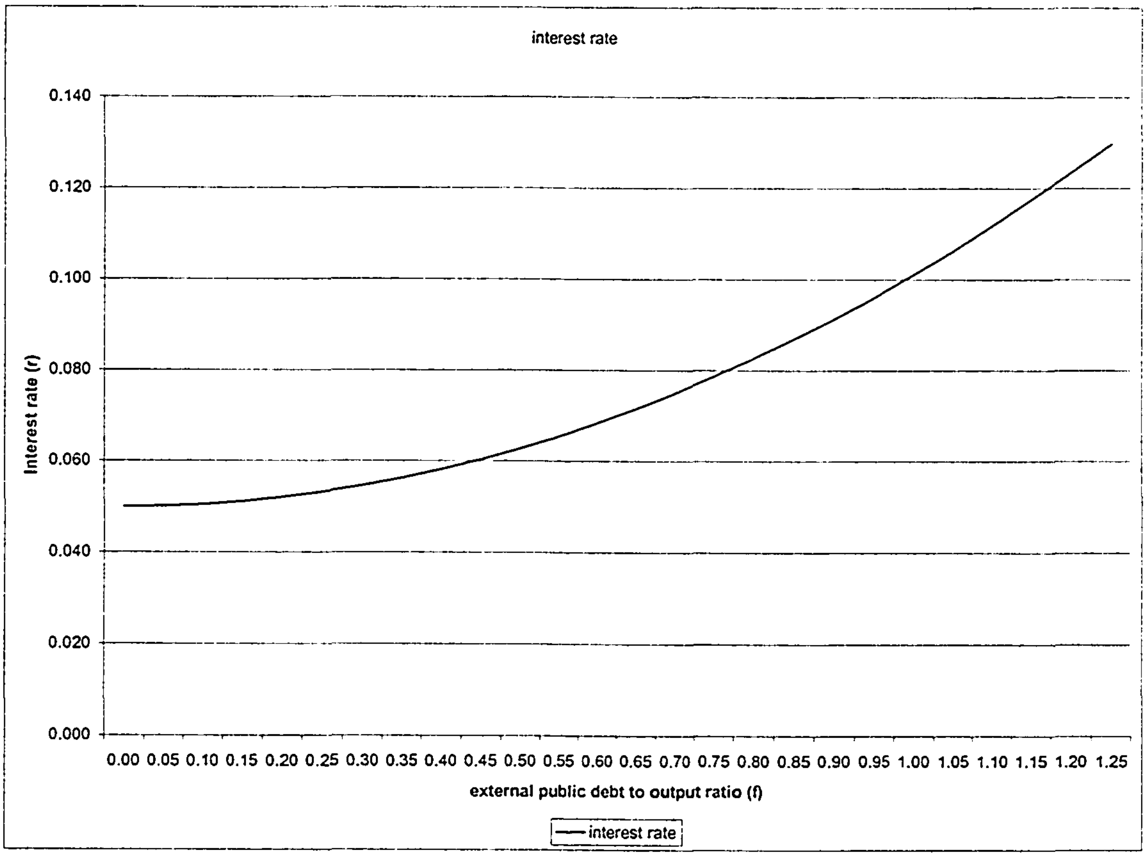


Figure 2-1b Interest rate and external public debt-to-output ratio (*f*).

As we argued before, excessive external public debt affects the growth rate because the debt service payments increase with the increase in the external public debt. The interest payment requires resources be diverted from domestic use and hence affects the growth rate adversely. Thus it may be interesting what our model implies about the relationship between interest rate and the growth rate. Figure 2-1c shows the relationship between interest rate and the growth rate for our base-case parameters.

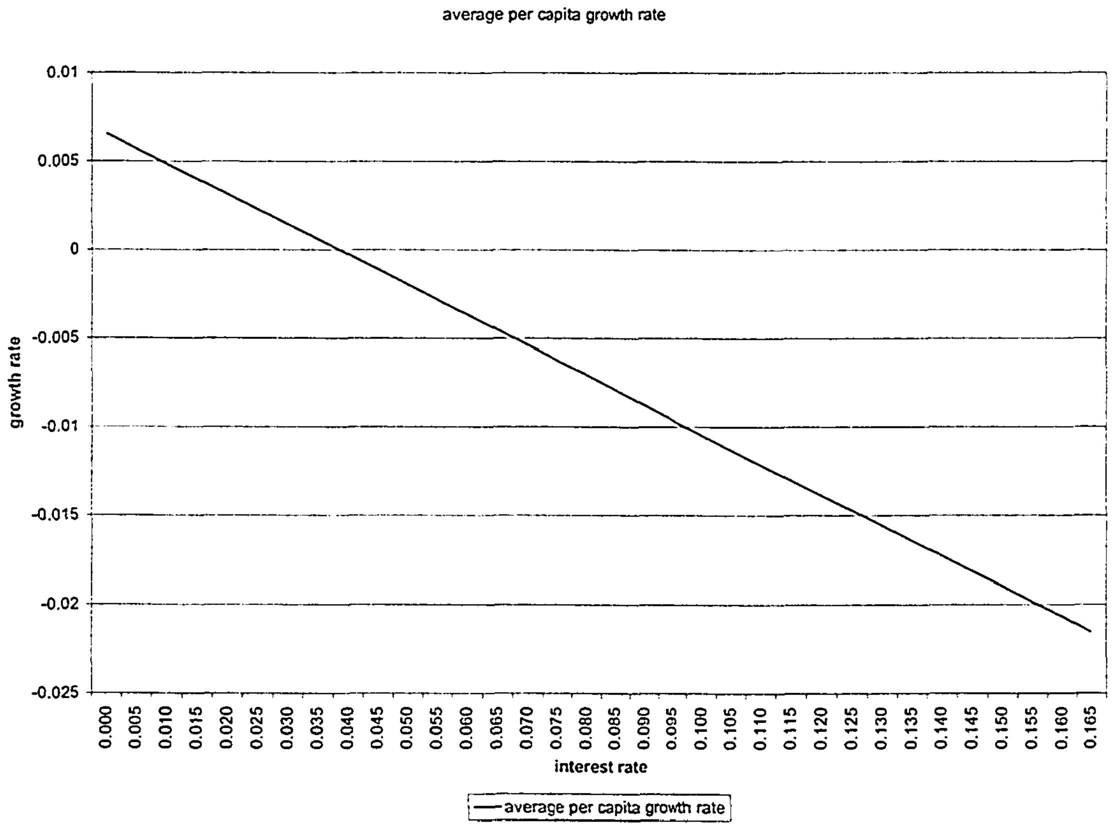


Figure 2-1c Growth rate and interest rate (r).

At the beginning of the HIPC debt relief initiative, the average external public debt ratio of these countries was higher than the growth maximizing value suggested in this model. In fact, beginning from late 1970s, most countries in the HIPC group accumulated external public debt in excess of the growth maximizing level. Thus, our analysis suggests that debt relief will be beneficial to the economic performance of the recipient debtor countries. Notice that debt relief reduces the external debt service payments of these countries. The reduction in the debt service payments affects the growth rate positively by reducing the distortionary tax rate that goes back in the form of debt service payments. In effect, the resources relieved from debt service payments can be utilized to lower the distortionary tax rate that reduces the return to private investment. This in turn improves economic growth.[7] This is consistent with the general belief that debt relief is beneficial to enhance the economic performance of the HIPCs.

2-3.9. Welfare effects of external public debt

External public debt reduces the utility of individuals living in the long run because the tax rate that is used to service the external public debt reduces consumption. In our model, however, external debt affects welfare through its effect on public capital accumulation that increases the productivity of private capital and through taxes needed to finance the interest payments. On the one hand, the debt service payments associated with the external debt increases the tax rate and this reduces the return to private investment. Ultimately this will reduce consumption and the welfare of individuals will be adversely affected. Infrastructural development financed by the flow of external borrowing on the other hand increases the productivity of capital and output will be higher. As a result, per capita consumption increases. Thus the net effect of the two opposite effects of external public debt on welfare is unclear.

---

[7] The fourth chapter of the dissertation will be devoted to examining the impact of debt relief on economic growth and welfare of the HIPCs in detail.

Alternatively, we can investigate the possible impact of external public debt on welfare by looking at its effect on the long run growth rate. For instance, we have shown that excessive external public debt reduces the long run growth rate. Since in the long run consumption, capital and output grow at the same rate, a reduction in the growth rate also implies a fall in consumption. Thus in the long run excessive external public debt reduces welfare by reducing the level of consumption.[8]

2-3.10. Implications for empirical studies

The model has an important implication for empirical studies. The relationship between the external public debt and economic growth discussed in this chapter applies to the balanced growth path. Thus we can use the model to empirically analyze the long-run impact of external public debt on the growth rate for different countries. The model implies that if we plot the average growth rate of countries over a long period of time against their external public debt, the relationship can be non-monotonic. In the next chapter, the possibility of a non-linear relationship between external public debt and economic growth will be empirically examined using data from the HIPCs and other (non-HIPC) developing countries.

2-4. Conclusion and some caveats

The main objective of this chapter has been to analyze the impact of external public debt on the long run growth rate. Using an endogenous growth model similar to Barro (1990)

[8] This issue will be explored further in the fourth chapter of the dissertation.

and Futagami et al. (1993) but modified to allow external public borrowing, we have shown that the impact of external public debt on growth is non-monotonic. At a lower level of external public debt ratio, the relationship between the long run growth rate and external public debt ratio is positive. However, if the external public debt ratio exceeds a certain critical value, the relationship between the long run growth rate and external public debt ratio becomes negative. Thus the critical external public debt ratio is simply the growth maximizing external public debt ratio. The growth maximizing external public debt ratio will be low if the interest rate is high or if the elasticity of output with respect to public capital is low.

We have also analyzed the impact of external public debt on fiscal policy. We have shown that external public debt affects growth and welfare maximizing fiscal policy. In particular, the simple model suggests that external public debt increases both growth maximizing tax rate and public capital ratio. The external public debt also affects welfare maximizing fiscal policy.

Calculations used to calibrate the average growth performance of the HIPCs for the period 1970-1999 reveal that the growth maximizing external public debt to GDP ratio is about 28 percent. Thus, our analysis shows that the marginal impact of external public debt on the growth rate becomes negative when it exceeds this critical level implying that excessive external public debt is an impediment to economic growth.

The analytical framework presented in this chapter has an important implication for empirical studies. As the impact of external public debt on the growth rate is non-monotonic, in empirical studies it is important that these different effects of low and high external public debt be taken into account. Thus, instead of relying on a simple linear relationship between external debt and growth, empirical studies need to consider appropriate non-linear specification.

Even though the model is useful in shedding some light on the impact of external public debt on economic growth, it is worth noting the following limitations. First, the analysis focused solely on external public debt. This may be a reasonable assumption for countries whose external debt is mainly public or publicly guaranteed but to those countries with a relatively large external private debt relaxing the simple assumption is important. Second, when we derive the non-monotonic relationship between external public debt and growth, we have assumed that public investment is financed only with external borrowing. But in reality, domestic resources and foreign aid may also be used. Thus a natural extension for future research would be to include other sources of financing. Such modification may be more realistic but obviously would complicate the analysis.

2-5. References

Aiyagari, R. S., McGrattan, E.R., 1998. The optimum quantity of debt. Journal of Monetary Economics 42, 447-469.

Aizenman, J., 1989. Investment, openness and country risk, in: Frenkel, J., Dooley, M., Wickham, P. (Eds.), Analytical Issues in Debt, International Monetary Fund, Washington, D.C., pp. 83-101.

Aizenman, J., Borensztein, E.R., 1989. Debt and conditionality under endogenous terms of trade adjustment, in: Frenkel, J.A., Dooley, M.P., and Wickaham, P. (Eds.), Analytical Issues in Debt, International Monetary Fund, Washington, D.C., pp. 102-129.

Arrow, K., Kurz, M., 1970. Public Investment, the Rate of Return and Optimal Fiscal Policy. Baltimore: The John Hopkins Press.

Aschauer, D. A., 2000a. Do states optimize? Public capital and economic growth. Annals of Regional Science 34, 343-363.

Aschauer, D.A., 2000b. Public capital and economic growth: issues of quantity, finance and efficiency. Economic Development and Cultural Change 48, 391-406.

Bade, R., 1972. Optimal growth and foreign borrowing with restricted mobility of foreign capital. International Economic Review 13, 544-552.

Bair, S. L., Glomm G., 2001. Long-run growth and welfare effects of public policies with distortionary taxation. Journal of Economic Dynamics and Control 25, 2007-2042.

Bardhan, P., 1967. Optimum foreign borrowing, in: Karl Shell (Ed.): Essays on the Theory of Optimal Growth. Cambridge, MIT Press.

Barro, R., Sala-I-Martin, X., 1995. Economic Growth, McGraw-Hill, New York.

Barro, R., 1990. Government spending in a simple model of endogenous growth. Journal of Political Economy 98, 103-126.

Barro, R., Mankiw, G., Sala-I-Martin, X., 1995. Capital mobility in neoclassical models of economic growth. American Economic Review 85, 103-115.

Borensztein, E., 1990. Debt overhang, credit rationing and investment. Journal of Development Economics 32, 315-335.

Burguet, R., Fernandez-Ruiz, J., 1998. Growth through taxes or borrowing? A model of development traps with public capital. European Journal of Political Economy 14, 327-344.

Calvo, G.A., 1998. Growth, debt and economic transformation: the capital flight problem, in: Coricelli, F., Matteo, M., Hahn, F. (Eds.), New Theories in Growth and Development, St. Martin's Press Ltd., New York, pp. 251-269.

Calvo, G.A., 2001. Explaining sudden stop, growth collapse, and BOP crisis: the case of distortionary output taxes. IMF Staff Papers 50, 1-20.

Chenery, H.B., Strout, A.M., 1966. Foreign assistance and economic development. American Economic Review 56, 679-733.

Claessens, S., Detragiache, E., Kanbur, R., Wickham, P., 1996. Analytical aspects of the debt problems of heavily indebted poor countries. World Bank Policy Research Working Paper No.1618.

Cohen, D., Sachs, J., 1986. Growth and external debt under risk of debt repudiation. European Economic Review 30, 529-60.

Cooper, R., Sachs, J., 1985. Borrowing abroad: the debtor's perspective, in: Smith, F. and Cuddington, J. (Eds.). International Debt and the Developing Countries, a World Bank Symposium, Washington.

Dahlby, B., 2003. The marginal cost of funds from public sector borrowing. Memo. Department of Economics, University of Alberta.

Easterly, W. R., 2001. Growth implosions and debt explosions: do growth slowdowns cause public debt crises? Contributions to Macroeconomics 1, 1-24.

Eaton, J., 1993. Sovereign debt: a primer. World Bank Economic Review 7, 137-172.

Elbadawi, I., Ndulu, B., Ndung'u, N., 1997. Debt overhang and economic growth in Sub-Saharan Africa, in: Zubair I., Ravi K., (Eds.), External Finance for Low-Income Countries, International Monetary Fund, Washington, D.C.

Farzin, H., 1988. The relationship of external debt and growth: Sudan's experience, 1975-1984. World Bank Discussion paper WDP24.

Fleming W, H., Stein L., 2003. Stochastic optimal control, international finance, and debt. Journal of Banking and Finance 28, 979-996.

Forslid, R., 1998. External debt and Ponzi-games in a small open economy with endogenous growth. Journal of Macroeconomics 20, 341-349.

Futagami, K., Morita, Y., Shibata, A., 1993. Dynamic analysis of an endogenous growth model with public capital. Scandinavian Journal of Economics 95, 607-625.

Glenn, K., 1997. The Optimal response of consumption, investment and debt accumulation to an exogenous shock when the world interest rate is endogenous. Journal of Macroeconomics 19, 327-348.

Glick, R., 1986. Economic Perspectives on Foreign Borrowing and Debt Repudiation: An Analytic Literature Review, Monograph Series in Finance and Economics, New York University.

Glick, R., Kharas, H., 1986. The costs and benefits of foreign borrowing: a survey of multi-period models. Journal of Development Studies January: 279-299.

Gomez, M. A., 2004. Optimal fiscal policy in a growing economy with public capital. Macroeconomic Dynamics 8, 419-435.

Greene, J., 1989. External debt problem of Sub-Saharan Africa, in: Frenkel, J., Dooley, M.P., Wickham P., (Eds.), Analytical Issues in Debt, International Monetary Fund, Washington D.C., pp. 38-74.

Greiner, A., Semmler, W., 2000. Endogenous growth, government debt, and budgetary regimes. Journal of Macroeconomics 22, 363-384.

Hamada, K., 1969. Optimal capital accumulation by an economy facing an international capital market. Journal of Political Economy 77, 684-697.

Hanson, J., 1974. Optimal international borrowing and lending. American Economic Review 64, 616-630.

Harberger, A., 1985. Lessons for debtor-country managers and policymakers, in: Smith, F., Cuddington, J., (Eds.), International Debt and the Developing Countries, A World Bank Symposium, pp. 236-257.

King, R.G., Levine, R., 1994. Capital Fundamentalism, Economic Development, and Economic Growth. Carnegie-Rochester Series on Public Policy 40, 259-92.

Kimbrough, K., 1986. Foreign aid and optimal fiscal policy. Canadian Journal of Economics 19, 35-61.

Krugman, P., 1988. Financing vs. forgiving a debt overhang: some analytical notes. Journal of Development Economics 29, 253-268.

Ortigueira S., 1998. Fiscal policy in an endogenous growth model with human capital accumulation. Journal of Monetary Economics 42, 323-355.

Osang T., Turnovsky, S. J., 2000. Differential tariffs, growth and welfare in a small open economy. Journal of Development Economics 62, 315-342.

Pattillo, C., Poirson, H., Ricci, L., 2002. External debt and growth. IMF Working Paper WP/02.

Pitchford, J., 1970. Foreign investment and the national advantage in a dynamic context, in: MacDougal and Snape (Eds.) Studies in International Economics, Amsterdam, North-Holland.

Pitchford, J., 1995. The Current Account and Foreign Debt. Routledge, New York.

Sachs, J., 1984.Theoretical Issues in International Borrowing. Princeton Studies in International Finance No.54, Princeton University.

Sachs, J., 1989. The debt overhang of developing countries, in: Calvo, G., Findlay, R., Kouri, P., Braga de Macedo, J., (Eds.), Debt, Stabilization and Development, Basil Blackwell, Oxford, pp. 80-102.

Saint-Paul, G., 1992. Fiscal policy in an endogenous growth model. Quarterly Journal of Economics 107, 1243-59.

Schmitt-Grohe, S., Uribe, M., (2003). Closing small open economy models. Journal of International Economics 61, 163-185.

Seiber, M.J., 1982. International Borrowing by Developing Countries. Pergamon Policy Studies on International Development. New York: Pergamon Press.

Turnovsky, S.J., 1996. Optimal tax, debt, and expenditure policies in a growing economy. Journal of Public Economics 60, 21-44.

Turnovsky, S.J., 1997a. Equilibrium growth in a small economy facing an imperfect world capital market. Review of Development Economics 1, 1-22

Turnovsky, S.J., 1997b. International macroeconomic dynamics, the MIT Press, Cambridge, Massachusetts.

Turnovsky, S.J., 1997c. Fiscal policy in a growing economy with public capital. Macroeconomic Dynamics 1, 615-639.

Turnovsky, S.J., 2000. Methods of macroeconomic dynamics, 2nd edition, MIT Press, Cambridge, Massachusetts.

Turnovsky, S.J., Chattopadhyay, P., 2003. Volatility and growth in developing economies: some numerical results and empirical evidence. Journal of International Economics 59, 267-295.

Van der Ploeg, F., 1996. Budgetary policies, foreign indebtedness, the stock market, and economic growth. Oxford Economic Papers 48, 382-396.

World Bank, 2003. Debt relief for the poorest: an OED Review of the HIPC initiative.

Zee H., 1994. Time-consistent optimal intertemporal taxation in externally indebted Economies. Public Finance 49, 113-125.

CHAPTER 3 ESTIMATION AND EMPIRICAL RESULTS

3-1. **Introduction.**

The foreign indebtedness of poor developing countries is a very important policy issue. The accumulation of foreign debt in these countries is often viewed as the main source of their poor economic performance; Sachs (1998). The problem posed by external debt is most pronounced in the Heavily Indebted Poor Countries (HIPC).[9] For instance, according to World Bank (2001), in 1999, the net present value of debt-to-exports and debt-to-GDP ratios for all HIPCs were 249 and 84 percent, respectively, while the corresponding figures for non-HIPC developing countries were 126 and 36 percent.[10]

The HIPCs generally have slow economic growth, low saving rates, small tax bases, and little inflow of foreign direct investment. Moreover, virtually all HIPCs depend on a small number of primary product exports to earn foreign exchange. The deterioration in the terms of trade of these primary products has weakened their foreign exchange earnings and thereby their import capacity. In such circumstances, foreign borrowing is attractive as it provides the funds needed for economic growth without the need for an immediate excessive increase in taxes or decrease in domestic consumption. Consequently, domestic borrowing in these countries is fairly low, but over the years they have accumulated huge foreign debt that has become difficult to service and many have experienced debt crises.

---

[9] As of 2001 there were 42 developing countries (34 African, 4 Latin American, one Middle Eastern, and 3 Asian countries) that are grouped as HIPC by the IMF and the World Bank.

[10] The net present value of debt is defined as the sum of all future debt-service obligations on existing debt discounted at the market interest rate.

In the literature, various causes are cited as the sources of the debt crises that began in the mid-1970s but became more apparent in the 1980s. Deterioration in the terms of trade, excessive borrowing by developing countries, reckless lending by the creditors, poor economic performance, and an increase in the world interest rate are widely considered as the main sources of the foreign debt problem; see for details Claessens et al. (1996), Iyoha (2000), and Easterly (2001). Alemayehu (2001, 2003) on the other hand argues that the historical origin of the debt crisis of African countries is the structural and international trade problems of these countries that took shape before the end of colonization.

In an attempt to lessen the debt problem faced by many developing countries, creditors relied on the traditional means of debt rescheduling and refinancing. But over the years, these traditional mechanisms proved to be futile and the debt problem got worse. Moreover, the economic performance of these countries has shown no sign of improvement. Rather, it has deteriorated alarmingly leaving many of their citizens in absolute poverty. The poor economic performance of these countries coupled with the accumulated huge debt signaled the need for a new way of dealing with the problem. The problem has also attracted the international community's attention and prominent world figures have become involved. In 1996, the World Bank and the IMF announced a more comprehensive plan for solving the debt problem of the world's poorest nations- the HIPCs debt initiative program. To be eligible for the HIPC initiative, countries must face an unsustainable foreign debt burden even after the traditional debt relief mechanisms have been applied.[11] In addition, the countries should implement IMF and World Bank supported economic reform programs and show a good track record of economic performance (IMF, 2002). If the two conditions are met, a country will be eligible for the Initiative and receive assistance and debt relief so that it can achieve a sustainable debt level; for details on the HIPC initiative see IMF (2000, 2002).

In the literature, there are many studies that examine the impact of foreign debt on economic growth empirically. Most of these previous studies, however, focus on developing countries or were confined to particular regions. The focus of this study is on the HIPCs, because the economic and political conditions of these countries are different and necessitate a separate detailed analysis (Claessens et al. 1996). Moreover, in light of the current effort to solve the debt burden of the HIPCs, analyzing these economies explicitly will allow us to investigate the potential benefits that these countries may receive from the recent HIPCs debt relief initiative.

One notable characteristic of the HIPCs is that governments are the main borrowing agents and the lion's share of these countries' foreign debt is either public or publicly guaranteed. For example, in 1999, the external public and publicly guaranteed debt of the HIPCs accounted more than 95 percent of their total foreign debt. Domestic public debt, on the other hand, generally accounts for only a very small portion of their total debt. Consequently, this chapter focuses on public and publicly guaranteed foreign debt rather than total external debt or domestic public debt.

---

[11] According to the IMF and the World Bank criteria, foreign debt is said to be unsustainable if the Net Present Value of debt-to-export ratio is greater than 150 percent.

HIPCs mainly borrow from bilateral and multilateral lenders. In order to strengthen the debt service capacity of the borrowing countries, lenders generally extend loans for productive purposes such as building infrastructure. Thus, debt creating capital inflows can help finance investment and may initially be favorable to economic growth. However, as more and more foreign debt is accumulated the debt service payments take resources away from domestic uses and may eventually affect the growth rate adversely. Thus, as we have shown in the second chapter, foreign public debt has a non-linear impact on economic growth in the sense that the relationship between external public debt and economic growth depends on the size of the external public debt.

The main objective of this chapter is to empirically test the implication of the simple theoretical model of the second chapter. Consequently, we investigate the possible non-linear impact of external public and public guaranteed debt on investment and growth for 30 HIPCs, for which complete data are available.[12] For comparative purposes, we also include other non-HIPC countries and examine whether the results obtained are applicable to other developing countries. To this effect, we use the recent threshold estimation technique of Hansen (1999, 2000). We find from growth regressions that the threshold external public debt to GDP ratios for the HIPCs and the full sample of developing countries are 22 and 31 percent, respectively. Similarly, for investment regressions we find that the threshold external public debt ratio is 26 percent for both the HIPCs and the full sample. Notice that the growth maximizing external public debt to

[12] The list of countries in the sample is presented in Appendix 1.

GDP ratio from the empirical model is slightly lower than what we find from the simple theoretical model.

The estimated regression results suggest that while a low external public debt ratio has a positive impact on investment and growth, a high external public debt ratio discourages investment and affects growth adversely. The implication of this finding is that external public debt reduces investment and becomes detrimental to economic growth only when it exceeds the threshold value. Thus the debt overhang hypothesis holds when external public debt reaches a certain critical threshold level. For the HIPCs, the empirical findings of this paper suggest that reducing the external public debt of these countries would increase investment and growth. For instance, reducing the external debt of these countries by half would increase their per capita GDP growth rate, on average, by about 0.85 percentage points.

The remaining part of this chapter is organized as follows. The second section presents a survey of the literature. A brief description of the data and a discussion of the various econometric methods to be employed are presented in the third section. The empirical model to be estimated is specified in the fourth section. In the fifth section, the empirical model is estimated. The sixth section gives a summary of the empirical findings.

3-2. Literature review

One feature of poor developing countries such as HIPCs is their low saving and investment rates. This is mainly due to scarcity of domestic resources. In such economies foreign inflow of resources like foreign direct investment, foreign aid and foreign borrowing can help finance investment and support economic growth. The theoretical foundation for the role of external finance in helping economic growth of developing countries is based on the famous Harrod-Domar growth model. According to this model, in which the economic growth rate depends solely on investment, the key to enhance economic growth is to invest more. Developing countries, however, may not be able to save enough to finance the desired level of investment. Essentially, there will be a gap between domestic saving and the desired level of investment. In such circumstances, external finance fills the gap between saving and investment. The increase in investment financed by external resources can ultimately boost economic growth in the recipient economy.

Chenery and Strout (1966) argued that the foreign exchange shortage in developing countries is an additional constraint that hinders economic growth. The implication of this is that relaxing this constraint is important to enhance economic growth. Thus they identify another gap - the trade or foreign exchange gap. The saving-investment gap and the foreign exchange (external gap) are usually referred in the literature as the dual gap. Griffin (1970) and Griffin and Enos (1970) later challenged the dual-gap model arguing that the additional resources inflow through foreign aid will be considered as an addition to income and hence consumption will increase as foreign aid increases unless the marginal propensity to save is one. The increase in consumption triggered by the inflow of foreign aid will reduce capital accumulation and hence casts doubt on the effectiveness of aid in enhancing growth. However, Griffin's critique itself is criticized on the ground that his argument is based on a simple accounting framework and hence does not rest on a well-founded economic theory (White, 1992). Griffin's criticism of the two-gap model was also attacked on the ground that it does not consider the multiplication effects of foreign aid. That is, foreign aid increases income through a multiplier effect, and this in turn may raise the domestic saving rate.

The impact of foreign capital inflows on economic performance of developing countries is also empirically examined in the empirical studies of Papenek (1972), Gupta (1975), Stoneman (1975), and Gupta and Islam (1983). To investigate the impact of foreign capital inflows on economic growth, Papenek (1973), Gupta (1975), and Gupta and Islam (1983) regressed the growth rate on the saving rate, and the different types of foreign capital inflows. Stoneman (1975), on the other hand, used aggregate foreign aid and other foreign capital inflows lumped together as an explanatory variable. Empirical results of Papanek (1973), Gupta (1975), and Gupta and Islam (1983) reveal that domestic saving and the various components of foreign capital inflows have positive and significant effects on the growth rate. Stoneman (1975) has also found that foreign aid has a positive and significant impact on the economic growth rate. In fact, recent theoretical and empirical works also have found a positive impact of foreign aid on growth; see Hansen and Tarp (2000, 2001) and Dalgaard and Hansen (2001).

Empirical studies on the relationship between external finance and growth provide mixed evidence. Dollar and Easterly (1999) and Burnside and Dollar (2000) argue that foreign aid fosters growth in countries where there is a good policy environment but has no impact if the policy environment is not conducive. However, Dalgaard and Hansen (2001) and Hansen and Tarp (2000, 2001) have challenged this finding. In particular, the authors argue that the dependence of aid effectiveness on good policies is not robust. Rather, they have found that foreign aid has a positive impact in any policy environment. Alemayehu and Befekadu (1999) have also found a positive long run relationship between foreign aid and growth.

In many developing countries, the flow of external aid and foreign direct investment is not sufficient to fill the gap between domestic saving and desired investment. To make matters worse, these countries are also plagued with a capital flight problem (Ajayi (1997), Collier et al. (1999)). In such economies, therefore, external borrowing may be of great help to finance investment; Seiber (1982).

In the wake of the foreign debt crisis of the 1980's, many studies tried to examine the link between foreign indebtedness and growth. One major hypothesis in the literature is the debt overhang hypothesis suggested by Krugman (1988) and Sachs (1989). The debt overhang hypothesis suggests that excessive external debt acts as a tax on the return to investment. As a result, external debt discourages investment and affects growth adversely. Empirical evidence on the debt overhang hypothesis is, however, inconclusive. For instance, for a sample of developing countries, Perasso (1992) has shown that the decline in investment in these countries was caused by both debt overhang and poor domestic economic policies. Savvides (1992) and Fosu (1999), among others, found empirical support for the debt overhang hypothesis implying that outstanding foreign debt has a deleterious effect on economic growth. For Sub-Saharan African countries, Green (1993) and Iyoha (2000) have found that debt overhang and foreign debt service payments have an adverse impact on investment and economic growth. This also implies that debt relief may enhance growth in indebted countries. For instance, for Argentina, Morisset (1991) has found that foreign debt reduction can result in an increase in investment and growth.

On the contrary, Hoffman and Reisen (1991), Warner (1992), and Pattillo et al. (2002) have found no evidence of the debt overhang hypothesis. Serieux and Samy (2001) also found only weak support for the hypothesis. Using simulation analysis, Borensztein (1990) has shown that it is credit rationing rather than the debt overhang that has a greater disincentive effect on investment in heavily indebted countries. For Mexico, Iscan (2000) also finds evidence for low investment following the debt crisis due to credit rationing. The implication of this finding is that in order to buttress investment and economic growth in these developing countries, debt relief should be accompanied by an inflow of more foreign lending.

In the early 1980's, many developing countries suffered a marked decline in the level of investment. Some people attributed this decline in investment to the external debt accumulated by these countries. In an attempt to examine whether the accumulated external debt was the cause of the fall in investment, Cohen (1993) focused on the empirical analysis of investment. The author estimated a structural equation of investment where primary school enrolment, per capita income, the export-to-GDP ratio, inflation, population growth, time and regional dummies were included as explanatory variables. The author's main objective was to investigate whether the external debt accumulated prior to 1982 caused the decline in the investment rate observed in the later years of the 1980's. He included an interaction variable between external debt to export ratio and a dummy variable for the period 1982-1987 in the investment equation. He found that there was a positive but insignificant effect of the interaction variable implying that the large debt accumulated prior to 1982 was not the cause of the decline in investment.

Another strand of the foreign debt literature discusses the impact of crowding out effects on economic growth. This arises when the foreign debt service payments take resources away from domestic investment and the level of investment falls. Foreign debt service payments also reduce the foreign exchange that is available to the debtor countries. This will result in import compression. Servicing a higher external public debt may also require the government to increase the tax rate or reduce government expenditure. If the debt service is financed by distortionary taxes, the level of private investment decreases, as taxes will reduce the return to investment. Debt service payments that are financed through a reduction in productive public expenditure, on the other hand, will decrease public investment. Thus debt service payments may crowd out investment in two ways. The decline in the investment rate obviously will result in a fall in the growth rate of the economy. Therefore, the crowding out effect also implies that foreign debt affects growth adversely.

Some authors also argue that foreign debt affects the efficiency of investment adversely and hence may reduce growth. That is, even if the impact of foreign debt on the level of investment is not that strong, growth may still be adversely affected through a reduction in the productivity or efficiency of investment. This is because debtor countries that face enormous debt service payments may be obliged to change the mix of their investment from long term (and perhaps more productive) to short term projects. Such a change in the investment mix can have an adverse impact on economic growth; Fry (1989) and Fosu (1996,1999). To investigate this possibility, Fry (1989) included an interacting term between foreign debt and investment. Fosu (1996), on the other hand, estimated a growth equation that includes both foreign debt and an interacting term between foreign debt and investment as explanatory variables. Both authors find empirical support for the crowding out effect.

All the previously discussed studies focus on the idea that the relationship between foreign debt and growth is linear. However, recent empirical studies documented the existence of a non-linear relationship between external debt and economic growth. Fry (1989), Elbadawi et al. (1997) and Pattillo et al. (2002) found a non-linear effect of foreign debt on growth. In particular using a quadratic specification Elbadawi et al. (1997) found a debt-to-GDP ratio turning point of 97 per cent for African countries. Pattillo et al. (2002) on the other hand found a wide range of debt turning points depending on the type of debt measure and econometric methodology employed. For developing countries, Cohen (1997) showed that borrowing countries fall into a debt crisis when the debt to GDP ratio reaches 50 percent.

Some authors have also found a non-linear impact of foreign debt on the level of investment. For instance, for a sample of 28 highly indebted developing countries, Fry (1989) analyzed the impact of public and publicly guaranteed foreign debt on domestic saving, investment, and growth over the period 1967-85. In the investment regression, Fry used the ratio of external public debt to GNP and its square as explanatory variables. The empirical results of this study show that the external public debt to GNP ratio and its square are both statistically significant implying that the impact of foreign debt on investment is non-linear. In fact, the author found that the impact of external public debt on investment is positive as long as it does not exceed 55 percent of GNP. For an external public debt to GNP ratio beyond 55 percent, the impact of external public debt on investment and growth is negative. In this study, however, the external public debt to GNP ratio is included as an interacting term with the investment rate and hence the possibility of an independent effect of foreign debt on growth is ignored. Fosu (1996) and Ndung'u (1998) also find a non-linear impact of foreign debt on the level of investment.

The implication of all these studies is that the foreign debt to GDP ratio must reach a certain critical level before it affects growth adversely. That is, the effect of foreign debt on growth becomes negative only when the foreign debt level of the countries passes this critical level. But what is the critical foreign debt-to GDP ratio level beyond which the impact of foreign debt becomes negative? This is the main question that this chapter to addresses.

3-3. Data and Estimation Methods.

3-3.1. Data issues

We use panel data from 30 HIPCs and 40 other developing countries for the period 1970-1999. To smooth out short-term fluctuations in economic activity we use six five-year periods. The data sources are the Summer-Heston Penn World Table (PWT 6.1), World Development Indicators, African Development Indicators, World Economic Outlook (WEO) and Freedom House. A detailed description of the data and definitions of the variables is provided in Appendix 1.

The external public debt of the countries in the sample has exhibited a marked increase over the period under consideration. As compared to the non-HIPCs, countries in the HIPC group have accumulated a higher external public debt. Figure 3-1 shows how the external public debt of the HIPCs, non-HIPCs, and the full sample of developing countries have evolved over time.

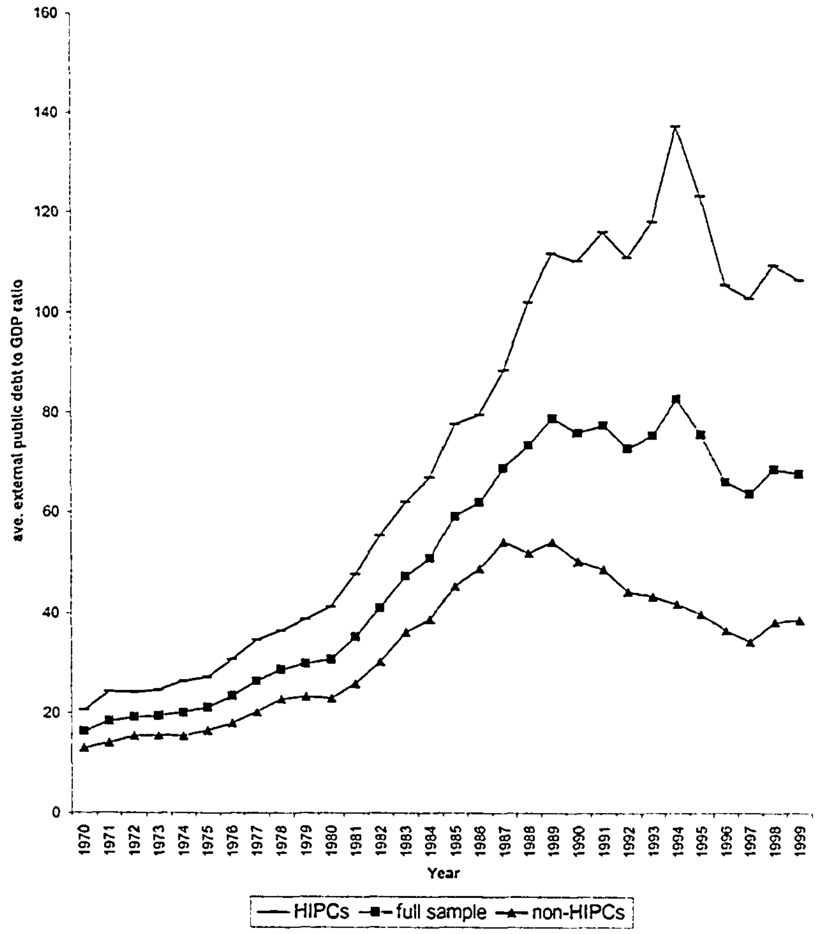


Figure 3-1 The external public debt to GDP ratio between 1970 and 1999.

The average external public debt of the HIPCs increased dramatically from 20.7 percent of GDP in 1970 to about 123 percent of GDP in 1995. Due to the large external debt accumulation, the HIPCs were forced to surrender an increasing share of their export receipts just to service the foreign debt. The external public debt service payments to export ratio of these countries was only 8.5 percent in 1970, but rose to 14.8 percent in 1995. The average figures conceal inter-country variation; a closer look at the data reveals that several countries have often used a significant portion of their export receipts just to finance the foreign debt service payments. In fact, after the 1980's many countries were unable to meet their debt service payments and thus were forced to continuously reschedule and seek debt relief. In the face of growing foreign indebtedness, the economic performance of the HIPCs has also been poor. The average per capita GDP growth rate of these countries, which was generally positive in the 1970's, became negative in the 1980's and 1990's. Over the same period, the average investment to GDP ratio fell from 11.4 percent in 1970 to just 7.65 percent in 1995.

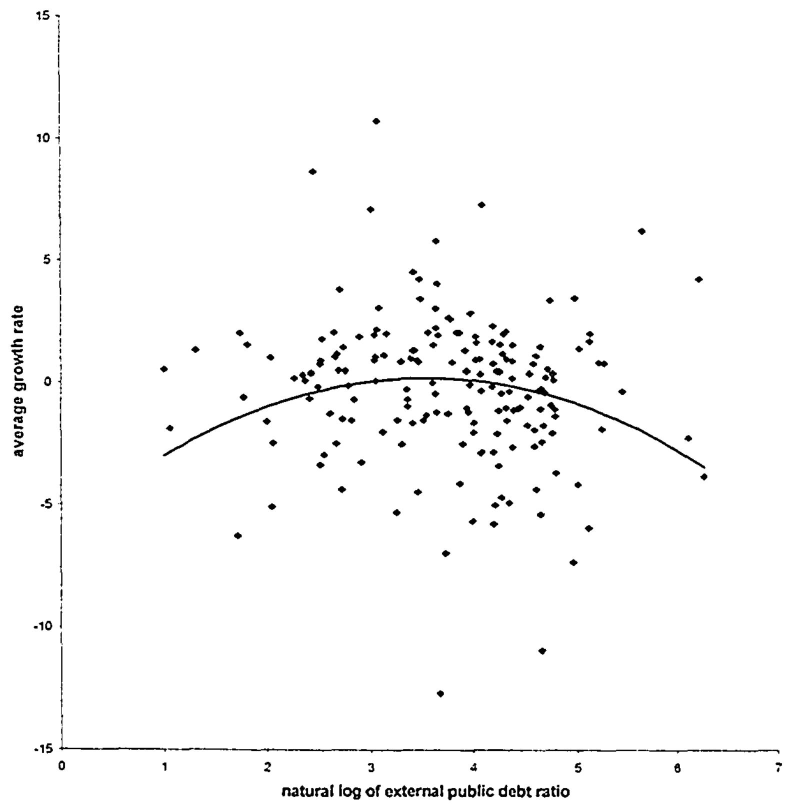


Figure 3-2 Average annual per capita GDP growth rate and average log of initial external public debt to GDP ratio (1970-1999).

The above scatter plot shows the relationship between the average annual per capita GDP growth rate of the HIPCs and the average log of initial external public debt to GDP ratio over the period under consideration. The polynomial regression curve fit into the above scatter plot suggests that the relationship between per capita GDP growth and external public debt to GDP ratio may be non-monotonic, an issue that we investigate in detail below.

3-3.2. Estimation methods

3-3.2.1. Threshold estimation method

How can we test for possible nonlinear effects of foreign debt in an empirical growth model? Previous empirical studies have attempted to address this issue by using a quadratic specification; Fry (1989), Elbadawi et al. (1997), Pattillo et al. (2002), Hansen (2001). That is, the foreign debt to GDP ratio and its square are included as explanatory variables in the regression model. In such formulation, the inverted U-shape relationship between foreign debt and growth is confirmed if the coefficient of the level of foreign debt to GDP ratio is positive and the coefficient of its square is negative. The difficulty with this approach, however, is that it imposes a strong functional restriction (i.e. quadratic specification) on the regression model. Instead, we use a continuous spline regression model that does not require a priori functional restrictions but still enables us to identify the turning point in the foreign debt-growth relationship.

Recently, Hansen (1999, 2000) has developed a methodology for threshold estimation. Threshold regression allows the regression parameters to vary depending on the threshold variable. A threshold regression model with a single threshold variable can be specified as:

$$y_{it} = \eta_i + \alpha_1' x_{it} I(q_{it} \leq \gamma) + \alpha_2' x_{it} I(q_{it} > \gamma) + u_{it} \quad , \qquad (1)$$

where $I\,(.)$ is the indicator function (which is equal to one if the expression in the parenthesis is true or zero otherwise), x_{it} is a vector of explanatory variables, q is the threshold variable, η_i represents fixed effects and u_{it} is the error term. The above specification divides the total observations into two regimes: below and above the threshold level γ.

One feature of the threshold estimation technique is that the relation between the dependent variable and the threshold variable (in our case the foreign debt variable) is discontinuous at the threshold value. To effectively search for the growth maximizing level of foreign debt, it would be better for the relation to be continuous. Consequently, we use a continuous spline model to estimate the model. A continuous spline model is similar to threshold estimation except that the former is constrained to be continuous in the threshold variable; for a similar application of this methodology see Sarel (1996), Khan and Senhadji (2001), and Cox et al. (2003). An important advantage of the continuous spline model is that it enables us to determine the growth maximizing level of the foreign debt to GDP ratio. If foreign debt affects growth favorably below the threshold value and adversely above the threshold value, then the threshold foreign debt to GDP ratio can be considered the growth maximizing level of foreign debt to GDP ratio. In such cases there will be an inverted V-shape relationship between foreign debt and economic growth.

Let f^* be the threshold level of external public debt to GDP ratio, D be a dummy variable that takes 1 when the external public debt to GDP ratio (f) exceeds the threshold level, f^* and 0 when f is less than or equal to f^*. Suppose that per capita GDP growth is denoted by $\Delta log\ (y_{it})$, where y_{it} is per capita GDP. For a vector of other control variables X_{it}, the continuous spline regression model is specified as:

$$\Delta log(y_{it}) = \eta_i + \lambda_t + \alpha_1 (1-D)[log\ (f_{it}) - log(f^*)] + \alpha_2 D[log\ (f_{it}) - log(f^*)] + \beta' X_{it} + u_{it}. \tag{2}$$

In the above specification, η_i and λ_t denote the country and time effects, respectively. Moreover, $(1-D)\ [log\ (f_{it}) - log\ (f^*)]$ and $D[log\ (f_{it}) - log\ (f^*)]$ show the impact of external public debt below and above the threshold value, respectively. Note that for a fixed value of the threshold external public debt to GDP ratio (f^*), equation (2) is a linear function of $(1-D)\ [log\ (f_{it}) - log\ (f^*)]$ and $D[log\ (f_{it}) - log\ (f^*)]$. If the threshold level of foreign debt to GDP ratio f^* was known, the above equation could easily be estimated by OLS. However, f^* is not known and hence we need to estimate the threshold foreign debt to GDP ratio along with the other parameters. In such circumstances, as Chan and Tsay (1998) have shown, the non-linear least square estimation (NLLS) method is the most appropriate one to estimate equation (2). The threshold value f^* enters equation (2) in a non-differentiable and non-linear manner. Thus the usual gradient search method of the NLLS does not work. Hansen (1999, 2000) proposed a solution to address this problem by estimating the above model by OLS for different values of f^* and choosing the value of f^* that minimizes the residual sum of squares or equivalently that maximizes the Rsquared value. As Chan and Tsay (1998) have shown these NLLS estimates are consistent and asymptotically normal.

Once the threshold value of the foreign debt to GDP ratio is found, it is important to test whether this threshold value is significant. From equation (2) the test for the statistical significance of the threshold effect is represented by the null hypothesis: H_O: $\alpha_1 = \alpha_2$. The null hypothesis, H_O states that there is no threshold effect. That is the null hypothesis implies that there is no structural break in the relationship between foreign debt and economic growth. Consequently, the threshold foreign debt to GDP ratio (f^*) is not identified under the null hypothesis. Thus classical tests do not have the usual standard distributions. That is, the usual t-and F-test statistics are invalid. To tackle this problem Hansen (1999, 2000) has suggested a bootstrapping technique. First, the fixed effects model of equation (2) is estimated under the null hypothesis, H_0. This gives the residual sum of squares S_0. Under the alternative hypothesis that there is a threshold effect, equation (2) is estimated. This provides the residual sum of squares S_1 (f^*) and the residual variance σ^2. The null hypothesis test of H_0 is then based on the likelihood ratio statistic:

$$LR_0=[S_0- S_1(f^*)]/\sigma^2. \tag{3}$$

Evaluation of the statistical significance of the threshold effect simply involves a comparison of the value obtained from equation (3) with the critical value at the chosen level of significance. Unfortunately, the asymptotic distribution of LR_0 is non-standard and the critical values for the test of the existence of threshold effects are not known. To solve this problem, we use a bootstrapping method. The bootstrapping procedure is conducted as follows. First, we generate a random sample of errors. By using the generated errors and the predicted value from the regression of the model that assumes the null hypothesis of no threshold effect, we construct a new dependent variable. Then the model would be re-estimated repeatedly with the new dependent variable. This will be done one thousand times yielding one thousand different residual sums of squares from the repeatedly estimated regressions. These are basically the bootstrapped value of the residual sum of squares under the null hypothesis of no threshold effect (S_0). Using a similar procedure, we calculate one thousand bootstrapped values of the residual sum of squares $(S_1(f^*))$ and residual variance $(\hat{\sigma}^2)$ under the alternative hypothesis. Then using equation (3) above we calculate one thousand bootstrapped values of the likelihood ratio.

The bootstrapped values of the likelihood ratios are arranged according to their numerical magnitude in ascending order. Once the likelihood ratios are arranged in ascending order, for the desired critical value, the asymptotic probability value for the test of the null hypothesis is obtained by looking at what percentage of the total bootstrapped values lie below the desired critical value. For instance, to obtain a critical value, say at 5 percent significance level, we simply take the likelihood ratio below which 95 percent of the bootstrapped likelihood ratios lie. Essentially, these likelihood ratios give us the asymptotic probability value (p-value) for the test of the null hypothesis. Then we compare this p-value with the desired critical value. The null is rejected if the bootstrapped critical value is lower than the desired critical value.

3-3.2.2. Dynamic panel estimation methods

A. Instrumental Variable (IV) method

Like many previous empirical growth studies, the empirical specification used in this paper includes the lag of log per capita GDP. This is used to test the conditional convergence hypothesis that countries with lower initial income grow faster. It is this inclusion of the lagged per capita GDP that makes the empirical model a dynamic panel. The model to be estimated in this paper takes the following form (where variables are in logarithmic form):

$$y_{it}-y_{t-1}=\beta y_{it-1}+\phi x_{it}+\eta_i+\lambda_t+u_{it}. \tag{4}$$

where y_{it} is the logarithm of per capita GDP, x_{it} is the set of other explanatory variables; η_i denote the unobserved country-specific effects, λ_t is time dummy, and u_{it} is the usual disturbance term. The growth rate is here measured as the first difference of the logarithm of per capita GDP. Equivalently equation (4) can be rewritten as

$$y_{it}=\alpha y_{it-1}+\phi x_{it}+\eta_i+\lambda_t+u_{it}, \tag{5}$$

where $\alpha = (\beta+1)$.

Equation (5) is a dynamic panel data model as the lagged dependent variable appears as an explanatory variable. One feature of a dynamic panel model of the above form is that there will be a correlation between the lagged per capita GDP variable and the η_i and / or the error term. As Hsiao (1986) shows, estimation of equation (5) by the ordinary least squares method, without taking into account the fixed country effects, will yield biased and inconsistent coefficient estimates. The problem becomes even more complicated in the presence of a lagged dependent variable as an explanatory variable.

To solve this problem, Anderson and Hsiao (1981) suggested transforming the dynamic panel data model by first differencing. First differencing of equation (5) yields the following:

$$y_{it} - y_{it-1} = \alpha(y_{it-1} - y_{it-2}) + \phi(x_{it} - x_{it-1}) + (\lambda_t - \lambda_{t-1}) + (u_{it} - u_{it-1}), \qquad (6)$$

$t=3,\ldots T$, and $i=1,\ldots,N$.

First differencing wipes out the time invariant country effects. In the above specification the differenced error term (u_{it}-u_{it-1}) and the differenced lagged dependent variable (y_{it-1}-y_{it-2}) are correlated. Anderson and Hsiao (1981) suggested estimating equation (6) by an instrumental variable estimation method that uses (y_{it-2}-y_{it-3}) or simply y_{it-2} as a valid instrument for the lagged difference dependent variable (y_{it-1}-y_{it-2}). This is because now these instruments are correlated with the lagged dependent variable but not correlated with the differenced error term. Arellano (1989) however argues that the use of (y_{it-2}-y_{it-3}) as an instrument for the lagged dependent variable results in large standard errors and is not efficient. The author instead recommends the use of a lagged level (y_{it-2}) that yields smaller variances as a better instrument.

B. Differenced General Method of Moments (Diff-GMM)

An alternative method of estimating dynamic panel data models is the differenced GMM method suggested by Arellano and Bond (1991). This method is generally more efficient than the instrumental variable method proposed by Anderson and Hsiao (1981). From equation (5) the sum of η_i and u_{it} can be thought of as the usual error term now inclusive of the fixed effects. Thus the usual standard assumptions of the error term imply [where

E(.) is the expected value operator] $E(\eta_i)=0$, $E(u_{it})=0$, and $E(\eta_i\ u_{it})=0$ for i=1, …, N and t=2,…,T. The initial conditions y_{i1} are predetermined and satisfy $E(y_{i1}\ u_{it})=0$ for i=1, …, N and t=2,…,T. If we also assume that u_{it} has finite moments- that is $E(u_{it}u_{is})=0$ for i=1, …, N and s≠t, then the above assumptions imply that level values of y lagged two periods or more are valid instruments in the set of first differenced equations. That is the above assumptions imply the following moment restrictions:

$E(y_{i,t-s}\ \Delta u_{it})=0$, for i=1, …, N and t=3,…,T and s≥2. (7)

The implication of this moment restriction is that level values of y lagged two periods or more are valid instruments in the set of first differenced equations, as they are not correlated with the differenced error terms. Note that a variable can be an instrument if it is correlated with the endogenous variable (for which an instrument variable is sought) but uncorrelated with the error term.

The available valid instruments for the other explanatory variables (denoted collectively as x_{it}), on the other hand, depend on whether the variables are strictly exogenous, predetermined or endogenous. If x_{it} is predetermined that is $E(x_{it}u_{is})=0$ for $s<t$, then all level values of x_{it} lagged one period or more are valid instruments. If, on the other hand, x_{it} is strictly exogenous, in the sense that the variables are not correlated with the disturbance term, that is $E(x_{it}u_{is})=0$ for all s, t, then past, present and future values of the variable can be used as instruments. Suppose x_{it} is endogenous that is $E(x_{it}u_{is})\neq 0$ for $s\leq t$ and $E(x_{it}u_{is})=0$ for $s>t$, then the level values of the variable lagged two periods or further can be used as valid instruments in the differenced equations.

C. System GMM (sys-GMM)

The first differenced GMM estimator discussed above mainly depends on the moment conditions of equation (7). In a dynamic panel model context, many previous empirical models rely on the differenced GMM econometric method to solve the problem of endogeneity of the explanatory variables caused by the inclusion of the lagged dependent variable. Recent econometric studies of Arellano and Bover (1995) and Blundell and Bond (1998), however, have pointed out the shortcomings of the differenced GMM estimator. One problem of the differenced GMM estimator is that first differencing of the variables eliminates fixed country effects and therefore important information about time invariant country characteristics will be lost. Secondly, the differenced GMM estimator suffers from weak instruments and produces biases in finite samples and the estimates are asymptotically inefficient. That is, the differenced GMM model has performed poorly in terms of bias, efficiency and precision of estimates in finite samples; Blundell and Bond (1998), Blundell et al. (2000), Bond et al. (2001).

In order to solve these problems of first differenced GMM models and obtain a more appropriate method of estimating dynamic panel data models, Arellano and Bover (1995) and Blundell and Bond (1998) proposed a system GMM procedure that involves the simultaneous estimation of a set of level and differenced equations. For the system GMM estimator, in addition to the above-mentioned assumptions of the differenced GMM model, Blundell and Bond (1998) introduced the following assumption:

$$E(\eta_i \Delta y_{i2})=0 \text{ for } i=1, \ldots, N. \qquad (8)$$

That is the time invariant fixed effects are uncorrelated with the differenced y_{i2}. Equation (8) is a restriction imposed on the initial condition process generating y_{i1}. The previously mentioned standard assumptions (of sub-section B above) and the initial condition restriction of equation (8) yield the following additional linear moment restriction:

$E(v_{it}\ \Delta y_{it-1})=0$ for i=1, ..., N and t=3,4,...,T, (9)

where $v_{it} = \eta_{it}+u_{it}$.

The significance of the moment restriction of equation (9) is that it allows lagged first differences of y to be used as instruments in the level equations. For the other variables, if the x_{it} are endogenous or predetermined, then lagged first differenced values of the variables can be used as instruments. If, on the other hand, the x_{it} are strictly exogenous, then we use first difference of the variables as instruments in the set of level equations (Blundell et al. (2001) and Hoeffler (2000)). Thus the system GMM model adds a set of level equations to the set of differenced equations of the differenced GMM estimators. In other words, while the differenced GMM model is based on the estimation of a set of differenced equations using the moment condition of equation (7), the system GMM model involves simultaneously estimating the set of differenced and level equations (i.e., equations (5) and (6)) using the moment conditions of equations (7) and (9). By including an additional set of equations in levels, the system GMM model retains information about the time invariant country effects. In both the differenced GMM and the system GMM models, the validity of the instruments used can be tested using a Sargan test for over-identification restrictions. A detailed discussion of the system GMM model can be found in Arellano and Bover (1995), Blundell and Bond (1998), Blundell et al. (2000), and Bond et al. (2001).

3-4. Model specification

The empirical model is based on the endogenous growth model augmented with foreign debt. The possible non-linear effect of the external public debt ratio on the growth rate is explicitly specified. The vector of control variables includes variables that are deemed to be essential in explaining growth and include: initial per capita income, the government consumption expenditure to GDP ratio, the rate of inflation, population growth rate, openness, foreign aid, terms of trade growth, secondary school enrolment, and democracy index.

Suppose $\Delta log(y_{it})$ is per capita GDP growth, Π is the rate of inflation, i is the investment to GDP ratio, g is the government consumption to GDP ratio, $S2$ is the secondary school enrolment rate, *FSX* is the public and public-guaranteed foreign debt service to export ratio, *DEMO* is the democracy index, *Yo* is the initial per capita GDP, *OPEN* is openness, *POP* is the population growth rate, *ODA* is the official development assistance to GDP ratio, *XTRA* is the external debt ratio below the threshold level and *EXTRA* denotes external debt ratio above the threshold level.[13] The model to be estimated is given as:

[13] That is *XTRA* and *EXTRA* denote $(1-D)\ [log(f_i)-log(fi^*)]$ and $D[log(fi)-log(f_i^*)]$, respectively.

$$\Delta Log(y_{it}) = \eta_i + \lambda_t + \alpha_0 log(Yo) + \alpha_1 XTRA_{it} + \alpha_2 EXTRA_{it} + \alpha_3 Log(S2_{it})$$

$$+ \alpha_4 \Pi_{it} + \alpha_5 Log(g_{it}) + \alpha_6 Log(POP_{it}) + \alpha_7 Log(OPEN_{it}) + \alpha_8 DEMO_{it} +$$

$$\alpha_9 Log(FSX_{it}) + \alpha_{10} Log(ODA_{it}) + \varepsilon_{it}. \qquad (10)$$

The above equation, which is specified in natural log form, falls in the class of one-way error fixed effects models. The time invariant unobserved country specific effects are captured by η_i. λ_t, on the other hand, represents country invariant time dummies.

As Fischer (1993) argues, macroeconomic variables affect growth through changes in the level of investment and productivity. In the growth literature many authors estimate growth regression equations that include investment as a control variable. However, it is difficult to interpret the impact of policy variables in growth regressions that include investment as one of the explanatory variables. If investment is one of our control variables, it means that the impact of any macroeconomic variable of interest on growth rate must be through a different channel, as investment is not allowed to change. Thus in order to circumvent this problem Fischer (1993), Barro (1997), King and Levine (1993), Easterly and Levine (1997), Burnside and Dollar (2000), Levine, Loayza, and Beck (2000), and Dalgaard and Hansen (2001), among others, exclude investment from the growth regression to examine the impact of macroeconomic variables on growth. Thus equation (10) above does not include the investment rate as one of the explanatory variables. This is because if we control for the level of investment it implies that any impact of foreign public debt on growth must be through productivity.

Previous empirical studies on the relationship between external debt and growth generally include investment as an explanatory variable; see Fosu (1996,1999) and Pattillo et al. (2002). However such a procedure is not appropriate if one also wants to investigate whether the foreign debt affects growth by changing the level of investment. Thus in order to analyze the channel through which foreign debt affects economic growth, we estimate the model by dropping the investment to GDP ratio. Furthermore, to examine how foreign debt affects investment, following Barro (1997), Fischer (1993), King and Levine (1993) and others we estimate an investment equation by using the right hand variables in the above model as explanatory variables. This will enable us to see whether the debt overhang hypothesis holds and shed some light on how changes in the foreign public debt affect investment and growth.

According to economic growth theory, human capital is important in explaining economic growth. Thus the model includes human capital measured by secondary school enrolment rate. Since human capital is a factor of production in the endogenous growth model, an increase in this variable will result in a rise in domestic output. Consequently, in the estimated regression we expect the coefficients of schooling to be positive.

Although our empirical analysis is based on endogenous growth models, in the tradition of empirical growth models, we also include initial income in the growth regression. That is, to allow for conditional convergence, we include the log of lagged real per capita GDP at the beginning of each period; for a similar treatment of this variable in endogenous growth model see for instance Kneller et al. (1999) and Bleaney et al. (2001). If the conditional convergence hypothesis holds, we expect the coefficient of lagged initial per capita GDP to be negative.

The variables *XTRA* and *EXTRA* are included to take into account the possible non-linear impact of foreign public debt on the growth rate and investment. More specifically, in the above specification *XTRA* and *EXTRA* capture the impact of external public debt below and above the threshold level, respectively. If a low external public debt to GDP ratio is favorable for growth and a high external public debt ratio is detrimental to growth we expect the estimated coefficient of low external public debt ratio (α_1) and high external public debt ratio (α_2) to be positive and negative, respectively.

Apart from the adverse incentive effect of debt overhang, foreign debt may also have a crowding out effect. That is, foreign debt service payments require resources be transferred away from domestic use. In the case of external public debt, this implies the need to reduce government expenditure, or to raise taxes, in order to finance the foreign debt. This is particularly true if the borrowing countries have not registered enough economic growth. A reduction in public investment arising from the need to service external public debt and a decline in private investment that resulted from an increase in taxes reduce economic growth. This is essentially the crowding out effect of foreign debt. In equation (10) above this effect is captured by the public and public-guaranteed debt service to export ratio (FSX). Because of the crowding out effect explained above we expect the coefficient of this variable to be negative.

In the above specification, the rate of inflation and government consumption expenditure to GDP ratio are included to capture the stability of the domestic economy. Prices play an important role in an economy by giving the different agents the desired signal in their attempt to allocate resources efficiently. High and rapidly increasing prices distort this role of prices. Thus a high level of inflation may be inimical to economic growth by adversely affecting the decision-making effort of agents; for the details see for instance Barro (1997) and Khan and Senhadji (2001). Thus we expect the coefficient of inflation to be negative.

Government consumption expenditure is generally believed to be one determinant of economic growth [Barro (1997), Commander et al. (1997), Miller and Russek (1997), and Bleaney et al. (2001)]. Expenditure by the government for non-productive purposes crowds out investment. That is, government consumption expenditure results in a reduction in public investment (if resources are shifted away from productive public expenditure) or a decline in private investment (if financed by distortionary taxes). Thus in the empirical model we expect the coefficient of government consumption expenditure to GDP ratio to be negative.

Developing countries generally depend on imported capital in their development endeavor. Countries that are more open to the international markets can generally export more. This enables them to import more goods and services that are essential for domestic output expansion. Therefore, we expect the coefficients of openness to be positive [Barro (1997), Easterly and Levine (1997), and Collier and Gunning (1997)].

In the literature, the impact of foreign aid on economic growth is mixed. While Hansen and Tarp (2000, 2001) have found that foreign aid affects growth positively, Dollar and Easterly (1999) and Burnside and Dollar (2000) have argued that the impact of foreign aid on growth depends on whether the policy environment is conducive. In fact, most recent studies confirm that foreign aid affects growth positively. Earlier works of Griffin (1970) and Griffin and Enos (1970), on the other hand, argue that foreign aid affects growth adversely. Still some authors suggest that the impact of foreign aid depends on the level of the flow of aid. But in our case, in line with most of the recent studies, we expect the coefficient of aid to GDP ratio to be positive.

Many studies have found that good governance or the efficiency of the government is an important determinant of economic growth [Barro (1997) and Commander et al. (1997)]. To capture this effect, following Barro (1997) we use the political freedom index as a democracy index. This index is a subjective measure in the 1 to 7 scale; 1 being the best and 7 the worst. We think that political freedom encourages investment and hence affects the growth rate of the economy positively. Consequently, we expect the coefficient of the democracy index to be negative, i.e. the higher the democracy index, the worse is the political freedom in the country and hence investment and growth will be adversely affected.

The population growth rate is relevant in explaining growth in developing countries. In countries where population growth is high, fertility is generally high and hence resources will be diverted away from productive purposes to raising children (Barro, 1997). Moreover as the population increases, part of an economy's investment is used to supply capital for the growing labor, and the capital-labor ratio will fall. Both of these effects of population growth depress the per capita growth rate. Thus we expect the coefficient of population growth rate to be negative.

3-5. Empirical results

3-5.1. Threshold effects of external public debt

3-5.1.1. Threshold estimation

Threshold estimation enables us to show the impact of foreign public debt on economic growth below and above the threshold value (f^*). Unfortunately, the threshold value (f^*) is not known. Therefore we need to obtain the value of f^* along with other parameter estimates using the procedure discussed above. In our case, we estimate equation (10) by ordinary least squares (OLS) for different values of f^* ranging from 1 to 100 percent changing by a percentage point each time. This involves estimation of 100 different regression equations. Then from these different regressions we choose the value of f that minimizes the residual sum of squares. From this estimation procedure the residual sum of squares is minimized when f^* is 22 percent and 31 percent for the HIPCs and the full sample, respectively. Thus the threshold level of external public debt to GDP ratio is 22 percent for the HIPCs and 31 percent for the full sample.[14]

[14] For comparative purposes, we have also estimated the threshold value for the total external debt to GDP ratio. Using a similar procedure, we found that the threshold total external debt to GDP ratios for the HIPCs and the full sample are 23 and 31 percent, respectively.

To examine whether there is also a threshold effect of external public debt on investment, we estimate the same model except that the dependent variable is the log of investment to GDP ratio. For the investment regression, we found that the threshold external public debt to GDP ratio is 26 percent for both the HIPCs and the full sample. Note that the threshold values for both the growth and investment regressions are not affected much by the inclusion or exclusion of the different control variables. In the growth regression, the threshold values can be considered as growth maximizing levels if foreign debt affects growth positively below these values and negatively above the values.

The following table shows the percentage of countries that fall in the high external public debt regime over the different time periods under consideration.

Table 3-1 Percentage of countries in the regime above the threshold external public debt to GDP ratio

	External public debt to GDP ratio	1970	1975	1980	1985	1990	1995	1999
HIPCs	>22%	30	50	73.3	90	100	100	100
Full sample	>31%	12.9	21.4	35.7	77.1	84.3	74.3	68.6

Over the entire sample period 1970-1999, about 74 percent of the total observations in the HIPCs group belong to the regime where external public debt to GDP ratio is in excess of the threshold level. From the whole sample, on the other hand, only 51 percent of the total observations belong to the regime where the external public debt to GDP ratio is above the threshold level of 31 percent. When we see the location of individual countries over the different periods, in the later periods of the sample, more and more countries fall in the regime where foreign public debt to GDP ratio is in excess of the threshold value. This can be easily seen from Table 3-1 above. Beginning from 1990, all HIPCs fall in the regime where foreign public debt is higher than the threshold level. Looking at the whole sample, on the other hand, we see that in the later years a growing number of countries fall in the regime where foreign debt to GDP ratio is above the threshold value.

How does this result compare with previous empirical findings? Fry (1989) explicitly analyzed the impact of public and public guaranteed foreign debt on economic performance of highly indebted countries. Using a quadratic specification the author found that external public and public guaranteed debt affects investment adversely if it exceeds about 55 percent of GNP. For a sample of African countries, Elbadawi et al. (1997) have found an even higher turning point in the relationship between foreign debt and growth. They have found that the turning point for the external debt induced growth Laffer curve occurs when the foreign debt to GDP ratio reaches 97 percent. In analyzing the foreign debt crisis of developing countries, Cohen (1998) has found that these countries are likely to fall into a debt crisis when the foreign debt to GDP ratio is above 50 percent. For African countries, Ndung'u (1998) also found that the debt overhang effect on investment starts when the external debt to GDP ratio reaches about 34 percent. Pattillo et al. (2002) reported external debt to GDP ratio turning points ranging from 1.32 percent to 19.04 percent using various estimation techniques. Thus the threshold estimates of this paper are well within the range of previous empirical studies.

3-5.1.2. Test for threshold effects

Once the threshold value of the external public debt to GDP ratio is found, it is important to test whether this threshold value is significant. Thus, employing the procedure discussed in the previous section, we calculate the bootstrap value of the likelihood ratio statistic using 1000 bootstrap replications. These likelihood ratios give us the asymptotic probability value for the test of the null hypothesis that there is no threshold effect. Specifically, we arrange the likelihood ratios according to their magnitudes and the proportion of the likelihood ratio values that are higher than the actual likelihood value gives us the probability value at which the threshold effect is significant. The results of the tests for the threshold effects from the growth and investment regressions are reported in Tables 3-2a and 3-2b below.

Table 3-2a Test Result of Threshold effects-growth regression
Dependent variable is five-year average per capita GDP growth rate.

Sample	Search range	Threshold estimate (%)	LR_0	Critical Values	Significance level
HIPCs	{1,2,3... 100}	22	14.86	6.99	0.01
Full sample	{1,2,3... 100}	31	13.03	12.03	0.01

Table 3-2b Test Result of Threshold effects-investment regression
Dependent variable is the log of five-year average investment to GDP ratio.

Sample	Search range	Threshold estimate (%)	LR_0	Critical Values	Significance level
HIPCs	{1,2,3... 100}	26	11.10	7.18	0.01
Full sample	{1,2,3... 100}	26	10.08	6.59	0.01

The test for threshold effect is conducted for all countries and for the HIPCs separately for the period 1970-1999. As shown in the second column of Table 3-2a, for the growth regression, the search for the threshold level of foreign public debt to GDP ratio was conducted between 1 and 100 percent.[15] This resulted in 100 regression equations. For the HIPCs and the full sample, the actual likelihood ratios (LR_o) are 14.86 and 13.03, respectively. The threshold value is statistically significant if the actual likelihood ratio is greater than the critical value obtained from the bootstrap procedure at the desired level of significance. In our case, the threshold estimates are significant at 1 percent significance level for both the HIPCs and the full sample implying that there is indeed a threshold effect of external public debt on economic growth. Likewise, as Table 3-2b shows, for the investment regression, the threshold effects are significant. Thus external public debt has a threshold effect on both investment and growth.

In the growth regression, the existence of the threshold effects only shows us that there is a structural break in the relationship between external public debt and economic growth. However, in order to investigate whether the effect of external public debt on investment and economic growth is different for external debt to GDP ratios below and above this threshold value we need to estimate the regression model.

3-5.2. Estimation results

[15] According to Hansen (1999, 2000) estimating the threshold value by dropping a certain fraction of the observations at the extreme ends does not affect the result but saves computing time. Consequently, even if there are few observations in excess of 100 % we ran the estimation from 1 to 100 percent. Running the estimation over the whole range of the observed foreign debt to GDP ratio values, however, does not affect the result.

3-5.2.1. Growth regressions

This section reports the dynamic panel results of estimating the growth equation on the various explanatory variables. As discussed before, the inclusion of lagged initial per capita GDP creates a potential endogeneity problem. Moreover some of the other explanatory variables may be endogenous. In such cases the OLS and the within group fixed effects model give biased and inconsistent estimates. The differenced GMM estimator performs poorly in finite samples due to the use of weak instruments. The system GMM model developed by Arellano and Bover (1995) and Blundell and Bond (1998), on the other hand, allows us to address the problem of endogeneity and omitted variable bias simultaneously by using appropriate instruments. Consequently, we estimate the dynamic panel growth equation using the system GMM estimation procedure.

Table 3-3 Growth Regressions (SYS-GMM)

Dependent variable is five-year period average annual growth rate of per capita GDP

	HIPCs				Full sample			
Regression	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial per capita income [a]	-3.60*** (-3.20)	-3.41*** (-3.37)	-3.21*** (-3.02)	-3.87*** (-3.82)	-1.60** (-2.01)	-1.26* (-1.66)	-1.57** (-2.06)	-1.33* (-1.87)
Schooling [a]	0.59 (0.83)	0.30 (0.51)	0.47 (0.72)	1.41** (2.38)	0.90* (1.81)	1.01** (2.00)	0.85* (1.76)	0.61 (1.35)
Population growth rate [a]	-6.97 (-1.56)	-7.74* (-1.78)	-6.40 (-1.46)	-7.10* (-1.70)	-4.19* (-1.89)	-2.93 (-1.36)	-4.18* (-1.89)	-4.79* (-2.31)
Democracy index	-0.24 (-1.40)	-0.30* (-1.81)	-0.29* (-1.71)	-0.27* (-1.70)	-0.23** (-2.09)	-0.20* (-1.87)	-0.23** (-2.10)	-0.20** (-1.97)
Inflation rate	-0.0004 (-0.49)	-0.001 (-0.53)	-0.001 (-0.77)	-0.001 (-0.62)	-0.001 (-0.48)	-0.0003 (-0.25)	0.001 (0.47)	0.0003 (0.29)
Government consumption ratio [a]	-0.96* (-1.69)	-0.62 (-1.11)	-0.89* (-1.67)	-0.80 (-1.44)	-0.26 (-0.65)	-0.17 (-0.43)	-0.25 (-0.65)	-0.46 (-1.27)
Openness [a]	1.89* (1.80)	2.17** (2.11)	1.78* (1.78)	1.19 (1.22)	1.27** (2.44)	1.00* (1.92)	1.26** (2.46)	0.54 (1.06)
Aid to GDP ratio [b]	0.48 (0.61)	0.06 (0.10)	0.32 (0.47)	0.59 (0.89)	-0.66 (-1.52)	-0.50 (-1.00)	-0.69 (-1.32)	0.09 (0.18)
Low external public debt ratio[a]		1.95** (2.33)		0.79 (0.69)		1.05** (2.13)		0.60 (1.44)
High external public debt ratio [a]		-1.22* (-1.91)		-1.16* (-1.90)		-0.88* (-1.81)		-0.76* (-1.75)
Debt service to export ratio			-0.001 (-0.02)				-0.008 (-0.33)	
Investment to GDP ratio [a]				1.15** (2.04)				1.52*** (3.15)
m2	0.39	0.42	0.37	0.35	0.51	0.50	0.52	0.58
Sargan test (p-value)	0.85	0.88	0.75	0.89	0.061	0.12	0.16	0.10
No. of observations	135	135	135	135	330	330	330	330

*, **, and *** show that coefficients are significant at 10%, 5%, and 1% significance levels, respectively.

[a] In the regression these variables enter as log (variable).

[b] In the regression this variable enters as log (variable +1).

m2 is the probability value for the second order serial correlation test.

Threshold external public debt to GDP ratios of 22% and 31% are used for HIPCs and full sample, respectively.

The results of the growth regressions for the two groups of countries are presented in Table 3-3 above. The figures in parentheses are t-ratios calculated from heteroscedasticity robust standard errors. *M2* denotes the probability value for the second order serial correlation test. In the growth regressions, we treat external public debt, debt service to export ratio, and foreign aid as potential endogenous variables. Note also that in all the growth regressions the dependent variable is the five-year average annual growth rate of real per capita GDP for the periods 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, and 1995-1999. Since the first period is lost though first differencing, the model is estimated over the last five periods yielding 150 observations for the 30 HIPCs and 350 observations for the full sample. We also dropped outlier observations and this further reduced the number of observations.[16] Time dummies are included in all the growth regressions and they are found to be jointly significant across all regressions. The reported growth regression results are one-step system GMM estimates.

The estimated growth regressions satisfy the various specification tests. The overall validity of the instruments used is tested using the Sargan test for over identification. The null hypothesis in the Sargan test is that the instruments used are valid. As Table 3-3 above shows, in the estimated growth regressions the Sargan test statistics for the null hypothesis of valid instruments cannot be rejected at the conventional 5 per cent level of significance supporting the validity of the instruments used in the growth regression.

[16] Outliers are defined as observations that deviate from their respective mean values by more than 5 standard deviations.

As Arellano and Bond (1998) and Blundell and Bond (1998) have shown the consistency of the GMM estimators depends on the absence of serial correlation in the error terms. Thus it is essential to test for the existence of autocorrelation in the first differenced disturbance terms. If there is no serial correlation in the level residuals, then the test for autocorrelation should show no evidence of second order serial correlation in the differenced residuals. In the above table, the probability values associated with the tests for the second order serial correlation in the residuals is denoted by *m2*. As we can see from Table 3-3 above, there is no evidence of second order serial correlation in the differenced error terms. Thus there is no evidence of autocorrelation in the level residuals implying that the coefficients are estimated consistently.

We begin with a regression of the growth model that includes only the control variables shown in columns (1) and (5) in the above table. In both regressions, the logarithm of initial per capita income is negative and statistically significant. Openness also appears to have a significant positive effect on growth for both sample groups. The democracy index denotes the level of political rights that varies from 1 (best) to 7 (worst). By construction a lower democracy index shows a better democratic environment. Thus the expected sign of the democracy index is negative; the lower the index the more democratic a country is. Regression (5) shows that for the full sample, the democracy index is statistically significant implying that democratization helps to improve economic growth. However, this effect is insignificant for the HIPCs. Moreover, for the full sample while population growth affects growth adversely, schooling which is used to capture human capital has a significant positive effect on growth. Government consumption expenditure appears to have a significant negative effect only in the HIPCs. Regressions (1) and (5) also show that foreign aid and inflation do not have significant effects on the growth rate.

Regressions (2) and (6) show the main result of this chapter and we focus our analysis on these regressions. As we argued before, the effect of external public debt ratio on growth depends on whether it is below or above the threshold level. In fact we have shown that this threshold effect is statistically significant. Consequently, for the HIPCs and the full sample, the above growth regressions assume threshold external public debt to GDP ratios of 22 percent and 31 percent, respectively. Thus, using these threshold external public debt ratios, we estimate the impact of external public debt on the growth rate. The coefficient associated with the low foreign public debt to GDP ratio variable is positive and statistically significant for both the HIPCs and the full sample. This suggests that the marginal impact of foreign public debt on the growth rate below the threshold level is positive. The coefficient associated with the high external public debt ratio, on the other hand, is negative and significant in both sample groups implying that the marginal effect of high external public debt on growth is negative. An important implication of such findings is that the debt-overhang hypothesis holds only when countries accumulate foreign public debt in excess of the threshold value.

The estimated magnitudes of the effects of high external public debt on the growth rate are also economically significant. A closer look at regressions (2) and (6) show that the numerical magnitudes of the estimated coefficients of external public debt are higher in the case of the HIPCs. In particular, excessive external public debt appears to have a stronger adverse effect on the growth rate in the case of the HIPCs. From the growth regressions of columns (2) and (6) of Table 3-3, the estimated coefficients of high debt ratio are –1.22 and –0.88. These coefficients mean that a one percent reduction in the external public debt ratio above the threshold value will result in an increase in the per capita GDP growth by about 0.012 and 0.01 percentage points per period for the HIPCs and the full sample, respectively.[17]

Currently there is an ongoing effort to reduce the foreign debt of eligible poor countries through the HIPC debt relief initiative. In such circumstances it is interesting to see the likely impact of foreign debt reduction on the economic growth of these countries.[18] This can be shown with a numerical exercise using the value of the estimated coefficients of the debt variables and controlling for the effect of the other variables. The finding of a strong negative effect of high external public debt on the growth rate has an important implication in the context of the HIPCs. At the beginning of the HIPC debt relief initiative program the outstanding external public debt of the eligible countries was in excess of the critical foreign debt to GDP ratio. The empirical results of this chapter suggest that debt relief, as currently being implemented under the HIPC initiative program would have a favorable impact on their per capita GDP growth. For instance, the above empirical result suggests that for the HIPCs halving their external public debt would result on average in an increase in their per capita GDP growth by 0.85 percentage

[17] The impact of a certain (say *m*) percentage change in the external public debt ratio on the growth rate is obtained by using the following: *change in the growth rate = estimated coefficient X ln(1+m)*, where ***ln*** denotes natural logarithm.

[18] The fourth chapter of the dissertation will be devoted to the analysis of debt relief and investigation of the current HIPC debt relief initiative.

points. As we will see later, debt reduction will also increase investment. Thus, if one takes into account the impact of debt reduction on growth through the investment channel, the growth benefits of debt relief will be larger.

To examine the possible crowding-out effect of foreign debt service payments on the growth rate, we include the debt service to export ratio in the growth regression. There is a high degree of multicollinearity between the debt service to export ratio and the external public debt to GDP ratio. Consequently, to focus on the impact of debt service payments we dropped the outstanding external public debt ratios. These results are reported in regressions (3) and (7) of Table 3-3 above. The expected sign of the coefficient of the debt service to export ratio is negative. For both groups of countries the estimated coefficient has the expected sign but it is statistically insignificant. This implies that the direct effect of debt service payments on the growth rate is not significant.

When we look at the other control variables in regressions (2) and (6), we see that all variables have their expected signs. Lagged per capita GDP enters the regression to capture the conditional convergence hypothesis. Our estimated coefficient of the logarithm of initial per capita GDP is negative and significant across the different growth regressions. This implies that the data from our sample countries lends support to the conditional convergence hypothesis.

The secondary school enrollment rate (which is used as a proxy for human capital) has the expected sign in both the HIPCs and the full sample but it is statistically significant only when we use the full sample data sets. For both sample groups, the coefficient of openness, on the other hand, is found to be positive and statistically significant. Thus, in the sample countries, openness has a positive effect on growth. The coefficient estimate of population is found to be negative for both the HIPCs and the full sample but it is significant only in the case of the former.

Does a good political environment encourage investment? If so, the expected sign of the coefficient of the democracy index is negative. The lower the index, the higher will be the per capita GDP growth.[19] For both the HIPCs and the whole sample, the estimated coefficient of the democracy index is negative and significant suggesting the importance of favorable political environment for economic growth.

We have used the government consumption expenditure to GDP ratio and the inflation rate in the growth regression to capture the possible impact of domestic macroeconomic stability. For both the HIPCs and the full sample, the estimated coefficients of inflation and government consumption expenditure are negative as expected but they are statistically insignificant.

External public debt can affect the growth rate indirectly by affecting the investment rate or directly by affecting productivity, say due to misallocation of resources. In order to see how foreign public debt affects the growth rate through productivity we also control for the investment rate. Once the investment rate is controlled for any effect of external public debt on the growth rate must be through the productivity channel. Thus in the

[19] For the details on the interplay between political rights and economic growth see Barro (1997).

growth regression, we include the low and high external public debt ratio variables along with the investment rate as explanatory variables. These results are reported as regressions (4) and (8) in Table 3-3. For both the HIPCs and the full sample, this resulted in a positive and highly significant coefficient for the investment rate. Now the effect of low external public debt is positive and insignificant for both groups. Thus if we control for the rate of investment in the growth regression the positive impact of low external public debt on the growth rate will be significantly reduced. The negative impact of high external public debt ratio on the growth rate, on the other hand, remains negative and significant whether we control for investment or not. This finding suggests that the adverse impact of high external public debt ratio on the growth rate works both through the productivity and investment channels. To explore the investment channel further, we estimate the investment regressions in the following section.

3-5.2.2. Investment regressions

In the previous section, we have shown that external public debt affects the growth rate non-linearly. We now turn to analyzing the investment channel through which external public debt affects the growth rate. Previous studies on the foreign debt mainly focused on the impact of foreign debt on economic growth. In this section following Barro (1997) and Cohen (1993) we estimate a structural equation for investment for both groups of countries. The explanatory variables are basically similar to those used in the growth regression. That is we run the same model as the growth regressions of the previous section except that now the dependent variable is the natural logarithm of the investment (both public and private investment) to GDP ratio. Instead of estimating the growth and investment equations simultaneously we focus on a separate analysis of the growth and investment regressions because we want to capture both the direct and indirect effects of external public debt ratio on the growth rate.

In the investment regressions, we used a threshold external public debt to GDP ratio of 26 percent for both HIPCs and the full sample. Because now there is no lagged dependent variable in the investment regression, we use the fixed effects estimation method that is commonly used in the literature. The results of the investment regressions are presented in Table 3-4. The reported t-ratios are based on heteroscedasticity and autocorrelation robust standard errors.

Regressions (1) and (5) are the basic regressions that contain only the control variables. For the HIPCs, regression (1) shows that while population growth rate and schooling affect investment positively, inflation and initial per capita income appear to have a negative impact. For the full sample, on the other hand, we find that openness and population growth rate have a significant positive effect on investment.

Table 3-4 Investment Regressions (fixed effects estimation method)
Dependent variable is the log of five-year period average investment to GDP ratio.

	HIPCs				Full sample			
Regression	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Initial per capita income [a]	-0.41** (-2.15)	-0.32 (-1.49)	-0.27 (-1.17)	-0.39* (-1.92)	-0.05 (-0.49)	-0.09 (-0.85)	-0.13 (-1.06)	-0.06 (-0.53)
Schooling [a]	0.34*** (2.65)	0.01 (0.09)	0.13 (0.99)	-0.05 (-0.43)	0.10 (1.09)	-0.001 (-0.01)	0.003 (0.09)	0.07 (0.81)
Population growth rate [a]	2.17*** (2.82)	1.91*** (2.70)	1.09 (1.31)	1.10* (1.69)	0.98** (2.37)	1.23*** (3.02)	0.78* (1.87)	1.04*** (2.60)
Democracy index	-0.01 (-0.27)	-0.02 (-0.73)	0.003 (0.13)	0.003 (0.10)	-0.01 (-0.82)	0.001 (0.08)	-0.01 (-0.54)	-0.01 (-0.70)
Inflation rate	-0.0002** (-2.35)	-0.0001* (-1.93)	-0.0002* (-1.78)	-0.0001 (-1.46)	-0.0001 (-1.16)	-0.0002* (-1.80)	-0.0002** (-2.12)	-0.0001 (-1.22)
Government consumption ratio [a]	0.16 (1.36)	0.22* (1.73)	0.19 (1.33)	0.16 (1.43)	0.08 (0.84)	0.17* (1.74)	0.18 (1.78)	0.06 (0.61)
Openness [a]	0.29 (1.57)	0.34* (1.82)	0.32** (2.03)	0.32* (1.79)	0.46** (5.22)	0.40*** (4.75)	0.38*** (4.39)	0.42*** (4.43)
Aid to GDP ratio [b]	0.09 (0.81)	-0.13 (-1.26)	-0.07 (-0.68)	-0.08 (-0.81)	-0.09 (1.48)	-0.10 (-1.64)	-0.12* (-1.97)	-0.08 (-1.26)
Low foreign public debt ratio [a]				0.33*** (2.86)				0.10* (1.74)
High foreign public debt ratio [a]				-0.24*** (-2.85)				-0.14** (-2.22)
Debt service to export ratio		-0.003 (-0.52)				-0.006** (-2.29)		
Lagged debt service ratio			-0.02*** (-3.46)				-0.01*** (-3.62)	
Adjusted R^2	0.63	0.61	0.62	0.64	0.72	0.72	0.75	0.73
No. of observations	177	177	147	175	416	416	346	414

The figures in parentheses are heteroscedasticity and autocorrelation robust t-statistics.
Note also that *, **, and *** show that coefficients are significant at 10%, 5%, and 1% significance levels, respectively.
[a] In the regression these variables enter as log (variable).
[b] In the regression this variable enters as log (variable +1).
A threshold external public debt to GDP ratio of 26 percent is used for both the HIPCs and full sample.

The investment regressions that include external public debt ratio are shown in columns (4) and (8) of Table 3-4. The key finding is that the impact of foreign public debt on investment is similar to its effect on the growth rate. In particular, while a low external public debt ratio increases investment, a high external public debt ratio reduces investment significantly. This is consistent with the previous finding that the debt overhang effect begins only when the external public debt passes the threshold external public debt ratio. Thus foreign public debt affects investment non-linearly exactly in the same way as it affects the growth rate.

The results from the investment regressions suggest that the favorable effect of a low external public debt to GDP ratio on the growth rate emanates from its positive impact on investment. That is, the investment rate is the main channel through which external public debt affects the growth rate positively. This is because external public debt can be used to finance investment that in turn increases the growth rate. High external public debt on the other hand discourages investment just as the debt overhang theory suggests. This implies that the adverse effect of high external public debt on the growth rate works through both the investment and productivity channels. Note that the adverse effect through the productivity channels occurs because high external public debt may lead to misallocation of resources.

In order to test the idea that debt service payments have a crowding-out effect on investment, we include the public external debt service to export ratio as an explanatory variable. These results are reported in regressions (2) and (6). When we use contemporaneous debt service to export ratio, we find an insignificant negative effect for the HIPCs. This effect however is negative and significant when we use the full sample data. We also estimate the investment regression using the lag debt service to export ratio. In Table 3-4, this is given in regressions (3) and (7). Now the variable is significant for both the HIPCs and the full sample implying that debt service crowds-out investment with a one period lag. Recall that the debt service to export ratio was found to be insignificant in the growth regression. The statistical significance of the debt service to export ratio in the investment regression suggests that the crowding-out effect works through the investment channel, that is, by reducing the investment rate. This has an important implication for the HIPCs. A reduction in the debt service payments increases investment albeit after a one period lag and this in turn helps raise the growth rate.

3-5.2.3. Sensitivity analysis

To examine whether the impact of foreign public debt on the growth rate and the investment rate is robust, we conducted various sensitivity checks. First we altered the control variables to see if the inclusion or exclusion of certain control variables changes the results significantly. Altering the various control variables in the regression did not affect the relationship between foreign public debt and growth. The finding that external public debt affects growth and investment adversely only when it passes the threshold value is not sensitive to the method of estimation used either. Ordinary least square, within group, and differenced GMM methods also yield the same result.

3-5.2.4. Reverse causality test

While we found that foreign public debt affects investment and growth non-linearly, it is also possible that growth and investment may in turn affect foreign public debt. In our case, this requires investigating the possibility that there is a reverse causality in the relationship between foreign public debt and investment and growth. To examine the possibility of reverse causality, following Holtz-Eakin et al. (1988), Carroll and Weil (1993), and Dawson (2003) we used a panel data Granger non-causality test. The main idea of the Granger non-causality test is to examine whether lagged values of a variable explain the contemporaneous value of another variable once the lagged values of the latter are controlled for. The results of this reverse causality test are presented in Tables A1-3 and A1-4 in the appendix. The causality test shows that the growth rate and investment do not Granger-cause the initial external debt. Thus there is no evidence of reverse causality in both the growth and investment regressions.

3-6. Conclusions

This chapter examines the impact of external public and public guaranteed external debt on investment and economic growth using data from 30 HIPCs for the period 1970-1999. For comparative purposes, data including other developing countries were also used. In an attempt to investigate the possible non-linear relationship between external public debt and growth, this chapter employs a threshold estimation method.

The threshold estimation method used in this chapter shows that for the growth regression, the threshold external public debt to GDP ratios for the HIPCs and the full sample of developing countries are 22 and 31 percent, respectively. Similarly, for investment regressions we find that the threshold external public debt ratio is 26 percent for both the HIPCs and the full sample. Using these critical threshold values, we estimate the impact of external public debt below and above the threshold values on both growth and investment. The estimated regression results suggest that low foreign public debt (below the threshold value) has a strong positive impact on both investment and growth for both the HIPCs and the full sample. In fact, the results from investment regressions suggest that the favorable effect of a low external public debt to GDP ratio on the growth rate emanates from its positive impact on investment. That is the investment rate is the main channel through which external public debt affects the growth rate positively.

High external public debt, on the other hand, affects the growth rate adversely whether we control for investment or not. Moreover, high external public debt discourages investment just as the debt overhang theory suggests. This implies that the adverse effect of high external public debt on the growth rate works through both the investment and productivity channels. The implication of this finding is that external public debt reduces investment and becomes detrimental to economic growth when it exceeds the threshold value. Thus the debt overhang hypothesis holds when external public debt reaches a critical threshold level.

For the HIPCs, which have accumulated a large external public debt, this has an important implication. The empirical results of this paper suggest that reducing the external debt of these countries would encourage investment and raise economic growth. For instance, halving the external public debt of these countries will increase their annual per capita GDP growth rate by 0.85 percentage points. Thus as most of the HIPCs are in the high external public debt regime at the start of the recent World Bank and IMF sponsored HIPC debt relief initiative, empirical evidence of this chapter suggests that debt relief will encourage investment and improve the economic performance of HIPCs.

The crowding-out hypothesis predicts that foreign debt service payments adversely affect the growth rate. We find that for both the HIPCs and the full sample the direct impact of external debt service payments on the growth rate is insignificant. However, external debt service payments reduce investment. This suggests that the crowding-out effect of debt service payments works through the investment channel. That is external debt service payments adversely affect economic growth indirectly by reducing the investment rate.

In a nutshell, consistent with the predictions of the simple theoretical model, the empirical evidence in this chapter suggests that there is a non-linear relationship between a country's outstanding external public debt and its rate of economic growth. A similar non-linear relationship between initial external public debt and investment is also found. The finding of a positive impact of external public debt on the growth rate below the threshold levels and a negative effect above the threshold values implies that the threshold external public debt to GDP ratios can be considered as the growth maximizing external debt ratios.

3-7. References

Aizenman, J., 1989. Investment, openness and country risk, in: Frenkel, J., Dooley, M., Wickham, P. (Eds.), Analytical Issues in Debt, International Monetary Fund, Washington, D.C., pp. 83-101.

Aizenman, J., Borensztein, E.R., 1989. Debt and conditionality under endogenous terms of trade adjustment, in: Frenkel, J.A., Dooley, M.P., and Wickaham, P. (Eds.), Analytical Issues in Debt, International Monetary Fund, Washington, D.C., pp. 102-129.

Ajayi, S.I., 1997. An Analysis of External Debt and Capital Flight in the Heavily Indebted Poor Countries of Sub-Saharan Africa, in: Zubair Iqbal and Ravi Kanbur (Eds.), External Finance for Low-Income Countries. Washington, D.C, International Monetary Fund.

Alemayehu G.F., 2001. Debt Issues in Africa: Thinking Beyond the HIPC Initiative to Solving Structural Problems. Paper presented at a WIDER Conference on Debt Relief, Helsinki.

Alemayehu, G. F., 2002. Finance and Trade in Africa: Macroeconomic Response in the World Economy Context, Palgrave Macmillan, New York.

Alemayehu, G. F., 2003. The historical origin of African debt crisis. Eastern Africa Social Science Research Review 16, 59-89.

Alemayehu, G.F., Befekadu, D., 1999. Management Transition from Aid: Dependence in Ethiopia, in: Lancaster and Wange (Eds.). Managing Transition from Aid in Sub-Saharan African.

Anderson, T., Hsiao, C., 1981. Estimation of dynamic models with error components. Journal of the American Statistical Association 76, 598-606.

Andrews D., Boote, A.R., Rizavi, S.S., and Singh, S. (1999). Debt Relief for Low income Countries: the Enhanced HIPC Initiative.

Arellano, M., 1989. A note on the Anderson-Hsiao estimator for panel data. Economics Letters 31, 337-341.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58, 277-297.

Arellano, M., Bond, S., 1998. Dynamic Panel Data Estimation Using DPD98 for GAUSS: A guide for Users. Memo.

Arellano, M., Bover, O., 1995. Another look at the instrumental variable estimation of error-component models. Journal of Econometrics 68, 29-52.

Arrow, K., Kurz, M., 1970. Public Investment, the Rate of Return and Optimal Fiscal Policy. Baltimore: The John Hopkins Press.

Arslanalp, S., Henry, P.B., 2002. Debt Relief: What Do the Markets Think? *National Bureau of Economic Research,* No. 9369.

Arslanalp, S., Henry, P.B., 2003. The world's poorest countries: debt relief or aid? Stanford Graduate School of Business, Research Paper No. 1809.

Aschauer, D. A., 2000a. Do states optimize? Public capital and economic growth. Annals of Regional Science 34, 343-363.

Aschauer D. A., 2000b. Public capital and economic growth: issues of quantity, finance and efficiency. Economic Development and Cultural Change 48, 391-406.

Asiedu, E., 2003. Debt relief and institutional reform: a focus on Heavily Indebted Poor Countries. Quarterly Review of Economics and Finance 43, 614-626.

Avramovic, D., 1964. Economic Growth and External Debt. John Hopkins Press, Baltimore.

Bade, R., 1972. Optimal growth and foreign borrowing with restricted mobility of foreign capital. International Economic Review 13, 544-552.

Bair, S, L., Glomm G., 2001. Long-run growth and welfare effects of public policies with distortionary taxation. *Journal of Economic Dynamics and control* 25, 2007-2042

Bardhan, P., 1967. Optimum foreign borrowing, in: Karl Shell (Ed.): Essays on the Theory of Optimal Growth. Cambridge, MIT Press.

Barro, R., 1990. Government spending in a simple model of endogenous growth. Journal of Political Economy 98, 103-126.

Barro, R., 1997. Determinants of Economic Growth: A Cross-country Empirical Study. Massachusetts Institute of Technology press, Cambridge.

Barro, R., Mankiw, G., Sala-I-Martin, X., 1995. Capital mobility in neoclassical models of economic growth. American Economic Review 85, 103-115.

Barro, R., Sala-I-Martin, X., 1995. Economic Growth, McGraw-Hill, New York.

Befekadu, D., 1992. Growth and Foreign Debt: The Ethiopian Experience 1964-1986. African Economic Research Consortium Research paper No.14.

Bigsten, A., Levin, J., Persson, H., 2004. debt relief and growth: a study of Zambia and Tanzania, in: Addison, T., Hansen, H., Tarp, F. (Eds.). Debt Relief for Poor Countries. Palgrave Macmillan, New York.

Bleaney, M., Gemmell, N., Kneller, R., 2001. Testing the endogenous growth model: public expenditure, taxation and growth over the long run. Canadian Journal of Economics 34, 36-57.

Blundell, R. Bond, S., Windmeijer, F., 2000. estimation in dynamic panel data models: improving on the performance of the standard GMM estimator, in: Baltagi, B. (Ed.). Nonstationary Panels, Panel cointegration, and Dynamic Panels, Elsevier Science.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87, 115-143.

Bond, S., Hoeffler A., Temple J., 2001. GMM estimation of empirical growth models. CEPR Discussion Paper NO. 3048 (London: Center for Economic Policy Research.).

Burguet, R., Fernandez-Ruiz, J., 1998. Growth through taxes or borrowing? A model of development traps with public capital. European Journal of Political Economy 14, 327-344.

Burnside, C., Fanizza, D., 2004. Hiccups for HIPCs. NBER working paper no. 10903.

Burnside, C., Dollar, D., 2000. Aid, policies and growth. American Economic Review 90, 847-68.

Calvo, G.A., 1998. Growth, debt and economic transformation: the capital flight problem, in: Coricelli, F., Matteo, M., Hahn, F. (Eds.), New Theories in Growth and Development, St. Martin's Press Ltd., New York, pp. 251-269.

Carroll, C.D., Weil D. N., 1993. Saving and growth: a reinterpretation. NBER working paper number 4470.

Cashin, P., 1995. Government spending, taxes and economic growth. IMF Staff Paper 42, 237-269.

Chan, K.S., Tsay, R.S., 1998. Limiting properties of the least squares estimator of a continuous threshold autoregressive model. Biometrika 45, 413-426.

Chenery, H.B., Strout, A.M., 1966. Foreign assistance and economic development. American Economic Review 56, 679-733.

Claessens, S., Detragiache, E., Kanbur, R., Wickham, P., 1996. Analytical aspects of the debt problems of heavily indebted poor countries. The World Bank Policy Research Working Paper No.1618

Cline, W. R., 1995. International Debt Reexamined. Institute for International Economics, Washington D.C.

Cohen, D., 1993. Low investment and large LDC debt in the 1980s. American Economic Review 83, 437-449.

Cohen, D., 1997. Growth and external debt: a new perspective on the African and Latin American tragedies. Center for Economic Policy Research Discussion Paper no.1753.

Cohen, D., 2000. The HIPC Initiative: True and False Promises. OECD Development Center, Working number 166.

Cohen, D., Sachs, J., 1986. Growth and external debt under risk of debt repudiation. European Economic Review 30, 529-60.

Collier, P., Gunning, J.W., 1999. Explaining African economic performance. Journal of Economic Literature 37, 64-111.

Collins, S.M., Park, W. 1989. External debt and macroeconomic performance in South Korea, in: Sachs, J. and Collins, S.M (Eds.). Developing Country Debt and economic performance. University of Chicago press, Chicago.

Commander, S., Davoodi, H., Lee, U., 1997. The causes and consequences of government for growth and well-being. World Bank, memo.

Cooper, R., Sachs, J., 1985. Borrowing abroad: The debtor's perspective, in: Smith, F. and Cuddington, J. (Eds.). International Debt and the Developing Countries, a World Bank Symposium.

Corden, W.M., Neary J.P., 1982. Booming sector and de-industrialization in a small open economy. Economic Journal 92, 825-848.

Cox, D., Hansen, B., Jimenez E., 2003. How responsive are private transfers to income evidence from a laissez-faire economy. Journal of Public Economics 88, 2193-2219.

Dalgaard, C.J., Hansen, H., 2001. On aid, growth and good policies. Journal of Development Studies 37, 17-41.

Daseking, C., Powell, R., 1999. From Toronto terms to the HIPC Initiative: a brief history of debt relief for low-income countries. IMF, working paper WP/99/142.

Dawson, W. J., 2003. Causality in the freedom-growth relationship. European Journal of Political Economy 19, 479-495.

Demekas, D., McHugh, J., Kosma, T., 2002. The Economics of post conflict aid. IMF Working Paper 198.

Dollar, D., Easterly, W., 1999. The search for the key aid, investment and policies in Africa. Journal of African Economies 8, 546-577.

Easterly, W., 2001. Growth implosions and debt explosions: do growth slowdowns cause public debt crises? Contributions to Macroeconomics 1, 1-24.

Easterly, W., 2002. How did heavily indebted poor countries become heavily indebted? Reviewing two decades of debt relief. World Development 30, 1677-1696.

Easterly, W., Levine R., 1997. Africa's growth tragedy: policies and ethnic divisions. Quarterly Journal of Economics 112, 1203-50.

Eaton, J., 1993. Sovereign debt: a primer. World Bank Economic Review 7, 137-172.

Elbadawi, I., Ndulu, B., Ndung'u, N., 1997. Debt overhang and economic growth in Sub-Saharan Africa, in: Zubair I., Ravi K., (Eds.), External Finance for Low-Income Countries, International Monetary Fund, Washington, D.C.

Farzin, H., 1988. The relationship of external debt and growth: Sudan's experience, 1975-1984. World Bank Discussion paper WDP24.

Fischer, S., 1993. The role of macroeconomic factors in growth. Journal of Monetary Economics 32, 485-512.

Fosu, A.K., 1996. The impact of external debt on economic growth in Sub-Saharan Africa. Journal of Economic Development 21, 93-118.

Fosu, A.K., 1999. The external debt burden and economic growth in the 1980s: evidence from Sub-Saharan Africa. Canadian Journal of Development Studies 20, 307-318.

Froot, K. 1989. Buybacks, exit bonds, and the optimality of debt and liquidity relief. International Economic Review 30, 49-70.

Fry, M., 1989. Foreign debt instability: an analysis of national saving and domestic investment responses on foreign debt accumulation in 28 developing countries. Journal of International Money and Finance 8, 315-344.

Greene, J., 1989. External debt problem of Sub-Saharan Africa, in: Frenkel, J., Dooley, M.P., Wickham P., (Eds.), Analytical Issues in Debt, International Monetary Fund, Washington D.C., pp. 38-74.

Gupta, K.L, Islam, M.A., 1983. Foreign Capital, Savings and Growth: An International Cross-Section Study. Reidel Publishers, Boston.

Hansen, B., 1999. Threshold effects in non-dynamic panels: estimation, testing and inference. Journal of Econometrics 93, 345-368.

Hansen, B., 2000. Sample splitting and threshold estimation. Econometrica 68, 575-603.

Hansen, H., 2001. The impact of aid and external debt on growth and investment: insights from cross-country regression analysis, in: Addison, T., Hansen, H., Tarp, F. (Eds.). Debt Relief for Poor Countries. Palgrave Macmillan, New York.

Hansen, H., Tarp, F., 2000. Aid effectiveness disputed. Journal of International Development 12, 375-98.

Hansen, H., Tarp, F., 2001. Aid and growth regressions. Journal of Development Economics 64, 547-70.

Hoeffman, B., Reisen, H., 1991. Some evidence on debt related determinants of investment and consumption in heavily indebted countries. Weltwirtschaffliches Archiv 127, 280-297.

Holtz-Eakin, D., Newey, W., Rosen, H.S., 1988. Estimating vector autoregressions with panel data. Econometrica 56, 1371-1395.

International Monetary Fund (2000). The Logic of Debt Relief for the Poorest Countries. *http://www.imf.org/external/np/exr/ib/2000/092300.htm*

International Monetary Fund (2001). Debt Relief for Poverty Reduction: the Role of Enhanced HIPC Initiative. http://www.imf.org/external/pubs/ft/exrp/debt/eng/#3

International Monetary Fund (2002). Debt Relief under the Heavily Indebted Poor Countries (HIPC) Initiative: A fact sheet. *(http://www.mafhoum.com/press2/59E15.htm)*

Iscan, T.B., 2000. Financing constraints and investment decline in Mexico. Manchester School 68, 24-43.

Iyoha, M., 2000. An econometric analysis of external debt and economic growth in sub-Saharan African countries, in: Ajayi, Khan, M., (Eds.), External Debt and Capital Flight in Sub-Saharan Africa. International Monetary Fund, Washington, D.C., pp. 160-209.

Khan, M., Sehadji, A.S., 2001. Threshold effects in the relationship between inflation and growth. IMF staff Papers 48, 1-21.

King, R.G., Levine, R., 1993. Finance, entrepreneurship and growth: theory and evidence. Journal of Monetary Economics 32, 513-542.

Kneller, R., Bleaney, M.F., Gemmell, N., 1999. Fiscal policy and growth: evidence from OECD countries. Journal of Public Economics 74, 171-190.

Krugman, P., 1988. Financing vs. forgiving a debt overhang: some analytical notes. Journal of Development Economics 29, 253-268.

Levine, R., Loayza, N., Beck, T., 2000. Financial intermediation and growth: causality and causes. Journal of Monetary Economics 46, 31-77.

Lin, S., Sosin, K., 2001. Foreign debt and economic growth. Economics of Transition 9, 635-655.

Mankiw, G., Romer, D., Weil, D., 1992. A contribution to the empirics of economic growth. Quarterly Journal of Economics 107, 407-437.

McMullen, N. J., 1979. Historical perspectives on developing countries' debt, in: Franko, Lawrence G. and Seiber, Mallyn J. (Eds.). Developing Country Debt. Paragon Policy Studies. Paragon Press. New York, 1979.

Michaely, M., 1981. Foreign aid, economic structure and dependence. Journal of Development Economics 9, 313-330.

Miller, S.M., Russek, F., 1997. Fiscal structures and economic growth: international evidence. Economic Inquiry 35, 603-613.

Ndung'u, N., 1998. The dynamic impact of external debt accumulation on private investment and growth in Africa. Economic Commission for Africa, Addis Ababa.

O'Cleireacain S., 1990. Third World Debt and International Public Policy. Praeger, New York.

Papaneck, G.F., 1972. The effect of aid and other resource transfers on savings and growth in Less Developed Countries. Economic Journal 82, 934-50.

Papaneck, G.F., 1973. Aid, foreign private investment, savings and growth in Less Developed Countries. Journal of Political Economy 81,120-30.

Pattillo, C., Poirson, H., Ricci, L., 2002. External debt and growth. IMF Working Paper WP/02.

Perasso, G., 1992. Debt reduction versus 'appropriate' domestic policies. Kyklos 45, 457-467.

Pitchford, J., 1995. The Current Account and Foreign Debt. Routledge, New York.

Rattso, J., Torvik, R., 1999. The macroeconomic effects of foreign aid in Sub-Saharan Africa: Dutch disease reconsidered, in: Gupta K.L., (Ed.) Foreign Aid: New Perspectives, Boston. Kluwer Academic Publishers.

Sachs, J., 1984.Theoretical issues in international borrowing. Princeton Studies in International Finance *No.54*, Princeton University.

Sachs, J., 1989. The debt overhang of developing countries, in: Calvo, G., Findlay, R., Kouri, P., Braga de Macedo, J., (Eds.), Debt, Stabilization and Development, Basil Blackwell, Oxford, pp. 80-102.

Sachs, J., 1998. External debt, structural adjustment and economic growth, in: United Nations Conference on Trade and Development, International Monetary and Financial Issues for the 1990s, Vol. 9.

Sachs, J., 2002. Resolving the debt crisis of low-income countries. Brookings papers on Economic Activity 1, 1-28.

Sarel, M., 1996. Nonlinear effects of inflation on economic growth. IMF staff papers 43, 199-215.

Savvides, A., 1992. Investment slowdown in developing countries during the 1980s: debt overhang or foreign capital inflows? Kyklos 45, 363-378.

Seiber, M.J., 1982. International Borrowing by Developing Countries. Pergamon Policy Studies on International Development. New York: Pergamon Press.

Serieux, J., 1999. Reducing the debt of the poorest: challenges and opportunities. The North-South Institute, Ottawa.

Serieux, J., Samy, Y., 2001. The debt service burden and growth: evidence from low-income countries. The North-South Institute, Ottawa.

Stoneman, C., 1975. Foreign capital and economic growth. World Development 3, 11-26.

Van Wijnbergen, S., 1985. Aid, export promotion and the real exchange rate: an African dilemma?" Center for Economic Policy Research.

Van Wijnbergen, S., 1986. Macroeconomic aspects of the effectiveness of foreign aid: the two-gap model, home goods disequilibrium and the exchange rate misalignment. Journal of International Economics 21, 123-136.

Warner, A.M., 1992. Did the debt crisis cause the investment crisis? Quarterly Journal of Economics 107, 1161-1186.

White, H., 1992. The macroeconomic impact of development aid: a critical survey." Journal of Development Studies 28, 163-240.

World Bank, 2001. *http://www.worldbank.org/hipc/about/hipcbr.htm*

World Bank, 2002. World development indicators CD-ROM. World Bank, Washington, D.C.

World Bank, 2003. Debt Relief for the Poorest: an OED Review of the HIPC Initiative. World Bank, Washington, D.C.

CHAPTER 4 EFFECTS OF DEBT RELIEF ON GROWTH AND WELFARE OF HIPCs.

4-1. Introduction

One problem that has been the focus of much attention recently is the excessive external debt of the world's poorest nations and its effect on the living standard of their citizens. Historically, foreign capital has played an important role in the process of economic development. Some developed countries, such as Canada, relied on foreign borrowing at the early stage of their development. In order to achieve a higher economic growth and improve the living standard of their citizens, developing countries needed to mobilize domestic resources for productive investment. Unfortunately, the domestic resources in most of the developing countries are not sufficient to finance their desired investment. Consequently, they have depended on foreign capital, and over the years, they have accumulated a large amount of external debt. The structure of their economies has also made them more vulnerable to external shocks and this also contributed to external debt accumulation.

Even though these countries have accumulated a large amount of debt, their economic performance has been generally very weak. A large proportion of their population lives in absolute poverty. In fact, in many of the debtor developing countries, especially Sub-Saharan African countries, malnutrition, hunger, and diseases are rampant. There are different factors behind the poor economic performance of these countries. Poor macroeconomic policies, bad governance and weak institutional capabilities are often cited as being the main factors behind their dismal performance. The huge outstanding external debt accumulated by these countries is also seen as an impediment to their economic growth. During the 1980's and early 1990's, many developing countries' debt service payments exceeded their expenditure on basic health care or primary education. The relatively high outflow of poor developing countries' resources in the form of foreign debt service payments at a time when a majority of their citizens are living in poverty and poor health is considered by many to be unfair and immoral. Consequently, in the 1990s a concerted worldwide movement by prominent world figures and Non-Governmental Organizations (NGOs) called for the cancellation of the debt of the world's poorest nations. In apparent response to the international community's call for debt relief for the poor countries, the IMF and the World Bank jointly launched the Heavily Indebted Poor Countries (HIPCs) initiative in September 1996.

In the literature, the debt overhang hypothesis of Krugman (1988) and Sachs (1989) provides the main argument in favor of debt relief. According to the debt overhang hypothesis, excessive external debt acts as a tax on the return to investment. When firms invest in highly indebted countries, they expect that future taxes will be higher in order to finance the debt service payments. As a result, they anticipate that part of their return to investment will be used to finance debt service payments. This discourages investment and reduces economic growth. Thus reducing the excessive debt is tantamount to reducing this disincentive effect for investment and helps to improve economic growth.

Cohen (2000) assessed the impact of the HIPC initiative empirically and evaluated the effects of debt crises on growth. Cohen regressed the growth rate on initial income, schooling, investment, ethnicity, terms of trade, and the risk of debt crisis index. In this regression, he found that the risk of a debt crisis had a negative and significant effect on economic growth. Then using these empirical estimates, he assessed the likely impact of the current HIPC initiative. He found that reducing the probability of a debt crisis increased growth. More specifically, he found that the HIPC initiative, which according to his calculation reduces the risk of a debt crisis from 70 percent to 39 percent, would increase the growth rate in these countries by 0.4 percentage points. However, this estimate of the effect of debt relief is likely to underestimate the positive effects of debt relief since investment is held constant while performing the empirical estimation. That is, the author captured only the direct effects of external debt on the growth rate but failed to take into account the indirect effects of foreign debt that work through the investment channel. Moreover, Cohen did not directly use an external debt variable in his analysis. Rather, he relied on a generated variable that simply serves as a proxy for the level of external debt.

Another attempt to gauge the benefits of external debt reduction in poor countries' economic performance was done by Iyoha (2000). Using data from a sample of Sub-Saharan African countries, Iyoha analyzed the impact of external debt on these countries' growth. Numerical simulations based on his empirical results suggest that a 75 percent reduction in the external debt of Sub-Saharan African countries would increase their GDP growth rate by about 6 percentage points. This is indeed a substantial gain in the growth rate of these economies. This growth gain from the debt reduction is obtained through an increase in investment. That is, Iyoha captures only the indirect effects of debt relief and the direct effect of debt relief through productivity is ignored.

Bigsten, Levin, and Persson (2001) have analyzed the impact of debt relief on the economic performance of Tanzania and Zambia using computable general equilibrium models. For both countries, the authors found that debt relief had an impact on the economic performance of these countries. In particular, simulating the impact of debt service payments reduction on the growth rate, they found that debt relief would increase real GDP of Tanzania by 2.4 percentage points through an increase in public investment and productivity. However, they found that for Zambia, debt relief associated with an increase in public spending and lower taxes would increase the country's GDP growth rate by a mere 0.2 percent compared to the baseline GDP growth rate which is equivalent to a growth gain of about 0.084 percentage points.

The level of consumption in heavily indebted poor countries is also likely to be adversely affected by the large debt service payments that require governments to levy relatively high taxes. This implies that debt reduction may affect the welfare of debtor countries positively. For instance, Froot (1989) has shown that debt reduction is welfare improving if countries are on the wrong side of the debt Laffer curve.[20] Husain (1993), on the other

[20] Debt Laffer curve relates a country's nominal debt obligations to the market's expectation of repayments on those obligations. Diagrammatically, the Laffer curve is drawn as upward sloping straight line for a low level of debt but after a certain point it becomes concave. Along the downward sloping part of the Laffer curve the disincentive effect of high external debt becomes so high that creditors may get more debt service payments if they forgive a certain a mount of debt.

hand, shows that debt reduction may be welfare improving even if the disincentive effect of debt overhang is not that strong.

In our model presented in the second chapter, we have shown that excessive external public debt and the associated debt service payments affect economic growth adversely. In fact, both the theoretical and empirical models provided support for the hypothesis that high external public debt hinders economic growth. Thus the main objective of this chapter is to perform a simulation of the impact of debt relief on HIPCs' growth and welfare based on the theoretical and empirical models presented in the previous chapters of the thesis.

The simulation exercise based on the empirical model shows that, the proposed two-third reduction in the external public debt of the HIPCs would increase their growth rate on average by about 1.6 percentage points. Similarly, the theoretical model suggests that the same debt reduction would result in a significant increase in the growth rate of the HIPCs. For instance, with reasonable values of the structural parameters, the proposed two-third reduction in the external public debt of the HIPCs would result in an increase in their growth rate by about 1.2 percentage points. Moreover, we find that debt relief provides a significant welfare gain for the debt relief recipient countries.

The remaining part of this chapter is structured as follows. In the second section, we briefly examine how the heavily indebted countries became heavily indebted. In the third section, we discuss the current HIPC initiative. In particular, we discuss the eligibility requirements, the objectives of the initiative and its possible shortcomings. Based on the simple theoretical model and empirical estimates presented in the second and third chapters of the dissertation, the fourth section presents simulation results of the impacts of debt relief on economic growth and welfare of the HIPCs. The fifth section concludes.

4-2. Evolution of foreign debt and debt crises

4-2.1. Evolution of the HIPCs' debt

In the 1960s and 1970s many developing countries tried to increase investment in order to raise the living standards of their citizens. However, the domestic resources were not sufficient to finance all the desired investment. Consequently, they borrowed heavily on world markets. In fact, the history of the now developed economies shows that they too were dependent heavily on foreign capital at the early stage of their economic progress. For instance, in the early 1900s, Canada, Australia and New Zealand accumulated an external debt to GNP ratio of 100 percent or more; see McMullen (1979). Immediately after the end of the Second World War, Europe also experienced a similar dependence on foreign capital. The recent experience of South Korea also provides a good example of the importance of foreign borrowing at the initial stage of economic development; see Collins and Park (1989).

The oil shocks of the 1970s created conducive environment for access to international financial markets for oil-importing developing countries. On the one hand, the oil exporting countries earned more income than they could absorb from high oil prices. Thus these countries deposited the excess funds in developed countries' banks. On the other hand, the oil importing developing countries needed more funds to cope with the high price of oil and to continue funding their investment and consumption projects. As a result, these countries increased their borrowing from international financial markets. Developed countries' banks were also happy to lend their excess funds that they received from oil exporting countries even at a lower interest rate.

The history of the HIPCs is similar to other developing countries. During the 1970's and 1980's, the HIPCs also accumulated external debt for similar reasons. However, while the middle-income developing countries borrowed from private creditors, the low-income developing countries such as the HIPCs borrowed mainly from bilateral and multilateral sources. Moreover, unlike other developing countries, the lion's share of these countries' total external debt is the liability of their governments. For instance, between 1970 and 1999, about 96.5 percent of the HIPCs' average external debt was public and publicly guaranteed.[21]

According to World Bank (2002), the external public debt of the 30 HIPCs used in the empirical analysis was about 5 billion US dollars in 1970 but increased by more than five fold at the beginning of the 1980s. During the same period, the associated debt service payments also increased by more than $3 billion. In fact, by the mid-1990s the outstanding external public debt of these countries reached about $115 billion. This huge external public debt has been very burdensome for these countries. For example, in 1995 the total external debt service payments of these countries were more than $5 billion. A better picture of the debt problem of the HIPCs can be obtained if we express the external

[21] Author's calculation from the World Bank (2002), World Development Indicators data set.

public debt of these countries relative to their GDP. The following table shows the evolution of the external public debt to GDP ratio of the HIPCs for the period between 1970 and 1999.

Table 4-1 External public debt as a percentage of GDP (period average)

	1970-74	75-79	80-84	85-89	90-94	95-99
HIPCs	24	34	55	92	118	109
Low middle income countries	3	7	13	20	26	24

Source: Author's calculation from the World Bank WDI 2002.

As the above table shows, the external public debt of the 30 HIPCs under consideration started low in the early 1970s. However, the average external public debt of these countries increased dramatically in the early 1980s. The associated debt service payments also rose overtime. Comparing the HIPCs external public debt to GDP ratio with those of the low-middle income countries shows the enormity of the problem that these countries face. Notice that the fall in the external debt after the mid-1990s reflects the impact of the current HIPC debt relief initiative that began in 1996.

4-2.2. Origins of the debt crisis

Many developing countries rely on a few primary products for export receipts that enable them to pay back their foreign debts. Unfortunately, following the oil shocks of the 1970s the developed countries, which are the ultimate destinations for developing countries' exports, slipped into recession. As a result, demand for developing countries' primary products in the world market fell. The decrease in demand for primary products and the associated fall in their prices made the countries even more dependent on foreign borrowing both to finance past debt and to cover their current account deficits. In fact, some of the developing countries were unable to meet their debt service payments without obtaining new borrowing from the international financial markets. Consequently, over the years, many developing countries have accumulated a large amount of foreign debt to the extent that they cannot finance the debt service payments as originally agreed upon. Thus the mid-1970s signaled the beginning of the debt crisis.

In the 1980s, many developing countries faced difficulties in meeting their debt service payments when the interest rate rose and the price of their exports plummeted. The problem was especially severe for middle-income countries that borrowed substantially from international banks. A debt crisis erupted in 1982 when Mexico announced that it would no longer be able to finance its debt service payments as originally agreed upon.

Many authors argue that developing countries' policies have also contributed to the debt crisis. For example, O'Cleireacain (1990) claims that the trade strategy of developing countries is the main factor behind the debt crisis. He argues that import substitution adopted by many of the poor countries as a development strategy was a major cause of the debt crisis. Thus the policy implication of this strand of literature is that the solution to the current debt crisis, particularly in Africa, transcends the HIPC debt relief initiative. That is, a successful debt relief effort requires addressing the structural or historical problems confronting these economies.

The structure of developing countries' economies also played a significant role in the debt crisis. According to UN (1999), the debt problems of the heavily indebted poor countries are structurally rooted. Alemayehu (2001, 2003) also argues that the historical origin of the debt crisis of African countries is the structural and international trade problem of these countries that took shape long before the end of colonization. In particular, these countries' dependence on a few primary exports and the problem inherent to the international trade arrangement have contributed significantly to the debt problem of African countries. The important implication of this argument is that the solution to the debt problem lies at the heart of international trade of these countries. More specifically, for Africa where most of the HIPCs are found, the long run solution to the current foreign debt problem of these countries necessitates the need to address trade and trade related structural problems of the countries. That is, according to these authors, the international trade environment must put the developing countries on equal footings by eliminating the subsidies and protections that most developed economies offer to their primary sectors.

It is generally argued that ill planned projects and bad governments also contributed to the debt problems of developing countries. In the context of HIPCs, Easterly (2002), for instance, argues that these countries have accumulated excessive external debt because politicians in these countries have a high discount rate against the future. The high discount rate may be a result of such factors as political instability and the presence of interest group polarization.

In a nutshell, various factors are behind the debt crises of developing countries in general and the HIPCs in particular. The causes of the debt crisis are a combination of the debtors' poor economic policy, excessive lending, macroeconomic shocks such as the oil shocks, an increase in the interest rate, the structure of the debtor countries' economies, and deterioration in the terms of trade; for details see Claessens et al. (1996), Iyoha (2000), and Easterly (2001).

4-3. The HIPC initiative

4-3.1. Background

The seriousness of the external debt problem of the low-income indebted countries has been recognized by their creditors for a long time. Creditors tried to lessen the problem by the traditional means of debt rescheduling and refinancing. In the early 1980s, the Paris Club creditors provided flow rescheduling for low-income debtor countries on a non-concessional basis. However, the creditors later realized that this did not solve the problem. Consequently, the Paris Club creditors decided to use concessional rescheduling to the debtor African countries in 1987. The attempt to solve the debt problem through the traditional mechanisms of flow rescheduling was based on the premise that the debt problem was a liquidity problem. That is, at first the creditors viewed the debt problem as a temporary cash flow problem. By the late 1980s, they recognized that the debt problem is in fact a solvency problem and repeated reschedulings would not solve it. Addressing the solvency problem requires not just cash-flow relief but debt reduction. Thus in 1989, the governments of the G7 countries decided to reduce the external debt of poor countries by about a third. This is what is called the "Toronto terms" in the literature.

Creditors later realized that debt reduction based on the Toronto terms was not sufficient to solve the debt problem of low-income countries. Thus, in December 1991, the creditors offered a 50 percent debt reduction according to the "London terms". Subsequent debt relief attempts also included "Naples terms" of 1994 (about 67 percent debt reduction). However, all the previous traditional debt relief mechanisms proved to be futile in solving the debt problem of the low-income countries. Moreover, the economic performance of these countries has shown no sign of improvement. Rather, it deteriorated alarmingly leaving a large part of their population in absolute poverty. The poor economic performance of these countries coupled with the accumulated huge debt signaled the need for a new way of dealing with the debt problem.

For middle-income countries that borrowed mainly from private creditors, various attempts were also made to solve their debt problems. In this regard the debt relief strategy proposed by the U.S. Treasury Secretary Nicholas J. Brady in March 1989, usually referred in the literature as the Brady plan, is the dominant one. The Brady plan was basically a market-based debt reduction by commercial banks. The creditor countries and commercial banks reduced the debt stock of the debtor countries and extended new borrowing. In return, the debtor countries were required to implement structural reforms and prudent macroeconomic policies. Thus the Brady plan helped solve the debt problem of middle-income countries by providing a significant debt relief and new borrowing; Rieffel (2003).

However, the deterioration of the living standard of many *poor* developing countries, which have been characterized by rampant poverty, disease and malnutrition and in general multifaceted socio-economic problems, has attracted the international community's attention. These countries have been spending more on external debt service payments than on health care or education. For instance, for the period immediately before the introduction of the HIPC, 1990-1994, the average health expenditure to GDP ratio of all HIPCs was about 1.68 per cent. However, for the same period, their public and public guaranteed debt service payments to GDP ratio was about 3.27 per cent.[22] As a result, in the 1990s many prominent world figures and Non-Governmental Organizations (NGOs) have started a worldwide concerted movement to fight for debt reduction of the world's poorest countries. This puts the debt problem of poor developing countries in the spotlight. In this regard, the relentless efforts of Oxfam International and Jubilee 2000 have put them at the forefront of a campaign that calls for the cancellation of the foreign debt of the poor countries. The governments of developed countries also began to pay attention to the problem. Consequently, in order to reduce the external debt of poor developing countries, in September 1996, the IMF and the World Bank jointly launched the HIPC initiative.

Of course, debt relief is not a recent phenomenon. As we have seen above, there were previous attempts to solve the debt crisis of debtor developing countries prior to the introduction of the HIPCs. However, instead of solving the debt problem, such attempts helped only postpone debt service payments and in the process the countries accumulated more and more external debt. For instance, between 1976 and 1988, 27 of the countries

---

[22] Author's calculation based on the World Bank World Development Indicators data set.

that are now included in the HIPC initiative, got 81 flow-reschedulings. However, these attempts were not successful in solving the debt problem. It only helped postpone debt service payments of about 23 billion dollars into the future; see Daseking and Powell (1999).

4-3.2. Eligibility conditions

The current debt relief initiative has focused on the poorest nations of the world on the premise that their large external debt and the associated debt service payments exacerbate their poverty. Moreover, despite various flow-rescheduling attempts, the external debt of these countries has become more and more burdensome in the face of their poor economic performance. It almost seems certain that these countries will not be able to service their external debt for the foreseeable future. In effect, the external debt of these countries is unsustainable. Thus the eligibility conditions of the HIPC initiative take into account the debtor countries' poverty and debt sustainability.

From its inception to date, the HIPC initiative has gradually evolved. Thus it is best to discuss the eligibility conditions for the debt relief initiative in the context of the evolution of the initiative itself. The HIPC debt relief initiative that started in September 1996 is usually known in the literature as the Original HIPC (O-HIPC). However, as we will discuss later, the O-HIPC initiative was criticized on various grounds and as a result the initiative was significantly enhanced in 1999. Thus the modified debt relief initiative known as the Enhanced HIPC initiative (E-HIPC) formally superseded the O-HIPC in 1999.

Under the O-HIPC framework, eligible countries must face an unsustainable foreign debt burden after utilizing the traditional debt relief mechanisms. Note that according to the original initiative, a country's external debt level is considered to be unsustainable if the net present value of external debt to export ratio is between 200-250 percent. Or, for countries with a high export to GDP ratio, the external debt is deemed unsustainable if the ratio of the net present value of external debt to government revenue exceeds 280 percent. Furthermore, the countries must also be considered poor in the sense that only those countries that rely on financial resources from the World Bank's International Development Association (IDA) are eligible.

The second eligibility requirement is that the countries should implement IMF and World Bank supported economic programs and show a good track record of economic performance. In this regard, the countries are also required to show that they are capable of putting to good use any resources they obtain. If the above two conditions are satisfied, then the country will be eligible for the initiative and receive debt relief to achieve a sustainable debt level; see IMF (2002).

The O-HIPC process was criticized for being too slow in alleviating the external debt problem of the eligible countries. As a result, in 1999 at their meeting in Cologne, the G7 countries agreed to make the debt relief initiative faster and broader. This modified debt relief initiative is the E-HIPC. Under the E-HIPC initiative, the eligibility requirements, including the threshold external debt level, were reduced. Consequently, in the E-HIPC, a country's debt level is considered to be unsustainable if its net present value of debt to export ratio exceeds 150 percent. For countries with a high export to GDP ratio, on the other hand, external debt is considered unsustainable if the net present value of external debt to government revenue ratio exceeds 250 percent. An important enhancement introduced in the E-HIPC was the additional requirement that the debtor countries prepare and implement Poverty Reduction Strategy Papers (PRSP) to be eligible for the debt relief. The countries are required to prepare PRSPs through a participation of domestic stakeholders and external financiers such as the World Bank and the IMF. Basically, the PRSPs describe a country's macroeconomic, structural and social polices designed to reduce poverty and achieve higher economic growth. Currently about 41 countries are eligible for the E-HIPC initiative. However, only 38 of the countries are expected to qualify for the debt relief.[23]

4-3.3. Objectives of the HIPC initiative

The debt relief initiative has three main objectives. Firstly, as the HIPCs have accumulated a huge unsustainable level of external debt and have been in a continuous need of debt relief and rescheduling, the initiative aims at providing these countries a permanent exit from rescheduling. Thus the first central objective of the HIPC initiative is to enable debt relief recipient countries to achieve a sustainable debt level by reducing their external debt stock.

Secondly, it is generally believed that economic growth in these countries is adversely affected by the debt overhang effects caused by excessive debt. Consequently, the

[23] The external debt ratios of Angola, Kenya, and Vietnam were expected to be below the HIPC threshold values after the full use of the traditional debt relief mechanism.

initiative aims at raising the growth rate of these countries by removing the debt overhang effect through a concerted debt reduction effort. Moreover, as a large number of the citizens of the HIPCs live in absolute poverty, the third goal of the HIPC initiative is to reduce poverty by freeing resources (from debt service payments) for social spending. This objective was later added in the E-HIPC initiative. In order to strengthen the link between the debt relief and poverty reduction efforts, the E-HIPC initiative requires debtor countries to prepare and implement the PRSP.

In a nutshell, the overall objectives of the HIPC initiative are to help debtor countries attain debt sustainability, increase their economic growth rate and reduce poverty by freeing up resources for poverty reducing public spending. The success or failure of the initiative can be evaluated on the basis of these broad objectives.

4-3.4. The process

Under the O-HIPC program, eligible countries needed to first show a 3-year track record of macroeconomic stability and policy reform. At the end of the 3-year period, the countries reached what is called the decision point. This is the point where the boards of the IMF and the World Bank decided whether the countries were eligible for debt relief. Consequently, at the decision point, a debt sustainability analysis was conducted by the IMF and the World Bank to determine whether a country's external debt was sustainable after using the traditional debt relief mechanisms. If the country's debt level was found to be unsustainable, then it qualified for debt relief. During the second stage of the initiative, i.e., after the decision point, creditors provided flow rescheduling on a case-by-case basis and commit the amount of relief they would provide when the countries complete the initiative.

For the eligible debtor countries to obtain full debt relief they must reach what is called the completion point. Under the O-HIPC program, after the decision point, the debtor countries had to show a further 3-year track record of macroeconomic stability and policy reform. This implied that under the O-HIPC initiative, debtor countries had to wait at least for 6 years to reach the completion point and get full debt relief. As a result, the O-HIPC program was criticized for being too slow.

Under the E-HIPC that superseded the O-HIPC in 1999, in order for countries to reach the decision point, in addition to showing a good track record of economic performance, they need to prepare and start to implement the PRSP. This firmly linked debt relief with poverty reduction efforts. At the decision point, qualifying countries begin receiving interim reduction in their debt service payments. Moreover, the international community commits itself to provide a further reduction in the debt owed by qualifying countries once the latter embark on policies that channel debt relief resources to reducing poverty in the recipient countries.

Unlike the O-HIPC program, qualifying countries begin receiving interim debt relief under the E-HIPC framework at the decision point and can also reach the completion point faster. Furthermore, while the period between the decision and completion points was fixed under the original initiative, the timing under the enhanced initiative depends on the performance of the debtor countries and fulfillment of the requirements for the debt relief. Now, countries can reach the completion point faster, provided that they maintain macroeconomic stability and complete the PRSP. Thus the completion point under the E- HIPC initiative is a floating completion point in the sense that it depends on the performance of individual countries. At the completion point, creditors provide the full amount of the committed debt relief irrevocably. The following table shows the classification of eligible countries in the E- HIPC as of August 2004.

Table 4-2 Grouping of countries under the E-HIPC, August 2004

		Completion point countries		
Benin	Bolivia	Burkina Faso	Ethiopia	Ghana
Guyana	Mali	Mauritania	Mozambique	Nicaragua
Niger	Senegal	Tanzania	Uganda	
		Decision point countries		
Cameroon	Chad	Congo, D.R.	Gambia	Guinea
Guinea-Bissau	Honduras	Madagascar	Malawi	Rwanda
Sao Tome Principe	Sierra Leone	Zambia		
		Pre-decision point countries		
Burundi	Central Africa Republic	Comoros	Congo, Republic of	Cote d'Ivoire
Lao, PDR	Liberia	Myanmar	Somalia	Togo
		Potentially sustainable countries[24]		
Angola	Kenya	Vietnam	Yemen	

So far, the E-HIPC initiative seems to be effective in raising pro-poor government expenditure. For instance, for the 27 countries that have reached their decision point or are in the interim period, the poverty reducing government expenditure increased from 6.4 percent in 1999 to 7.9 percent of GDP in 2003; see IMF (2004b). In fact, according to IMF's projection, the average annual external debt service payments to export ratio of

[24] These countries' debt ratios were expected to be below the HIPC thresholds after full use of the traditional debt relief mechanism.

these countries would further be reduced by about 24 percent from their average 1998-99 level. Moreover, for those countries that have reached their completion point, debt relief has resulted in the reduction of their external debt stock by about 67 percent in net present value terms; see IMF and IDA (2004).

The 14 completion point countries have received a substantial reduction in their external public debt. The experience of these countries so far shows that they are performing better after the debt relief. The following table shows how much debt relief these countries obtained and their per capita GDP growth before and after they received debt relief.

Table 4-3a Real per capita GDP growth rate (%) for completion countries before and after the HIPC.

Country	Completion point date	Debt relief under O-HIPC (Million US $)	Debt relief under E-HIPC (Million US $)	Growth before HIPC(1970-95)	Growth during O-HIPC (1996-99)	Growth during E-HIPC(00-03)	Growth since HIPC(1996-03)
Benin	Mar-03	0	265	0.17	2.57	2.90	2.74
Bolivia	Jun-01	448	854	0.13	1.31	-0.24	0.53
Burkina Faso	Apr-02	229	324	1.16	2.51	2.11	2.31
Ethiopia	Apr-04	0	1982	0.10	2.22	0.92	1.57
Ghana	Jul-04	0	2186	-0.52	2.02	2.88	2.45
Guyana	Dec-03	256	335	0.57	3.39	-0.34	1.53
Mali	Mar-03	121	417	0.30	3.19	3.90	3.54
Mauritania	Jun-02	0	622	0.02	0.97	3.27	2.12
Mozambique	Sep-01	1717	306	-0.29	8.10	5.11	6.39
Nicaragua	Jan-04	0	3308	-2.68	2.47	2.14	2.31
Niger	Apr-04	0	664	-2.16	0.42	0.04	0.23
Senegal	Apr-04	0	488	-0.22	2.31	2.66	2.48
Tanzania	Nov-01	0	2026	0.59	1.17	4.41	2.79
Uganda	May-00	347	656	0.13	3.27	1.70	2.49

Source: IMF and IDA (2004) and growth rates are author's calculation using data from the World Bank (2002).

Table 4-3a shows the dates in which the completion countries reach the completion points. The third and fourth columns show the amount of debt relief that these countries obtained in net present value terms in millions of US dollars under the O-HIPC and E-HIPC frameworks, respectively. To compare how these countries performed before and after the introduction of the HIPC initiative, we also presented the simple average real per capita GDP growth rates before the introduction of debt relief (i.e., 1970-95), during the O-HIPC framework (i.e., 1996-1999), during the E-HIPC (i.e., 2000-2003), and for the whole period of the HIPC (i.e., 1996-2003). As we can see from the above table, the growth rate of the completion point countries significantly improved during the HIPC debt relief initiative. However, to establish a direct link between the debt relief effort and the observed improvement in the economic performance of the HIPCs, we need a formal analysis.

We can get a better understanding of how much debt relief the HIPCs receive if we express the debt relief in terms of some measure of the size of these economies. Table 4-3b shows by how much the net present value of the external debt of those countries at decision/completion point, measured relative to GDP or exports, changed as a result of the current debt relief effort. We also report the associated savings from a reduction in the debt service payments to export ratio of these countries.

Table 4-3b Debt indicators for 27 HIPCs that have reached decision/completion point in July 2004 (In percent, weighted average)

Debt indicators	Before E-HIPC	Debt indicators for 2003	After E-HIPC at the completion point
NPV of debt to export ratio	274	206	121
NPV of debt to GDP ratio	61	45	29
Debt service to export ratio	16	10	7

Source: IMF and IDA (2004).

As the above table shows those HIPCs that have reached decision/completion point are receiving significant debt relief. The reduction in the external public debt stock of these countries also reduces their debt service payments. As a result, resources released from debt service payments can be channeled to poverty reducing expenditure. In fact, at the completion point, the HIPCs are expected to see a reduction in their debt service payments by more than half. Their external debt stock is also expected to fall by about 67 percent in net present value terms.

4-3.5. Limitations of the HIPC initiative.

As we discussed before, the main objective of the HIPC initiative is to provide the eligible countries a permanent exit from continuous debt rescheduling and to achieve debt sustainability. However, debt sustainability depends on the countries' growth rates. Thus, to achieve the desired debt sustainability the countries must register a strong economic growth performance. It is argued that the IMF and the World Bank often use unreasonably high growth rate forecasts in the HIPC debt sustainability analysis. The problem with this is that if the expected high growth rate does not materialize, the debt sustainability analysis will be flawed and the countries will fail to achieve debt sustainability even if they are granted debt relief under the initiative.

Some people openly express pessimism about the success of the current HIPC debt relief initiative. For instance, Easterly (2001) points out that the current debt relief initiative is unlikely to be successful in solving the external debt problem of the HIPCs. In fact, he argues that most of the governments of these countries are corrupt and hence transferring resources through debt relief to corrupt governments actually harms the countries because these countries' governments have a high discount rate. If they are granted debt relief, they will accumulate external debt or decumulate assets until the desired level of external debt is attained.

Arslanalp and Henry (2002, 2003) also are pessimistic on the effectiveness of the HIPC debt relief initiative. They argue that previous debt relief efforts notably the Brady plan, were successful because the countries involved were adversely affected by the collective action problem that severely restricted the inflow of new lending to these countries. On the other hand, the authors argue that the countries in the HIPC initiative are not characterized by this problem. Rather, their main problems are lack of basic infrastructure and institutions that may not be solved by the debt relief effort. That is, because of the lack of infrastructure in these economies, unlike the countries under the Brady Plan, an increase in the inflow of foreign capital may not occur that will lead to a higher investment and economic growth. Thus according to these authors, as the principal problem of the HIPCs is not debt overhang or debt service payments *per se*, it would be better to provide these countries with aid, not debt relief, to improve their economic performance and reduce poverty. In short, according to their analysis, claiming that the HIPCs' main problem is debt overhang is a faulty diagnosis and debt relief is the wrong prescription.

The HIPC initiative is also criticized for using arbitrary thresholds to judge whether a country's external debt level is sustainable or not.[25] For instance, Sachs (2002) emphatically criticizes the arbitrary formulas used by both bilateral creditors (Paris Club) and the IMF and the World Bank to decide whether a country's debt level is sustainable. He argues that even under the current E-HIPC initiative that has lowered the debt threshold level, it is possible that a country's debt level is sustainable (judged by the threshold values) while a significant proportion of its citizens die of hunger and disease. Rather than basing debt relief on arbitrary threshold values, Sachs (2002) argues that a country's need for debt relief and other external assistance should be based on achieving some targets of economic development such as the Millennium Development Goals; for a detailed discussion of the shortcomings of the HIPC initiative see also Gunter (2004).

4-4. Simulated effects of debt relief on growth and welfare

[25] Even though there is no theoretical evidence that suggests the threshold external debt level for debt sustainability, the choice of the threshold debt level under the O-HIPC seems to be consistent with Cohen's (1997) empirical work that suggests that countries are likely to fall into debt crisis when their external debt to GDP ratio exceeds 50 percent (or equivalently in NPV terms when the debt to export ratio exceeds 250%). But again, the willingness of creditors to change the threshold in the E-HIPC shows that the threshold is in fact arbitrary.

4-4.1. Simulation of the theoretical model

4-4.1.1. Debt relief and economic growth

In this section, we analyze the welfare and long run growth effects of external public debt reduction. To do so, we use the theoretical model presented in the second chapter of the thesis. Suppose the external public debt to capital ratios before and after debt relief are denoted by z_0 and z_1, respectively. Let γ_0 and γ_1 denote the growth rates of the economy before and after the debt relief. The effect of debt relief on the growth rate measured in percentage points is given as:

$$\textit{Change in growth rate} = 100(\gamma_1 - \gamma_0) \,, \tag{1}$$

where $\gamma_0 = \dfrac{\sigma[(1-\alpha)Ap^{\alpha} - (1-\alpha)r(z_0)z_0 - \rho]}{[1-\sigma(1-\alpha)(1-\theta)z_0]}$,

$$\gamma_1 = \frac{\sigma[(1-\alpha)Ap^{\alpha} - (1-\alpha)r(z_1)z_1 - \rho]}{[1-\sigma(1-\alpha)(1-\theta)z_1]} .$$

Debt relief affects growth and welfare through its effects on the distortionary tax rate. The effect of debt relief on the growth rate and welfare through changes in the distortionary tax rate is straightforward. Debt relief reduces the distortionary tax and this in turn increases the return to private investment and the level of investment increases. The increase in investment in turn raises the growth rate. Moreover, private consumption would increase and hence debt relief will also have a welfare benefit. Thus in the following simulation exercise, the effect of debt relief on both the growth rate and welfare emanate from its effect on the distortionary tax rate. A similar line of analysis was used in Bigsten et al. (2001).

In order to simulate the effects of debt relief on the growth rate and welfare, we need to assign numerical values to the structural parameters. For developing countries such as HIPCs, empirical evidence on the values of the various structural parameters is generally scarce. But, as much as possible we attempt to assign numerical values to the parameters consistent with previous studies. One study often cited in the literature for its numerical estimate of the intertemporal elasticity of substitution is Hall (1988) who found that the intertemporal elasticity of substitution is well below one. Ogaki and Reinhart (1998), on the other hand, found that when preferences are allowed to be non-separable in durable and non-durable goods, the estimates of the intertemporal elasticity of substitution fall in the range of 0.32 to 0.45. Thus in our case we assume that the intertemporal elasticity of substitution, $\sigma = 0.4$ (as in Turnovsky and Chattopadhyay (2003)). For the rate of time preference, on the other hand, we assign a value of $\rho = 0.05$ (as in Ortigueira (1998)).

As data on the proportion of external public borrowing used to finance public investment are not available, we assume that $\theta = 0.75$. This implies that 75 percent of the flow of external public borrowing is used for public investment. However, as we will see later the simulation results are not sensitive to lower values of θ. In line with previous studies, we assume that the elasticity of output with respect to public capital α to be 0.15. This is within Aschauer's (2000) empirical estimates for a sample of low-income countries. While the exogenous world interest rate, r^* is assumed to be 5 percent (as in Osang and Turnovsky (2000), and Burnside and Fanizza (2004)), the coefficient in the risk premium function is set to be $\beta = 0.1$.

We choose the value of the structural parameters to match the average real per capita GDP growth rate for the HIPCs for the period 1970-99. Over this period, the average annual per capita GDP growth rate of the 30 HIPCs in the sample was about -0.2 percent. For the same period, the average external public debt to GDP ratio of the HIPCs was about 67 percent. Assuming an average capital to output ratio of 1.4 for these countries, this implies external public debt to capital ratio (z) of about 48 percent. Thus, assuming $\gamma = -0.002$, $z = 0.48$, $\beta = 0.1$, $r^* = 0.05$, $\theta = 0.75$, $\rho = 0.05$, $\alpha = 0.15$, and $\sigma = 0.4$, the technology parameter, A, can be endogenously determined from the growth rate equation as 0.103.

Using the above values for the structural parameters, we perform the simulation exercise for various alternative debt relief scenarios. For the proportion of foreign public borrowing that goes to public investment (θ) and intertemporal elasticity of substitution (σ), we use low and high values. We experiment with a reduction in external public debt for the HIPCs beginning from their 1995 average value. This is because, as the HIPC initiative began in 1996, the 1995 external debt ratio provides the relevant debt burden measure not only to determine the countries eligibility but also to show the level of debt relief that these countries would receive. In 1995, the average external public debt to GDP ratio of the 30 HIPCs under investigation was about 123 percent. Thus our main objective here is to investigate the likely impact of debt relief beginning from this high value.

In the current HIPC debt relief initiative, it is proposed that eligible countries would see a two-third reduction in their external debt stock. Therefore, in our analysis we examine the impact of a two-third reduction in external public debt on the growth rate. However, different alternative debt reduction scenarios are also considered.

Table 4-4 Debt relief and increase in average per capita GDP growth rate (in percentage points)

	θ = 0.50			θ = 0.75		
Debt reduction (%)	σ = 0.25	σ = 0.4	σ = 1	σ = 0.25	σ = 0.4	σ = 1
5	0.13	0.22	0.74	0.12	0.20	0.59
10	0.24	0.41	1.39	0.23	0.38	1.12
15	0.35	0.59	1.96	0.33	0.55	1.58
25	0.54	0.91	2.90	0.51	0.84	2.35
40	0.76	1.27	3.90	0.73	1.17	3.18
45	0.82	1.37	4.15	0.79	1.26	3.40
50	0.88	1.46	4.38	0.84	1.35	3.58
55	0.93	1.55	4.57	0.89	1.42	3.74
60	0.98	1.62	4.74	0.94	1.49	3.89
65	1.02	1.69	4.89	0.98	1.55	4.01
67	1.04	1.71	4.94	0.99	1.57	4.06

Note: σ is elasticity of intertemporal substitution and θ is the proportion of foreign borrowing used for financing public investment.

The model predicts that external public debt reduction would increase the long run growth rate. In Table 4-4 above, we present the gain in long run growth rate from various debt relief scenarios. The simple theoretical model in general suggests that debt relief has a large positive impact on the long run growth rate of the HIPCs. Notice that there is a difference in the simulated effects of debt relief depending on the values of the structural parameters. In particular, the value assigned to the elasticity of intertemporal substitution (σ) appears to have a significant impact on the growth rate.

For our base-case parameter values, the simulated growth effects of the proposed 67 percent debt reduction are given in the last row of Table 4-4. As we discussed above, the simulated growth effects show some difference at a lower and a higher value of the elasticity of intertemporal substitution. However, there is no significant difference in the growth effects of debt relief between a lower and a higher value of θ. When we assume $\theta = 0.75$ and $\sigma = 0.25$, the simulation result suggests that the growth rate of the HIPCs would increase by about 0.99 percentage points. This is a substantial improvement in the growth rate of the HIPCs. For the same value of θ, suppose the elasticity of intertemporal substitution takes a larger value (i.e.,σ =0.4), then the increase in the growth rate associated with the 67 percent debt relief would be even higher. More specifically, now for our base-case parameter values, the simulation results imply that the debt relief would increase the growth rate of the HIPCs' by about 1.57 percentage points. Figure 4-1a indicates how the impact of debt relief on the growth rate differs for a lower and a higher value of intertemporal elasticity of substitution.

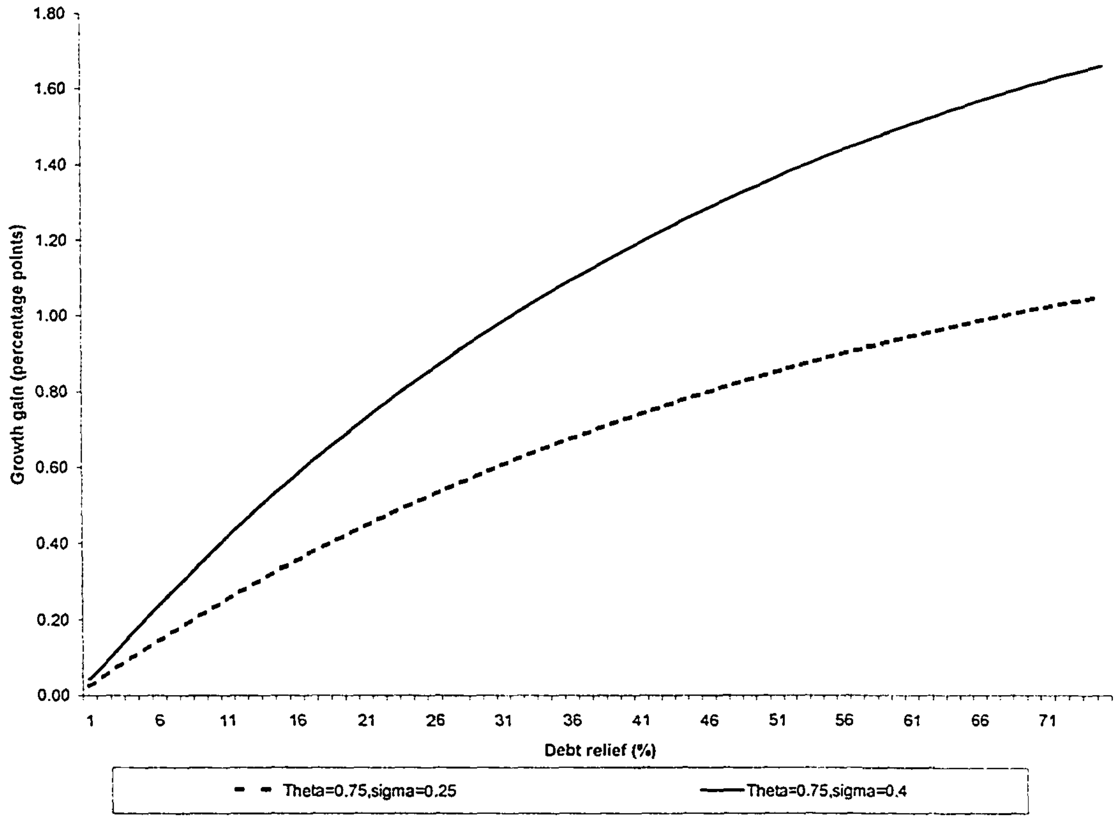


Figure 4-1a Growth effects of debt relief.

As Table 4-4 shows, the growth gain from debt relief increases with the amount of debt relief provided. Thus it is easy to see that debt relief has a substantial growth gain for the HIPCs. For instance, for our base-case parameter values, the proposed two-third reduction in the external debt stock of the HIPCs would increase their average growth rate by about 1.57 percentage points. Similarly, a 100 percent debt relief for the HIPCs would increase their average per capita GDP growth rate by about 1.9 percentage points. Note that each additional percent debt reduction increases the growth rate. However, the rate of increase in the growth gain from debt relief gradually decreases as the level of debt relief increases. The following figure shows how the rate of increase in the growth gain changes as we increase the level of debt reduction.

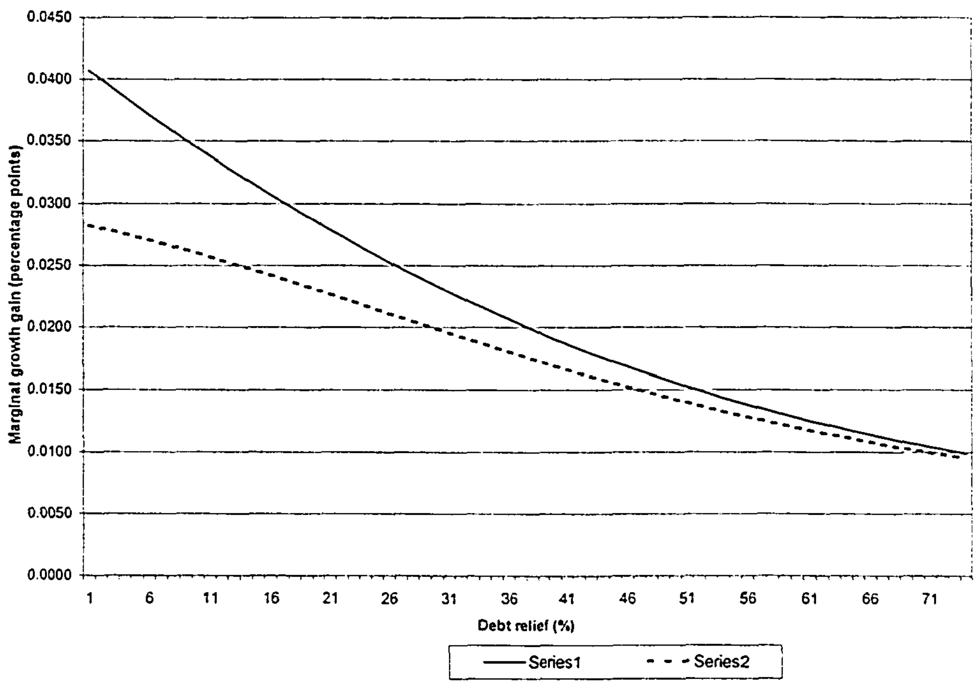


Figure 4-1b Marginal growth and welfare gains from debt relief based on the theoretical model.

4-4.1.2. Debt relief and welfare gain

In this section we examine the possible impacts of debt relief on the welfare of the HIPCs. Our analysis of the welfare effects of debt relief relies on the theoretical framework outlined in the second chapter of the thesis. The theoretical framework used shows that debt relief reduces debt service payments and affects economic growth favorably. The increase in the growth rate in turn implies a rise in the level of consumption. Thus, the welfare gain from debt relief emanates from the increase in the level of consumption brought about by the higher growth rate.

We follow the methodology employed in Lucas (1987), King and Rebelo (1990), Ireland (1994), and Ortigueira (1998), among others, to evaluate the welfare gain from debt relief. We assume that the economy was initially (i.e., before debt relief) on a balanced growth path. Let *C*(t)* denote the consumption level along this initial balanced growth path. After the debt relief, the economy will be along a new balanced growth path and the corresponding consumption level is denoted by $\hat{C}(t)$. Then, the welfare gain from debt relief is the value of Φ such that:

$$\int_0^\infty \frac{\sigma}{\sigma-1}(C_t^*(1+\Phi))^{\frac{\sigma-1}{\sigma}} e^{-\rho t}dt = \int_0^\infty \frac{\sigma}{\sigma-1}\hat{C}_t^{\frac{\sigma-1}{\sigma}} e^{-\rho t}dt. \tag{2a}$$

Suppose that γ_1 and γ_2 denote the growth rates of consumption along the pre- and post-debt relief balanced growth paths, respectively. Let *C*(0)* and $\hat{C}(0)$ also denote the initial consumption levels before and after debt relief, respectively. Then, we can rewrite equation (2a) as:

$$\int_0^\infty \frac{\sigma}{\sigma-1}\left[C(0)_t^* e^{\gamma_1 t}(1+\Phi)\right]^{\frac{\sigma-1}{\sigma}} e^{-\rho t}dt = \int_0^\infty \frac{\sigma}{\sigma-1}\left[\hat{C}(0)_t\, e^{\gamma_2 t}\right]^{\frac{\sigma-1}{\sigma}} e^{-\rho t}dt. \tag{2b}$$

The numerical value of Φ can be interpreted as the constant percentage increase in consumption that is required to make the consumers indifferent between the state of debt relief and no debt relief. In other words, since along the balanced growth path consumption grows at a constant rate, the value of Φ is such that the representative agent is indifferent between the debt relief and the state of no debt relief but his consumption level is increased by 100XΦ. Thus, the welfare gain from debt reduction can be calculated by finding the value of Φ that satisfies equation (2b). From equation (2b) above, the value of Φ is given by the following expression:

$$\Phi = \left(\frac{\hat{C}(0)}{C^{*}(0)} \right) \left[\frac{\sigma\rho + (1-\sigma)\gamma_1}{\sigma\rho + (1-\sigma)\gamma_2} \right]^{\frac{\sigma}{\sigma-1}} - 1. \tag{3}$$

Note that the growth rates of consumption γ_1 and γ_2 are calculated from the simple theoretical model. Using the representative agent's budget constraint, equation (3) can also be rewritten as:

$$\Phi = \left[\frac{\sigma\rho + (1-\sigma)\gamma_2}{\sigma\rho + (1-\sigma)\gamma_1} \right]^{\frac{1}{1-\sigma}} - 1. \tag{4}$$

The above equation provides the welfare gain from debt relief as we move from one balanced growth path to another. As discussed in the second chapter, the decentralized equilibrium involves transitional dynamics due to the presence of public capital that private agents take as exogenous. Note that the welfare gain from debt relief along the transition to the new steady state is not captured by the above equation. That is we examine only the long run effects of debt relief on welfare as we move from one balanced growth path to another. Consequently, our simulation of the effects of debt relief is based on a simple steady state comparison of welfare.

In order to simulate the welfare gain from debt relief, we use the structural parameters specified previously. In the following table we calculate the welfare gain for different values of σ and θ. We consider debt reduction from 5 percent to 67 percent. For example, for our base-case parameter values ($r^* = 0.05$, $\beta = 0.1$, $\rho = 0.05$, $\sigma = 0.4$, $\theta = 0.75$, and $\alpha = 0.15$), the welfare gain for a 67 percent debt reduction is about 129 percent. That is the debt relief is equivalent to about 129 percent upward shift in the steady-state consumption path. Thus our simulation result shows that external public debt reduction has a substantial welfare gain for the HIPCs. This gain in welfare is due to an increase in consumption brought about by the reduction in taxes required to finance external debt service payments. The simulation results also reveal that the total welfare gain from the debt reduction rises as the rate of debt reduction increases. Thus, not surprisingly, the highest welfare gain is attained when the debt reduction is the largest. However, the rate of increase in the welfare gain from debt relief falls with a rise in the level of debt relief; see Figure 4-1b.

Table 4-5 Debt relief and welfare gain (in percent)

	$\theta = 0.50$			$\theta = 0.75$		
Debt reduction (%)	$\sigma = 0.25$	$\sigma = 0.4$	$\sigma = 1$	$\sigma = 0.25$	$\sigma = 0.4$	$\sigma = 1$
5	19.13	18.21	16.00	15.76	14.01	12.62
10	37.43	35.87	32.11	30.74	27.42	25.08
15	54.78	52.79	48.03	44.87	40.14	37.20
25	86.42	83.99	78.44	70.51	63.31	59.92
40	126.21	123.58	118.17	102.56	92.28	88.98
45	137.56	134.88	129.54	111.66	100.46	97.19
50	148.03	145.29	139.96	120.05	107.97	104.68
55	157.69	154.87	149.45	127.77	114.85	111.48
60	166.60	163.68	158.05	134.89	121.16	117.62
65	174.85	171.79	165.84	141.46	126.94	123.17
67	177.98	174.86	168.74	143.95	129.12	125.23

The welfare effects from debt relief depend on the assumed values of the structural parameters. From the above table, we can see that the intertemporal elasticity of substitution appears to have a strong effect on welfare. However, the welfare gain from debt relief does not differ much between a lower and a higher value for θ. Figure 4-2 plots the welfare gain from various alternative debt relief scenarios for two different values of the intertemporal elasticity of substitution.

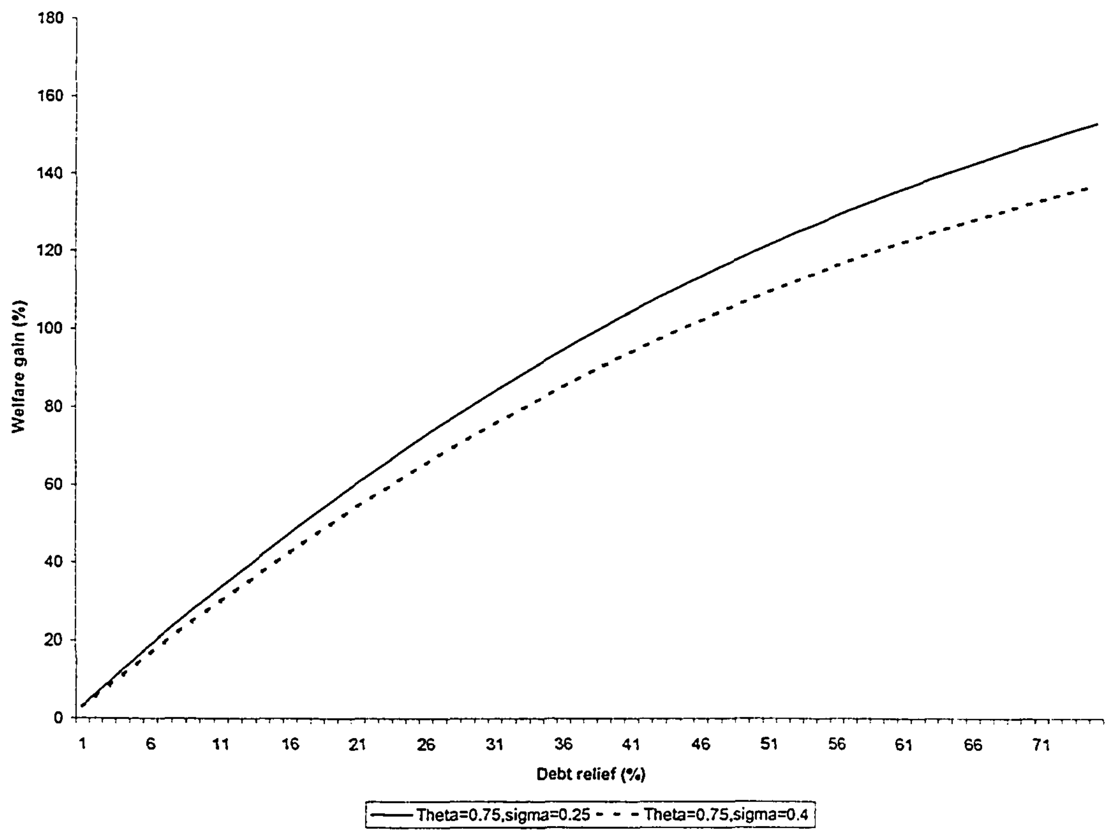


Figure 4-2 Welfare gain from debt relief.

In the above figure, the solid and the dotted lines show the welfare gains from debt reduction for different levels of debt reduction when the value of the intertemporal elasticity of substitution are assumed to be 0.4 and 0.25, respectively. The figure shows that the welfare gain from debt relief rises as the rate of debt reduction increases. However, as shown in Figure 4-1b, the rate of increase in the welfare gain from debt relief decreases as the level of debt relief increases.

4-4.1.3. The MCF from external public borrowing and debt relief

As shown in the second chapter, high external public debt reduces economic growth rate. That is, accumulating excessive external public debt reduces future output. Thus high external public debt has an opportunity cost to the economy in the form of a reduction in future output. To shed some light on this opportunity cost of high external public debt and gauge the social gain from debt relief we use the concept of "marginal cost of public funds". The Marginal Cost of public Funds (MCF) shows the economic loss incurred by the economy when it raises an additional dollar of revenue. We are particularly interested in measuring the loss to the society when it accumulates excessive external public debt. In this regard, we need to calculate the MCF from external public borrowing. When the government increases its external public debt, it requires increasing taxes to finance the debt service payments. Dahlby defined that "the MCF from public borrowing is the marginal economic loss caused by the additional taxes that have to be levied in order to finance an additional dollar of public debt." (2004, 217)

In this section, following the methodology outlined in Dahlby (2004), we derive an expression for the MCF from external public borrowing to shed some light on the social welfare gain from the debt relief. This section heavily draws on Dahlby (2004). We make use of the simple theoretical model presented in chapter two to drive the MCF expression. The following equations are the basic components of the simple model given in the second chapter of the thesis.

The production function is given as (where p is the public to private capital ratio):

$$Y = AK^{1-\alpha}K_G^{\ \alpha} = Ap^{\alpha}K. \qquad (5)$$

The representative private agent's constraint is expressed as:

$$\dot{K} = (1-\tau)Y - C. \qquad (6)$$

Similarly, the government's budget constraint is given as:

$$\dot{F} = r(z)F + \dot{K}_G - \tau Y. \qquad (7)$$

The utility function of the representative agent is

$$U = \int_0^{\infty} \frac{\sigma}{\sigma-1} C_t^{\frac{\sigma-1}{\sigma}} e^{-\rho t} dt. \qquad (8)$$

As shown in chapter two, maximization of equation (8) subject to equation (6) yields the growth rate of the economy as:

$$\gamma = \sigma\big((1-\tau)(1-\alpha)Ap^{\alpha} - \rho\big). \qquad (9)$$

From equation (7), the intertemporal budget constraint of the government can be written as:

$$\tau Ap^{\alpha} - p\gamma = (r(z) - \gamma)z = \Theta z. \qquad (10)$$

For the sake of simplicity, we assume here that the risk premium in foreign borrowing that we discussed in the second chapter is equal to zero (i.e., β=0). The foreign debt literature tells us that the condition for optimal external borrowing requires an equality between the marginal cost of borrowing and the marginal product; see for instance Glick and Kharas (1986). That is, $r = (1-\alpha)Ap^{\alpha}$. Thus using the growth rate expression given in equation (9), we get

$$\Theta = r - \gamma = (1-\alpha)Ap^{\alpha}(1-\sigma(1-\tau)) + \sigma\rho \,. \tag{11}$$

Let $\mu = C/K$ denote the consumption to capital ratio. From equation (6) we obtain:

$$\mu = \Theta + (\alpha - \tau)Ap^{\alpha} \,. \tag{12}$$

Since $C = \mu K = \mu K_0 e^{\gamma t}$, the discounted value of the representative private agent's utility function is given as:

$$V(\tau, p) = \frac{\left(\frac{\sigma}{\sigma-1}\right)(\mu K_0)^{\frac{\sigma-1}{\sigma}}}{\rho - \left(\frac{\sigma-1}{\sigma}\right)\gamma} \,. \tag{13a}$$

$$V(\tau, p) = \frac{\left(\frac{\sigma}{\sigma-1}\right)(\mu K_0)^{\frac{\sigma-1}{\sigma}}}{D} \,. \tag{13b}$$

Using the growth rate expression, the denominator in the above equation can be rewritten as:

$$D = \Theta - \tau(1-\alpha)Ap^{\alpha} \,. \tag{14}$$

The intertemporal budget constraint of the government given in equation (10) implies that the government's Present Value of Net Revenue (PVNR) equals the external public debt. This can be summarized using the following equation:

$$PVNR = \frac{(\tau A p^{\alpha} - \gamma p)K_0}{\Theta} . \tag{15}$$

Plugging equation (9) into equation (10) and noting that $r = (1-\alpha)Ap^{\alpha}$, the model yields the following expression for the tax rate:

$$\tau = \frac{(1-\alpha)Ap^{\alpha}z + \sigma(p-z)[(1-\alpha)Ap^{\alpha} - \rho]}{Ap^{\alpha}[1+\sigma(p-z)(1-\alpha)]} . \tag{16}$$

As shown in Dahlby (2004), in a dynamic model, the MCF is defined as:

$$MCF_{\tau} = \frac{\left(\frac{-1}{\lambda}\right)\left(\frac{\partial V}{\partial \tau}\right)}{\frac{\partial PVNR}{\partial \tau}} , \tag{17}$$

where $\lambda = (\mu K)^{-1/\sigma}$ is the marginal utility of consumption.

Taking the partial derivative of equation (17) with respect to τ and using the definition of λ one can obtain:

$$\frac{-1}{\lambda_0}\frac{\partial V}{\partial \tau} = \frac{Ap^{\alpha}K_0\{D+(\mu-D)\sigma(1-\alpha)\}}{D^2}. \tag{18}$$

The above equation gives as the monetary value of the loss in the private agent's utility due to the distortionary tax.

Similarly, from equation (15) taking the partial derivative of PVNR with respect to τ we obtain:

$$\frac{\partial PVNR}{\partial \tau} = \frac{Ap^{\alpha}K_0\{1+(p-z)\sigma(1-\alpha)\}}{\Theta}. \tag{19}$$

We can now derive an expression for the MCF using equations (18) and (19) as:

$$MCF_{\tau} = \frac{\left(\frac{-1}{\lambda}\right)\left(\frac{\partial V}{\partial \tau}\right)}{\frac{\partial PVNR}{\partial \tau}} = \frac{\Theta\{D+(\mu-D)\sigma(1-\alpha)\}}{D^2[1+\sigma(p-z)(1-\alpha)]}, \tag{20}$$

where D, Θ, and μ are as defined above.

External public debt requires governments to increase the tax rate in order to finance the debt service payments. Thus following Dahlby (2004), we can also derive the MCF from external borrowing as:

$$MCF_f = \frac{\left(\frac{-1}{\lambda_0}\right)\left(\frac{\partial V}{\partial f}\right)df}{(Ap^{\alpha}K_0)df} = \frac{\left(\frac{-1}{\lambda_0}\right)\left(\frac{\partial V}{\partial \tau}\right)\left(\frac{d\tau}{df}\right)}{Ap^{\alpha}K_0}, \tag{21}$$

where $f = z/Ap^{\alpha}$ is the external public debt to GDP ratio. Note also that the denominator is simply the derivative of the PVNR with respect to f from equation (15).

From equation (16), the impact of external public debt to GDP ratio on the tax rate is given by:

$$\frac{d\tau}{df} = \frac{\sigma\rho + Ap^{\alpha}(1-\alpha)[1-\sigma(1-\tau)]}{1+\sigma(1-\alpha)p - \sigma(1-\alpha)Ap^{\alpha}f} = \frac{\Theta}{1+\sigma(1-\alpha)(p-z)}. \tag{22}$$

Substituting equations (18) and (22) into equation (21) yields the MCF from external public borrowing as:

$$MCF_f == \frac{\Theta\{D+(\mu-D)\sigma(1-\alpha)\}}{D^2[1+\sigma(p-z)(1-\alpha)]}. \tag{23}$$

Comparing equations (23) and (20), we see that the MCF from external public borrowing is the same as the MCF from the distortionary tax rate. This is not surprising as there is only one tax rate in the model. In a closed economy framework, Dahlby (2004) also found that the MCF from public borrowing is equal to the MCF from income tax. Notice that in equation (23), D, Θ, and μ all depend on the structural parameters and the tax rate, τ. We can use the expression for τ given in equation (15) into equation (23) and calculate the MCF.

Using our base-case parameter values that reflect the HIPCs' economies over the period 1970-99 (i.e., $\gamma = -0.002$, $z = 0.48$, $\beta = 0$, $r^* = 0.05$, $\theta = 0.75$, $\rho = 0.05$, $\alpha = 0.15$, $\sigma = 0.4$, and $A = 0.09$), we found that the MCF from external public borrowing is 1.79. This implies that an additional dollar of external public debt costs the society $1.79. This loss to the economy occurs in the form of reduced output. In the context of our main focus, this MCF value also implies that reducing the external public debt by $1.00 yields a social gain of $1.79. Thus the simple model suggests that the current debt relief initiative has a substantial social gain for the HIPCs. The MCF from external public borrowing has also an important implication for public projects financed by external public borrowing. The calculated MCF value implies that public projects financed through external public borrowing must have a benefit cost ratio of 1.79 to improve social welfare.

4-4.2. Simulation of the empirical model

4-4.2.1. Growth effects of debt relief

In the previous section, we examined the impact of debt relief on the growth rate based on the simple theoretical model. It is also interesting to examine what our empirical model has to say about the possible long-run growth effects of the current debt relief initiative program. The main objective of the simulation exercise is to examine the impact of debt relief on investment and growth. Our empirical results show that excessive external public debt affects investment and growth adversely. Consequently, debt relief would increase investment and growth. The simulation experiment will allow us to shed some light on the magnitude of the effect of debt relief on per capita GDP growth and investment.

From the empirical model, we have seen that external public debt affects the growth rate directly by affecting productivity and indirectly through the investment channel. Thus, in our simulation exercise, unlike previous studies such as Iyoha (2000) and Cohen (2000), we examine both the direct and indirect effects of external public debt reduction on the growth rate. For the simulation exercise, we use the growth regression that includes the investment to GDP ratio as an explanatory variable. This will help us capture both the direct and indirect effects of debt relief on the growth rate.

It is to be recalled that the estimated growth equation that includes investment as an additional explanatory variable is of the following form:

$$G = \Delta ln(y_{it}) = \alpha_1(1-D)[ln\,(f_{it})-ln(f^*)]+\alpha_2 D[ln(f_{it})-ln(f^*)]+\alpha_3\, ln(IY_{it})+\,\theta' X_{it}. \quad (24)$$

where y_{it} is per capita GDP, G is per capita GDP growth, f_{it} is external public debt to GDP ratio, f^* is the threshold external public debt to GDP ratio, D is a dummy variable that equals one when f is greater than f^* and zero otherwise, IY is the investment to GDP ratio, X is a vector of control variables, and ln denotes the natural logarithm of the variable. Similarly, the estimated investment equation is given by:

$$ln(IY_{it})=\beta_1(1-D)[ln(f_{it})-ln(f^*)]+\beta_2 D[ln(f_{it})-ln(f^*)])+\pi' X_{it}. \quad (25)$$

Analyzing both the direct and indirect effects of debt relief on the growth rate requires considering both equations (24) and (25). Thus, substituting equation (25) into equation (24) we obtain the following:

$$G = \alpha_1\,(1-D)[ln\,(f_{it})-ln(f^*)]+\alpha_2 D[ln\,(f_{it})-ln(f^*)]\,+$$

$$\alpha_3\,\{\beta_1\,(1-D)[ln\,(f_{it})-ln(f^*)]+\beta_2 D[ln\,(f_{it})-ln(f^*)])+\,\pi' X_{it}\}+\,\theta' X_{it}\;. \quad (26)$$

Thus from equation (26), for given values of the other control variables, the impact of reducing the excessive or high external public debt on per capita GDP can be obtained as

$$\Delta G = (\alpha_2 + \alpha_3 \beta_2) \Delta ln\, (f_{it}) \,. \tag{27}$$

Similarly, the impact of a given percentage change in the external public debt ratio on the investment to GDP ratio can be obtained using the following approximation $\Delta(IY_{it}) = (\beta_2 \Delta ln\, (f)) IY_{it-1}$, where IY_{it-1} is the investment to GDP ratio before the debt relief. Suppose f_1 is the average external public debt to GDP ratio for the period 1995, and f_2 is the average external public debt ratio after the debt relief, then $\Delta ln\, (f) = ln(f_2) - ln(f_1)$. While the coefficient estimates of α_2 and α_3 can be obtained from the growth regression, β_2 can be obtained from the investment regression reported in the third chapter of the thesis.

Notice that from equation (27) the impact of debt relief on per capita GDP growth emanates from two sources. The first one is the direct effect of debt reduction on the per capita GDP growth rate. This is basically given by the coefficient of the high external public debt ratio from the growth regression results (α_3). The second one is the indirect effect of debt relief that works through investment. This is because debt relief affects investment and the latter in turn affects per capita GDP growth. In Table 4-6, we present the impacts of debt relief on growth and investment based on the empirical model estimated in Chapter three.

Table 4-6 Effects of debt relief on growth and investment under alternative debt relief scenarios (in percentage points)

Debt reduction (%)	Direct effects on growth	Indirect effects on growth	Total effects on growth	Total effect on Investment
5	0.06	0.01	0.07	0.09
10	0.12	0.03	0.15	0.18
15	0.19	0.04	0.23	0.28
25	0.33	0.08	0.41	0.49
40	0.59	0.14	0.73	0.87
45	0.69	0.17	0.86	1.02
50	0.80	0.19	1.00	1.18
55	0.93	0.22	1.15	1.36
60	1.06	0.25	1.32	1.56
65	1.22	0.29	1.51	1.79
67	1.29	0.31	1.59	1.89

Note: Parameter estimates are obtained from the growth and investment regression estimates presented in Chapter 3.

Our empirical analysis indicates that excessive external public debt can affect growth and investment adversely. In particular, high external public debt affects the growth rate indirectly by reducing investment (i.e. through the investment channel) and directly because of the possible misallocation and productivity effects of external public debt on the growth rate. From the investment regression, we have also seen that reducing excessive external public debt has a positive effect on the investment to GDP ratio. The last column in Table 4-6 above shows this effect of debt relief on the investment to GDP ratio. Our empirical results have shown that investment increases the growth rate. Thus debt relief affects per capita GDP growth through its positive impact on investment. These indirect effects of debt relief on per capita GDP growth that work through the investment channel are shown in the third column of Table 4-6.

We argued before that even when the investment to GDP ratio is held constant, excessive external public debt directly affects the growth rate by affecting productivity. Thus debt relief can affect the growth rate positively by improving productivity. This direct effect of debt relief on the growth rate is shown in column 2 of Table 4-6. Therefore, the total effect of debt relief on per capita GDP growth is simply the sum of the direct and indirect effects. Notice that the indirect effects of debt relief on growth are relatively smaller. In fact, the direct effects of debt relief are about 5 times higher than the indirect effects implying that debt relief affects the growth rate mainly through its positive effect on productivity. This is because even if debt relief has a significant positive effect on investment, its impact on the growth rate through changes in investment is not that strong as the numerical magnitude of the effect of investment on the growth rate is small. The following figure shows the direct and indirect effects of debt relief on growth for different levels of debt reduction.

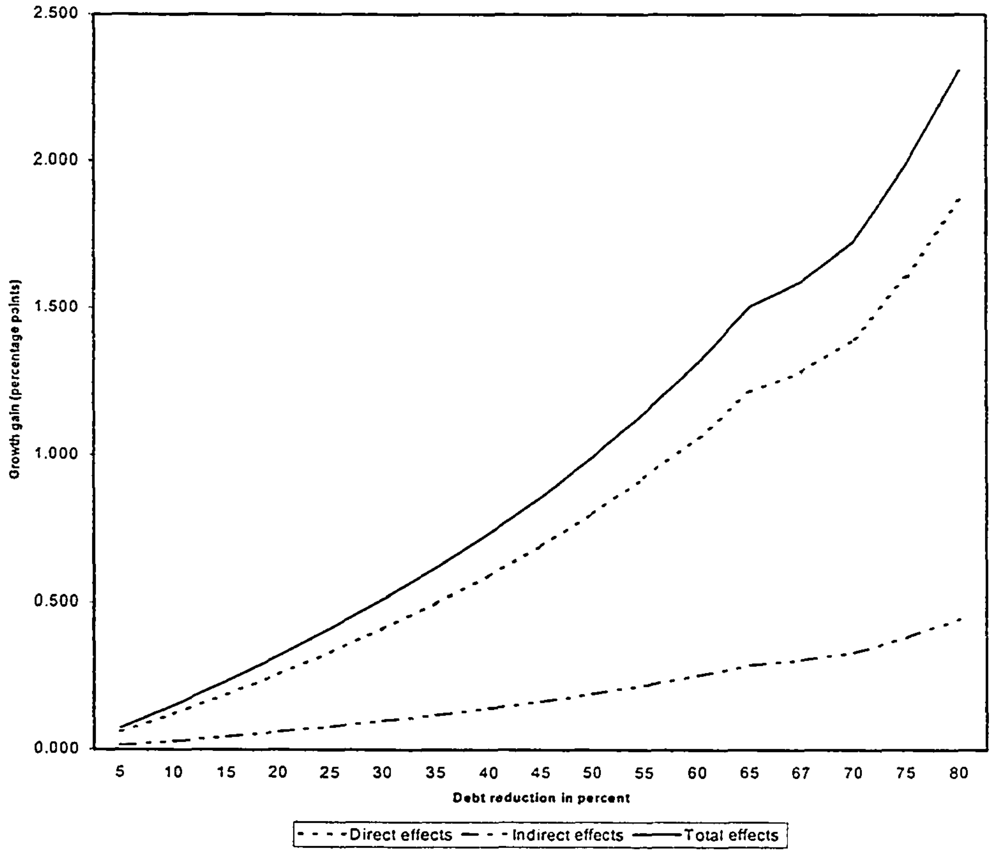


Figure 4-3 Direct and indirect growth effects of debt relief.

The current HIPC initiative is expected to reduce the external debt of the eligible countries at the completion point by about 67 percent. Our simulation results of Table 4-6 show that this would increase the average annual investment to GDP of the HIPCs by about 1.90 percentage points. It also results in an improvement in productivity. Thus the total effect is that the debt relief would increase the average annual per capita GDP growth rate of the HIPCs by about 1.6 percentage points. This is a significant gain in the growth rate of the HIPCs that have registered little or no improvement in their per capita growth rate for a long time. Notice also that this result is remarkably close to what we obtained from the simulation of the simple theoretical model. Thus our result suggests that debt relief would significantly increase the growth rate of the HIPCs. The simulation results of the impact of debt reduction on the growth rate are within previous results for various countries. More specifically, the results are generally higher than what is obtained in Cohen (2000) and Bigsten et al. (2001) but lower than Iyoha's (2000) findings for Sub-Saharan Africa.

4-4.2.2. Welfare effects of debt relief

Previously we analyzed how debt relief affects welfare based on the simple theoretical model. In this section, on the other hand, we examine the implication of the empirical model on how debt relief affects welfare in the debt relief recipient economies. To this effect, we use the welfare gain expression given in equation (4). However, now the growth rates γ_1, the growth rate prevailing along the initial balanced growth path and γ_2, the growth rate along the new balanced growth path after the debt relief are computed from the empirical model. More specifically, we use the average predicted or fitted value of the per capita GDP growth rate from the empirical model as γ_1. γ_2, on the other hand, is obtained by adding the growth gain from debt relief at each level of debt reduction to γ_1. The welfare gain based on the empirical model for different parameter values is presented in Table 4-7 below.

Table 4-7 Debt relief and welfare gain based on the empirical model (in percent)

	θ = 0.50		θ = 0.75	
Debt reduction (%)	σ = 0.25	σ = 0.4	σ = 0.25	σ = 0.4
5	6.0	3.7	6.0	3.7
10	12.3	7.7	12.3	7.7
15	19.2	12.0	19.2	12.0
25	34.5	21.5	34.5	21.5
40	62.9	39.4	62.9	39.4
45	74.3	46.6	74.3	46.6
50	87.0	54.7	87.0	54.7
55	101.4	63.8	101.4	63.8
60	117.7	74.3	117.7	74.3
65	136.6	86.4	136.6	86.4
67	145.1	91.9	145.1	91.9

As the proportion of foreign borrowing that goes to public investment (θ) is not explicitly shown in the empirical model, the welfare gain based on the empirical model does not depend on θ. Thus in the above table, the welfare gain from debt relief are the same regardless of the size of θ. When we compare the welfare gain computed from the theoretical and empirical models, we observe that the latter generally yield a higher welfare gain when the level of debt reduction is lower. As the amount of debt reduction increases, the difference in welfare gain from the two models decreases. For instance, for our preferred parameter $\sigma = 0.4$, which is consistent with our base-case parameter values, the empirical model suggests that the welfare gain from the proposed 67 percent debt relief is about 92 percent. Surprisingly, this welfare gain is similar to what we obtained from the theoretical model for the same set of parameter values.

4-4.3. Sensitivity analysis

In a simulation exercise, results generally depend on the parameterization of the model. In our case, long run growth and welfare effects of debt relief obtained from the simple model are sensitive to the parameter values assigned in the simulation experiment. These effects are particularly sensitive to the intertemporal elasticity of substitution. More specifically, the lower σ, the lower will be the impact of debt relief on growth and welfare. Likewise, the lower the rate of time preference the higher will be the impact of debt relief on both the growth rate and welfare. However, performing the simulation for the different values of the structural parameters does not result in any major qualitative change in the simulation results. But not surprisingly, the magnitudes of the change in the growth rate and the welfare gain from debt relief vary depending on the parameter values assumed in the simulation exercise.

4-5. Summary and conclusions

The external debt problem of many poor developing countries has recently attracted significant attention. Many low-income developing countries have accumulated a very large external public debt over the past 20 years. Despite a substantial accumulation of external debt, they have failed to show any noticeable economic improvement and a large proportion of their population is still living in absolute poverty. These countries spend more on external debt service payments than on health care or primary education. In fact, the low-income countries were unable to service their external debt service payments in full. Consequently, they have been continuously seeking more new loans and rescheduling from their creditors. In an attempt to give the world's poorest countries a permanent exit from the debt crisis and raise their growth rate, the IMF and the World

Bank introduced a debt relief program in 1996, the HIPC Initiative. The initiative was also substantially modified in 1999 to expedite the debt relief process and provide more relief.

In this chapter, we have attempted to evaluate the long run growth and welfare effects of the on going HIPC debt relief initiative. We based our evaluation on the simple theoretical model and empirical results obtained using data from sampled HIPCs. Numerical examples based on the simple theoretical model and simulations of the empirical model suggest that debt relief provides a significant growth benefit to the HIPCs. For example, using parameter estimates of the empirical model we found that, for the HIPCs, the proposed 67 percent debt reduction would increase the annual per capita growth rate of the countries by about 1.6 percentage points. The simulation exercise based on the simple theoretical model yields a similar growth gain. In particular, simulation of the simple theoretical model suggests that the proposed 67 percent debt relief would result in an increase in the growth rate of the HIPCs by about 1.57 percentage points. This result is in the range of what the few previous studies have also found. Furthermore, we have found that debt relief yields a substantial welfare gain for the HIPCs.

The finding of this chapter that debt relief would yield long-run growth and welfare benefits for the heavily indebted poor countries is consistent with the literature. Nevertheless, one should take into account the following limitations when trying to interpret the quantitative estimates of the growth and welfare gains of the HIPC initiative.

The simulation exercise has ignored some aspects of reality. First, in the HIPC initiative, eligible countries are required to go through structural adjustment programs. The policy improvements associated with the initiative may have beneficial effects on the growth rate of the debtor countries. However, our theoretical model ignores these improvements in economic policy. Second, in the theoretical model, apart from debt service payments, we have abstracted from non-productive government expenditure. Given these considerations, simulation results of the theoretical model should be viewed as indicative of the effects of debt relief.

In a nutshell, the simulation results of the theoretical and empirical models show that the current debt relief effort would raise the growth rate of the HIPCs significantly. Although debt relief can help increase the growth rate of recipient countries by increasing poverty-reducing government expenditure, the HIPC initiative is not a panacea for multitude of economic problems that these countries face. In fact, even if all the HIPCs' debt were cancelled, they may still need foreign assistance to effectively reduce poverty.

The results of this chapter rely on the assumption that resources relieved from debt service payments are used for productive purposes. In our case, the debt relief can be used to reduce distortionary taxes or increase productive government expenditure. For the debt relief to be effectively used for productive purposes there is a need to track the use of debt relief by the recipient governments. Thus for the debt relief initiative to be successful in raising economic growth in the world's poorest nations, the current efforts of the international community to track whether the governments of these countries put the resources to good use should be strengthened.

4-6. References

Alemayehu, G.F., 2001 Debt Issues in Africa: Thinking Beyond the HIPC Initiative to Solving Structural Problems. Paper presented at a WIDER Conference on Debt Relief, Helsinki.

Alemayehu, G.F., 2003. The historical origin of African debt crisis. Eastern Africa Social Science Research Review 16, 59-89.

Andrews D., Boote, A.R., Rizavi, S.S., Singh, S., 1999. Debt relief for low-income countries: the enhanced HIPC initiative.

http://www.imf.org/external/pubs/ft/pam/pam51/contents.htm

Arslanalp, S., Henry, P.B., 2002. Debt Relief: What Do the Markets Think? National Bureau of Economic Research, No. 9369.

Arslanalp, S., Henry, P.B., 2003. The world's poorest countries: debt relief or aid? Stanford Graduate School of Business, Research Paper No. 1809.

Aschauer, D. A., 2000. Public capital and economic growth: issues of quantity, finance and efficiency. Economic Development and Cultural Change 48, 391-406.

Asiedu, E., 2003. Debt relief and institutional reform: a focus on Heavily Indebted Poor Countries. Quarterly Review of Economics and Finance 43, 614-626.

Bigsten, A., Levin, J., Persson, H., 2004. Debt relief and growth: a study of Zambia and Tanzania, in: Addison, T., Hansen, H., Tarp, F. (Eds.). Debt Relief for Poor Countries. Palgrave Macmillan, New York.

Burnside, C., Fanizza, D., 2004. Hiccups for HIPCs. NBER working paper no. 10903.

Burnside, C., Dollar, D., 2000. Aid, policies and growth. American Economic Review 90, 847-68.

Cline, W.R., 1995. International Debt Reexamined. Institute for International Economics, Washington D.C.

Cohen, D., 1997. Growth and external debt: a new perspective on the African and Latin American tragedies. Center for Economic Policy Research Discussion Paper no.1753.

Cohen, D., 2000. The HIPC initiative: true and false promises. OECD Development Center, Working number 166.

Collins, S.M., Park, W., 1989. External debt and macroeconomic performance in South Korea, in: Sachs, J. and Collins, S.M (Eds.). Developing Country Debt and economic performance. University of Chicago press, Chicago.

Dahlby, B., 2004. What does the debt cost us? In: Ragan, C. and Watson, W. (Eds.). Is the Debt War over? Institute for Research on Public Policy, McGill, Montreal.

Daseking, C., Powell, R., 1999. From Toronto terms to the HIPC Initiative: a brief history of debt relief for low-income countries. IMF, working paper WP/99/142.

Easterly, W., 2001. Think again: debt relief. Foreign Policy Magazine, Nov-Dec, 2001. (Available at: http://www.foreignpolicy.com/Ning/archive/archive/127/TA.pdf)

Easterly, W., 2002. How did heavily indebted poor countries become heavily indebted? Reviewing two decades of debt relief. World Development, 30:1677-1696.

Froot, K., 1989. Buybacks, exit bonds, and the optimality of debt and liquidity relief. International Economic Review 30, 49-70.

Glick, R., Kharas, H., 1986. The costs and benefits of foreign borrowing: a survey of multi-period models. Journal of Development Studies January: 279-299.

Gunter, B.G., 2004. What is wrong with the HIPC Initiative and what is next? Development Policy Review 20, 5-24.

Hall, R.E. 1988. Intertemporal substitution in consumption. Journal of Political Economy 96, 339-57.

Husain, A.M., 1993. Debt relief schemes and welfare. Journal of International Money and Finance 12, 632-643.

International Monetary Fund (2000). The Logic of Debt Relief for the Poorest Countries. *http://www.imf.org/external/np/exr/ib/2000/092300.htm*

International Monetary Fund (2001). Debt Relief for Poverty Reduction: the Role of Enhanced HIPC Initiative. http://www.imf.org/external/pubs/ft/exrp/debt/eng/#3

International Monetary Fund (2002). Debt Relief under the Heavily Indebted Poor Countries (HIPC) Initiative: A fact sheet. *(http://www.mafhoum.com/press2/59E15.htm)*

International Monetary Fund (2004a). Heavily Indebted Poor Countries (HIPC) Initiative-Statistical Update. (http://www.imf.org/external/np/hipc/2004/033104.htm).

International Monetary Fund (2004b). Heavily Indebted Poor Countries (HIPC) Initiative-statistical update. (http://www.imf.org/external/NP/hipc/2004/082004.pdf).

International Monetary Fund and International Development Association (2004c). Heavily Indebted Poor Countries Initiative: status of implementation. Available at: http://www.imf.org/external/NP/hipc/2004/082004.pdf

Ireland, P.N., 1994. Supply-side economics and endogenous growth. Journal of Monetary Economics 33, 559-571.

Iyoha, M., 2000. An econometric analysis of external debt and economic growth in sub-Saharan African countries, in: Ajayi, Khan, M., (Eds.), External Debt and Capital Flight in Sub-Saharan Africa, International Monetary Fund, Washington, D.C., pp. 160-209.

Khan, M., Sehadji, A.S., 2001. Threshold effects in the relationship between inflation and growth. IMF staff Papers 48, 1-21.

King, R.G., Rebelo, S., 1990. Public policy and economic growth: Developing neoclassical implications. Journal of Political Economy 98, 126-150.

Knight, M., Loayaz, N., Villanueva, D., 1996. The peace dividend: military spending cuts and economic growth. IMF staff papers 43, 1-37.

Krugman, P., 1988. Financing vs. forgiving a debt overhang: some analytical notes. Journal of Development Economics 29, 253-268.

Lucas, R., 1987. Models of Business Cycles. Oxford: Basil Blackwell

McMullen, N., J., 1979. Historical perspectives on developing countries' debt, in: Franko, Lawrence G. and Seiber, Mallyn J. (Eds.). Developing Country Debt. Paragon Policy Studies. Paragon Press. New York.

Nafziger, W., E., 1993. The Debt Crises in Africa. John Hopkins University Press, Baltimore, Maryland.

O'Cleireacain S., 1990. Third World Debt and International Public Policy. Praeger, New York.

Ogaki, M., Reinhart, C.M., 1998. Measuring intertemporal substitution: the role of durable goods. Journal of Political Economy 106, 1078-1098.

Ortigueira, S., 1998. Fiscal policy in an endogenous growth model with human capital accumulation. Journal of Monetary Economics 42, 323-355.

Oxfam, 1999. Oxfam international submission to the Heavily Indebted Poor Country (HIPC) Debt Review. http://www.oxfam.org.uk/what_we_do/issues/debt_aid/downloads/oi_hipc.rtf

Rieffel, L., 2003. Restructuring Sovereign Debt: the Case for Ad hoc Machinery. Brooking Institution Press, Washington D.C.

Sachs, J., 1989. The debt overhang of developing countries, in: Calvo, G., Findlay, R., Kouri, P., Braga de Macedo, J., (Eds.), Debt, Stabilization and Development, Basil Blackwell, Oxford, pp. 80-102.

Sachs, J., 2002. Resolving the debt crisis of low-income countries. Brookings papers on Economic Activity 1, 1-28.

Sanford, J.E., 2004. IDA Grants and HIPC debt cancellation: their effectiveness and impact on IDA resources. World Development 32, 1579-1607.

Strulik, H., 2003. Capital tax reform, corporate finance, economic growth and welfare. Journal of Economic Dynamics and Control 28, 595-615.

Turnovsky, S.J., Chattopadhyay, P., 2003. Volatility and growth in developing economies: some numerical results and empirical evidence. Journal of International Economics 59, 267-295.

United Nations (UN) (1999). Finding solutions to the debt problems of developing countries: Report of the Executive Committee on Economic and Social Affairs of the United Nations. http://www.un.org/esa/coordinations/ecesa/eces99-2.htm

World Bank, 2002. World development indicators CD-ROM. World Bank, Washington, D.C.

World Bank, 2003. Debt Relief for the Poorest: an OED Review of the HIPC Initiative. World Bank, Washington, D.C.

CHAPTER 5 CONCLUSIONS

This dissertation examines the impact of external public debt on growth, fiscal policy and welfare of developing countries. In particular, we undertake theoretical and empirical analyses of the impact of external public debt on growth and welfare focusing primarily on the HIPCs. We also conduct a simulation exercise to shed some light on the possible effects of the current HIPC debt relief initiative on the eligible countries economic performance and welfare.

The dissertation contributes to the literature both theoretically and empirically. In the theoretical front, we provide a theoretical model that shows how external public debt may affect growth non-linearly. We show that the non-linear impact of external public debt on the long run growth rate emanates from the benefit of external public borrowing in financing public investment and the associated cost of financing debt service payments that require diverting resources away from domestic use. In this regard, we find that as long as a certain portion of the flow of external public borrowing is used to finance public investment, a low level of external public debt is good for growth. However, as more and more external public debt is accumulated, debt service payments require higher taxes or lower productive government spending. This ultimately reduces the growth rate. Thus, external public debt has a non-monotonic relationship with the growth rate.

Another theoretical contribution of the dissertation is the examination of the effects of external public debt on the growth and welfare maximizing fiscal policies. In this regard, we show that external public debt increases the optimal public capital to private capital ratio and the optimal income tax rate. Previous theoretical studies that use a similar framework in a closed economy context or in an open economy framework without external public debt show that the optimal steady state income tax rate is zero. However, in this dissertation we show that in the presence of external public debt, the optimal steady state income tax rate is non-zero. We also show that the growth maximizing income tax rate and public capital ratio increase with external public debt.

The dissertation also contributes to the literature in the empirical front. We use the recent threshold estimation method that is robust in detecting the possibility of non-linear relationship between variables. In an attempt to search for the growth maximizing level of external public debt ratio and test the implication of the simple theoretical model we use the powerful threshold estimation method rather than the traditional quadratic specification that is frequently used in the literature. Thus, in this regard the dissertation introduces the relevance of this powerful estimation technique to the external debt literature. Moreover, while previous empirical studies in the literature generally examine either the direct or indirect effects of external debt on growth, this dissertation shows the relevance of considering both effects. To this end, we show that external public debt affects growth both through the productivity and investment channels.

For policy makers in developing countries, determining the level of external public debt ratio that maximizes economic growth is very indispensable. Growth oriented policy makers of developing countries want to make sure that the borrowed foreign funds are at the level that will help them foster their growth endeavor without throwing them into debt crises. Consequently, analyzing the impacts of foreign debt on economic growth and determining the growth maximizing foreign debt to GDP ratio is of paramount importance from the perspective of policy makers. Using the threshold estimation method, we find that the threshold external public debt-to-GDP ratios are 22 percent and 31 percent for the HIPCs and the full sample of developing countries, respectively. Further empirical analysis using the system GMM econometric method that is popular and powerful in the estimation of growth models shows that external public debt has a positive effect below the threshold value for both the HIPCs and the full sample.

We also find that excessive external public debt (i.e., above the threshold value) has a significant negative effect on growth for both sample groups. That is, the debt overhang effect works only when the external public debt passes the critical threshold values. While the positive effect of external public debt on growth works through the investment channel, the adverse impact of excessive external public debt on the growth rate works through both the investment and productivity channels. The fact that external public debt has a positive impact below the threshold value and a negative impact beyond the threshold value suggests that external public debt-to-GDP ratios of 22 percent and 31 percent are the growth maximizing levels for the HIPCs and the full sample, respectively. Similarly, from the theoretical model we find that the growth maximizing external public debt to GDP ratio is 28 percent. This result has an important policy implication for the HIPCs. If HIPCs use a significant part of the external public borrowing for productive purposes, a certain level of external public debt is good for their growth. However, accumulating external public debt in excess of the growth maximizing levels will affect their growth adversely. Thus they should monitor their external public debt not to deviate significantly from the growth maximizing level.

We attempt to investigate the growth and welfare implications of the current HIPC debt relief initiative through a simulation exercise using the theoretical model and parameter estimates of the empirical result. Our simulation exercise shows that the current debt relief initiative has substantial growth and welfare gains for the eligible poor countries. In particular, we find that the proposed two-third reduction in the external debt of HIPCs will increase their per capita GDP growth rate, on average, by about 1.57 percentage points (according the theoretical model) and 1.6 percentage points (according to the empirical model). Furthermore, we find that the current debt relief initiative will provide a significant welfare gain.

This dissertation can be expanded both theoretically and empirically. There is particularly a tremendous potential for future theoretical work. In our theoretical model for the sake of analytical tractability, we use just one type of tax, income tax, and one type of public spending, productive spending. Moreover, we restrict public investment to be financed only through external public borrowing. These are obviously shortcomings of the dissertation that need be addressed in future studies. This is because in reality governments in developing countries use different taxes and foreign aid to finance their expenditures. They also make various kinds of spending. Thus future studies can incorporate these important elements of reality. Another shortcoming of this dissertation is the absence of domestic public debt in the theoretical model. Although this is unlikely to affect the relationship between external public debt and growth, it may affect the impact of external public debt on growth and welfare maximizing fiscal policies. Thus future research can also expand the theoretical model in this direction. Furthermore, the possibility of debt repudiation and credit constraint, which are ignored in this dissertation, can be another promising direction for future research. In the empirical front, future studies will have the advantage of time to analyze the impact of debt relief on growth using pre and post debt relief data and examine whether the HIPC initiative achieves its objectives of debt sustainability and higher economic growth.

APPENDIX 1 DEFINITION OF VARIABLES AND DATA SOURCES

The Data for this study are from various sources.

- *Per capita GDP growth*: the period average growth rate of per capita GDP in constant 1996 international dollars from Summer and Heston Penn world tables (PWT 6.1).
- *Initial per capita income:* the natural log of the real per capita GDP in 1996 prices at the beginning of each period. Source: PWT 6.1.
- *Investment to GDP ratio:* the ratio of real investment (both public and private) to real GDP in constant 1996 international dollars. Source: PWT 6.1.
- *Government consumption to GDP ratio:* real government consumption to real GDP ratio in constant 1996 international dollars. Source: PWT 6.1.

- *External public debt to GDP ratio:* nominal public and public guaranteed (PPG) foreign debt to nominal GDP ratio. Source: World Bank, World Development Indicators (WDI 2002).
- *Debt service to export ratio:* the ratio of external public debt service to export ratio. Source: WDI 2002.
- *Inflation rate:* the growth rate of the Consumer Price Index. Source IMF, World Economic Outlook (WEO) 2002.
- *Openness*: the sum of exports and imports as a ratio of GDP. Source: PWT 6.1.
- *Democracy index*: freedom (political rights) index constructed by Freedom House. The value ranges from 1 (the best) to 7 (the worst). Source: Freedom House, 2002.
- *Population growth:* the natural logarithm of the population growth rate. Following Mankiw, *et al.* (1992) we augmented this variable with 3 percent depreciation and 2 percent technical change rates. Source: PWT 6.1.
- *Schooling*: the secondary school enrollment rate at the beginning of each period. Source: World Bank, World Development Indicators.
- *Foreign aid to GDP ratio*: official development assistance to nominal GDP ratio. Source: World Bank, World Development Indicators.

Note that for initial per capita GDP and the external public debt to GDP ratio, we take the values of the variables at the beginning of each period. For the other variables, on the other hand, we take average values of the variables in each period.

Countries in the sample:

HIPCs:

Benin	Congo Demo.R	Honduras	Senegal
Bolivia	Congo Rep.	Kenya	Sierra Leone
Burkina Faso	Cote d'Ivoire	Madagascar	Tanzania
Burundi	Ethiopia	Malawi	Togo
Cameroon	Gambia	Mali	Uganda
Central A.R	Ghana	Mauritania	Zambia
Chad	Guinea	Nicaragua	
Comoros	Guyana	Niger	

Non-HIPCs:

Algeria	El Salvador	Mauritius	Philippines
Argentina	Guatemala	Mexico	Sri Lanka
Botswana	Haiti	Morocco	Syria
Brazil	India	Nepal	Thailand
Chile	Indonesia	Nigeria	Trinidad & To.
Colombia	Jamaica	Pakistan	Tunisia
Costa Rica	Jordan	Panama	Turkey
Dominican	Korea, R.	Papua N.G.	Uruguay
Ecuador	Lesotho	Paraguay	Venezuela
Egypt	Malaysia	Peru	Zimbabwe

Table A1-1: Descriptive Statistics –HIPCs

Number of Observations: 180 (HIPCs)

Variable	Mean	Std Dev	Minimum	Maximum
Per capita growth (%)	-0.20	3.03	-12.67	10.74
Initial per capita income	1420.71	733.11	321.71	4366.96
External public debt to GDP ratio (%)	66.72	73.86	2.73	531.51
Investment to GDP ratio (%)	9.07	6.61	0.96	42.15
Openness (%)	60.11	30.32	12.87	215.47
Secondary school enrolment (%)	18.26	16.47	1.12	83.39
Debt service to export ratio (%)	13.98	9.22	0.84	50.31
Foreign aid to GDP ratio (%)	11.25	8.17	0.63	48.77
Democracy Index	5.38	1.48	1.40	7.00
Population growth rate (%)	2.12	0.52	0.04	3.29
Government spending to GDP ratio (%)	24.20	12.32	3.88	69.53
Inflation (%)	104.24	613.67	-2.84	6403.70

Table A1-2: Descriptive Statistics Full Sample
Number of Observations: 420 (Full Sample)

Variable	Mean	Std Dev	Minimum	Maximum
Per capita growth (%)	0.87	2.95	-12.67	12.06
Initial per capita income	2951.79	2274.68	321.71	13552.63
External public debt to GDP ratio (%)	46.50	54.81	0.33	531.51
Investment to GDP ratio (%)	12.64	7.41	0.96	42.15
Openness (%)	59.72	31.08	8.45	215.47
Secondary school enrolment (%)	31.22	21.67	1.12	100.87
Debt service to export ratio (%)	14.65	9.83	0.41	66.98
Foreign aid to GDP ratio (%)	6.67	7.56	-0.02	48.77
Democracy Index	4.44	1.81	1.00	7.00
Population growth rate (%)	1.91	0.61	0.04	4.95
Government spending to GDP ratio (%)	22.15	11.09	3.88	69.53
Inflation (%)	0.87	2.95	-12.67	12.06

Table A1-3: Granger Causality Tests in Levels
Dependent variable: Log of initial external public debt to GDP ratio ($LPPGGDPO_{it}$)

Sample	HIPCs	HIPCs	Full	Full
$LPPGGDPO_{it-1}$	0.49	0.97	0.96***	0.39**
	(1.59)	(1.59)	(2.41)	(2.31)
$RGDPLG_{it-1}$	0.02		0.01	
	(0.38)		(0.63)	
$LINVGDP_{it-1}$		-6.04		0.10
		(-0.02)		(0.07)

Figures in parentheses are t-ratios. The estimation method employed is 2SLS.
RGDPLG and LINVGDP denote the per capita GDP growth rate and the log of the investment to GDP ratio, respectively.
Note also that *, **, and *** show that coefficients are significant at 10%, 5%, and 1% significance levels, respectively.

Table A1-4: Granger Causality Tests in First Differences
Dependent variable first difference of external public debt to GDP ratio ($DPPGGDP_{it}$)

Sample	HIPCs	HIPCs	Full	Full
$DPPGGDP_{it-1}$	0.82***	0.89**	0.54***	1.05***
	(2.65)	(2.38)	(2.89)	(3.76)
$DRGDPLG_{it-1}$	0.01		0.01	
	(0.39)		(0.28)	
$DLINVY_{it-1}$		0.47		0.47
		(1.55)		(1.27)

Figures in parentheses are t-ratios. The estimation method used is 2SLS.
DRGDPLG and DLINVY denote the first differences of the per capita GDP growth rate and the log of the investment to GDP ratio, respectively.
Note also that *, **, and *** show that coefficients are significant at 10%, 5%, and 1% significance levels, respectively.