Concessional Loans versus Grants: a Benevolent Donor's Problem with a Participation Constraint

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Abstract

Why do so many countries remain poor? The culprit may be aid with certain eligibility criterion. The paper's focus is on the incentive effect of a cutoff, an income level above which the recipient country is ineligible for aid in the form of concessional loans or grants. The key result is that concessional loans are better than grants, provided that the loan scheme's perverse incentive effects, which induce the country to remain below the cutoff to reap the benefit of the concessional interest rate, are small enough. The paper shows that if the initial debt is high, these perverse effects are greater, thus providing a theoretical rationale for "debt overhang".

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It is debatable how effectively aid can contribute to growth in low-income countries (LICs). This paper argues that aid with certain eligibility criterion may impede growth by making recipient countries aid-dependent.

More than just a theoretical possibility, I find in the data that growth rates tend to stagnate around the threshold between low and lower-middle income countries. My model suggests that this stagnation may be due to the existence of a cutoff, a level of income above which a country loses its eligibility for aid. Such a cutoff exists, for example, in multilateral concessional lending such as the World Bank International Development Association (IDA) loans and International Monetary Fund (IMF) loans under the Poverty Reduction and Growth Facility (PRGF).

I compare two types of aid programs: concessional loans and grants, two programs that have attracted policy attention in recent years but have not yet been fully discussed in academic papers[1]. This paper formulates Cohen and Sachs's (1986) sovereign debt model as a dynamic contracting model and numerically demonstrates how aid can create perverse incentives against growth–this result is in line with Easterly (2002), who emphasizes the incentive aspects of aid programs.

There are two types of agents in the model: a benevolent donor who is assumed to care purely about the welfare of LICs and an LIC recipient who maximizes the welfare of its households. Some researchers argue that the focus should be on "bad" governments who care about their own welfare, rather than that of households. An important point of the paper, however, is that even with a benevolent government, aid-dependency problems may occur; depending on the form of aid, this provides a caveat to an influential view that aid works in good policy environments (Burnside and Dollar [2000]).

Aid programs in this paper are as follows. The donor has full access to the world financial markets but the recipient country has no access. Under concessional lending, the donor lends at a fixed subsidized interest rate if the recipient country lies below or at the cutoff. Above the cutoff, the donor lends at the world interest rate. The donor can

commit itself to the contracts but the recipient country cannot. The donor thus imposes a participation constraint to prevent the country from default. The recipient country maximizes the representative agent's welfare subject to this lending rule. On the other hand, under a grant program, the benevolent donor designs the sequence of gifts that maximizes the country's welfare, imposing a similar eligibility criterion and keeping the same budget across different programs.

The key result of the paper is that concessional lending is better than its grant counterpart, provided that the perverse effects of concessional loans -over-borrowing and overspending due to the subsidized interest rate and the existence of a cutoff –are sufficiently small. Otherwise, the country becomes permanently aid-dependent and remains at the cutoff. The size of these perverse effects depends on the country's initial conditions. This gives a possible explanation of how debt overhang (i.e., the relationship between debt burden and stagnation) is *generated* in aid recipient countries. In existing debt-overhang models[2], no explanation is provided as to why the debtor country has excess debt in the first place.

The structure of the paper is as follows. Section I documents empirical motivation. Section II analyzes each aid program and section III evaluates welfare implications. Section IV concludes.

I Empirical Motivation

I begin motivating my work through empirical documentation that shows that growth rates tend to stagnate around the cutoff between low and lower-middle income countries. I run standard growth regressions using an unbalanced panel of 91 countries, of which 29 countries are low-income countries. The data are taken from Summers-Heston data set (version 6.1) and the World Bank's World Development Indicators. I consider the periods between 1980-2000, excluding the 1970s when many LICs had accumulated significant amount of *non*-concessional debts. The dependent variable is the growth rate of Gross

National Income (GNI)[3] per capita. The explanatory variables are those typically included in a standard growth regression (see Levine and Renelt, 1992): the average annual rate of population growth (GPO), the investment share of real GDP per capita (INV), the initial secondary schooling attained[4] in the total population (SEC80), and the initial level of real GDP per capita in 1980 (RGDP80)[5]. In addition to these variables, I include the variable of interest, a measure of proximity to the cutoff (GNI per capita below which the country is categorized as a LIC) in the form of a Bartlett kernel:

$$\text{PROX}_{it}=\begin{cases} 1-|z_{it}| & \text{for } |z_{it}| \leqq 1 \\ 0 & \text{for } |z_{it}| > 1 \end{cases} \qquad \text{where } z_{it}=\frac{\ln y_{it}-\ln \overline{y}_t}{\ln(1+b)}$$

where y_{it} is country i's GNI per capita in year t, $\overline{y}_t$ is the cutoff in year t, and b is a scaling factor which controls the bandwidth of the kernel.

Table 1 reports the case where $b = 1/2$. It shows that the OLS coefficient for PROX is negative and statistically significant at the 1-percent level. When I consider country specific fixed effects[6], the corresponding level of significance decreases to the 10-percent level, but I believe that this value is satisfactory for fixed effect estimation. I obtain similar results in the cases where $b = 1/3$ and $b = 1/4$. This empirical evidence is consistent with the paper's theoretical result–the existence of a cutoff may result in economic stagnation at or around it.

II The Model

In order to analytically compare concessional loans with grants, I introduce another scheme that generalizes them–transfers. Transfers are a sequence of lump-sump payments that can be positive or negative. I treat the optimal transfer scheme as a theoretical benchmark. Grants, non-negative lump-sump payments, are a special case of transfers. Concessional loans in this paper only offer two fixed levels of interest rates–a subsidized one and the

world interest rate–and there is always a sequence of transfers that duplicates any given concessional lending but not vice versa.

Participation constraints are imposed in transfer and concessional lending problems in order to motivate the LIC to adhere to the contracts[7]. With the constraint, the value function under the aid scheme is always greater than or equal to the value function under a violation of the aid scheme. I do not consider grant schemes with participation constraints because a country has no incentive to violate grant contracts since there are no repayment obligations.

I solve the transfer and grant problems given the donor's budget, α. The value of α is determined by solving the concessional lending problem. In this way, I can preserve the donor's budget across different schemes.

The country is assumed to have no access to foreign private financing because in practice the majority of loans to LICs are offered by official lenders. In section III, I will briefly discuss cases where the recipient country has full access to world financial markets.

A Transfers: the Constrained Optimum

Consider an LIC recipient which receives a positive or negative transfer in each period with the net present value of transfers from the donor to recipient defined as $\overline{T}$. $\overline{T}$ is equal to the donor's budget (α) minus the initial liability that the recipient owes to the donor (L). I first solve the optimal sequence of transfers in the absence of an eligibility criterion that transfers cannot be positive above a certain level of income (i.e., a cutoff, $\overline{y}$). I then show that the solution also holds with the criterion. The benevolent donor who has full access to the world financial markets chooses the optimal paths of consumption and capital. The donor's problem is formally given by:

$$\max_{\{c_t,k_{t+1}\}_{t=1}^{\infty}} \sum_{t=1}^{\infty} \beta^{t-1} u(c_t) \tag{1}$$

subject to:

$$
\begin{aligned}
v^A(k_t) &\leq u(c_t) + \beta \sum_{j=1}^{\infty} \beta^{j-1} u(c_{t+j}),\ \forall t && (2)\\
\overline{T} &\geq \sum_{t=1}^{\infty} \left(\frac{1}{1+r}\right)^{t-1} \tau_t && (3)\\
\tau_t &= c_t + x_t - f(k_t) && (4)\\
k_{t+1} &= (1-\delta)k_t + x_t && (5)\\
& \quad k_1 \text{ and } \overline{T} \text{ are given} && (6)
\end{aligned}
$$

where τ, c, x, and k denote transfers, consumption, investment, and capital respectively. β is the rate of time preference and r is the world interest rate[8]. The LIC's flow budget constraint is given by (4). The production function is given by $y_t = f(k_t)$. The transition equation for capital is given as (5), where δ is the rate of capital depreciation. The value function under default, $v^A(.)$, is the value function in autarchy with penalties for violating the participation constraint:

$$v^A(k) = \max_{k'} \left\{ u((1-\lambda)f(k) - k' + (1-\delta)k) + \beta v^A(k') \right\} \tag{7}$$

where λ is the fraction of output lost. I assume that such a violation incurs two types of costs: the exclusion of the violator from future aid and the loss of a fraction of the violator's output[9]. I also assume that when the participation constraint is binding, the LIC adheres to the aid contract.

In order to solve this sequential problem, i.e. eq. (1) subject to eqs. (2) - (6), I write the problem recursively. Define T_t as the NPV of transfers from the donor to the recipient, denoted in period t value:

$$T_t = \sum_{s=t}^{\infty} \left(\frac{1}{1+r}\right)^{s-t} \tau_s \tag{8}$$

where the difference between T_t and $\frac{T_{t+1}}{1+r}$ is equal to the transfer in period t, or equivalently the excess demand in period t :

$$\tau_t = T_t - \frac{T_{t+1}}{1+r} = c_t + x_t - f(k_t) \tag{9}$$

The recursive formulation is given by:

$$v(k,T) = \max_{c,x} u(c) + \beta v(k',T') \tag{10}$$

subject to:

$$\begin{aligned}
v(k',T') &\geq v^A(k') && (11)\\
k' &= (1-\delta)k + x && (12)\\
T' &= (1+r)[T + f(k) - c - x] && (13)\\
T' &\geq -B \qquad B \text{ is finite} && (14)\\
T_1 &\leq \overline{T} && (15)\\
& k_1 \text{ and } T_1 \text{ are given} && (16)
\end{aligned}$$

where (11) is the participation constraint, and (12) and (13) are transition equations for k and T, respectively. $-B$ is the lower bound for T'. If B is large enough (so that $-B$ is a large negative number), then the optimal solution will never violate (14) and Ponzi games can be excluded.

Since one cannot solve this problem analytically unless the participation constraint is absent, I solve it numerically using the value function iteration method. I specify the functional forms of the utility and production functions as $u(c) = c^{1-1/\sigma}/(1-1/\sigma)$ and $f(k) = Ak^{\eta}$. I set $\eta = 1/3$ and use Ostry and Reinhart's (1992) calibration results for "African" countries for the values of the elasticity of intertemporal substitution ($\sigma = 0.451$) and the discount factor ($\beta = 0.945$). I set the rate of capital depreciation (δ) at 0.1,

the fraction of output lost upon default (λ) at 0.05, and the world interest rate (r) at $1/\beta - 1 \simeq 0.0582$ in order for consumption in the steady state to be flat. Here, regardless of the starting function, I obtain the same fixed point in the functional space.

Consider the benchmark economy with initial income (y_1) equal to 70 percent of steady state output (y_{ss}), and an initial liability-output ratio (L/y_1) of 1. Figure 1 shows the optimal path of transfers. Since initial capital is assumed to be lower than the steady state, the marginal product of capital is initially higher, so a large transfer in period 1 is preferable. When the donor's budget is not very large, the country has to compensate with negative transfers from period 2 onward. Note that this path is still optimal even if I impose an additional rule that transfers are nonpositive above a cutoff, $\overline{y}$.

B Grants

Since grants are a special case of transfers, one may guess that the optimal grant sequence is a single grant of α in period 1 (i.e., $\{\tau_t\}_{t=0}^{\infty} = \{\alpha, 0, 0, 0...\}$). The grant problem is formally given by:

$$\max_{C_t, K_{t+1}} \sum_{t=1}^{\infty} \beta^{t-1} u(C_t)$$

$$\begin{aligned}
\tau_t &= C_t + I_t - f(K_t) - rL && (17)\\
K_{t+1} &= (1-\delta)K_t + I_t && (18)\\
\alpha &\geqq \sum_{t=1}^{\infty} \left(\frac{1}{1+r}\right)^{t-1} \tau_t \text{ (The donor's budget)} && (19)\\
\tau_t &\geq 0 && (20)
\end{aligned}$$

As in the case of transfers, I again solve this problem without a cutoff rule then show that the solution also holds with a cutoff rule (grants must be zero above $\overline{y}$) . I assume that the country makes interest payments of the initial liability (L) to the donor in every period. The

optimal grant sequence can be derived from the Euler equation and flow budget constraint:

$$u'(c_t) = \beta u'(c_{t+1}) \left[f'(k_{t+1}) + 1 - \delta \right], \tag{21}$$

$$c_t = f(k_t) + (1-\delta)k_t - k_{t+1} - rL + \tau_t, \tag{22}$$

$$\tau_t \geq 0. \tag{23}$$

From (21), as long as $k_{t+1} < k_{ss}$, consumption is increasing ($c_t < c_{t+1}$) and marginal utility is decreasing ($u'(c_t) > u'(c_{t+1})$) over time. The country stays below the steady state level in early periods if α is not very large. Below the steady state level, the country can increase its utility by reducing the future grant by one unit and increasing the present grant by the appropriate amount to preserve the total grant amount. This is because the marginal productivity of capital is greater in the present period. This alteration, however, is not possible because future grants are already at their minimum value, zero.

The optimal grant path, a one-time grant of α in period 1, may seem like an unrealistic assumption with respect to donor commitment. It may be more practical to consider a grant scheme that offers a fixed amount ($\overline{g}$) every period as long as the GNI per capita (y) is less than or equal to the cutoff ($\overline{y}$).

$$\tau_t = \begin{cases} \overline{g} & if\ y_t \leq \overline{y} \\ 0 & otherwise \end{cases} \tag{24}$$

I numerically solve this fixed-amount grant problem in a non-recursive way. Here I let the economy converge to the steady state within T periods and solve the path of consumption and capital, i.e., $\{c_1, ..., c_T\}$ and $\{k_2, ..., k_{T+1}\}$, using flow budget constraints (22), and the Euler equations (21), $\forall\ t = 1, 2, ..., T$, the initial level of capital k_1, and the path of grants that follows (24). I find that generally there exists a level of $\overline{g}$ above which the country is trapped at the cutoff. For example, in the benchmark economy, the corresponding level of $\overline{g}$ is about 6.6 percent of the cutoff.

C Concessional Loans

Official creditors typically fix their concessional interest rates; for example, the rates of the World Bank's IDA and of the IMF's PRGF are 0.75 percent[10] and 0.5 percent, respectively. In principle, only LICs are eligible for such concessional loans. I thus consider the following concessional lending rule: the benevolent lender lends at a fixed subsidized interest rate as long as the country's GNI per capita is below a cutoff. The interest rates for concessional lending are set according to the following rule:

$$\widetilde{r}_{t+1} = \begin{cases} \overline{r} & if\ y_t \leq \overline{y} \\ r & otherwise \end{cases} \tag{25}$$

where $\overline{r}$ is the concessional interest rate. The flow budget constraint is given by eq (4) where the transfer in period t has a specific form:

$$\tau_t = (\widetilde{D}_{t+1} - \widetilde{D}_t) - \widetilde{r}_t \widetilde{D}_t \tag{26}$$

where $\widetilde{D}_t$ is concessional debt in period t. In order to preserve the LIC's initial liability to the donor across different schemes, I set $L = (1 + \widetilde{r_1})\widetilde{D}_1$, where $\widetilde{D}_1$ and $\widetilde{r_1}$ are the initial concessional debt and concessional interest rate, respectively. Note that the donor's budget is given by:

$$\alpha \equiv \widetilde{D}_2 + \sum_{t=2}^{\infty} \left(\frac{1}{1+r}\right)^{t-1} \left(\widetilde{D}_{t+1} - (1+\widetilde{r}_t)\widetilde{D}_t\right). \tag{27}$$

The concessional lending problem can be solved recursively. In each period, the borrower country compares the value function under repayment, $v^R(k, \widetilde{D})$, with that under default, $v^A(k)$[11]. When $v^R(k, \widetilde{D}) \geq v^A(k)$ the country repays, otherwise it defaults. The value

function under repayment, $v^R(.,.)$, is given by:

$$v^R(k,\widetilde{D}) = \max_{k',\widetilde{D}'} \left\{ u \left[\begin{array}{c} f(k)-k'+(1-\delta)k \\ +\widetilde{D}'-\widetilde{D}(1+\widetilde{r}) \end{array} \right] + \beta v^R(k',\widetilde{D}') \right\} \quad (28)$$

$$\text{subject to } v^R(k',\widetilde{D}') \geq v^A(k') \quad (29)$$

where $v^R(.,.)$ is increasing in k and is decreasing $\widetilde{D}$. $v^A(.)$, given by (7), is the value function if the recipient country violates the participation constraint.

The participation constraint can be replaced with a debt ceiling function, $h(k)$, which is defined implicitly by $v^R(k,h) = v^A(k)$, where $\partial v^R(k,\widetilde{D})/\partial\widetilde{D}$ is strictly negative. In other words, given k, $h(k)$ is uniquely determined[12]. Thus the debt ceiling function is well-defined. The original value function under repayment can be rewritten as:

$$v^R(k,\widetilde{D}) = \max_{k',\widetilde{D}'} \left\{ u \left[\begin{array}{c} f(k)-k'+(1-\delta)k \\ +\min\{\widetilde{D}',h(k')\}-\widetilde{D}(1+\widetilde{r}) \end{array} \right] + \beta v^R(k',\widetilde{D}') \right\} \quad (30)$$

This formulation with the debt ceiling (30) is the same as Cohen and Sachs's (1986)[13] except that in this paper I numerically derive the value functions and the implied debt ceiling function using the value function iteration method. This paper also extends their model to analyze the dynamics of concessional loans to low-income countries.

Recall that it is not possible to analytically solve this constrained problem, thus I solve it numerically. I keep the same parameter values unless otherwise mentioned. In addition, I set the concessional interest rate ($\overline{r}$) at 1 percent and fix the cutoff level ($\overline{y}$) at 0.7796 of steady state output (y_{ss}). This number (0.7796) is based on two additional assumptions. First, I introduce a TFP difference between the US and LICs. A cursory glance of TFP ratios of forty LICs to the US between 1960 and 2000[14] shows that about 1/4 of LICs have TFP levels that are stable and less than 1/3 of the US level. I thus assume that the TFP ratio of LIC to the US (A/A_{us}) is 1/3. Second, I believe it is reasonable to set $\overline{y}$ as a

percentage of the steady state US output (y_{us}). I set this percentage at 15 percent because in the data[15] the PPP-adjusted real outputs per capita in most of lower-middle income countries[16] are above this level. In this way, this paper's aid schemes can be interpreted as ones that restrict eligibility for concessional loans only to LICs. Given these assumptions and the parameter values (σ, η, β, r and δ), it is easily shown that the steady state output ratio of the LIC to the US is 0.1924. Therefore $\overline{y}$ is 0.7796 of y_{ss}. Given this number, the benchmark economy's initial income, which is assumed to be 70 percent (precisely 70.47 percent) of the steady state output, is 90 percent of the cutoff.

To better understand the dynamics of concessional lending, these results are displayed with those of *non-concessional* lending. The only difference between these two loans is the interest rate level: for all t under non-concessional loans $\widetilde{r}_t = r$. Figure 2 (a)-(d) show the paths of output, consumption, investment, and debt as a fraction of y_{ss} under concessional loans (solid) and under non-concessional loans (dashed). Figure 3 reports endogenous debt ceilings under each lending scheme. It shows that concessional debt ceilings (solid) are much higher than the non-concessional counterparts (dashed). This is because the lower the interest rate, the smaller the debt burden becomes, and thus the higher the level of debt the country can sustain.

I find a striking result: with concessional loans, the country accumulates a significant amount of debt and remains at the cutoff. The country manages its debt by rolling it over at a subsidized interest rate. Here the country is better off by allocating funds to consumption rather than investment. Investment is equal to capital depreciation at the cutoff. This provides a possible explanation of how an aid recipient country accumulates debt with no growth. In other words, the model gives a formal description of how debt overhang may be generated.

Thus under concessional loans, the benchmark country converges to the cutoff, whereas under non-concessional loans it converges to a higher output level. I call the corresponding steady states the "low" and "high" steady states, respectively. There are trade-offs between

these steady states. The realization of the low steady state enables the country to sustain a higher debt level (figure 2 (d)). On the other hand, the benefit of reaching the high steady state is that the country can achieve higher output in the long-run. Figure 2 (a) shows that output in the high steady state is more than 20 percent (in percentages of steady state output) than that in the low steady state.

Once the country is in this low steady state (point L), it is too painful to move to the high steady state (point H) because if the country were to surpass the cutoff, it would have to significantly reduce its debt level in order to retain debt sustainability. Note that there is a sudden fall in the concessional debt ceiling when a country hits the cutoff. This is because when the capital level exceeds the cutoff, the country faces the world interest rate. Here, the only way to reduce its debt is to cut consumption (at least by 10 percent of y_{ss}) in order not to default. Also, the country cannot reduce investment because in order to accumulate capital it must increase investment. (Note: the steady state investment is equal to capital depreciation.)

Whether or not the country becomes permanently aid-dependent under concessional loans depends on the country's initial conditions: initial capital and debt. The intuition is as follows. First, the lower the country's initial capital, the larger the impact of short-run growth. Thus, the country tries to borrow a larger quantity of concessional loans in the short-run and is likely to be trapped in the low steady state. Second, the higher the initial debt level, the more likely the country is to converge to the low steady state, because this allows the country to manage heavier debt with a low interest rate. In short, the country chooses to converge to the high steady state only if initial income is high enough, initial debt is low enough, or both conditions hold.

Figure 4 shows the combinations of initial income and debt that can achieve the high and low steady states, the areas above and below the line, respectively. There are two interesting points. First, debt cancellation may solve a debt overhang problem. Suppose that the benchmark economy's initial debt level is now lower and the initial debt-output

ratio is 0.2, ceteris paribus (call this the "lower debt" case). In this case with lower debt, the country lies below the line so that the country converges to the high steady state. Second, even if a country initially lies above the cutoff, it may have an incentive to go back to the cutoff. Consider a situation where the country's initial output level is already above the cutoff with relatively high initial liability (for example, the initial output is 105 percent of the cutoff with $L/y_1 = 1$). In this case, the country lies above the line, where the benefit of raising the debt ceiling by reducing capital is greater than the cost of lowering output. The country is thus better-off *reducing* output by one unit until it eventually falls to the cutoff.

III Welfare Evaluation

I now evaluate the welfare cost of each scheme by calculating the constant level of consumption that acheves the maximized lifetime utility under each scheme. Table 2 reports the corresponding consumption levels under concessional loans, non-concessional loans, the optimal grant program, and the fixed grant program (see (18)) as a percentage of that under transfers (the constrained optimum). I report the three different cases discussed earlier: the benchmark case, a lower initial debt case, and a case where the country is initially above the cutoff but with heavy debt. The table shows that when the country has relatively better initial conditions, i.e., the lower debt case, loans may achieve more efficient allocations than grants. On the other hand, if the country has relatively poor initial conditions and has an incentive for debt overhang, the donor's cost (i.e., α) is large under concessional loans.

So far I have considered the environment where the recipient country has no access to world financial markets. Suppose now the country has full access to foreign private financing at the world interest rate. Then grants achieve more efficient allocations than loans because one can always find a combination of grants and private loans that realizes

the same allocation as any given path of transfers. On the other hand, access to foreign private financing does not change the allocation under concessional loans. This is because the country has no incentive to borrow from foreign private lenders at the world interest rate as long as it is eligible for subsidized loans.

To summarize this section, whether or not concessional lending is better than its grant counterpart depends on initial conditions and the degree of access to financial markets.

IV Conclusion

Motivated by the political interest in the choice of aid schemes and my empirical finding that growth rates tend to stagnate around the cutoff, I have presented a theoretical framework to analyze the effectiveness of concessional loans versus grants.

The model has shown that this stagnation is due to the existence of a cutoff. In particular, concessional lending drives the recipient countries to permanently remain at the cutoff, depending on the country's initial conditions. The cost to the donor is large when the country is stuck at the cutoff. With regards to the optimal grant sequence (i.e., a one-time gift in period 1), I find that even if I impose a cutoff rule (i.e., grants must be zero above the cutoff), a dependency on aid does not result. However in reality, it may be difficult for the donor to commit itself to such a grant sequence. Thus I have also analyzed a fixed-amount (more practical) grant scheme; this non-optimal scheme may cause a poverty trap.

Since official lenders make up the majority of lenders to LICs, I have mainly considered environments where the recipient countries have no access to foreign private financing. In these environments, concessional lending is better than grants when the perverse effects of concessional loans are sufficiently small.

Finally, I present a few recommendations to the donors who make contributions to LICs which have little access to foreign private financing. If the LIC in question has good

policy performance with relatively better initial conditions, concessional loans may be more effective than grants simply because loans can provide more funds than grants. However if the LIC has relatively poor initial conditions, grants may be more effective than loans. If the optimal grant scheme is not a practical option, it may be effective to tie grants to projects that can directly raise TFP. This can improve output capacities in these countries so that eventually they find it too costly to remain at the cutoff and become independent from aid assistance.

Notes

[1]For a summary of existing studies, see Clements, Gupta, Pivovarsky, and Tiongson (2004) and Daseking and Joshi (2005). Also, Bulow and Rogoff (2005) highlight drawbacks of multilateral loans in the case of middle-income countries.

[2]Sachs (1989) and Krugman (1988) represent early work on debt overhang problems.

[3]GNI is commonly denoted as GNP. GNI is the new terminology under the 1993 System of National Accounts (SNA), replacing the old terminology–GNP–under the 1968 SNA. Note that GNIt is the growth rate from year t to $t+1$.

[4]Similar results are obtained when the completion rate of secondary schooling is used instead of the attainment rate.

[5]Summers-Heston data do not provide information on investment share of GNI or real GNI per capita. Here data based on GDP are used instead.

[6]I carry out fixed effect estimation because there may exist unobserved country specific effects which are not caputured by the initial conditions (SEC and RGDP) in the OLS estimation.

[7]The cases with no participation constraint are discussed in appendix A.

[8]$r \equiv 1/\beta - 1$ is assumed in order to have flat consumption in the steady state.

[9]In order to impose a participation constraint, there must be some cost to default. Rose (2005) finds that debt renegotiation is associated with an economically and statistically significant decline in bilateral trade between a debtor and creditors.

[10]More precisely, this is the service charge that the World Bank currently imposes on the credits.

[11]The superscript A stands for autarchy with penalties for violating the contract imposed.

[12]Thus I can exclude the case where $h(K)$ is backward bending in K.

[13]An extension of Sachs & Cohen (1986) can be seen in Borensztein and Ghosh (1989).

[14]I calculate TFP levels by using $y = Ak^{\eta}$ (where $\eta = 1/3$); data on capital (k) are obtained from extended Penn World Tables by Adalmir Marquetti; the data are downloadable at http://homepage.newschool.edu/~foleyd/epwt/

[15]The data are take from the same source as in the previous footnote.

[16]The World Bank's definition of lower-middle income countries are those countries that have GNI per capita equal to $766 - $3,035 in 2003, calculated using the World Bank Atlas method.

Table 1: Growth Regressions 1980-2000 (b=1/2)

Estimation method	OLS	Fixed Effects
PROX	-3.33***	-2.79*
	(1.21)	(1.63)
GPO	-0.62***	0.26
	(0.22)	(0.29)
INV	0.16***	0.01
	(0.04)	(0.07)
SEC80	0.02	—
	(0.02)	—
RGDP80	-5.95e-05	—
	(-7.3e-05)	—

* significantly different from 0 at the 10-percent level

*** significantly different from 0 at the 1-percent level

Note: standard errors are in parenthesis

Table 2: Welfare Evaluation

Cases	α/y_{ss}	concessional	non-concessional	optimal grant	fixed grant
benchmark	93.59	94.22*	89.88	99.78	93.54*
lower debt	3.87	100	99.60	97.18	97.16
above the cutoff	80.88	94.14*	92.62	99.97	93.69*

* Cases where the LIC permanently remains at the cutoff

Note 1: α is the donor's budget and y_{ss} is the long-run output level

Note 2: The corresponding $\overline{g}$ in the fixed grant case is determined by $\overline{g} = \alpha r/(1+r)$

Figure 1: The Optimal Path of Transfers (in fractions of y_{ss})

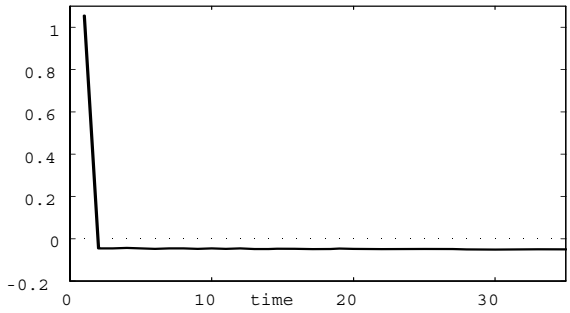
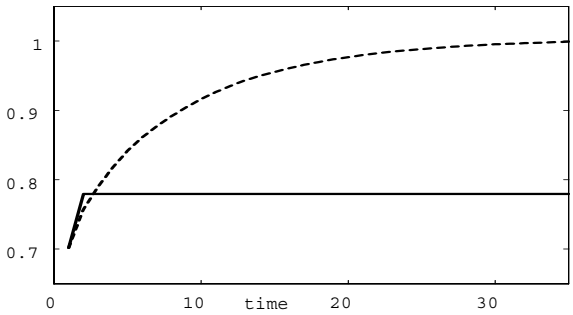
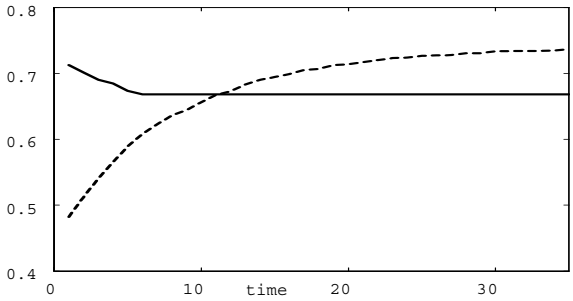


Figure 2: The Benchmark Economy

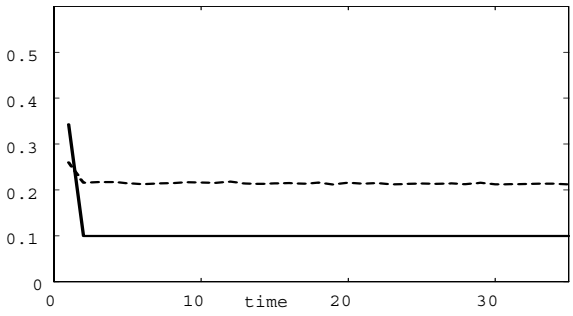
(a) output (in fraction of y_{ss})



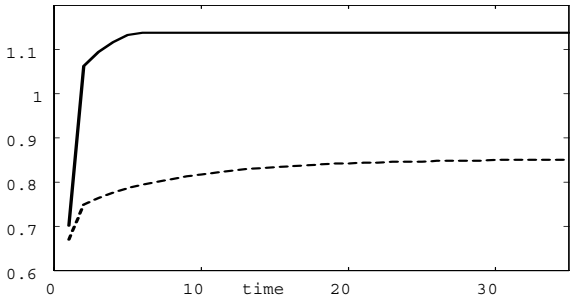
(b) consumption (in fraction of y_{ss})



(c) investment (in fraction of y_{ss})

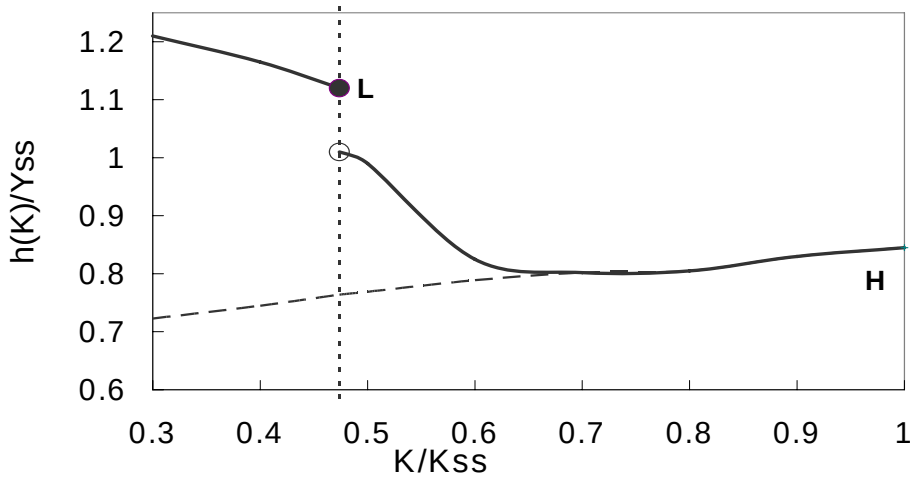


(d) debt (in fraction of y_{ss})



concessional loans (solid) and non-concessional loans (dashed)

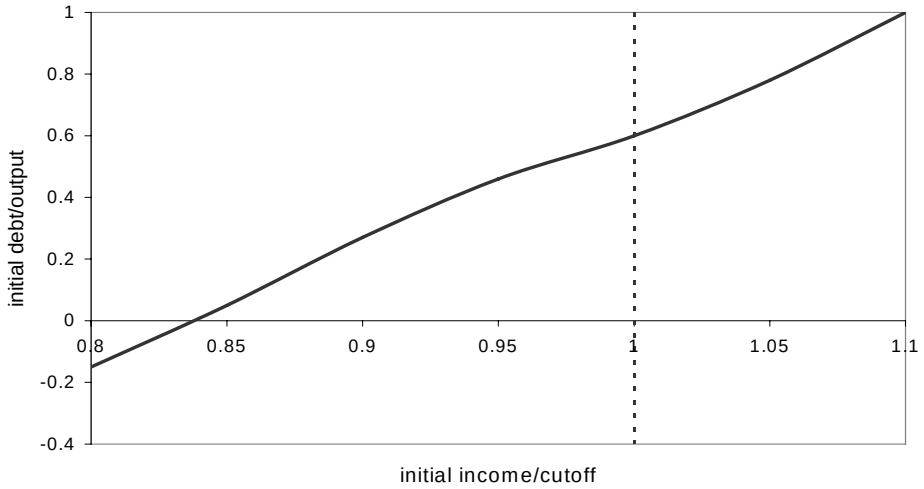
Figure 3: Debt Ceilings (the benchmark case)



concessional (solid) and non-concessional (dashed)

Note: the vertical dotted line is the cutoff

Figure 4: The Initial Conditions and Aid Dependency



A No Participation Constraints

This appendix considers the environment in which the LIC fully precommits itself to honoring the conditions of the aid scheme that is imposed by the benevolent donor so that there is no need to impose a participation constraint. In practice though, this is an unrealistic assumption because it allows the LIC to have unlimited access to the donor's funds. Analyzing this non-participation constraint environment, however, is still useful as a means of comparing concessional loans with transfers.

Under transfers, the country achieves the first best allocation–an instant jump to the steady state–because the marginal product of capital is initially greater than the steady state level. The problem is given by:

$$\max_{C_t, K_{t+1}} \sum_{t=1}^{\infty} \beta^{t-1} u(C_t)$$

subject to the flow budget constraint and the donor's budget:

$$C_t = f(K_t) + (1-\delta)K_t - K_{t+1} + \tau_t \tag{A-1}$$

$$\overline{T} \geqq \sum_{t=1}^{\infty} \left(\frac{1}{1+r}\right)^{t-1} \tau_t \tag{A-2}$$

where K_1 is given. The FOCs are given by:

$$C_t : u'(C_t) = \mu \tag{A-3}$$

$$K_{t+1} : r = f'(K_{t+1}) - \delta \tag{A-4}$$

Eq. (A-3) implies that consumption is constant over time. Eq. (A-4) indicates that capital is constant from period 2 onward. In other words, the country receives a very large transfer and jumps to the steady state in period 1. If α is not sufficiently large (a realistic assumption given limitations on a donor's budget), then negative transfers in subsequent periods must

compensate for the transfer in period 1. The optimal path of transfers is thus a one-time transfer followed by constant negative transfers (i.e. $\{\tau_1^*, \tau_{ss}, \tau_{ss}, ...\}$ where τ_1^* is positive and τ_{ss} is negative). This is *the first best allocation*. Note that this path is still optimal even if I impose an additional rule that transfers cannot be positive above a certain level of income (i.e. a cutoff, $\overline{y}$). τ_1^* and τ_{ss} can be pinned down by combining the flow budget constraints in the first two periods (eq (A-5)) and the donor's budget equation (eq (A-6)):

$$f(K_{ss}) - \delta K_{ss} + \tau_{ss} = f(K_1) + (1-\delta)K_1 - K_{ss} + \tau_1^* \quad \text{(A-5)}$$

$$\tau_1^* + \frac{\tau_{ss}}{r} = \overline{T}, \quad \tau_1^* > 0, \ \tau_{ss} < 0 \quad \text{(A-6)}$$

Under concessional lending, capital overshoots in period 1 due to the existence of subsidized interest rate. The problem is given by:

$$\max_{C_t, K_{t+1}} \sum_{t=1}^{\infty} \beta^{t-1} u(C_t)$$

subject to the intertemporal budget constraint:

$$\begin{aligned} & f(K_1) + (1-\delta)K_1 + \sum_{t=2}^{\infty} \left(\prod_{s=2}^{t} \left(\frac{1}{1+\widetilde{r}_s} \right) (f(K_t) + (1-\delta)K_t) \right) \\ = \ & (1+\widetilde{r}_1)\widetilde{D}_1 + C_1 + K_2 + \sum_{t=2}^{\infty} \left(\prod_{s=2}^{t} \left(\frac{1}{1+\widetilde{r}_s} \right) (C_t + K_{t+1}) \right) \end{aligned}$$

where $K_1, \widetilde{D}_1$, and $\widetilde{r}_1$ are given. FOCs are given by:

$$u'(C_t) = \mu, \quad for \ \ t = 1 \quad \text{(A-7)}$$

$$\beta^{t-1} u'(C_t) = \mu \prod_{s=2}^{t} \left(\frac{1}{1+\widetilde{r}_s} \right), \quad for \ t \geq 2 \quad \text{(A-8)}$$

$$\widetilde{r}_{t+1} = f'(K_{t+1}) - \delta, \quad for \ t \geq 1 \quad \text{(A-9)}$$

Initially, the country can borrow at the concessional interest rate (i.e. $\widetilde{r}_2 = \overline{r}$) because I

assume that initial output lies below the cutoff. At any level of capital above the cutoff, the country can borrow only at the world interest rate. The capital levels in period 2 and in the steady state, K_2 and K_{ss}, are pinned down by $\overline{r} = f'(K_2) - \delta$ and $r = f'(K_{ss}) - \delta$ (by (A-9)). These equations imply that K_2 is greater than K_{ss} because the concessional interest rate is lower than the world interest rate ($\overline{r} < r$). Thus capital overshoots steady state in period 1. However, from period 3 onwards, capital is at its steady state level (i.e. $K_j = K_{ss}$ for $j \geq 3$) because as of period 2, the country no longer has access to concessional loans. Its capital level exceeds the cutoff ($K_2 > \theta K_{ss}$) and the capital level is K_{ss}(from (A-9)). Consumption, too, overshoots in period 1 ($C_1 > C_2 = C_{ss}$). This is implied by the following Euler equations: $u'(C_1) = \beta(1 + \overline{r})u'(C_2)$ and $u'(C_2) = \beta(1 + r)u'(C_3)$ because $\beta(1+\overline{r}) < 1$, $\beta(1+r) = 1$, and $u'(C)$ is decreasing in C. Once $\{K_2, K_{ss}\}$ and $\{C_1, C_{ss}\}$ are pinned down, the path of debt, $\{\widetilde{D}_2, \widetilde{D}_{ss}\}$, can be derived via the budget constraint. The dynamics of concessional loans without a participation constraint are thus characterized by the overshootings of capital and consumption in period 1 due to the low concessional interest rate. The donor's budget, α, is determined by:

$$\alpha \equiv \frac{\widetilde{D}_2(r - \overline{r})}{1 + r} \tag{A-10}$$

B Data Appendix

Variables	Definition and source	Source
GNI	GNI per capita in current US$, Atlas methodology	World Development Indicators
$\overline{y}$	IDA eligibility in terms of GNI per capita in US$, Atlas methodology	World Bank GNI/capita operational guidelines
GPO	Percentage of population growth (in percentage per annual)	Constructed from population (POP) in Summers-Heston data, version 6.1
INV	Investment share of Real GDP per capita (in percentage per annual)	Summers-Heston data set, version 6.1
RGDP80	Real GDP per capita in 1980, Constant Prices: Laspeyres (in percentage)	Summers-Heston data set, version 6.1
SEC80	Percentage of secondary schooling attained in the total population in 1980	Barro-Lee data set

Country Coveage of the Data Set

low-income	lower-middle income	upper-middle income	high-income
Bangladesh	Algeria	Argentina	Australia
Benin	Bolivia	Barbados	Austria
Cameroon	Brazil	Botswana	Belgium
Central African Republic	Colombia	Chile	Canada
Congo, Dem. Rep.	Dominican Republic	Costa Rica	Cyprus
Congo, Republic of	Ecuador	Dominica	Denmark
Gambia, The	El Salvador	Hungary	Finland
Ghana	Fiji	Malaysia	France
Guinea-Bissau	Guatemala	Mexico	Germany
Haiti	Guyana	Panama	Greece
India	Honduras	St.Vincent & Grenadines	Hong Kong
Kenya	Indonesia	Trinidad &Tobago	Iceland
Lesotho	Iran	Uruguay	Ireland
Malawi	Jamaica	Venezuela	Israel
Mali	Jordan		Italy
Nepal	Paraguay		Japan
Nicaragua	Peru		Korea, Republic of
Niger	Philippines		Netherlands
Pakistan	South Africa		New Zealand
Papua New Guinea	Sri Lanka		Norway
Rwanda	Syria		Portugal
Senegal	Thailand		Singapore
Sierra Leone	Tunisia		Spain
Togo	Turkey		Sweden
Zambia			Switzerland
Zimbabwe			United Kingdom
			United States

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