Debt Relief for Poor Countries: Conditionality and Effectiveness

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COMMENTS WELCOME

Abstract

This paper analyzes whether debt relief is an effective instrument to stimulate economic growth in the most heavily indebted poor countries. We develop a neoclassical framework with a conflict of interest between the altruistic donor and the recipient government and model conditionality as an imperfectly enforceable dynamic contract. Quantitative findings suggest that imposing incentive-compatible conditions on the provision of debt relief substantially promotes fiscal reform and investment in the short- and long-run. In contrast to the recent practice of fully canceling multilateral debt, optimal policy is characterized by a combination of outright grants and 'soft' loans. Losing loans as a policy instrument reduces welfare considerably.

JEL: E13, F35, O11, O19.
Keywords: foreign aid, concessional lending, debt relief, conditionality, limited enforceability, dynamic contracts, neoclassical growth

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1 Introduction

The most heavily indebted poor countries in the world, the HIPCs, have been suffering from low income levels, stagnating economic growth and high external public debt for many years. In 1996, motivated by the concern to stimulate growth and reduce poverty, the International Monetary Fund and the World Bank founded the Initiative for Heavily Indebted Poor Countries that was supplemented by the Multilateral Debt Relief Initiative in 2005. The objective of the initiative is to provide substantial debt cancelations so that the recipient governments have free resources left to finance efficient growth-enhancing economic policies. In 2007, total costs of debt relief were estimated at $ 71 billions (IMF Factsheet, 2010).

In their seminal contributions, Krugman (1988) and Sachs (1989) show that debt relief may facilitate new lending, investment and growth if a country suffers from a debt overhang.[1] However, as argued by Arslanalp and Henry (2004, 2006) and Eaton (1990), it is questionable whether the HIPCs are characterized by a debt overhang since they have continuously received positive net loans on concessional terms and face debt obligations to official creditors rather than commercial banks. To emphasize this point, figure 1 shows the components of public external debt as well as the components of official development assistance (ODA). Since positive ODA net loans have replaced market debt by official concessional debt, Easterly (2002) argues that debt relief has been implicitly granted to the HIPCs over the past three decades. The concern about the unsustainability of external debt burdens motivated the recommendation made by the Meltzer (2000) Commission that development assistance should be provided through outright grants rather than concessional loans.

This paper studies the question whether debt relief - provided explicitly via outright grants and implicitly via concessional loans - is an effective instrument to stimulate economic growth in the most heavily indebted poor countries. We take into account that the main economic problem of the HIPCs is the lack of functional economic institutions rather than debt overhang (Cordella, Dell'Ariccia and Kletzer, 2003, Arslanalp and Henry, 2006). Instead of implementing efficient policies, the recipient government may divert transfers from their intended use and follow poor or wasteful economic policies (Easterly, 2002). To prevent this from happening, it has become a common policy to impose conditionality on the provision of debt relief.[2] However, the sovereign recipient government may not be willing to keep the conditions and, as already argued by Sachs (1989), the enforcement of

[1] Arslanalp and Henry (2005) provide empirical evidence that the debt reduction agreements under the 'Brady Plan' in the 1980s generated efficiency gains and stimulated investment in middle-income developing countries.

[2] To be considered for the HIPC Initiative countries must meet certain criteria, e.g., countries must have developed a Poverty Reduction Strategy Paper.

conditionality is weak.

The objective of the paper is to analyze how conditionality and debt relief should be designed to induce the recipient government to cooperate so that efficient growth-enhancing economic policies are implemented. We follow Cordella et al. (2003), Kletzer (2005), Cordella and Dell'Ariccia (2007) and formulate conditionality as an imperfectly enforceable contract between the donor and the recipient government.[3] To ensure that the recipient government fulfills the conditions and implements economic policies that coincide with the donor's intention, the donor threatens with punishments.

To study the optimal design of debt relief, we analyze incentive-compatible conditionality in a neoclassical growth model of a small open economy. The government of the small open economy finances non-productive government consumption by issuing foreign debt and raising taxes. To reflect the risk of sovereign default on non-concessional debt, market interest rates are assumed to be increasing in the debt-to-capital ratio and, therefore, limit the access to international credit markets. The donor provides costly debt relief in form of concessional loans and outright grants and cares solely about the welfare of the households. In contrast, the recipient government also values non-productive government consumption and discounts the future at a higher rate, which can be interpreted as a short-hand for political economy factors that lead to overspending and debt accumulation (Easterly, 2002). The conflict of interest between the donor and the recipient government raises the issue of conditionality: the donor offers loans and/or grants and, in return, expects the government to implement fiscal as well as debt policies that coincide with the donor's intention.

In our analysis, we impose two important assumptions. First, we define conditionality to be self-enforcing if, at any point in time, the contract is supportable by the threat of a permanent cutoff from any kind of assistance. Second, official creditors are able to enforce the repayment of concessional debt, i.e., a failure on conditionality does not come along with a default on concessional debt. These two assumptions imply that a permanent cutoff from assistance is the worst possible punishment threat so that the associated self-enforcing conditionality generates the best achievable outcome for the donor. We interpret our findings as an upper benchmark on the effectiveness of debt relief and discuss the effects of relaxing these assumptions.

Quantitative results suggest that self-enforcing conditionality substantially promotes fiscal reform and stimulates investment and growth. In contrast to the recent practice of canceling 100 percent of

[3] Papers that deal with limited enforceable dynamic contracts in different areas of research are e.g., Kocherlakota (1996), Kletzer and Wright (2000), Alvarez and Jermann (2000), Kehoe and Perri (2002), Krüger and Perri (2006), Krüger and Uhlig (2006), Azariadis and Kaas (2008). Marcet and Marimon (1992) study external financing opportunities under limited commitment in a stochastic growth model and apply their theoretical model to the case of Africa in Giovannetti, Marcet and Marimon (1993).

multilateral debt under the Multilateral Debt Relief Initiative, optimal conditionality is accompanied by a combination of concessional loans and outright grants. This is true as long as official creditors are able to enforce the repayment of concessional debt. The intuition is that loans, unlike grants, imply repayment obligations that increase the donor's leverage over the recipient government's policies and make conditionality easier to enforce. If official creditors are not able to enforce concessional loans so that a failure on conditionality goes hand in hand with a default on concessional debt, it is optimal to provide outright grants only. Losing loans as a policy instrument reduces the effectiveness of one unit of development assistance and generates a considerable welfare loss.

In the short-run, it is optimal to impose strong conditions on the provision of debt relief to promote economic growth. In our theoretical economy, substantial reductions in market debt and government consumption as well as large tax cuts substantially increase investment. Over time, as capital grows, the recipient economy becomes richer and benefits from an improved access to international credit markets so that breaching the contract becomes more attractive. As a consequence, to induce the recipient government to continue to cooperate, conditionality becomes less severe. The dynamic patterns of self-enforcing conditionality and the optimal combination of subsidized loans and outright grants are crucially determined by the degree of the recipient's non-benevolence and impatience since these parameters determine the strength of the conflict of interest and the access to international financial markets. In the long-run, to prevent that the recipient government returns to wasteful fiscal policies, the donor has to permanently provide subsidized loans and grants.

This paper is related to recent studies by Murshed and Sen (1995), Svensson (2000a, 2000b, 2003), Pedersen (1996, 2001), Azam and Laffont (2003) and Hagen (2006) who use static or two-period game-theoretic models to analyze incentive-compatibility, moral hazard and informational problems in the context of foreign aid. Our paper is closely related to Cordella et al. (2003) who analyze the interaction of conditional aid and debt relief in a stylized infinite horizon endowment economy. They show analytically that regaining access to international credit markets decreases the recipient's incentives to cooperate so that conditionality becomes more difficult to enforce. Cordella and Dell'Ariccia (2007) contrast conditional budget support and project aid while Kletzer (2005) focuses on the credibility of aid sanctions. Scholl (2009) contributes to this literature by analyzing the impact of incentive-compatible conditional aid on fiscal policy reform and investment in a neoclassical growth framework. However, Scholl (2009) abstracts from international financial markets and concessional debt.

This paper builds on Cordella et al. (2003) and Scholl (2009) and provides a novel quantitative-

theoretical analysis of the dynamic properties of explicit and implicit debt relief in a neoclassical framework that accounts for incentive compatibility problems. In particular, our framework allows us to analyze the short- and long-run impact of optimal concessional loans and outright grants on fiscal policies and capital accumulation as well as the interaction of market debt and concessional loans. Therefore, our study extends the theoretical setup of Cordella et al. (2003) and complements their analytical findings. Moreover, we contribute to the discussion whether outright grants should be preferred to concessional loans, see e.g., Bulow and Rogoff (2005), Cordella and Ulku (2004) and Cohen, Jacquet and Reisen (2007).

Our neoclassical theoretical framework builds on the literature that studies the link between foreign aid and economic growth, e.g., Chenery and Strout (1966), Boone (1996), Chatterjee, Sakoulis and Turnovsky (2003) and Chatterjee and Turnovsky (2007). These studies, however, abstract from incentive compatibility issues and take aid as exogenously given. Our paper is related to Aguiar and Amador (2010) who develop a political economy model of sovereign debt and show that unconditional aid and debt relief have no long-run effects. However, since their focus is the analysis of debt default, they do not study the issue of optimal conditional aid.

The paper is structured as follows. In section 2 we develop a neoclassical framework of a small open economy with a conflict of interest between the donor and the recipient government. In section 3 we analyze the quantitative properties of incentive-compatible conditional debt relief by studying transition paths and long-run properties. Finally, section 4 concludes.

2 The Model

2.1 The Environment

In the following, we consider a small open developing economy that is inhabited by a large number of infinitely-lived households who maximize lifetime utility. Preferences of the representative household are given by

$$\sum_{t=0}^{\infty} \beta_p^t u(c_t), \qquad 0 < \beta_p < 1, \tag{1}$$

where c_t denotes household consumption at time t. The utility function $u(c_t)$ satisfies $u_c(c_t) > 0$ and $u_{cc}(c_t) < 0$. β_p denotes the private discount factor.

The household produces the consumption good and saves by investing in the capital stock k_t. The household's budget constraint is described by

$$c_t + k_t = (1 - \tau_t) y_t + (1 - \delta) k_{t-1}, \tag{2}$$

The capital stock depreciates at rate $0 \leq \delta < 1$. y_t denotes production at time t and τ_t is the income tax raised by the government. More broadly, one may interpret τ_t as the share of income that is lost due to inefficient economic policies. Note that we assume that households do not have access to international credit markets.

The household produces y_t by employing the production function

$$y_t = F(k_{t-1}, n_t). \tag{3}$$

The production function has constant returns to scale in capital k_{t-1} and labor n_t. In the following, we normalize labor $n_t \equiv 1$, for all t, such that $F(k_{t-1}, 1) \equiv f(k_{t-1})$.

Preferences of the government are given by

$$\sum_{t=0}^{\infty} \beta_g^t v(c_t, g_t), \qquad 0 < \beta_g < 1, \tag{4}$$

where the utility function v satisfies $v_c(c_t, g_t) > 0$, $v_{cc}(c_t, g_t) < 0$, $v_g(c_t, g_t) > 0$ and $v_{gg}(c_t, g_t) < 0$. We label unproductive government consumption by g_t and interpret it as e.g. expenditures supporting the political elite (see also Cordella and Dell'Arriccia, 2007, and Scholl, 2009). Importantly, we allow that the government discounts the future at a different rate than the public, $\beta_g \leq \beta_p$. The higher discount rate can be interpreted as short-hand for political economy factors that lead to overspending and debt accumulation, see Easterly (2002) and Aguiar and Amador (2010).

The recipient government finances non-productive government consumption g_t by raising the income tax τ_t and issuing foreign debt $d_t \geq 0$ at the market interest rate r_{t+1} and by receiving transfers $\ell_t \geq 0$ from the donor. The government's budget constraint reads as

$$g_t + (1 + r_t)d_{t-1} + (1 + r_t - q_t)\ell_{t-1} = \tau_t f(k_{t-1}) + d_t + \ell_t, \tag{5}$$

where $q_{t+1} \geq 0$ determines the concessionality level of the transfers ℓ_t. If $q_{t+1} \equiv 0$, then the donor provides non-concessional loans at the market interest rate. If $q_{t+1} \equiv r_{t+1}$ the donor provides loans without interest. If $q_{t+1} \equiv 1 + r_{t+1}$, transfers ℓ_t are given as an outright grant.[4]

We follow e.g. Chatterjee et al. (2003) and assume that the market interest rate takes the functional form $r_t = \Phi\left(\frac{d_{t-1}}{k_{t-1}}\right)$ with $\Phi(0) = r^\star$ and $\Phi_{\frac{d}{k}}\left(\frac{d_{t-1}}{k_{t-1}}\right) > 0$. Thus, the market rate is at least as large as the world interest rate $r^\star$ and is assumed to be strictly increasing in the debt to capital ratio reflecting the risk of sovereign default. The country risk premium is given by $r_{t+1} - r^\star \geq 0$.

[4] See also Cordella and Ulku (2004) who formulate the transfer scheme in a similar way.

We assume that there is a representative altruistic donor who cares about the welfare of the households and provides costly development assistance by choosing ℓ_t and q_{t+1}.[5] The donor's preferences take the following form

$$\sum_{t=0}^{\infty} \beta_p^t [u(c_t) - h(q_t \ell_{t-1})]. \tag{6}$$

The cost function $h(q_t \ell_{t-1})$ satisfies $h(q_t \ell_{t-1}) > 0$ if ℓ_{t-1} or q_t are strictly greater than zero, and $h(q_t \ell_{t-1}) = 0$ if $q_t \ell_{t-1} = 0$. Moreover, $h_q(q_t \ell_{t-1}) > 0$, $h_\ell(q_t \ell_{t-1}) > 0$, $h_{qq}(q_t \ell_{t-1}) \geq 0$, $h_{\ell\ell}(q_t \ell_{t-1}) \geq 0$.

2.2 Conditionality as Self-Enforcing Contract

Since the recipient government discounts the future at a higher rate than the donor and, in addition, finances unproductive government consumption, there is a conflict of interest between the donor and the recipient government. The recipient government may use transfers to implement policies that do not coincide with the donor's intention. To prevent the government from doing so, the donor imposes conditions on the provision of assistance. However, the recipient government may not be willing to fulfill these conditions.

We follow Cordella et al. (2003), Kletzer (2005), Cordella and Dell'Ariccia (2007) and Scholl (2009) and define conditionality as a dynamic contract between the donor and the recipient country. The donor offers to provide debt relief and, in return, expects the government to fulfill certain conditions, namely, to implement fiscal as well as debt policies that are in line with the donor's preferences. However, the contract is imperfectly enforceable since the sovereign recipient government can always dishonor the conditions and implement ineffective economic policies. We define the contract to be self-enforcing, if, at any point in time, the conditions are supportable by the threat of a permanent cutoff from any form of assistance. In addition, we assume that the donor is able to enforce the repayment of concessional loans. We impose these two assumptions to consider the worst possible punishment threat so that the associated self-enforceable conditionality generates the best achievable outcome for the donor. We interpret this scenario as an upper benchmark on the effectiveness of debt relief. In section 3.5 we take into account that official creditors may not be able to enforce the repayment of concessional loans and analyze the optimal design of debt relief and conditionality in such a scenario.

The default value is characterized by the optimal policy decisions of the recipient government taking

[5] In reality, there are many other reasons for giving aid. By assuming an altruistic donor we take the most optimistic view on the effectiveness of development assistance.

as given the optimal consumption and investment choices of the household. The household's optimality conditions are given by the usual Euler equation that connects the marginal rate of substitution between consumption today and tomorrow with the rate of return on capital

$$u_c(c_t) = \beta_p u_c(c_{t+1})[1 - \delta + (1 - \tau_{t+1}) f_k(k_t)] \tag{7}$$

together with the budget constraints of the household and the government, equations (2) and (5).

The default value $D(k_{t-1}, d_{t-1}, \ell_{t-1}, q_t)$ is characterized by the following maximization problem, given $\ell_t = 0$, for all $t \geq 0$:

$$\begin{aligned} &\max_{\{c_t, g_t, k_t, d_t, \tau_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta_g^t v(c_t, g_t) \\ &\text{s.t.} \\ &(2),\ (5) \text{ and } (7) \end{aligned} \tag{8}$$

given $k_{-1} > 0$, $d_{-1} \geq 0$, $\ell_{-1} \geq 0$ and $q_0 \geq 0$. $\ell_{-1} \geq 0$ reflects the repayment obligations of official loans that have been provided by the donor in the past. The optimality conditions associated to (8) are given in the appendix.

The donor designs a contract that offers a transfer scheme $\{\ell_t, q_{t+1}\}_{t=0}^{\infty}$ and, in return, expects the recipient government to implement tax and debt policies $\{\tau_t, d_t\}_{t=0}^{\infty}$ that are associated with the allocation $\{c_t, g_t, k_t\}_{t=0}^{\infty}$. The optimal self-enforcing contract is given by the solution to the following maximization problem:

$$\max_{\{c_t, g_t, k_t, d_t, \tau_t, \ell_t, q_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta_p^t [u(c_t) - h(q_t \ell_{t-1})] \tag{9}$$

s.t.

$$\sum_{j=0}^{\infty} \beta_g^j v(c_{t+j}, g_{t+j}) \geq D(k_{t-1}, d_{t-1}, \ell_{t-1}, q_t) \tag{10}$$

$(2),\ (5)$ and (7)

given $k_{-1} > 0$ and $d_{-1} \geq 0$. Equation (10) is the enforcement constraint of the contract: the contract is self-enforcing as long as the value of fulfilling the conditions, $\sum_{j=0}^{\infty} \beta_g^j v(c_{t+j}, g_{t+j})$, is at least as large as the value of defecting, $D(k_{t-1}, d_{t-1}, \ell_{t-1}, q_t)$.

In the spirit of Marcet and Marimon (2010, 1992), to solve the donor's maximization problem, we introduce an additional co-state variable μ_t that measures the binding pattern of the enforcement constraint.[6] Let $\gamma_t \geq 0$ be the Lagrange-multiplier on the enforcement constraint (10). Then, the

[6]This method has been frequently applied in the macroeconomic literature on limited commitment, see e.g. Kehoe and Perri (2002) and Cooley, Marimon and Quadrini (2004).

donor's maximization problem (9) can be transformed into the following saddle-point formulation:[7]

$$\min_{\{\gamma_t>0\}_{t=0}^{\infty}} \max_{\{c_t,g_t,k_t,d_t,\tau_t,\ell_t,q_{t+1}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty}\beta_p^t\Big[u(c_t)-h(q_t\ell_{t-1})+\mu_t v(c_t,g_t) -\gamma_t D(k_{t-1},d_{t-1},\ell_{t-1},q_t)\Big] \tag{11}$$

s.t.

$$\mu_t=\Big(\frac{\beta_g}{\beta_p}\Big)\mu_{t-1}+\gamma_t, \qquad \mu_{-1}=0, \tag{12}$$

(2), (5) and (7).

The additional co-state variable μ_t enters as a weight on government's preferences. If the enforcement constraint is never binding, $\gamma_t = 0$, for all t, the weight on government's preferences is zero, $\mu_t = 0$ for all t, and the donor can enforce the first best solution. If the recipient government has an incentive to default on the contract, constraint (10) is binding, $\gamma_t > 0$. If $\gamma_t > \frac{\beta_g}{\beta_p}\mu_{t-1}$, the weight on government's preferences μ_t increases.

The optimal contract is characterized by the following first order conditions:

$$\begin{aligned}
\zeta_t &= \beta_p\Big[\lambda_t u_c(c_{t+1})(1-\tau_{t+1})f_{k,k}(k_t)+\zeta_{t+1}((1-\tau_{t+1})f_k(k_t)+1-\delta) \\
&\quad +\mu_{t+1}v_g(c_{t+1},g_{t+1})\tau_{t+1}f_k(k_t)-\gamma_{t+1}D_k(k_t,d_t,q_{t+1}\ell_t)\Big] && (13)\\
\mu_t v_g(c_t,g_t) &= \beta_p\Big(\mu_{t+1}v_g(c_{t+1},g_{t+1})(1+r_{t+1})+\gamma_{t+1}D_d(k_t,d_t,\ell_t,q_{t+1})\Big) && (14)\\
\mu_t v_g(c_t,g_t) &= \beta_p\Big(\mu_{t+1}v_g(c_{t+1},g_{t+1})(1+r_{t+1}-q_{t+1})+h_\ell(q_{t+1}\ell_t) \\
&\quad +\gamma_{t+1}D_\ell(k_t,d_t,\ell_t,q_{t+1})\Big) && (15)\\
\mu_{t+1}v_g(c_{t+1},g_{t+1})\ell_t &= h_q(q_{t+1}\ell_t)+\gamma_{t+1}D_q(k_t,d_t,\ell_t,q_{t+1}) && (16)\\
\zeta_t f(k_{t-1}) &= \mu_t v_g(c_t,g_t)f(k_{t-1})-\lambda_{t-1}u_c(c_t)f_k(k_{t-1}) && (17)\\
\zeta_t &= u_c(c_t,g_t)+\mu_t v_c(c_t,g_t)+u_{cc}(c_t)\lambda_{t-1}\Big[(1-\tau_t)f_k(k_{t-1})+1-\delta\Big] \\
&\quad -\lambda_t u_{cc}(c_t) && (18)\\
0 &= \gamma_t\Big(\sum_{j=0}^{\infty}\beta_g^j v(c_{t+j},g_{t+j})-D(d_{t-1},k_{t-1},\ell_{t-1},q_t)\Big) && (19)
\end{aligned}$$

together with (2), (5) and (7). λ_t denotes the Lagrange multiplier on the Euler equation and measures its tightness while ζ_t is the Lagrange multiplier on the budget constraint.

Equation (13) relates the marginal costs and benefits of investing one additional unit in the capital stock. If capital is raised by one unit, the recipient's incentive to default on the contract increases, re-

[7] The details are given in the appendix.

flected by the term $\gamma_{t+1} D_k(k_t, d_t, \ell_t, q_{t+1}) > 0$. Equation (24) can be interpreted as the government's Euler equation since it relates the marginal costs and marginal benefits of issuing one additional unit non-concessional debt. Here, the increasing market debt implies higher repayment obligations decreasing the recipient values of dishonoring the contract conditions, $\gamma_{t+1} D_d(k_t, d_t, \ell_t, q_{t+1}) < 0$. Equation (15) determines the optimal level of transfers ℓ_t. The recipient government faces marginal benefits and costs equal to $\mu_t v_g(c_{t+1}, g_{t+1})$ and $\mu_{t+1} v_g(c_{t+1}, g_{t+1})(1 + r_{t+1} - q_{t+1})$, respectively, when getting access to one additional unit of ℓ_t while the donor is confronted with marginal costs equal to $h_\ell(q_{t+1}\ell_t)$. However, at the same time, higher official loans imply higher repayment obligations decreasing the government's outside option, $\gamma_{t+1} D_\ell(k_t, d_t, q_{t+1}\ell_t) \leq 0$, and increasing the donor's leverage over the recipient government's policies. Equation (16) characterizes the optimal degree of concessionality q_{t+1} by equalizing the marginal benefits, $\mu_{t+1} v_g(c_{t+1}, g_{t+1})$, and the marginal costs $h_q(q_{t+1}\ell_t) + \gamma_{t+1} D_q(k_t, d_t, \ell_t, q_{t+1})$. Note that a higher degree of concessionality decreases the repayment obligations and, thus, increases the recipient government's value of dishonoring the contract, $\gamma_{t+1} D_q(k_t, d_t, \ell_t, q_{t+1}) \geq 0$. Equation (17) describes the optimal tax rate and equation (18) determines the optimal choice of household's consumption. Equation (19) is the complementary slackness condition.

The equilibrium conditions form a system of highly nonlinear equations that depend on the state variables k_t, d_t, ℓ_t, λ_t and μ_t. Because no analytical closed-form solution can be derived, we solve the model numerically to study transition paths and steady states. Since the model assumes no exogenous growth, we suppose that the economy converges to a steady state that is characterized by a constant weight $\overline{\mu}$, a constant allocation $(\overline{c}, \overline{g}, \overline{k})$, a constant transfer scheme $(\overline{\ell}, \overline{q})$ and constant policies $(\overline{\tau}, \overline{d})$ that fulfill the optimality conditions associated with the donor's maximization problem (9). The absence of uncertainty allows us to apply a backward procedure to solve for the transitional dynamics. The details of the numerical algorithm are described in the appendix.

3 Quantitative Results

3.1 Parameterization

Table 1 provides some details on the history of debt relief shown in figure 1 and summarizes data on annual per capita income measured in constant 2000 US $, non-concessional and concessional debt and Official Development Assistance (ODA) as shares of GDP in percent. We consider a subset of the HIPCs for which data from 1975 to 2005 are available and report 10-year-averages. We sort the

countries with respect to their average level of non-concessional debt between 1975 and 1985 and divide them into quartiles. The statistics refer to the median country of each quartile and reveal that there is substantial heterogeneity across HIPCs: between 1975 and 1985 average non-concessional debt shares of the median countries vary between approximately 4 and 46 percent. The data reveal that countries with very low levels of debt are also extremely poor in terms of annual per capita income indicating a fairly limited access to international financial markets. All countries received considerable amounts of ODA in form of grants and concessional loans. However, the impact on per capita income seems to be limited, calling the effectiveness of aid into question.[8] Average ODA net loans appear to be positive for the entire time period so that substantial levels of concessional debt have been accumulated in the HIPCs. All countries received considerable debt relief under the HIPC-Initiative and the Multilateral Debt Relief Initiative; in 2006 Burkina Faso and Cameroon received debt relief equal to 24 and 22 percent of GDP, respectively, while Haiti and Congo Republic were granted 29 and 34 percent of GDP in the years 2005 to 2007.

To parameterize the model on an annual basis we first suppose that the recipient economy does not receive any form of assistance, i.e., $\ell_t = 0$, for all t. The optimal choices of the recipient government are characterized by the solution to the government's maximization problem (8). We consider this as our initial situation and choose the functional forms and parameters of the model as to mimic the heterogeneity of average non-concessional debt shares between 1975 and 1985.

We assume that the household and the government have logarithmic utilities:

$$\begin{aligned} u(c_t) &= \ln c_t \\ v(c_t, g_t) &= \ln c_t + \alpha \ln g_t \end{aligned}$$

where $\alpha \in \{0.2; 0.4; 0.6\}$ is the weight that the recipient government puts on the utility of non-productive consumption g_t. It measures the benevolence of the government and determines the government consumption share as well as the tax rate. We set the private discount rate $\beta_p = 0.95$ and define $r^\star = 1/\beta_p - 1$ so that the world interest rate equals 5.26 percent. We follow Chatterjee et al. (2003) and assume that the market interest rate is strictly increasing in the debt-to-capital ratio $r_t = r^\star + e^{\phi \frac{d_{t-1}}{k_{t-1}}} - 1$ with $\phi = 0.4$. We suppose that the recipient government discounts the future at a higher rate reflecting political instability leading to overspending and debt accumulation (East-

[8] There is a large empirical literature on aid and economic growth, e.g., Burnside and Dollar (2000, 2004), Hansen and Tarp (2000, 2001), Svensson (1999), Dollar and Svensson (2000), Dalgaard, Hansen and Tarp (2004, 2001), Collier and Dollar (2002), Easterly, Levine and Roodman (2004) and Easterly (2003). According to a recent contribution by Raghuram and Subramanian (2008) there seems to be no robust evidence concerning the interaction of foreign aid, sound economic policies and growth.

erly, 2002). Since β_g determines the non-concessional debt share in the economy, we analyze its impact by assuming the values 0.85, 0.88, 0.91 and 0.94. The production function is specified as $f(k_{t-1}) = k_{t-1}^{\theta}$ with $\theta = 0.3$. The capital stock depreciates at the rate $\delta = 0.1$.

Table 2 summarizes the steady state properties for these functional forms and parameter values. In the following we refer to this steady state as the 'No Aid' steady state. Our parameterization generates non-concessional debt shares between 3 and 43 percent of GDP which square well with average debt shares observed between 1975 and 1985. Country risk premia vary between 1 and 12 percent which seems to be reasonable in comparison with other low-income countries. Private consumption shares vary between 52 and 69 percent while government consumption shares range from 11 to 32 percent, depending on the parameter values for α and β_g. The associated steady state tax rates vary between 13 and 36 percent. Thus, we consider economies in which up to 36 percent of GDP are lost due to inefficient economic policies. Investment shares vary between 12 and 17 percent, respectively.

It is evident that the larger α, i.e., the less benevolent the recipient government, the larger the income tax rate, the lower investment share and, thus, the poorer the economy in terms of capital and output levels. The government consumption share is increasing while the private consumption share is decreasing in α. Moreover, non-concessional debt as a share of total output is decreasing in α reflecting the fact that poor countries have limited access to international debt markets.

With respect to β_g, our theoretical economy implies that recipient governments that discount the future at higher rates accumulate more debt leading to higher risk premia issued by international credit markets. The more indebted countries face considerable debt service obligations and suffer from low capital levels and high tax rates as well as high government consumption and low private consumption shares.

In our analysis of optimal debt relief we assume that the donor's preferences are described by a linear cost function: $h(q_t \ell_{t-1}) = \kappa q_t \ell_{t-1}$. κ is set equal to 1.5 such that the steady state value of outright grants under self-enforcing conditionality mimics the properties of the data.

3.2 Long-Run Properties of Self-Enforcing Conditionality

Table 3 summarizes the long-run properties of the optimal self-enforcing contract between the altruistic donor and the recipient government. The steady state depends on the parameters α and β_g that determine the strength of the conflict of interest between the donor and the recipient government. It turns out that incentive-compatibility requires permanent assistance $\overline{\ell}$ between 13 to 21 percent of GDP. Define $\pi_{t+1} \equiv 1 + r_{t+1} - q_{t+1}$ as the share of ℓ_t that is provided in form of interest-free loans.

The steady state value $\overline{\pi}$ is between 53 and 78 percent indicating that the optimal transfer scheme is characterized by a combination of loans and grants. The donor imposes conditions that require substantial tax cuts and considerable reductions in government consumption and non-concessional debt shares. These economic policies provide incentives to invest and generate a substantial increase in the long-run capital stock as well as in the private consumption share. Note that the implication of our theoretical model is in contrast to the recommendation made by the Meltzer (2000) Commission that development assistance should be provided through outright grants rather than concessional loans. The intuition is that loans, unlike grants, imply repayment obligations that increase the donor's leverage over the recipient government's policies and make conditionality easier to enforce. This is true as long as official creditors are able to enforce the repayment of international loans. We relax this assumption in section 3.5.

Let $w_t \equiv \frac{\alpha\mu_t}{1+\mu_t}$ be the relative weight that the donor needs to put on the utility of government consumption $\ln g_t$ to induce the recipient government to cooperate and to implement efficient fiscal policies. Recall that μ_t is the additional costate-variable that measures the binding pattern of the enforcement constraint. In the steady state, the relative weight is increasing in α and decreasing in β_g. Hence, the weight making the recipient government indifferent between fulfilling the contract and choosing the outside option is increasing in the non-benevolence and in the impatience of the recipient government. This is reflected by the conditions that are imposed on the provision of assistance: tax cuts are lower whereas government consumption and non-concessional debt shares are higher.

Interestingly, $\overline{\pi}$ is decreasing in α, i.e., the share of subsidized loans is decreasing in the non-benevolence of the recipient government. Since high values of α imply severe conflicts of interest between the altruistic donor and the recipient government, the government has high incentives to dishonor the conditions. It turns out to be efficient to improve the attractiveness of the contract by decreasing the share of loans and providing more outright grants. On the other hand, $\overline{\pi}$ is decreasing in β_g. Although high values of β_g imply only weak conflicts of interest between the donor and the recipient government, more outright grants are provided to more patient governments. The intuition is that patient governments implement decent debt policies so that country risk premia are not too high and do not limit the access to private international credit markets. The small wedge between the concessional and the market interest rate makes a permanent cutoff from any form of assistance a less threatening outside option. As a consequence, to make the contract more attractive, the donor needs to provide more assistance in form of outright grants.

3.3 Implicit Debt Relief

Figure 1 and table 1 have shown that between 1975 and 1985 the HIPCs accumulated considerable levels of non-concessional debt at high interest rates. To reduce the debt burden, debt relief was implicitly granted to the HIPCs by replacing market debt by concessional debt (Easterly, 2002). This led to a substantial accumulation of concessional debt in the mid-'90s. The objective of this section is to analyze the properties of optimal debt relief in a situation where the recipient country faces non-concessional debt at high interest rates but limited concessional debt as it was the case between 1975 and 1985. To simplify our analysis, we consider the 'No Aid' steady state as initial situation. Recall that we have chosen the parameters of the model in such a way that the 'No Aid' steady state values of non-concessional debt mimic the empirical ones between 1975 and 1985. In the following, we analyze the short- and long-run effects of optimal debt relief as well as the dynamic properties of self-enforcing conditionality.

In figure 2 the transition paths to the steady state are plotted for various values of α and β_g. All variables are normalized by their respective 'No Aid' steady state values except for w_t and π_{t+1} that are given in levels. Transfers ℓ_t are normalized by the 'No Aid' steady state value of output. The figure shows that it is optimal to give high transfers in the initial situation since the recipient country suffers from a low capital stock and non-concessional debt at high interest rates. In return, the recipient government has to reduce government consumption and to decrease the tax rate substantially. In fact, in the initial period, the tax rate may be negative meaning that the recipient government subsidizes production to improve the incentives to invest in the capital stock. Over time, as the capital stock grows and non-concessional debt shrinks, the recipient government becomes richer and benefits from an improved access to private international credit markets. As a permanent cutoff from any form of assistance becomes less threatening, the relative weight w_t increases over time, i.e., the donor needs to raise the weight on the utility of government consumption to ensure the enforceability of the contract. This implies that the tax rate as well as government consumption rise over time. In the short run, the relative weight is higher for more patient governments while in the long-run the opposite is true. This is due to the fact that patient governments initially face lower country risk premia and are less dependent on the provision of development assistance. In the long-run, the impatient recipient governments have higher incentives to defect on conditionality since the conflict of interest is more severe. This is reflected by the pattern of government consumption: in the short-run (long-run), the reduction in government consumption is higher (lower) for the more impatient governments.

The dynamic pattern of the optimal transfer scheme is crucially determined by the degree of impatience. First suppose that the recipient government is impatient, $\beta_g = 0.85$. Total transfers ℓ_t decrease as the capital stock grows and non-concessional debt decreases over time. Note, however, that transfers do not converge to zero since the recipient government would return to the initial inefficient economic policies in that case. Over time, as the recipient government becomes richer, the incentives to breach the contract and to dishonor the conditions increase. It turns out to be optimal to provide a rising fraction π_{t+1} in form of subsidized loans so that the repayment obligations increase the donor's leverage over the recipient government's policies. Now suppose that the recipient government is patient, $\beta_g = 0.91$, but quite non-benevolent, $\alpha = 0.6$. In this case, the fraction π_{t+1} of total transfers that is provided as subsidized loans is falling over time. Moreover, after a sharp short-run decrease, total transfers continuously increase until the steady state level is reached. The transition path of this transfer scheme can be explained by the strong incentives to defect on conditionality. The outside option is less threatening in this setup for three reasons. First, there is a severe conflict of interest between the altruistic donor and the non-benevolent recipient government lowering the government's value of the conditionality contract. Second, as patient recipient governments are mildly indebted and face moderate country risk premia, the wedge between the market and the subsidized interest rate is low making the recipient less dependent on development assistance. Third, the growing capital stock increases the value of the outside option over time. To prevent that the recipient government fails to meet the conditions and takes the outside option, the donor needs to make the contract more attractive by providing higher transfers and, in addition, raising the fraction that is provided as outright grant over time.

Overall, the impact of incentive-compatible conditional debt relief is substantial. Relative to the initial 'No Aid' situation, capital and private consumption is substantially increased. Thereby, the relative impact is increasing in α while the differences for the various values of β_g are minor. Although the relative impact is increasing in α, the countries that suffer from non-benevolent governments are still the poorest in terms of per capita income levels, see table 3.

The transitional dynamics show that optimal debt relief is characterized by a combination of concessional loans and outright grants in the short- and long-run. Thus, non-concessional debt is partly replaced by subsidized loans and partly repaid by using outright grants. In contrast to the historical experience, however, optimal concessional debt levels are quite moderate.

3.4 Explicit Debt Relief

Figure 1 and table 1 have shown that the HIPCs accumulated large amounts of concessional debt between 1980 and the early 2000. This pattern motivated the foundation of the HIPC Initiative and the Multilateral Debt Relief Initiative that allow for a 100 percent cancelation of official multilateral debt. In our analysis so far, we have considered the 'No Aid' steady state as initial situation to analyze the dynamic properties of optimal implicit debt relief. The objective of this section is to analyze the properties of optimal explicit debt relief. As initial situation we assume that the recipient economy faces a substantial, non-optimal level of concessional debt and, at the same time, receives considerable amounts of outright grants. Since the impact on per capita income levels has been rather limited, see table 1 and Raghuram and Subramanian (2008) for econometric evidence, we suppose that total transfers are provided unconditionally, i.e., the recipient government takes them as given and chooses optimal fiscal policies by solving its maximization problem (8).

We assume that the recipient government initially faces concessional debt equal to 45 percent of GDP at a concessional interest rate equal to 0.5 percent and receives grants that amount to 5 percent of GDP. This is in line with what happened on average between 1995 and 2005 in Cameroon and Haiti, see table 1. The interest rate of 0.5 percent covers the administrative costs and is commonly imposed on loans provided to the poorest countries. In terms of our model these values correspond to $\overline{\pi} = 0.8939$ and $\frac{\overline{\ell}}{\overline{y}} = 0.45$. As the findings are qualitatively similar for the various values of α, we consider $\alpha = 0.4$ and $\beta_g = 0.85$ and $\beta_g = 0.91$. The initial situation is characterized by a low effectiveness of unconditional assistance: relative to the 'No Aid' steady state, the capital stock and private consumption are raised by only 5 to 6 percent. Instead of using transfers to finance efficient policies, the recipient government increases its consumption by 5 to 6 percent relative to the 'No Aid' steady state.[9]

Figure 3 plots the transition paths to the steady state associated with self-enforcing conditional debt relief. All variables are normalized by their respective 'No Aid' steady state values except for w_t and π_{t+1} that are given in levels. Transfers ℓ_t are normalized by the 'No Aid' steady state value of output. If the recipient economy faces high, non-optimal levels of concessional debt, optimal debt relief is characterized by a jump decrease in π from 0.89 to a value between 0.55 and 0.6 indicating that part of the debt is explicitly canceled by an outright grant. At the same time, optimal transfers ℓ_t show a fall from 45 percent as a share of 'No Aid' steady state output to 28 and 23 percent for

[9]To save space we omit the table that summarizes all properties of the steady state if assistance is unconditionally provided.

$\beta_g = 0.85$ and $\beta_g = 0.91$, respectively. The negative net loans are financed by a large reduction in government consumption and by a moderate increase in non-concessional debt. Moreover, initially, the tax rate remains nearly unchanged. Thus, on the one hand, optimal debt relief is characterized by outright grants, but, on the other hand, conditionality forces the recipient government to repay part of its concessional debt. In contrast to recent policies implemented by the Multilateral Debt Relief Initiative, a 100 percent cancelation of official debt is not optimal. This, however, is true only if the donor is able to enforce the repayment of concessional debt.

3.5 Outright Grants Only

In the previous sections we have assumed that official creditors are able to enforce the fulfillment of concessional debt obligations. This assumption is in line with the view that the IMF and the Worldbank have better enforcement technologies than private creditors. Moreover, the historical experience indicates that debtors rarely default on official debt (Jeanne and Zettelmeyer, 2001). On the other hand one might argue that, over the past decades, official creditors continued to provide positive net loans just to prevent default on concessional debt. Therefore, in this section, we take into account that recipient governments may not be willing to repay official loans and assume that a failure on conditionality goes hand in hand with a default on concessional debt. In such a scenario, the donor loses loans as a policy instrument and provides outright grants only, as recommended by the Meltzer (2000) Commission and by Bulow and Rogoff (2005).

In figure 4 we consider the 'No Aid' steady state as initial situation and plot the transition paths to the steady state. Since the dynamic patterns are qualitatively similar for different constellations of α and β_g we focus on $\alpha = 0.4$ and $\beta_g = 0.91$ to save space. To facilitate a comparison with the previous scenario, we plot the transition paths of the optimal combination of grants and loans (dotted line) together with the transition paths associated with outright grants in isolation (solid line). Moreover, to make the findings interpretable, we analyze the impact of one unit of development assistance and show non-concessional debt, capital, government consumption and consumption per unit of assistance $q_{t+1}\ell_t$, where one unit is normalized to 0.01. The relative weight, transfers, the tax rate and the interest rate are given in levels.

Overall, the general pattern of the transition paths associated with optimal grants look very similar to those of section 3.3. The donor provides grants to implement tax cuts and to reduce government consumption so that private incentives to invest in capital increase. Over time, the growing capital stock and the shrinking level of non-concessional debt make fulfilling the conditions less attractive

for the recipient government. To ensure that the contract is self-enforcing, conditionality becomes less severe, i.e., government consumption and the tax rate increase over time.

In the medium- and long-run, if concessional loans are not enforceable and assistance takes the form of outright grants only, the relative weight on the utility of government consumption is larger compared to the weight that would be optimal otherwise. As a consequence, the size of assistance $q_{t+1}\ell_t$ as well as government consumption and market debt per unit of assistance are permanently higher. It is evident that the impact of one unit of assistance on capital, consumption and non-concessional debt is lower if the donor loses loans as a policy instrument.

In the short-run, if giving grants is the only instrument, the tax rate is higher compared to the tax rate associated with the optimal combination of loans and grants. The intuition for this finding is that loans allow larger transfers that substantially relax the government's budget constraint so that considerable tax cuts can be implemented. For this reason, the short-run effect of one unit of assistance on capital, consumption, debt and interest rate is substantial if the donor is able to implement a combination of loans and grants. However, the lower market interest rate improves the access to international financial markets making the outside option less severe. For this reason, in the short-run, self-enforcing conditionality requires a higher relative weight and larger government consumption per unit of assistance if optimal policy is characterized by a combination of loans and grants instead of being restricted to outright grants only. The opposite is true in the long-run.

In table 4 we consider the 'No Aid' steady state as initial situation and analyze household's welfare per unit of assistance $q_{t+1}\ell_t$. We compare the welfare impact of the optimal combination of loans and grants, 'LG', with the welfare impact of grants in isolation, 'G'. As benchmark we take the steady state associated with the optimal combination of loans as grants. We use compensating variations to formulate differences in lifetime utility and express the change in welfare Δ^{LG} and Δ^{G} as follows:

$$\sum_{t=0}^{\infty}\beta_p^t\, u\Big((1+\Delta^{LG})(\frac{\overline{c}}{\overline{q\ell}})^{LG}\Big) \;=\; \sum_{t=0}^{\infty}\beta_p^t u\Big((\frac{c_t}{q_{t+1}\ell_t})^{LG}\Big) \tag{20}$$

$$\sum_{t=0}^{\infty}\beta_p^t\, u\Big((1+\Delta^{G})(\frac{\overline{c}}{\overline{q\ell}})^{LG}\Big) \;=\; \sum_{t=0}^{\infty}\beta_p^t u\Big((\frac{c_t}{q_{t+1}\ell_t})^{G}\Big). \tag{21}$$

If concessional debt is enforceable and the donor implements the optimal combination of loans and grants, the impact on welfare Δ^{LG} varies between -13.78 and -1.89 percent of steady state consumption per unit of assistance, depending on the parameter values α and β_g. The welfare gain of providing the optimal combination of loans and grants is increasing in the non-benevolence and decreasing in the impatience of the recipient government. In the absence of any assistance non-

benevolent governments implement extremely wasteful economic policies so that the capital stock is very low making one unit of development assistance quite effective.

If concessional loans are not enforceable and the donor provides assistance in form of outright grants only, the impact on welfare Δ^G follows qualitatively the same pattern as before. However, losing loans as a policy instrument generates welfare losses up to 5 percent of steady state consumption per unit of assistance. In line with our findings of the previous sections, the importance of loans as a policy instrument is decreasing in the non-benevolence and the patience of the recipient government.

4 Conclusions

This paper has analyzed whether debt relief is an effective instrument to stimulate economic growth in the most heavily indebted poor countries. We have developed a neoclassical growth framework with a conflict of interest between the altruistic donor and the recipient government. Following the recent literature on incentive-compatibility in the context of foreign aid, conditionality has been modeled as an imperfectly enforceable dynamic contract: the donor offers to provide debt relief and, in return, expects the government to implement fiscal as well as debt policies that coincide with the donor's intention.

Quantitative findings have suggested that imposing incentive-compatible conditions on the provision of debt relief substantially promotes fiscal reform and investment. If official creditors are able to enforce the repayment of concessional loans, optimal policy is characterized by a combination of loans and outright grants. Unlike grants, loans imply repayment obligations that increase the donor's leverage over the recipient government's policies and make conditionality easier to enforce. If official loans are limited enforceable such that a failure on conditionality goes hand in hand with a default on concessional debt, optimal policy is characterized by outright grants only. Losing loans as a policy instrument reduces the effectiveness of one unit of development assistance and lowers welfare. The dynamic patterns of the optimal transfer scheme and self-enforcing conditionality have been shown to depend on the degree of the recipient's non-benevolence and impatience since these parameters affect the strength of the conflict of interest, the country risk premium and the access to international credit markets.

Our analysis has been based on the assumption that the punishment threat is fully credible. However, this may not be the case since the donor is altruistic and might gain by relaxing the sanctions. In an endowment economy Cordella et al. (2003) and Kletzer (2005) show that a renegotiation-proof

equilibrium is characterized by aid flows in punishment that are smaller than those made in equilibrium. If we allow for reduced transfers in punishment, the value of breaching the conditionality contract becomes larger so that the recipient government's incentives to defect increase. As a result, conditionality is less severe and the effectiveness of debt relief is lower. Since we consider a dynamic setting with capital and two types of debt, the specification of renegotiation-proof equilibria is beyond the scope of this paper. Instead, we interpret our findings as an upper benchmark on the effectiveness of debt relief.

A Optimality Conditions

A.1 The Default Value

The default value is given by the solution to the recipient government's maximization problem (8). The optimality conditions are:

$$\begin{aligned}
\zeta_t &= v_c(c_t, g_t) + \frac{\beta_p}{\beta_g} u_{cc}(c_t)\lambda_{t-1}\Big[(1-\tau_t)f_k(k_{t-1}) + 1 - \delta\Big] - \lambda_t u_{cc}(c_t) && (22)\\
\zeta_t &= \beta_g\Big(\frac{\beta_p}{\beta_g}\lambda_t u_c(c_{t+1})(1-\tau_{t+1})f_{k,k}(k_t) + \zeta_{t+1}((1-\tau_{t+1})f_k(k_t) + 1 - \delta)\\
&\quad + v_g(c_{t+1}, g_{t+1})\tau_{t+1}f_k(k_t)\Big) && (23)\\
v_g(c_t, g_t) &= \beta_g v_g(c_{t+1}, g_{t+1})(1 + r_{t+1}) && (24)\\
\zeta_t f(k_{t-1}) &= v_g(c_t, g_t)f(k_{t-1}) - \frac{\beta_p}{\beta_g}\lambda_{t-1}u_c(c_t)f_k(k_{t-1}), && (25)
\end{aligned}$$

where ζ_t and λ_t are the Lagrange multipliers associated to the household's budget constraint and the Euler equation, respectively. Equation (22) determines the optimal choice of households' consumption. Equation (23) relates the marginal costs and benefits of investing one additional unit in the capital stock. Equation (24) can be interpreted as the government's Euler equation since it relates the marginal costs and marginal benefits of issuing one additional unit foreign debt. Finally, equation (25) determines the optimal tax choice.

A.2 Self-Enforcing Conditionality

The Lagrangian associated to the donor's maximization problem (9) is given by

$$L = \sum_{t=0}^{\infty}\beta_p^t\Big[u(c_t) - h(q_t\ell_{t-1}) + \gamma_t\Big(\sum_{j=0}^{\infty}\beta_g^j v(c_{t+j}, g_{t+j}) - D(k_{t-1}, d_{t-1}, \ell_{t-1}, q_t)\Big)\Big]$$

subject to (2), (5) and (7). It is straightforward to show that the following equality holds:

$$\begin{aligned}
&\sum_{t=0}^{\infty}\beta_p^t\gamma_t\sum_{j=0}^{\infty}\beta_g^t v(c_{t+1}, g_{t+1}) = \sum_{t=0}^{\infty}\beta_p^t\mu_t v(c_t, g_t)\\
&\text{s.t.}\\
&\mu_t = \Big(\frac{\beta_g}{\beta_p}\Big)\mu_{t-1} + \gamma_t, \qquad \mu_{-1} = 0.
\end{aligned}$$

Thus, the Lagrangian becomes

$$\begin{aligned}
&L = \sum_{t=0}^{\infty}\beta_p^t\Big[u(c_t) - h(q_t\ell_{t-1}) + \mu_t v(c_t, g_t) - \gamma_t D(k_{t-1}, d_{t-1}, \ell_{t-1}, q_t)\Big)\Big]\\
&\text{s.t.}\\
&\mu_t = \Big(\frac{\beta_g}{\beta_p}\Big)\mu_{t-1} + \gamma_t, \qquad \mu_{-1} = 0.
\end{aligned}$$

B Numerical Algorithm

Due to the complexity of the model, we rely on numerical simulations to analyze the properties of different debt relief policies. Since there is no uncertainty we use a backward procedure to solve for the transitional dynamics, see also Scholl (2009) and Trabandt (2009).

Considering the optimal value of default, the equilibrium is characterized by the equations (2), (5), (7), (22) to (25). To make the system of equations finite dimensional we assume that the economy converges to the steady state in finitely many periods $T+1$. Hence, as time starts in $t=0$, in period T the state variables are given by their steady state values, $k_T = \overline{k}$, $d_T = \overline{d}$ and $\lambda_T = \overline{\lambda}$. Given the initial values k_{-1}, d_{-1}, and λ_{-1}, we need to solve for $\{c_t, g_t, \tau_t, \zeta_t\}_{t=0}^{T}$ and $\{k_t, d_t, \lambda_t\}_{t=0}^{T-1}$. To do so, we consider the equilibrium conditions (2), (5), (22) and (25) for $t = 0, \ldots, T$ and the equilibrium conditions (7), (23) to (24) that look forward to $t+1$ for $t = 0, \ldots, T-1$. Since we have as many unknowns as equations the system of nonlinear equations can be solved by employing a numerical nonlinear equation solver.

Considering the case of self-enforcing conditionality, the absence of uncertainty implies that the enforcement is always binding until the steady state is reached. Hence, we can employ the same solution strategy as above. Note that the enforcement constraint requires the calculation of the default value $D(k_{t-1}, d_{t-1}, \ell_{t-1}, q_t)$ that includes the transitional dynamics to the steady state that occurs if no development assistance is provided to the recipient government. As before, to make the system of equations finite dimensional we assume that the economy converges to the steady state in finitely many periods $T+1$. Hence, as time starts in $t=0$, in period T the state variables are given by their steady state values, $k_T = \overline{k}$, $d_T = \overline{d}$, $\ell_T = \overline{\ell}$, $\mu_T = \overline{\mu}$ and $\lambda_T = \overline{\lambda}$. Given the initial values k_{-1}, d_{-1}, ℓ_{-1}, q_0, μ_{-1} and λ_{-1}, we need to solve for $\{c_t, g_t, \tau_t, q_{t+1}, \zeta_t\}_{t=0}^{T}$ and $\{k_t, d_t, \ell_t, \mu_t, \lambda_t\}_{t=0}^{T-1}$. To do so, we consider the equilibrium conditions (2), (5), (16) and (18) for $t = 0, \ldots, T$ and the equilibrium conditions (7), (13) to (15) and (19) that look forward to $t+1$ for $t = 0, \ldots, T-1$. Since we have as many unknowns as equations the system of nonlinear equations can be solved by employing a numerical nonlinear equation solver.

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Tables and Figures

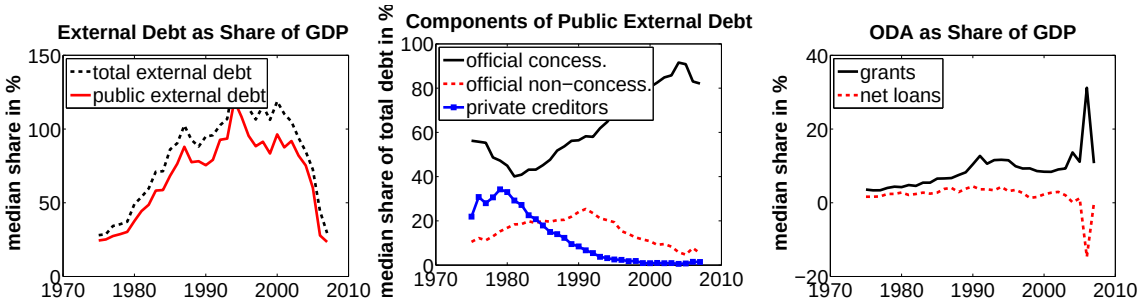

Figure 1: The History of Debt Relief in HIPCs; Annual data on debt are taken from the World Bank, World Development Indicators. Annual data on Official Development Assistance (ODA) are taken from the OECD. We consider a subset of the HIPCs for which data for the entire time period is available. These countries are: Benin, Bolivia, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Ghana, Guyana, Haiti, Honduras, Liberia, Madagascar, Malawi, Mali, Mauritania, Nicaragua, Niger, Rwanda, Senegal, Sudan, Togo, Uganda and Zambia.

Table 1: Income, Debt and Official Development Assistance in HIPCs

	per capita income	debt as share of GDP non-concess.	debt as share of GDP concess.	ODA as share of GDP grants	ODA as share of GDP net loans
Percentile of d/y: $0-25$			Median: Burkina Faso		
1975 - 1985	163	3.70	12.52	8.86	2.05
1985 - 1995	181	6.30	28.93	11.48	3.47
1995 - 2005	225	2.06	41.10	11.37	2.55
Percentile of d/y: $25-50$			Median: Cameroon		
1975 - 1985	746	13.51	11.84	1.77	1.67
1985 - 1995	747	28.32	20.89	2.58	1.35
1995 - 2005	632	34.58	46.57	3.87	0.86
Percentile of d/y: $50-75$			Median: Haiti		
1975 - 1985	1054	24.88	14.84	2.21	2.81
1985 - 1995	1066	50.55	39.95	7.01	2.08
1995 - 2005	1161	23.93	45.84	5.09	2.83
Percentile of d/y: $75-100$			Median: Congo Republic		
1975 - 1985	1057	46.19	25.36	3.85	2.17
1985 - 1995	1146	105.73	61.09	4.14	2.40
1995 - 2005	1065	83.71	67.67	6.69	0.32

Notes: Annual data on per capita income and concessional and non-concessional debt are taken from the World Bank, World Development Indicators. Annual data on Official Development Assistance (ODA) are taken from the OECD. Per capita income is measured in constant 2000 US $; the shares are given in percent. We consider a subset of the HIPC for which data for the entire time period is available. These countries are: Benin, Bolivia, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Ghana, Guyana, Haiti, Honduras, Liberia, Madagascar, Malawi, Mali, Mauritania, Nicaragua, Niger, Rwanda, Senegal, Sudan, Togo, Uganda and Zambia. All entries are averages for the time periods $1975-1985$, $1985-1995$ and $1995-2005$. We consider the period $1975-1985$ and sort the countries with respect to their level of non-concessional debt as share of GDP. Statistics refer to the median country of each quartile.

Table 2: Steady State Properties, No Aid

	$\overline{k}$	$\overline{\tau}$	$\overline{r} - r^{\star}$	$\frac{\overline{c}}{\overline{y}}$	$\frac{\overline{x}}{\overline{y}}$	$\frac{\overline{g}}{\overline{y}}$	$\frac{\overline{d}}{\overline{y}}$
				$\alpha = 0.2$			
$\beta_g = 0.85$	1.94	19.15	12.38	64.96	15.89	11.58	42.86
$\beta_g = 0.88$	2.00	17.40	8.37	66.36	16.23	13.20	30.86
$\beta_g = 0.91$	2.06	15.55	4.63	67.85	16.60	13.75	18.17
$\beta_g = 0.94$	2.12	13.88	1.12	69.20	16.93	13.58	4.67
				$\alpha = 0.4$			
$\beta_g = 0.85$	1.64	28.02	12.38	57.83	14.15	21.29	38.16
$\beta_g = 0.88$	1.67	27.08	8.37	58.59	14.33	23.37	27.24
$\beta_g = 0.91$	1.73	25.44	4.63	59.90	14.65	23.86	16.04
$\beta_g = 0.94$	1.79	23.58	1.12	61.40	15.02	23.32	4.15
				$\alpha = 0.6$			
$\beta_g = 0.85$	1.40	35.57	12.38	51.77	12.66	29.54	34.16
$\beta_g = 0.88$	1.43	34.76	8.37	52.41	12.82	31.44	24.37
$\beta_g = 0.91$	1.48	33.02	4.63	53.81	13.16	31.60	14.41
$\beta_g = 0.94$	1.55	30.89	1.12	55.53	13.58	30.65	3.75

Notes: $\overline{k}$, $\overline{\tau}$, $\overline{c}$, $\overline{x}$, $\overline{g}$, $\overline{d}$, and $\overline{y}$ denote the steady state values of capital, the tax rate, household consumption, investment, government consumption, non-concessional debt and output, respectively. $\overline{r} - r^{*}$ is the country risk premium. The tax rate, the country risk premium and the shares are given in percent.

Table 3: Steady State Properties, Self-Enforcing Conditionality

	$\overline{k}$	$\overline{\tau}$	$\overline{r}-r^{\star}$	$\frac{\overline{c}}{\overline{y}}$	$\frac{\overline{x}}{\overline{y}}$	$\frac{\overline{g}}{\overline{y}}$	$\frac{\overline{d}}{\overline{y}}$	$\frac{\overline{\ell}}{\overline{y}}$	π	$\frac{\overline{a}}{\overline{y}}$	$\overline{w}$
						$\alpha = 0.2$					
$\beta_g = 0.85$	2.41	5.79	4.99	75.70	18.52	6.38	21.77	13.00	78.22	2.83	7.90
$\beta_g = 0.88$	2.47	4.16	3.40	77.00	18.84	6.25	15.38	13.33	74.35	3.42	7.77
$\beta_g = 0.91$	2.52	2.87	1.92	78.04	19.09	6.05	8.94	13.50	71.71	3.82	7.57
$\beta_g = 0.94$	2.55	1.94	0.48	78.78	19.27	5.78	2.30	13.46	70.54	3.96	7.31
						$\alpha = 0.4$					
$\beta_g = 0.85$	2.33	8.02	5.45	73.90	18.08	11.77	23.07	17.61	64.70	6.22	14.97
$\beta_g = 0.88$	2.39	6.28	3.71	75.30	18.42	11.53	16.33	17.93	62.55	6.71	14.71
$\beta_g = 0.91$	2.44	4.89	2.08	76.42	18.69	11.14	9.49	18.31	62.04	6.95	14.31
$\beta_g = 0.94$	2.48	3.82	0.52	77.28	18.91	10.64	2.43	17.51	60.19	6.97	13.80
						$\alpha = 0.6$					
$\beta_g = 0.85$	2.26	10.02	5.76	72.29	17.68	16.24	23.80	21.01	57.95	8.84	21.21
$\beta_g = 0.88$	2.32	8.17	3.92	73.78	18.05	15.94	16.88	20.44	54.41	9.32	20.88
$\beta_g = 0.91$	2.38	6.72	2.20	74.95	18.33	15.39	9.83	20.97	55.16	9.40	20.24
$\beta_g = 0.94$	2.42	5.56	0.55	75.87	18.56	14.68	2.52	20.01	53.70	9.26	19.48

Notes: $\overline{k}$, $\overline{\tau}$, $\overline{c}$, $\overline{x}$, $\overline{g}$, $\overline{d}$, $\overline{y}$ and $\overline{\ell}$ denote the steady state values of capital, the tax rate, household consumption, investment, government consumption, non-concessional debt, output and transfers, respectively. $\overline{r} - r^{*}$ is the country risk premium. $\overline{\pi} \equiv 1+\overline{r}-\overline{q}$ denotes the degree of concessionality. $\overline{a} \equiv -(\overline{r}-\overline{q})\overline{\ell}$ denotes outright grants. $\overline{w} \equiv \frac{\alpha\overline{\mu}}{1+\overline{\mu}}$ denotes the relative weight that the donor puts on the utility of government consumption to ensure enforceability. The tax rate, the country risk premium, the shares and the relative weight are given in percent.

Table 4: Welfare Analysis

	Δ^{LG}	Δ^{G}	$\Delta^{\text{G}} - \Delta^{\text{LG}}$
		$\alpha = 0.2$	
$\beta_g = 0.85$	-13.78	-18.85	-5.06
$\beta_g = 0.88$	-7.48	-11.56	-4.08
$\beta_g = 0.91$	-4.24	-6.74	-2.50
$\beta_g = 0.94$	-1.89	-2.44	-0.55
		$\alpha = 0.4$	
$\beta_g = 0.85$	-9.49	-11.99	-2.50
$\beta_g = 0.88$	-6.00	-8.11	-2.11
$\beta_g = 0.91$	-4.00	-5.37	-1.37
$\beta_g = 0.94$	-2.52	-2.75	-0.23
		$\alpha = 0.6$	
$\beta_g = 0.85$	-7.12	-8.96	-1.84
$\beta_g = 0.88$	-5.02	-6.48	-1.46
$\beta_g = 0.91$	-3.73	-4.71	-0.98
$\beta_g = 0.94$	-2.70	-2.90	-0.20

Notes: The initial situation of the welfare analysis is given by the 'No Aid' steady state. 'LG' refers to the optimal combination of loans and grants while 'G' refers to optimal grants in isolation. The benchmark is the steady state that would occur if the donor implements the optimal combination of loans as grants. Welfare gains Δ^{LG} and Δ^{G} are given in percent of steady state consumption and calculated per unit of assistance $q_{t+1}\ell_t$, see equations (20) and (21).

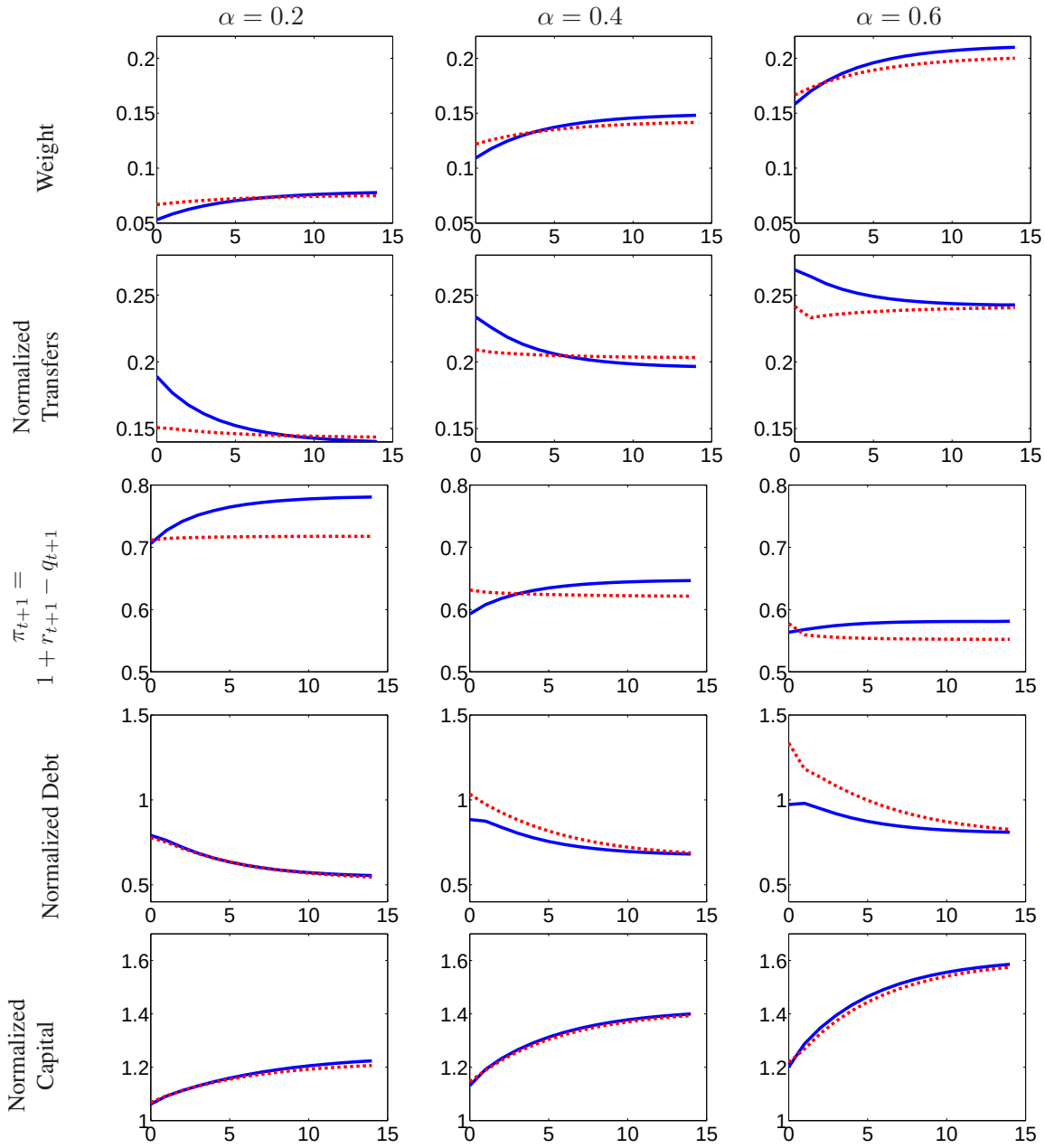

Figure 2: Dynamic Effects of Implicit Debt Relief; The initial situation is given by the 'No Aid' steady state. The weight w_t and $\pi_{t+1} = 1 + r_{t+1} - q_{t+1}$ are given in levels. Transfers ℓ_t are normalized by the 'No Aid' steady state value of output. Non-concessional debt d_t and capital k_t are normalized by their respective 'No Aid' steady state values. The solid line refers to $\beta_g = 0.85$ while the dotted line refers to $\beta_g = 0.91$.

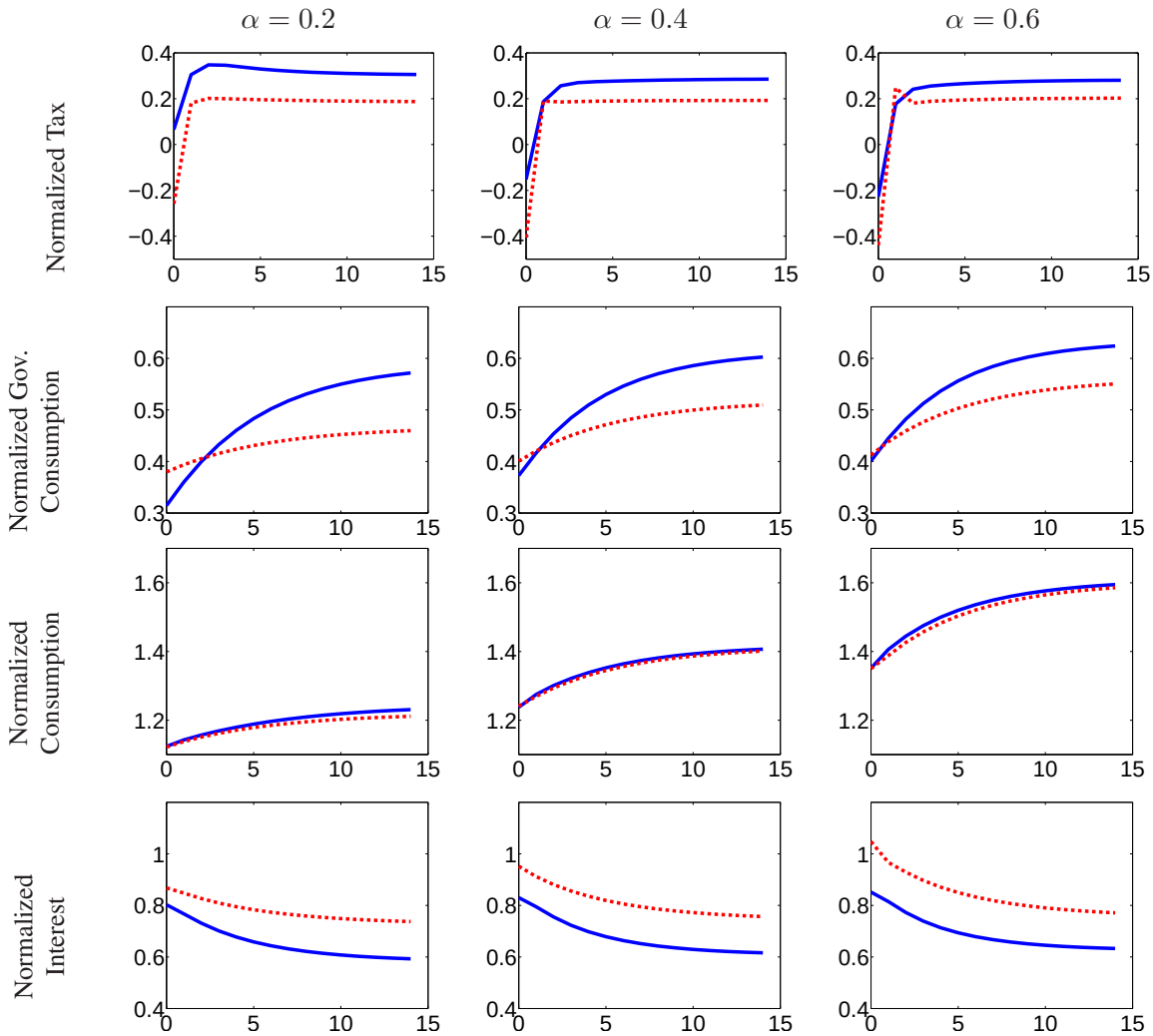

Figure 2 continued; Tax rates τ_t, government consumption g_t, consumption c_t and the market interest rate r_{t+1} are normalized by their respective 'No Aid' steady state values. The solid line refers to $\beta_g = 0.85$ while the dotted line refers to $\beta_g = 0.91$.

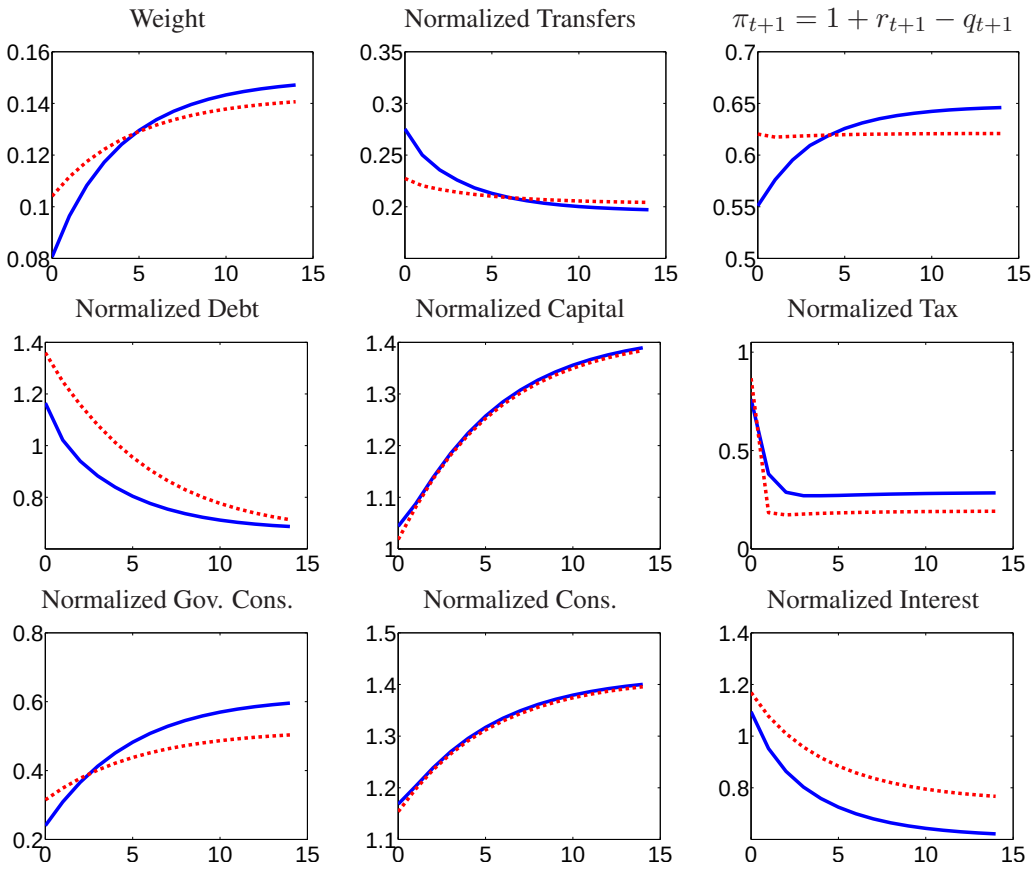

Figure 3: Dynamic Effects of Explicit Debt Relief; The initial situation is given by the steady state that is associated with unconditionally provided transfers with $\frac{\overline{\ell}}{\overline{y}} = 0.45$ and $\overline{\pi} = 0.8939$. The relative weight w_t and $\pi_{t+1} = 1 + r_{t+1} - q_{t+1}$ are given in levels. Transfers ℓ_t are normalized by the 'No Aid' steady state value of output. Non-concessional debt d_t, capital k_t, tax rates τ_t, government consumption g_t, consumption c_t and interest rate r_{t+1} are normalized by their respective 'No Aid' steady state values. The figure refers to $\alpha = 0.4$. The solid line refers to $\beta_g = 0.85$ while the dotted line refers to $\beta_g = 0.91$.

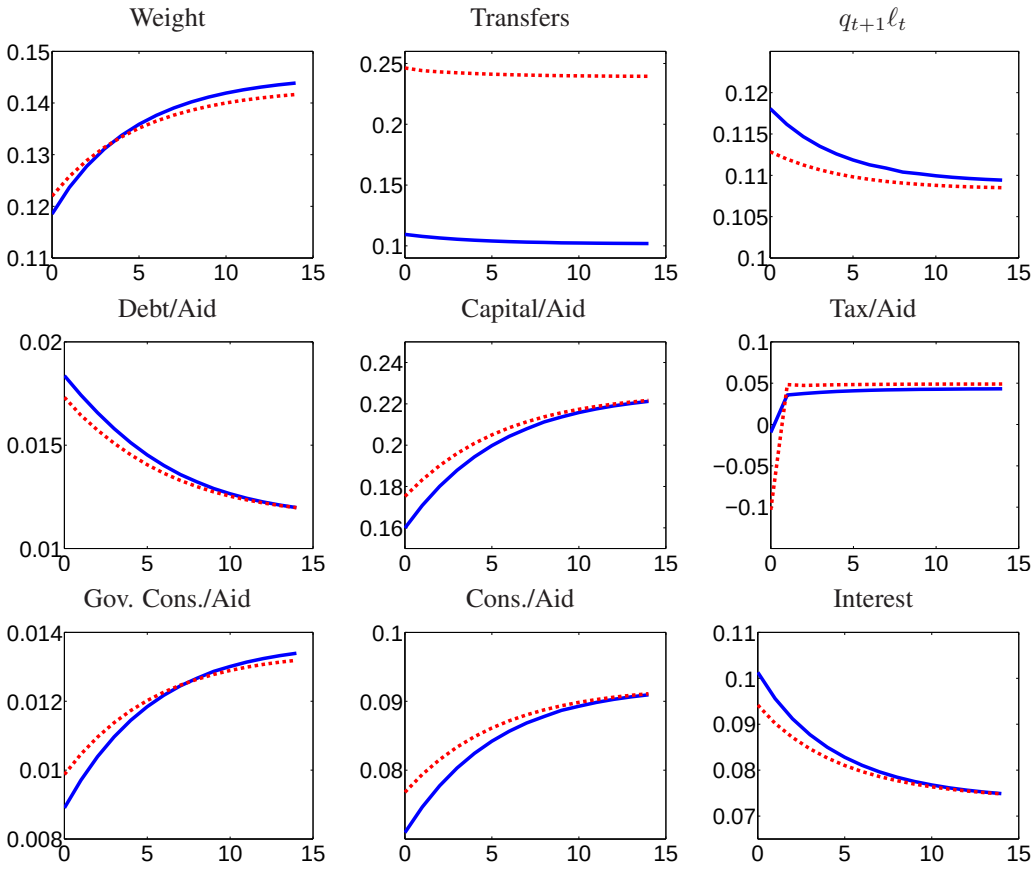

Figure 4: Dynamic Effects of Grants Only; The initial situation is given by the 'No Aid' steady state. The figure refers to $\alpha = 0.4$ and $\beta_g = 0.85$. The solid line refers to optimal grants while the dotted line refers to the optimal combination of grants and loans. The relative weight w_t, $q_{t+1}\ell_t$, the tax rate τ_t and the interest rate r_{t+1} are given in levels. Non-concessional debt d_t, capital k_t, government consumption g_t, consumption c_t are given per unit of $q_{t+1}\ell_t$, where one unit is normalized to 0.01.