Erschienen in: Economica. 2018, 85(339), pp. 626-648
https://doi.org/10.1111/ecca.12216

Debt Relief for Poor Countries: Conditionality and Effectiveness

By ALMUTH SCHOLL

University of Konstanz

This paper studies the effectiveness of debt relief 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. In contrast to the recent practice of fully cancelling debt, optimal incentive-compatible conditionality is accompanied by a concessionality level that implies a combination of subsidized loans and outright grants. The optimal concessionality level depends on the recipient's access to international financial markets and on the strength of the conflict of interest. Incentive-compatible transfers with optimal concessionality levels generate substantial welfare gains. If the donor does not implement the optimal concessionality level and provides subsidized loans only, then the effectiveness of transfers decreases in the long run with severe welfare implications. In contrast, transfers are less effective in the short run if the donor offers outright grants only.

INTRODUCTION

The most heavily indebted poor countries (HIPCs) in the world 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 (IMF) 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 cancellations so that the recipient governments have free resources to finance efficient growth-enhancing economic policies. In 2007, total costs of debt relief were estimated at $71 billion (IMF 2010).

In their seminal contributions, Krugman (1988) and Sachs (1988, 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 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 debt, Easterly (2002) argues that debt relief has been implicitly granted to the HIPCs over the past three decades. Concern about the unsustainability of external debt burdens motivated the recommendation made by the Meltzer Commission (Meltzer 2000) that development assistance should be provided through outright grants rather than subsidized loans.

This paper studies the question of how debt relief should be provided in order to be an effective instrument to stimulate economic growth in HIPCs. Our theoretical framework builds on the macroeconomic literature on economic development and takes into account that the main economic problem of HIPCs is the lack of functional g.[2] Instead of implementing efficient

Konstanzer Online-Publikations-System (KOPS)
URL: http://nbn-resolving.de/urn:nbn:de:bsz:352-2-iwpns1nrgr244

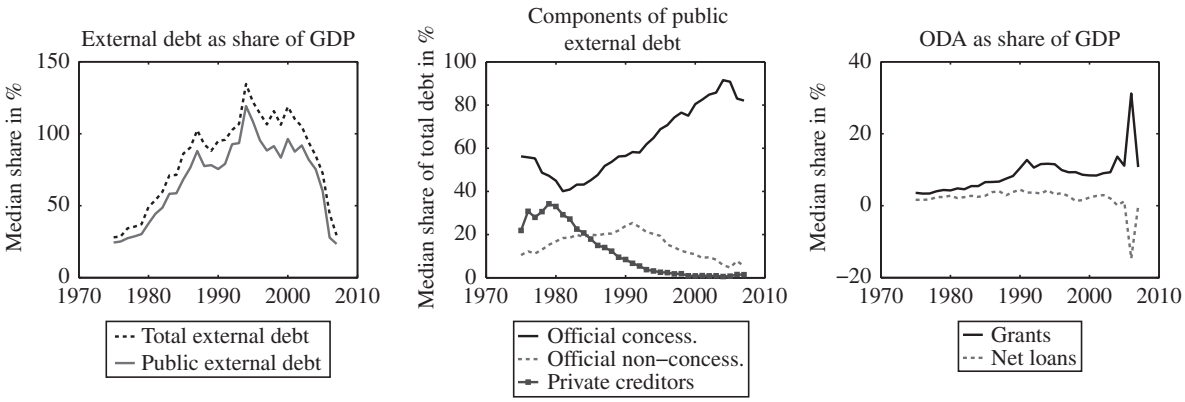

FIGURE 1. Debt relief in HIPCs.
Notes: Annual data on debt are taken from the World Bank World Development Indicators. Annual data on Official Development Assistance (ODA) are taken from the OECD. We consider a subset of the HIPCs for which data for the entire time period are available. These countries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

policies, the recipient government may divert transfers from their intended use and follow poor or wasteful economic policies. To prevent this from happening, it has become a common policy to impose conditionality on the provision of debt relief.[3] As the sovereign recipient government may not be willing to keep the conditions, conditionality can be interpreted as an imperfectly enforceable contract between the donor and the recipient government; see, for example, Besley and Persson (2011), Cordella *et al*. (2003), Kletzer (2005) and Cordella and Dell'Ariccia (2007).

Building on the literature on limited enforceable contracts in macroeconomic settings,[4] this paper analyses the dynamic properties of optimal debt relief and incentive-compatible conditionality that induce the recipient government to cooperate in the short and long run. We focus on the role of the concessionality level as a policy instrument to affect the recipient's incentives to keep the conditions and to affect production, consumption and welfare in the short and long run.

We develop a neoclassical growth model of a small open economy in which the recipient government finances non-productive government consumption by issuing foreign debt and raising taxes. To reflect the risk of sovereign default on non-concessional debt, and to highlight the role of international financial markets, we follow Chatterjee *et al*. (2003) and assume that market interest rates are increasing in the debt-to-capital ratio and, therefore, limit the access to international credit markets.[5] The donor provides costly debt relief and cares solely about the welfare of 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 shorthand for political economy factors that lead to overspending and debt accumulation. The conflict of interest between the donor and the recipient government raises the issue of conditionality: the donor ties the provision of debt relief to specific fiscal policy conditions that coincide with the donor's intention. To ensure that conditionality is fulfilled, the donor threatens to impose aid sanctions if the recipient government does not implement the appropriate fiscal policies. The optimal design of debt relief is characterized by two policy instruments: the size of transfers and the concessionality level.

The complex dynamic structure of the model requires numerical simulations to analyse the short- and long-run properties of optimal incentive-compatible policies. Building on the methodological approach proposed by Marcet and Marimon (2011), our findings suggest that self-enforcing conditionality substantially promotes fiscal reform and stimulates investment and growth. In contrast to the recent practice of cancelling 100% of debt under the Multilateral Debt Relief Initiative, optimal conditionality is accompanied by a concessionality level that implies a combination of subsidized loans and outright grants. The dynamic patterns of self-enforcing conditionality and the optimal concessionality level crucially depend on the recipient's access to international financial markets and on the strength of the conflict of interest between the donor and the recipient. Since high market interest rates limit access to private international credit, losing access to subsidized loans is a severe threat, and a low concessionality level is required to ensure the enforceability of the conditionality contract. A severe conflict of interest implies that the recipient government has high incentives to dishonour the conditions. Consequently, the donor needs to make the contract more attractive by raising the concessionality level.

In our welfare analysis, we consider the steady state in the absence of any form of assistance as the initial situation, and calculate the welfare gains of providing optimal incentive-compatible transfers. Welfare gains are substantial and depend on the recipient's degree of non-benevolence and impatience. Next, we study the welfare gains if the donor does not implement the optimal concessionality level. If the donor provides interest-free loans only, instead of the optimal combination of loans and grants, then households face substantially reduced welfare gains since the high official debt burden adversely affects production and consumption in the long run. In contrast, outright grants in isolation turn out to be less effective only in the short run, such that overall welfare gains are affected less strongly.

Our paper is related to that of Cordella *et al*. (2003), who analyse debt relief and conditionality in a stylized infinite horizon endowment economy. They show analytically that regaining access to international credit markets decreases the recipient's incentives to cooperate.[6] However, Cordella *et al*. (2003) abstract from fiscal policy and economic growth as well as the interaction of subsidized loans and outright grants. Scholl (2009) contributes to this literature by analysing the impact of incentive-compatible conditional aid on fiscal policy reform and investment in a neoclassical growth framework. However, Scholl (2009) considers a closed economy setup and abstracts from international financial markets, and therefore does not analyse the issue of debt relief. This paper extends Cordella *et al*. (2003) and Scholl (2009) to provide a quantitative analysis of the dynamic impact of optimal incentive-compatible conditional debt relief on fiscal policy reform and growth, highlighting the important role of the recipient's access to private international credit markets and the interaction of market debt and subsidized loans. Since our framework allows us to derive the optimal concessionality level, we contribute to the discussion on whether outright grants should be preferred to concessional loans; see, for example, Bulow and Rogoff (2005), Cordella and Ulku (2007), and Cohen *et al*. (2007).

Our paper is related to Murshed and Sen (1995), Svensson (2000, 2003), Pedersen (1996, 2001), Azam and Laffont (2003), and Hagen (2006a,b), who use static or two-period game-theoretic models to analyse incentive-compatibility, moral hazard and informational problems in the context of foreign aid. Moreover, the paper is connected to the literature on aid fungibility; for example, Hagen (2006b) and Pack and Pack (1990, 1993). Our neoclassical theoretical framework builds on the literature that studies the link between foreign aid and economic growth; for example, Chenery and Strout (1966),

Boone (1996), Chatterjee *et al.* (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 that of Aguiar and Amador (2011), 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. Recent studies on the optimal allocation of aid are Carter (2014) and Carter *et al.* (2015).

The paper is structured as follows. In Section I we develop a neoclassical framework of a small open economy with a conflict of interest between the donor and the recipient government. In Section II we analyse the quantitative properties of incentive-compatible conditional debt relief by studying transition paths, long-run properties and welfare. Section III concludes.

I. The Model

The environment

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

Preferences of the representative household are given by

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

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

$$(1) \qquad c_t + k_t \quad (1 \quad \tau_t)y_t + (1 \quad \delta)k_{t-1}.$$

The capital stock depreciates at rate $0 \leq \delta \leq 1$. 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.

The household produces y_t by employing the production function

$$y_t \quad F(k_{t-1}, n_t).$$

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

Preferences of the government are given by

$$\sum_{t\ 0}^{\infty} \beta_g^t v(c_t, g_t), \quad 0<\beta_g<1,$$

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,

for example, expenditures supporting the political elite (see also Cordella and Dell'Ariccia 2007; Scholl 2009). Importantly, we allow that the government discounts the future at a different rate than the public, $\beta_g < \beta_p$. The different discount rate can be interpreted as shorthand for political economy factors that lead to overspending and debt accumulation; see Easterly (2002) and Aguiar and Amador (2011).

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

$$g_t + (1 + r_t)d_{t-1} + (1 + r_t \quad q_t)\ell_{t-1} \quad \tau_t f(k_{t-1}) + d_t + \ell_t, \tag{2}$$

where $q_{t+1} \geq 0$ determines the concessionality level of the transfers ℓ_t. If $q_{t+1} = 0$, then the donor provides non-concessional loans at the market interest rate. If $q_{t+1} = r_{t+1}$, then the donor provides loans without interest. If $q_{t+1} = 1+r_{t+1}$, then transfers ℓ_t are given as an outright grant.[7]

We follow, for example, Chatterjee *et al*. (2003) and assume that the market interest rate takes the functional form

$$r_t \quad \Phi\left(\frac{d_{t-1}}{k_{t-1}}\right), \quad \text{with } \Phi(0) \quad r^* \text{ and } \Phi_{d/k}\left(\frac{d_{t-1}}{k_{t-1}}\right) > 0.$$

Thus the market rate is at least as large as the world interest rate r^* 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 $r_{t+1} \quad r^* \geq 0$.

We assume that there is a representative altruistic donor who cares about the welfare of the households and provides costly financial assistance.[8] The donor's preferences take the form

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

The cost function $h(q_t\ell_{t-1})$ satisfies $h(q_t\ell_{t-1}) > 0$ if ℓ_{t-1} and q_t are strictly greater than zero, and $h(q_t\ell_{t-1}) = 0$ if $q_t\ell_{t-1} = 0$. Moreover, $h_q(q_t\ell_{t-1}) > 0$, $h_\ell(q_t\ell_{t-1}) > 0$, $h_{qq}(q_t\ell_{t-1}) \geq 0$, $h_{\ell\ell}(q_t\ell_{t-1}) \geq 0$. The cost function is assumed to depend on $q_t\ell_{t-1}$ to capture the donor's costs of providing loans at a subsidized rate rather than the market interest rate. If, for example, $q_t = 0$, then the provision of transfers comes at no cost since the loans ℓ_{t-1} earn the market interest rate. In contrast, the donor faces the costs of foregone market interest earnings if transfers are provided as interest-free loans, $q_t = r_t$. Outright grants $q_t = 1+r_t$ are associated with the costs of providing transfers ℓ_{t-1} as well as the foregone interest earnings $r_t\ell_{t-1}$. This formulation of the costs of financial aid is related to Cordella and Ulku (2007), who assume that the degree of loan concessionality times the loan amount equals the amount of development assistance provided by the donor.

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) and define conditionality as a dynamic contract between the donor and the recipient country. The donor provides debt relief and, in return, ties the provision of financial assistance to specific economic conditions on tax and debt policies. However, the contract is imperfectly enforceable since the sovereign recipient government can always dishonour the conditions and implement ineffective economic policies that are not in line with the donor's preferences. We define the contract to be self-enforcing if, at any point in time, the conditions are supportable by the threat of a permanent cut-off from any form of assistance.

Our analysis is based on the assumption that there is full commitment on the donor's side and that the punishment threat is fully credible. However, this may not be the case, and altruistic donors might gain by relaxing sanctions because they care about the welfare of the poor. Moreover, besides humanitarian reasons, donors may have political or strategic reasons to provide financial assistance. The empirical experience of the World Bank and the IMF suggests that conditionality is subject to renegotiations. From a theoretical point of view, 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. In our theoretical setup, if we allow for reduced transfers in punishment, then the value of breaching the conditionality contract becomes larger, so the recipient government's incentives to defect increase. As a result, conditionality will be less severe and less effective. Therefore we follow Scholl (2009) and argue that a permanent cut-off from any form of financial assistance is the strongest punishment such that the resulting self-enforcing contract is the best that an altruistic donor can achieve. Similarly, allowing for limited commitment on the donor's side introduces additional sources for ineffectiveness of financial assistance. Since our theoretical framework considers a dynamic setting with capital and two types of debt, the analysis of two-sided limited commitment and the specification of renegotiation-proof equilibria are beyond the scope of this paper. Instead, we interpret our findings as an upper benchmark on the effectiveness of debt relief.

In our analysis, we assume that the donor is able to enforce the repayment of concessional loans. This assumption is in line with the empirical evidence presented by Jeanne and Zettelmeyer (2001), who analyse the empirical repayment history of official loans provided by the IMF and report rather low default risks. In the subsection entitled 'Loans versus grants' in Section II, we take into account that official creditors may not be able to enforce the repayment of concessional loans, and analyse the optimal design of debt relief and conditionality in such a scenario.

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

$$u_c(c_t) \quad \beta_p u_c(c_{t+1})[1 \quad \delta + (1 \quad \tau_{t+1}) f_k(k_t)] \tag{3}$$

together with the budget constraints of the household and the government, equations (1) and (2).

The value of the outside option $D(k_{t-1},\ d_{t-1},\ \ell_{t-1},\ q_t)$ is determined by the solution to the following maximization problem, given $\ell_t = 0$, for all $t \geq 0$:

$$\max_{\{c_t,g_t,k_t,d_t,\tau_t\}_{t=0}^{\infty}} \sum_{t\ \ 0}^{\infty} \beta_g^t v(c_t, g_t) \tag{4}$$
$$\text{s.t. } (1), (2), (3) \text{ hold,}$$

given $k_{-1} > 0$, $d_{-1} \geq 0$, $\ell_{-1} \geq 0$ and $q_0 \geq 0$. The condition $\ell_{-1} \geq 0$ reflects the repayment obligations of official loans that have been provided by the donor in the past. The optimality conditions associated with (4) 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 of the following maximization problem:

$$\max_{\{c_t,g_t,k_t,d_t,\tau_t,\ell_t,q_{t+1}\}_{t=0}^{\infty}} \sum_{t\ \ 0}^{\infty} \beta_p^t [u(c_t) \quad h(q_t \ell_{t-1})] \tag{5}$$

$$\text{s.t.} \quad \sum_{j\ \ 0}^{\infty} \beta_g^j v(c_{t+j}, g_{t+j}) \geq D(k_{t-1}, d_{t-1}, \ell_{t-1}, q_t) \tag{6}$$
$$\text{and } (1), (2), (3) \text{ hold,}$$

given $k_{-1} > 0$, $d_{-1} \geq 0$ and $\ell_{-1} \geq 0$. Equation (6) 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, $D(k_{t-1},\ d_{t-1},\ \ell_{t-1},\ q_t)$.

As the enforcement constraint (6) contains future realizations of the decision variables, we follow Marcet and Marimon (1992, 2011) and introduce an additional co-state variable μ_t to solve the donor's maximization problem.[9] Let $\gamma_t \geq 0$ be the Lagrange multiplier on the enforcement constraint (6). In the Appendix it is shown that the donor's maximization problem (5) can be transformed into the following saddle-point formulation:

$$\min_{\{\gamma_t > 0\}_{t=0}^{\infty}} \max_{\{c_t,g_t,k_t,d_t,\tau_t,\ell_t,q_{t+1}\}_{t=0}^{\infty}}$$
$$\sum_{t\ \ 0}^{\infty} \beta_p^t \left[u(c_t) \quad h(q_t \ell_{t-1}) + \mu_t v(c_t, g_t) \quad \gamma_t D(k_{t-1}, d_{t-1}, \ell_{t-1}, q_t)\right] \tag{7}$$
$$\text{s.t.} \quad \mu_t \quad \left(\frac{\beta_g}{\beta_p}\right) \mu_{t-1} + \gamma_t, \quad \mu_{-1} \quad 0,$$
$$\text{and } (1), (2), (3) \text{ hold.}$$

The additional co-state variable μ_t enters as a weight on government's preferences. Since μ_t is determined by μ_{t-1}, it contains all the past binding patterns of the enforcement constraint reflected by the Lagrange multiplier γ_t. If the enforcement constraint is never binding, $\gamma_t = 0$ for all t, then 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, then constraint (6) is binding, $\gamma_t > 0$. If $\gamma_t > \mu_{t-1}\beta_g/\beta_p$, then the weight on government's preferences μ_t increases.

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

$$\begin{aligned}(8)\qquad \zeta_t \quad & \beta_p\big[\lambda_t u_c(c_{t+1})(1 \quad \tau_{t+1})f_{k,k}(k_t) + \zeta_{t+1}\big((1 \quad \tau_{t+1})f_k(k_t) + 1 \quad \delta\big) \\ & + \mu_{t+1}v_g(c_{t+1}, g_{t+1})\tau_{t+1}f_k(k_t) \quad \gamma_{t+1}D_k(k_t, d_t, q_{t+1}\ell_t)\big],\end{aligned}$$

$$(9)\qquad \mu_t v_g(c_t, g_t) \quad \beta_p\big(\mu_{t+1}v_g(c_{t+1}, g_{t+1})(1 + r_{t+1}) + \gamma_{t+1}D_d(k_t, d_t, \ell_t, q_{t+1})\big),$$

$$\begin{aligned}(10)\qquad \mu_t v_g(c_t, g_t) \quad & \beta_p\big(\mu_{t+1}v_g(c_{t+1}, g_{t+1})(1 + r_{t+1} \quad q_{t+1}) + h_\ell(q_{t+1}\ell_t) \\ & + \gamma_{t+1}D_\ell(k_t, d_t, \ell_t, q_{t+1})\big),\end{aligned}$$

$$(11)\qquad \mu_{t+1}v_g(c_{t+1}, g_{t+1})\ell_t \quad h_q(q_{t+1}\ell_t) + \gamma_{t+1}D_q(k_t, d_t, \ell_t, q_{t+1}),$$

$$(12)\qquad \zeta_t f(k_{t-1}) \quad \mu_t v_g(c_t, g_t)f(k_{t-1}) \quad \lambda_{t-1}u_c(c_t)f_k(k_{t-1}),$$

$$(13)\qquad \zeta_t \quad u_c(c_t, g_t) + \mu_t v_c(c_t, g_t) + u_{cc}(c_t)\lambda_{t-1}\big[(1 \quad \tau_t)f_k(k_{t-1}) + 1 \quad \delta\big] \quad \lambda_t u_{cc}(c_t),$$

$$(14)\qquad 0 \quad \gamma_t\left(\sum_{j\ 0}^{\infty}\beta_g^j v(c_{t+j}, g_{t+j}) \quad D(d_{t-1}, k_{t-1}, \ell_{t-1}, q_t)\right),$$

together with (1), (2) and (3). 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 (8) relates the marginal costs and benefits of investing one additional unit in the capital stock. If capital is raised by one unit, then the recipient's incentive to default on the contract increases, reflected by the term $\gamma_{t+1}D_k(k_t, d_t, \ell_t, q_{t+1}) > 0$. Equation (9) can be interpreted as the government's Euler equation since it relates the marginal costs and marginal benefits of issuing one additional unit of non-concessional debt. Here, the increasing market debt implies higher repayment obligations decreasing the recipient values of dishonouring the contract conditions, $\gamma_{t+1}D_d(k_t, d_t, \ell_t, q_{t+1}) < 0$. Equation (10) 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 $\mu_{t+1}v_g(c_{t+1}, g_{t+1})(1+r_{t+1} \quad q_{t+1})$, 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 (11) characterizes the optimal concessionality level 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 dishonouring the contract, $\gamma_{t+1}D_q(k_t, d_t, \ell_t, q_{t+1}) \geq 0$. Equation (12) describes the optimal tax rate, and equation (13) determines the optimal choice of household's consumption. Equation (14) is the complementary slackness condition.

The equilibrium conditions form a system of highly non-linear 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 $\bar{\mu}$, a constant allocation ($\bar{c}$, $\bar{g}$, $\bar{k}$), a constant transfer scheme ($\bar{\ell}$, $\bar{q}$), and constant policies ($\bar{\tau}$, $\bar{d}$) that fulfill the optimality conditions associated with the donor's maximization problem (5). 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.

II. Quantitative Results

Parametrization

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 %.

Table 1
Income, Debt and Official Development Assistance in HIPCs

	Per capita income	Debt as share of GDP		ODA as share of GDP	
		Non-concess.	Concess.	Grants	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 %. We consider a subset of the HIPC for which data for the entire time period are available. These countries are: Benin, Bolivia, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Côte 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.

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%. The data show that countries with very low levels of debt are also extremely poor in terms of annual per capita income, indicating 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.[10] Average ODA net loans appear to be positive for the entire time period, so substantial levels of concessional debt have been accumulated in the HIPCs. All countries received substantial debt relief under the HIPC Initiative and the Multilateral Debt Relief Initiative; for example, in 2006 Burkina Faso and Cameroon received debt relief equal to 24% and 22% of GDP, respectively, while Haiti and Congo Republic were respectively granted 29% and 34% of GDP in the years 2005–7.

To parametrize the model on an annual basis, we first suppose that the recipient economy does not receive any form of assistance, that is, $\ell_t = 0$ for all t. The optimal choices of the recipient government are characterized by the solution to the government's maximization problem (4). We consider this as our initial situation, and choose the functional forms and parameters of the model 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

$$u(c_t) \quad \ln c_t, \quad v(c_t, g_t) \quad \ln c_t + \alpha \ln g_t,$$

where $\alpha \in \{0, 0.25, 0.5\}$ is the weight that the recipient government puts on the utility of non-productive consumption g_t. This measures the benevolence of the government and determines the government consumption share as well as the tax rate. We set the private discount rate $\beta_p = 0.96$ and define $r^* = 1/\beta_p \quad 1$ so that the world interest rate equals 4.17%. We follow Chatterjee *et al.* (2003) and assume that the market interest rate is strictly increasing in the debt-to-capital ratio

$$r_t \quad r^* + \exp\left(\phi \frac{d_{t-1}}{k_{t-1}}\right) \quad 1,$$

with $\phi = 0.25$. We suppose that the recipient government discounts the future at a higher rate, reflecting political instability leading to overspending and debt accumulation (Easterly 2002). Since β_g determines the non-concessional debt share in the economy, we analyse its impact by assuming the values 0.86, 0.88, 0.90 and 0.92. The production function is specified as $f(k_{t-1}) \quad k_{t-1}^{\theta}$, with $\theta = 0.36$. 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 parametrization generates non-concessional debt shares between 86% and 30% of GDP. Country risk premia vary between 4% and 12%, which seems to be reasonable in comparison with other low-income countries. Private consumption shares vary between 53% and 72%, while government consumption shares range from 0% to 26%, depending on the parameter values for α and β_g. The associated steady-state tax rates vary between 3.5% and 32%. Thus we consider economies in which up to 32% of GDP is lost due to inefficient economic policies. Investment shares vary between 17% and 24%.

TABLE 2
STEADY STATE PROPERTIES, NO AID

	$\overline{k}$	$\overline{\tau}$	$\overline{r} - r^*$	$\frac{\overline{c}}{\overline{y}}$	$\frac{\overline{x}}{\overline{y}}$	$\frac{\overline{g}}{\overline{y}}$	$\frac{\overline{d}}{\overline{y}}$
$\alpha = 0$							
$\beta_g = 0.86$	3.39	14.05	12.11	64.11	21.84	0.00	86.29
$\beta_g = 0.88$	3.64	10.02	9.47	67.12	22.87	0.00	73.45
$\beta_g = 0.90$	3.87	6.47	6.94	69.76	23.77	0.00	58.26
$\beta_g = 0.92$	4.06	3.55	4.53	71.94	24.51	0.00	40.81
$\alpha = 0.25$							
$\beta_g = 0.86$	2.82	23.54	12.11	57.03	19.43	11.04	76.76
$\beta_g = 0.88$	2.90	22.24	9.47	58.00	19.76	13.59	63.47
$\beta_g = 0.90$	3.01	20.39	6.94	59.38	20.23	14.88	49.59
$\beta_g = 0.92$	3.12	18.42	4.53	60.85	20.73	15.42	34.52
$\alpha = 0.5$							
$\beta_g = 0.86$	2.33	32.37	12.11	50.45	17.19	21.31	67.90
$\beta_g = 0.88$	2.35	32.07	9.47	50.67	17.26	24.51	55.44
$\beta_g = 0.90$	2.42	30.67	6.94	51.71	17.62	25.87	43.19
$\beta_g = 0.92$	2.52	28.83	4.53	53.08	18.09	26.21	30.11

Notes
$\overline{k}$, $\overline{\tau}$, $\overline{c}$, $\overline{x}$, $\overline{g}$, $\overline{d}$ and $\overline{y}$ denote the steady-state values of capital, tax rate, private 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 %.

To focus on the role of political economy frictions, we first consider the case in which $\alpha = 0$ such that there is no unproductive government consumption. Our theoretical economy implies that recipient governments that discount the future at higher rates have higher incentives to finance today's consumption by borrowing. Higher debt levels imply higher risk premia issued by international credit markets. The more indebted countries face considerable debt service obligations that need to be financed via taxes, leading to low capital levels, low production and low private consumption shares.

The larger α, that is, the less benevolent the recipient government, the larger the income tax rate, the lower the investment share and 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.

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 1.2 so that the steady-state values of outright grants under self-enforcing conditionality mimic the properties of the data.

Long-run properties of self-enforcing conditionality and optimal concessionality

Table 3 summarizes the long-run properties of the optimal self-enforcing contract between the altruistic donor and the recipient government.

TABLE 3
STEADY-STATE PROPERTIES, SELF-ENFORCING CONDITIONALITY AND OPTIMAL CONCESSIONALITY

	$\bar{k}$	$\bar{\tau}$	$\bar{r} - r^*$	$\frac{\bar{c}}{\bar{y}}$	$\frac{\bar{x}}{\bar{y}}$	$\frac{\bar{g}}{\bar{y}}$	$\frac{\bar{d}}{\bar{y}}$	$\frac{\bar{\ell}}{\bar{y}}$	$\bar{\pi}$	$\frac{\bar{a}}{\bar{y}}$
$\alpha = 0$										
$\beta_g = 0.86$	4.02	4.11	3.71	71.52	24.37	0.00	33.72	2.44	99.86	0.00
$\beta_g = 0.88$	4.09	3.07	2.94	72.30	24.63	0.00	27.38	4.33	92.90	0.31
$\beta_g = 0.90$	4.15	2.15	2.20	72.99	24.87	0.00	20.97	5.52	89.41	0.58
$\beta_g = 0.92$	4.21	1.29	1.48	73.62	25.08	0.00	14.46	6.24	85.84	0.88
$\alpha = 0.25$										
$\beta_g = 0.86$	3.90	5.90	4.45	70.19	23.91	6.95	39.18	12.98	65.93	4.42
$\beta_g = 0.88$	3.99	4.56	3.52	71.19	24.25	6.86	31.92	13.55	64.92	4.75
$\beta_g = 0.90$	4.07	3.33	2.63	72.11	24.57	6.74	24.53	13.56	62.52	5.08
$\beta_g = 0.92$	4.14	2.30	1.75	72.87	24.83	6.56	16.84	13.96	62.36	5.26
$\alpha = 0.5$										
$\beta_g = 0.86$	3.77	8.03	4.99	68.60	23.37	12.69	42.54	17.68	51.61	8.55
$\beta_g = 0.88$	3.86	6.56	3.94	69.70	23.75	12.57	34.77	17.64	49.92	8.83
$\beta_g = 0.90$	3.95	5.24	2.93	70.68	24.08	12.34	26.72	17.65	49.02	9.00
$\beta_g = 0.92$	4.02	4.11	1.95	71.52	24.37	12.01	18.30	17.44	48.32	9.01

Notes
$\bar{k}$, $\bar{\tau}$, $\bar{c}$, $\bar{x}$, $\bar{g}$, $\bar{d}$, $\bar{y}$ and $\bar{\ell}$ denote the steady-state values of capital, tax rate, private consumption, investment, government consumption, non-concessional debt, output and transfers, respectively. $\bar{r}$ r^* is the country risk premium. $\bar{\pi}$ $1 + r$ q denotes the share of transfers that is given as interest-free loans. $\bar{a}$ $(\bar{r}$ $\bar{q})\bar{\ell}$ denotes outright grants. The tax rate, the country risk premium and the shares are given in %.

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 ℓ between 2% and 17% of GDP. Define $\pi_{t+1} \equiv 1 + r_{t+1}$ q_{t+1} as the share of transfers ℓ_t that is provided in form of interest-free loans. Moreover, define outright grants as $a_{t+1} \equiv$ $(r_{t+1}$ $q_{t+1})\ell_t$. The steady-state value $\bar{\pi}$ is between 48% and 99%, indicating that the optimal transfer scheme is characterized by a combination of subsidized loans and outright 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 sizeable increase in the long-run capital stock as well as in the private consumption share.

We first study the role of political economy frictions and consider $\alpha = 0$ to focus on the impact of the government's impatience on the properties of the optimal self-enforcing contract. In the long-run equilibrium, transfers as shares of output are increasing in β_g, while the fraction of financial assistance that is provided in the form of interest-free loans is decreasing as the recipient government becomes more patient. 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 face market interest rates that 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 cut-off from subsidized loans a less threatening outside option. As a consequence, to make the contract more attractive and to induce the recipient to fulfill conditionality, the donor needs to raise transfers and to increase the concessionality level such that more assistance is provided in the form of outright grants.

Next we study the importance of the recipient's degree of benevolence and analyse the long-run properties of the optimal self-enforcing contract for different values of α. Table 3 shows that transfers as shares of output are increasing in α; that is, less benevolent governments receive relatively more development assistance. Since high values of α imply severe conflicts of interest between the altruistic donor and the recipient government, the government has high incentives to dishonour the conditions. In line with Scholl (2009), it is efficient to improve the attractiveness of the contract by providing more financial assistance. At the same time, to ensure the enforceability of the contract, it is optimal to decrease the share of interest-free loans and to provide more outright grants.

Debt relief

Figure 1 and Table 1 have shown that between 1975 and 1985, HIPCs accumulated considerable levels of non-concessional debt at high interest rates. To reduce the debt burden, debt relief was implicitly granted to HIPCs by replacing market debt by concessional debt (Easterly 2002). This led to a substantial accumulation of concessional debt in the mid-1990s. The objective of this subsection is to analyse the properties of optimal debt relief in a situation where the recipient country faces non-concessional debt at high market interest rates but limited concessional debt, as was the case between 1975 and 1985. To simplify our analysis, we consider the 'no aid' steady state as the 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 analyse the short- and long-run effects of optimal debt relief as well as the dynamic properties of self-enforcing conditionality.

Figures 2A and 2B consider various values of α and β_g, and plot the transition paths to the steady state that are the outcome of the donor's maximization problem (5) given $k_{-1} \quad \overline{k}^{\text{noaid}}$, $d_{-1} \quad \overline{d}^{\text{noaid}}$ and $\ell_{-1} = 0$. All variables are normalized by their respective 'no aid' steady-state values except for μ_t and π_{t+1}, which are given in levels. Transfers ℓ_t are normalized by the 'no aid' steady-state value of output.

Figures 2A and 2B show 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, for $\alpha = 0.25$ and $\alpha = 0.5$, in order to stimulate economic growth, the recipient government has to substantially reduce government consumption, which allows large tax cuts. 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 capital stock. In case there is no government consumption, $\alpha = 0$, optimal self-enforcing conditionality requires the government to increase the tax rate in order to reduce the non-concessional debt level and the market interest rate.

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 cut-off from any form of assistance becomes less threatening, the additional co-state variable μ_t increases over time; that is, the donor needs to raise the weight on the government's utility to ensure the enforceability of the contract. This implies that conditionality becomes less severe and government consumption rises over time.

In the short run, μ_t is higher for more patient governments than for impatient governments, while in the long run the opposite is true. This is due to the fact that patient governments initially face lower market interest rates, have better access to international

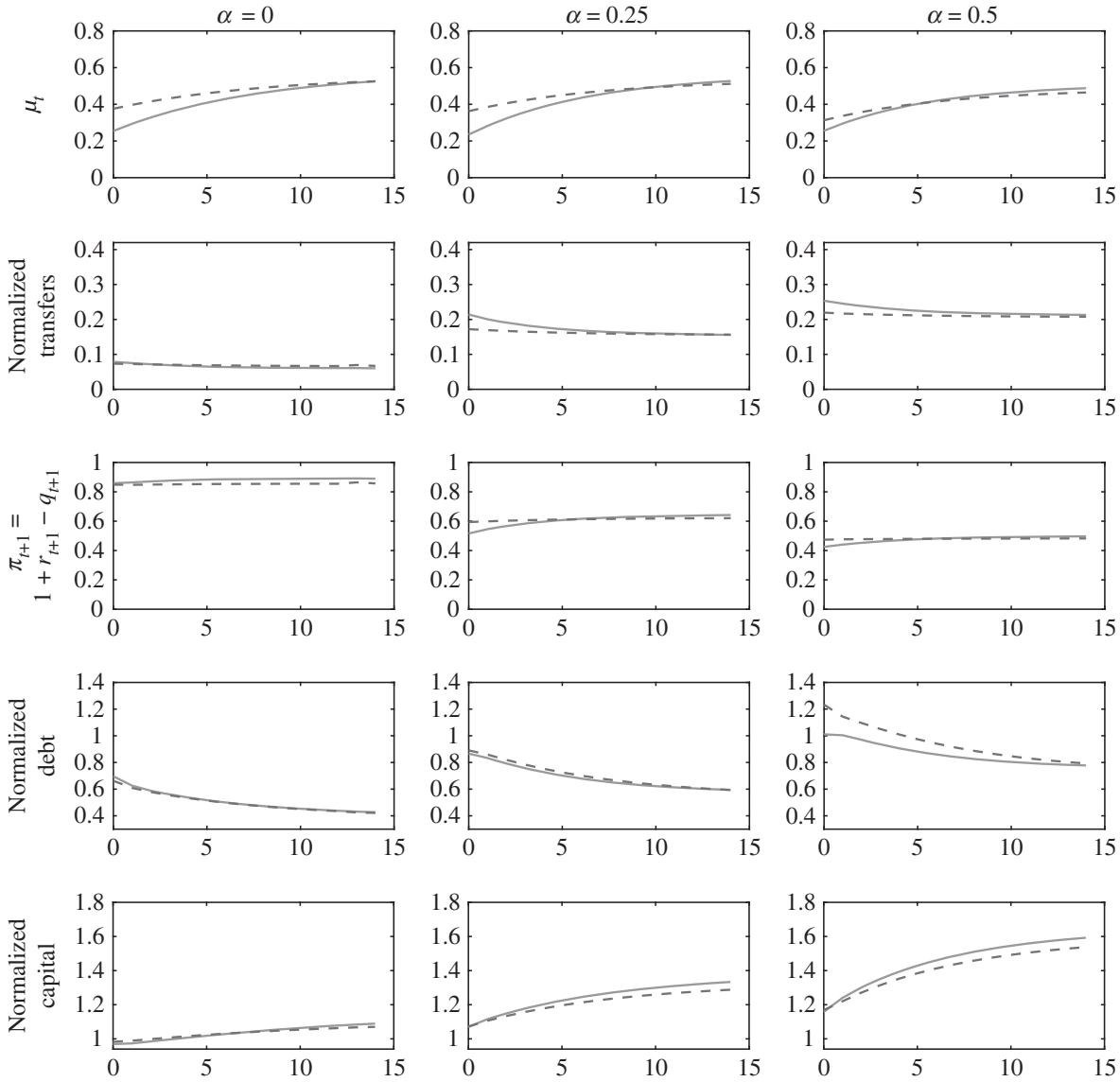

FIGURE 2A. Dynamic effects of debt relief.
Notes: The initial situation is given by the 'no aid' steady state. The co-state variable μ_t and $\pi_{t+1} = 1 + r_{t+1} \quad q_{t+1}$ are given in levels. Transfers ℓ_t are normalized by the 'no aid' steady-state value of output. Non-concessional debt d_t and capital k_t are normalized by their respective 'no aid' steady-state values. The solid lines refer to $\beta_g = 0.88$, while the dashed lines refer to $\beta_g = 0.92$.

private credit and are less dependent on the provision of 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 in the pattern of government consumption: in the short run (long run), the reduction in government consumption is higher (lower) for more impatient governments.

Transfers 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 dishonour the conditions increase. It turns out to be optimal to provide a rising fraction π_{t+1} in the form of interest-free loans so that the repayment obligations decrease the value of the recipient's outside option.

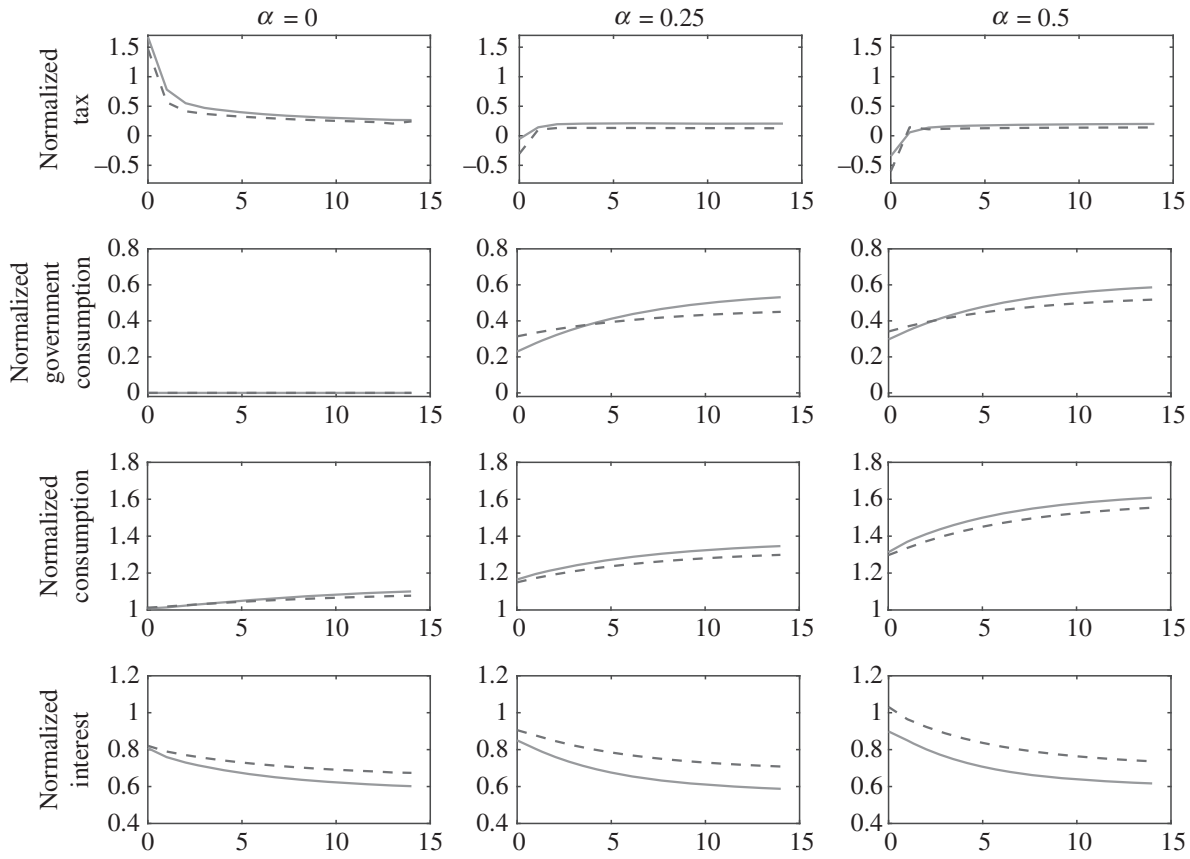

FIGURE 2B. Dynamic effects of debt relief (continued).
Notes: The tax τ_t, government consumption g_t, private consumption c_t and the market interest rate r_{t+1} are normalized by their respective 'no aid' steady-state values. The solid lines refer to $\beta_g = 0.88$, while the dashed lines refer to $\beta_g = 0.92$.

Overall, the impact of incentive-compatible conditional debt relief is sizeable. Relative to the initial 'no aid' situation, capital and private consumption are substantially increased. Thereby, the relative impact is increasing in the non-benevolence measured by α and the impatience measured by β_g. The reason behind this finding is that the initial 'no aid' situation is characterized by rather low private consumption and production levels for less-benevolent and impatient governments so that the effectiveness of development assistance is high. Note, however, that the countries suffering from non-benevolent impatient 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 subsidized loans and outright grants in the short and long run. Thus non-concessional debt is partly replaced by official loans and partly repaid by using outright grants. In contrast to the historical experience, optimal concessional debt levels are quite moderate.

Loans versus grants

In this subsection, we analyse the short- and long-run properties of incentive-compatible conditional transfers if the donor does not implement the optimal combination of grants and loans but uses one policy instrument only: either interest-free loans or outright grants.

In Figure 3 we consider the 'no aid' steady state as the initial situation, and plot the transitional dynamics. Since the dynamic patterns are qualitatively similar for different constellations of α and β_g, we focus on $\alpha = 0.25$ and $\beta_g = 0.92$. To facilitate a comparison with the previous scenario, we plot the transition paths of the optimal combination of grants and loans (optimal q_t) together with the transition paths associated with interest-free loans in isolation ($q_t \equiv r_t$) and outright grants in isolation ($q_t \equiv 1 + r_t$). As before, we normalize all variables by their respective 'no aid' steady-state values except for μ_t, which is given in levels. Transfers ℓ_t and the costs of transfers $q_{t+1}\ell_t$ are normalized by the 'no aid' steady-state value of output.

First suppose that the donor provides interest-free loans only, instead of implementing the optimal concessionality level. Since official loans are assumed to be repaid, they are less costly than grants. Therefore the donor provides large amounts of transfers. In the short run, considerable tax cuts can be implemented such that capital, output and private consumption strongly increase. Moreover, non-concessional debt falls such that the market interest rate decreases. The lower market interest rate reduces the donor's costs of providing transfers, and subsidized loans replace market debt over time. A high level of official debt makes a permanent cut-off from any form of assistance a severe threat such that the additional co-state variable μ_t decreases over time. In the long run, the high official debt repayment obligations have adverse effects on the economy: the steady-state values of capital and private consumption are lower compared to the corresponding values associated with the optimal combination of grants and loans.

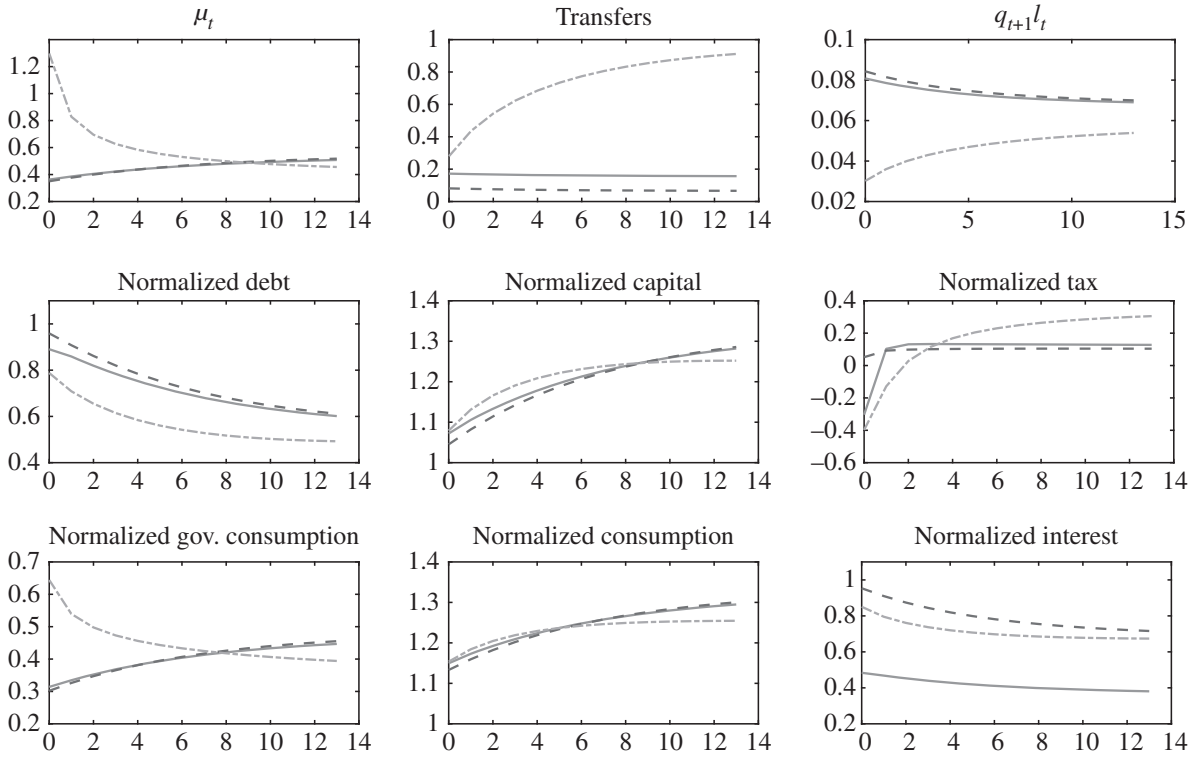

FIGURE 3. Dynamic effects of one policy instrument only: loans versus grants.
Notes: The initial situation is given by the 'no aid' steady state. The figure refers to $\alpha = 0.25$ and $\beta_g = 0.92$. The solid lines refer to the optimal combination of grants and loans (optimal q_t), the dashed lines refer to optimal grants ($q_t \equiv 1 + r_t$), and the dashed-dotted lines refer to optimal loans ($q_t \equiv r_t$). The co-state variable μ_t is given in levels. Transfers ℓ_t and the costs of transfers $q_{t+1}\ell_t$ are normalized by the 'no aid' steady-state value of output. Non-concessional debt d_t and capital k_t, tax 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.

So far, we have assumed that official creditors are able to enforce the fulfilment of concessional debt obligations. This assumption is in line with the view that official creditors have better enforcement technologies than private creditors. Moreover, the historical experience indicates that debtors rarely default on official debt; see 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 the following, 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, in the absence of uncertainty, the donor loses loans as a policy instrument and provides outright grants only. Overall, the general pattern of the transition paths associated with optimal grants look very similar to those associated with the optimal concessionality level. However, in the short run, if giving grants is the only policy instrument, then the tax rate is substantially higher than 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, compared with the optimal combination of grants and loans, in the short run, outright grants increase capital and private consumption by smaller amounts. Moreover, non-concessional debt and the market interest rate are reduced less. At the same time, grants in isolation are more costly than the optimal combination of grants and loans.

Welfare analysis

In Table 4 we consider the 'no aid' steady state as the initial situation, and analyse the welfare gains of optimal incentive-compatible conditional assistance.

We use compensating variations to formulate differences in lifetime utility, and express the change in welfare as follows:

$$\sum_{t\ 0}^{\infty} \beta_p^t u\big((1+\Delta_d)\overline{c}^{\text{noaid}}\big) \quad \sum_{t\ 0}^{\infty} \beta_p^t \big(u(c_t) \quad h(q_t \ell_{t-1})\big), \tag{15}$$

$$\sum_{t\ 0}^{\infty} \beta_p^t u\big((1+\Delta_h)\overline{c}^{\text{noaid}}\big) \quad \sum_{t\ 0}^{\infty} \beta_p^t u(c_t). \tag{16}$$

Δ_d and Δ_h refer to the welfare gains of the donor and the household, respectively. Note that the welfare gains include the transitional dynamics to the new long-run equilibrium that is characterized by permanent transfers. We assess the relative welfare loss associated with using one policy instrument only by comparing the welfare gains of optimal concessionality levels with the welfare gains of interest-free loans, $q_t \equiv r_t$, and grants, $q_t \equiv 1 + r_t$.

If the donor provides optimal incentive-compatible conditional transfers and implements the optimal concessionality level, then the welfare gain of the household varies between 7.72% and 57.57% of steady-state 'no aid' consumption, depending on the parameter values α and β_g. The donor's welfare gain reflects the costs of providing transfers and is in the range between 4.96% and 27.70% of steady-state 'no aid' consumption. In line with the results presented in the subsection 'Debt relief' above, the

TABLE 4
WELFARE ANALYSIS

	Optimal q_t		Loans $q_t \equiv r_t$		Grants $q_t \equiv 1+r_t$	
	Δ_d	Δ_h	Δ_d	Δ_h	Δ_d	Δ_h
$\alpha = 0$						
$\beta_g = 0.86$	14.13	17.36	14.08	17.30	14.10	17.96
$\beta_g = 0.88$	10.77	12.68	10.73	12.49	10.71	13.33
$\beta_g = 0.90$	7.52	9.82	7.39	8.96	7.52	10.14
$\beta_g = 0.92$	4.96	7.72	4.84	6.90	4.96	7.95
$\alpha = 0.25$						
$\beta_g = 0.86$	16.60	34.71	16.33	29.88	16.58	35.36
$\beta_g = 0.88$	16.86	33.00	16.12	28.60	16.84	33.57
$\beta_g = 0.90$	15.39	30.97	14.54	26.94	15.37	31.39
$\beta_g = 0.92$	13.61	28.73	13.31	24.03	13.59	29.01
$\alpha = 0.5$						
$\beta_g = 0.86$	25.21	56.17	24.73	49.54	25.18	56.80
$\beta_g = 0.88$	27.70	57.57	26.83	51.06	27.65	58.08
$\beta_g = 0.90$	26.89	55.87	26.03	49.98	26.84	56.24
$\beta_g = 0.92$	25.01	52.77	24.72	48.18	24.96	52.99

Notes
Welfare gains are calculated in terms of compensating variations. Δ_d and Δ_h are calculated according to equations (15) and (16), respectively. The initial situation is given by the 'no aid' steady state.

welfare gain of providing the optimal combination of loans and grants is increasing in the non-benevolence and the impatience of the recipient government.

If we consider a concessionality level $q_t \equiv r_t$ such that the donor provides interest-free loans only, then the welfare gain of the household is reduced by up to 6 percentage points. Relative welfare losses decrease with α since the share of interest-free loans implied by the optimal concessionality level increases for more benevolent recipient governments (see Table 3). Although loans are quite effective in increasing private consumption in the short run (see Figure 3), they have an adverse impact on the economy in the long run that dominates the overall welfare gain. The welfare gain of the donor is hardly affected because of the compensating effect of lower costs.

If the donor provides assistance in the form of outright grants, $q_t \equiv 1 + r_t$, instead of implementing the optimal concessionality level, then transfers are less effective in increasing private consumption in the short run; see Figure 3. In the long run, permanent grants are more costly for the donor but have a positive impact on production and private consumption. Overall, the donor faces relative welfare losses of up to 0.06 percentage points, while households have small relative gains.

III. CONCLUSIONS

This paper has studied the effectiveness of debt relief as a policy 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 modelled 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.

Our findings suggest that imposing incentive-compatible conditions on the provision of debt relief substantially promotes fiscal reform and investment. Optimal conditionality is accompanied by a concessionality level that implies a combination of subsidized 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. The dynamic patterns of optimal transfers and optimal concessionality levels have been shown to depend critically on the degree of the recipient's non-benevolence and impatience since these parameters affect access to international credit markets and the strength of the conflict of interest.

Incentive-compatible optimal debt relief generates substantial welfare gains. If the donor does not implement the optimal concessionality level and provides subsidized loans only, then welfare gains decrease substantially because the high official debt burden has an adverse impact on production and consumption in the long run. In contrast, outright grants in isolation turn out to be less effective only in the short run such that welfare gains are affected less strongly.

Our analysis has been based on the assumptions that there is full commitment on the donor's side and that the punishment threat is fully credible. However, this may not be the case and altruistic donors might gain by relaxing sanctions because they care about the welfare of the poor. Moreover, donors may have political or strategic reasons to provide financial assistance. We have argued that a permanent cut-off from any form of financial assistance is the strongest punishment such that the resulting self-enforcing contract is the best that an altruistic donor can achieve. Similarly, allowing for limited commitment on the donor's side introduces additional sources for ineffectiveness of debt relief. Since our theoretical framework considers a dynamic setting with capital and two types of debt, the analysis of two-sided limited commitment and strategic motives for providing development assistance is beyond the scope of this paper. Instead, we interpret our findings as an upper benchmark on the effectiveness of debt relief.

APPENDIX

OPTIMALITY CONDITIONS

Default value

The default value is given by the solution to the recipient government's maximization problem (4). The optimality conditions are

$$\zeta_t = v_c(c_t, g_t) + \frac{\beta_p}{\beta_g} u_{cc}(c_t)\lambda_{t\ 1}\left[(1-\tau_t)f_k(k_{t\ 1}) + 1 - \delta\right] - \lambda_t u_{cc}(c_t), \tag{A1}$$

$$\begin{aligned}\zeta_t =& \beta_g \left(\frac{\beta_p}{\beta_g} \lambda_t u_c(c_{t+1})(1-\tau_{t+1}) f_{k,k}(k_t) + \zeta_{t+1}\left((1-\tau_{t+1})f_k(k_t) + 1 - \delta\right) \right. \\ &\left. + v_g(c_{t+1}, g_{t+1})\tau_{t+1} f_k(k_t) \right),\end{aligned} \tag{A2}$$

$$\text{(A3)} \qquad v_g(c_t, g_t) = \beta_g v_g(c_{t+1}, g_{t+1})(1 + r_{t+1}),$$

$$\text{(A4)} \qquad \zeta_t f(k_{t\ 1}) = v_g(c_t, g_t) f(k_{t\ 1}) - \frac{\beta_p}{\beta_g} \lambda_{t\ 1} u_c(c_t) f_k(k_{t\ 1}),$$

where ζ_t and λ_t are the Lagrange multipliers associated with the household's budget constraint and the Euler equation, respectively. Equation (A1) determines the optimal choice of households' consumption. Equation (A2) relates the marginal costs and benefits of investing one additional unit in the capital stock. Equation (A3) 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 (A4) determines the optimal tax choice.

Self-enforcing conditionality

The Lagrangian associated to the donor's maximization problem (5) is given by

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

subject to (1), (2) and (3). It is straightforward to show that the following equality holds:

$$\sum_{t=0}^{\infty} \beta_p^t \gamma_t \sum_{j=0}^{\infty} \beta_g^t v(c_{t+1}, g_{t+1}) = \sum_{t=0}^{\infty} \beta_p^t \mu_t v(c_t, g_t)$$
$$\text{s.t.} \quad \mu_t = \frac{\beta_g}{\beta_p} \mu_{t\ 1} + \gamma_t, \quad \mu_{\ 1} = 0.$$

Thus the Lagrangian becomes

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

NUMERICAL ALGORITHM

Due to the complexity of the model, we rely on numerical simulations to analyse 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 equations (1) and (2), (3) and (A1)–(A4). 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 $\lambda_{\ 1}$, 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 (1), (2), (A1) and (A4) for $t = 0,\ldots,T$, and the equilibrium conditions (3), (A2) and (A3) that look forward to t+1 for $t = 0,\ldots,T-1$. Since we have as many unknowns as equations, the system of non-linear equations can be solved by employing a numerical non-linear 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 (1), (2), (11) and (13) for $t = 0,\ldots,T$, and the equilibrium conditions (3), (8), (9), (10) and (14) that look forward to $t + 1$ for $t = 0,\ldots,T - 1$. Since we have as many unknowns as equations, the system of non-linear equations can be solved by employing a numerical non-linear equation solver.

ACKNOWLEDGMENTS

Helpful comments by Matthias Döpke, Fabian Fink and seminar participants at the University of Stockholm, Bonn, Karlsruhe Institute of Technology, ESEM 2011, CEF 2010 conference, EEA meetings 2010 and the German Economic Association Meeting 2010 are gratefully acknowledged. I thank the editor and the anonymous referees for excellent suggestions and comments.

This research was supported by the junior professor programme of the state Baden-Württemberg. All errors are mine.

NOTES

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. See also Arslanalp and Henry (2004, 2006).
3. To be considered for the HIPC initiative, countries must meet certain criteria; for example, countries must have developed a Poverty Reduction Strategy Paper.
4. See, for example, Kocherlakota (1996), Kletzer and Wright (2000), Alvarez and Jermann (2000), Kehoe and Perri (2002), Krüger and Perri (2006), Krüger and Uhlig (2006), and 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 *et al*. (1993).
5. We abstract from default in equilibrium and endogenous interest rates as analysed in, for example, Arellano (2008). Fink and Scholl (2016) analyse the impact of conditionality on sovereign risk but do not explicitly model the donor's behaviour; see also references therein.
6. In similar setups, Cordella and Dell'Ariccia (2007) contrast conditional budget support and project aid, while Kletzer (2005) focuses on the credibility of aid sanctions.
7. See also Cordella and Ulku (2007), who formulate the transfer scheme in a similar way.
8. 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.
9. This method has been frequently applied in the macroeconomic literature on limited commitment, see, for example, Kehoe and Perri (2002) and Cooley *et al*. (2004).
10. There is a large empirical literature on aid and economic growth; for example, Burnside and Dollar (2000, 2004), Hansen and Tarp (2000, 2001), Svensson (1999), Dollar and Svensson (2000), Dalgaard and Hansen (2001), Dalgaard *et al*. (2004), Collier and Dollar (2002), Easterly, Levine and Roodman (2004), Easterly (2003) and Clemens *et al*. (2011). According to Rajan and Subramanian (2008), there seems to be no robust evidence concerning the interaction of foreign aid, sound economic policies and growth.

REFERENCES

Aguiar, M. and Amador, M. (2011). Growth in the shadow of expropriation. *Quarterly Journal of Economics*, **126**(2), 651 97.

Arellano, C. (2008). Default risk and income fluctuations in emerging economies. *American Economic Review*, **98**(3), 690 712.

Arslanalp, S. and Henry, P. B. (2004). Helping the poor to help themselves: debt relief or aid. NBER Working Paper no. 10230.

and (2005). Is debt relief efficient? *Journal of Finance*, **60**(2), 1017 51.
and (2006). Policy watch: debt relief. *Journal of Economic Perspectives*, **20**(1), 207 20.
Alvarez, F. and Jermann, U. J. (2000). Efficiency, equilibria, and asset pricing with risk of default. *Econometrica*, **68**(4), 775 98.
Azam, J.-P. and Laffont, J.-J. (2003). Contracting for aid. *Journal of Development Economics*, **70**, 25 58.
Azariadis, C. and Kaas, L. (2008). Credit and growth under limited commitment. *Macroeconomic Dynamics*, **12**(1), 20 30.
Besley, F. and Persson, T. (2011). Fragile states and development policy. *Journal of the European Economic Association*, **9**(3), 371 98.
Boone, P. (1996). Politics and the effectiveness of foreign aid. *European Economic Review*, **40**(2), 289 329.
Bulow, J. and Rogoff, K. (2005). Grants versus loans for development banks. *American Economic Review*, **95** (2), 193 397.
Burnside, C. and Dollar, D. (2000). Aid policies and growth. *American Economic Review*, **90**(4), 847 68.
and (2004). Aid, policies and growth: revisiting the evidence, World Bank Policy Research Working Paper no. 3251.
Carter, P. (2014). Aid allocation rules. *European Economic Review*, **71**, 132 51.
, Postel-Vinay, F. and Temple, J. (2015). Dynamic aid allocation. *Journal of International Economics*, **95**(2), 291 304.
Chatterjee, S. and Turnovsky, S. J. (2007). Foreign aid and economic growth: the role of flexible labor supply. *Journal of Development Economics*, **84**(1), 507 33.
, Sakoulis, G. and Turnovsky, S. J. (2003). Unilateral capital transfers, public investment and economic growth. *European Economic Review*, **47**(6), 1077 103.
Chenery, H. B. and Strout, A. M. (1966). Foreign assistance and economic development. *American Economic Review*, **56**(4), 679 733.
Clemens, M. H., Radelet, S., Bhavnani, R. and Bazzi, S. (2011). Counting chickens when they hatch: timing and the effects of aid on growth. *Economic Journal*, **122**, 590 617.
Cohen, D., Jacquet, P. and Reisen, H. (2007). Loans or grants? *Review of World Economics*, **143**(4), 764 82.
Collier, P. and Dollar, D. (2002). Aid allocation and poverty reduction. *European Economic Review*, **46**(8), 1470 500.
Cooley, T., Marimon, R. and Quadrini, V. (2004). Aggregate consequences of limited contract enforceability. *Journal of Political Economy*, **112**(4), 817 47.
Cordella, T. and Dell'Ariccia, G. (2007). Budget support versus project aid: a theoretical appraisal. *Economic Journal*, **117**, 1260 79.
and Ulku, H. (2007). Grants versus loans. *IMF Staff Papers*, **54**(1), 139 62.
, Dell'Ariccia, G. and Kletzer, K. M. (2003). Conditional aid, sovereign debt, and debt relief. Mimeo, IMF.
Dalgaard, C.-J. and Hansen, H. (2001). On aid, growth and good policies. *Journal of Development Studies*, **37** (6), 17 41.
, and Tarp, F. (2004). On the empirics of foreign aid and growth. *Economic Journal*, **114**, 191 216.
Dollar, D. and Svensson, J. (2000). What explains the success or failure of structural adjustment programmes? *Economic Journal*, **110**, 894 917.
Easterly, W. (2002). How did heavily indebted poor countries become heavily indebted? Reviewing two decades of debt relief. *World Development*, **30**(10), 1677 96.
(2003). Can foreign aid buy growth? *Journal of Economic Perspectives*, **17**(3), 23 48.
, Levine, R. and Roodman, D. (2004). New data, new doubts: a comment on Burnside and Dollar's 'Aid policies and growth (2000)'. *American Economic Review*, **94**(3), 774 80.
Eaton, J. (1990). Debt relief and the international enforcement of loan contracts. *Journal of Economic Perspectives*, **4**(1), 43 56.
Fink, F. and Scholl, A. (2016). A quantitative model of sovereign debt, bailouts and conditionality. *Journal of International Economics*, **98**(1), 176 90.
Giovannetti, G., Marcet, A. and Marimon, R. (1993). Growth, capital flows and enforcement constraints. *European Economic Review*, **37**(2), 418 25.
Hagen, R. J. (2006a). Samaritan agents? On the delegation of aid policy. *Journal of Development Economics*, **79** (1), 249 63.
(2006b). Buying influence: aid fungibility in a strategic perspective. *Review of Development Economics*, **10** (2), 267 84.

HANSEN, H. and TARP, F. (2000). Aid effectiveness disputed. *Journal of International Development*, **12**(3), 375 98.
and (2001). Aid and growth regressions. *Journal of Development Economics*, **64**(2), 547 70.
INTERNATIONAL MONETARY FUND (IMF) (2010). Debt relief under the heavily indebted poor country initiative. Factsheet.
JEANNE, O. and ZETTELMEYER, J. (2001). International bailouts, moral hazard and conditionality. *Economic Policy*, **61**(33), 407 32.
KEHOE, P. J. and PERRI, F. (2002). International business cycles with endogenous incomplete markets. *Econometrica*, **70**(3), 907 28
KLETZER, K. (2005). Aid and sanctions. Mimeo, University of California, Santa Cruz.
and WRIGHT, B. D. (2000). Sovereign debt as intertemporal barter. *American Economic Review*, **90**(3), 621 39.
KOCHERLAKOTA, N. (1996). Implications of efficient risk sharing without commitment. *Review of Economic Studies*, **63**(4), 595 609.
KRÜGER, D. and PERRI, F. (2006). Does income inequality lead to consumption inequality? Evidence and theory. *Review of Economic Studies*, **73**(1), 163 93.
and UHLIG, H. (2006). Competitive risk sharing contracts with one-sided commitment. *Journal of Monetary Economics*, **53**(7), 1661 91.
KRUGMAN, P. (1988). Financing versus forgiving a debt overhang. *Journal of Development Economics*, **29**(3), 253 68.
MARCET, A. and MARIMON, R. (1992). Communication, commitment, and growth. *Journal of Economic Theory*, **58**, 219 49.
and (2011). Recursive contracts. Working Paper no. 552, Barcelona Graduate School of Economics.
MELTZER, A. H. (2000). The Report of the International Financial Institution Advisory Commission: comments on the critics. *CESifo Forum*, **1**(4), 9 17.
MURSHED, M. and SEN, S. (1995). Aid conditionality and military expenditure reduction in developing countries: models of asymmetric information. *Economic Journal*, **105**, 498 505.
PACK, H. and PACK, J. R. (1990). Is foreign aid fungible? The case of Indonesia. *Economic Journal*, **100**, 188 94.
and (1993). Foreign aid and the question of fungibility. *Review of Economics and Statistics*, **75**(2), 258 65.
PEDERSEN, K. R. (1996). Aid, investment and incentives. *Scandinavian Journal of Economics*, **98**(3), 423 38.
(2001). The Samaritan's Dilemma and the effectiveness of foreign aid. *International Tax and Public Finance*, **8**(5), 693 703.
RAJAN, R. G. and SUBRAMANIAN, A. (2008). What does the cross-country evidence really show? *Review of Economics and Statistics*, **90**(4), 643 55.
SACHS, J. (1988). *Conditionality, debt relief, and the developing country debt crisis*. In J. Sachs (ed.), Developing Country Debt and Economic Performance, Vol. **1**. Chicago, IL: University of Chicago Press, pp. 255 98.
(1989). *The debt overhang in developing countries*. In G. A. Calvo, R. F. P. Kouri and J. B. Marcedo (eds), Debt Stabilization and Development. Oxford: Basil Blackwell, pp. 80 102.
SCHOLL, A. (2009). Aid effectiveness and limited enforceable conditionality. *Review of Economic Dynamics*, **12** (2), 377 91.
SVENSSON, J. (1999). Aid, growth and democracy. *Economics and Politics*, **11**(3), 275 97.
(2000). When is foreign aid policy credible? Aid dependence and conditionality. *Journal of Development Economics*, **61**(1), 61 84.
(2003). Why conditional aid does not work and what can be done about it. *Journal of Development Economics*, **70**(2), 381 402.
TRABANDT, M. (2009). Optimal pre-announced tax reform. Mimeo, Sveriges Riksbank.