RIETI Discussion Paper Series 07-E-051

Foreign Aid and Recurrent Cost: Donor Competition, Aid Proliferation and Budget Support

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Foreign Aid and Recurrent Cost: Donor Competition, Aid Proliferation and Budget Support*

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August, 2007

Abstract

Recent empirical studies reveal that effectiveness of aid on growth is ambiguous. This paper considers aid proliferation - excess aid investment relative to recurrent cost - as a potential cause that undermines aid effectiveness, because aid projects can only produce sustainable benefits when sufficient recurrent costs are disbursed. We consider the donor's budget support as a device to supplement the shortage of the recipient's recurrent cost and to alleviate the misallocation of inputs. However, when donors have self-interested preferences over the success of their own projects to those conducted by others, they provide insufficient budget support relative to aid which results in aid proliferation. Moreover, aid proliferation is shown to be worsened by the presence of more donors.

Keywords foreign aid, aid proliferation, budget support, donor competition, common-pool-resource

JEL Classification F35, O19

*This research is part of the project "Economics of Foreign Aid" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). The authors would like to thank RIETI for generous financial support to the project. The authors are grateful to Yasuyuki Sawada and Motoki Takahashi and other members of the project for useful comments and suggestions. The opinions expressed and arguments employed in this paper are the sole responsibility of the authors and do not necessarily reflect those of RIETI or the Ministry of Economy, Trade and Industry of Japan.

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1 Introduction

There is a growing debate on whether aid is effective for development and growth (World Bank, 1998; Bourguignon and Sundberg, 2007). Numerous empirical studies using cross-country panel data has been conducted but aid effectiveness is found to be fragile (Roodman, 2007; Rajan and Subramanian, 2005). Why is aid not so effective as expected? A well-known but recently criticized thesis is that lack of good policy undermines aid effectiveness. World Bank (1998) and Burnside and Dollar (2000) argues that aid promotes growth only when it is associated with good policy. However, their empirical evidence based on cross-country growth regression analysis has been found to be fragile (Easterly et al., 2004; Roodman, 2007).

An alternative possible cause of aid ineffectiveness is aid proliferation, fragmentation, and bombardment[1], that is, too many donors and aid projects relative to recipient's absorption capacity (Morss, 1984; World Bank, 2001). There are several channels in which aid proliferation can harm aid effectiveness. Recent studies indicate that aid proliferation increases transaction costs and depreciate the real amount of aid (Acharya et al., 2006). Aid proliferation can also induce a version of "tragedy of the commons": donors compete and scramble for a common-pool-resource of "complementary domestic resources (Cassen, 1994, p.176)" such as recurrent cost, or foreign exchange (Bräutigam, 2000; Bräutigam and Knack, 2004; Svensson, 2005; Knack and Rahman, 2007). Kimura et al. (2007) includes donor-concentration index as an explanatory variable in the cross-country aid-growth regression and finds that aid proliferation involves a negative effect on on economic growth.

Local recurrent costs are important for aid effectiveness since it is essential for sustaining aid projects and producing effects in the long run (Heller, 1974, 1979; Agbonyitor, 1998). According to Hood et al. (2002), the ratios of annual recurrent expenditure to investment expenditure of World Bank projects ranges from 0.003 to 0.074 depending on the sector, with an average of 0.03. However, recipient countries often fail to cover such costs and the consequence is: "roads and public utilities are in disrepair, schools are without teachers or supplies, and vehicles for health and agricultural extension are without spare parts or fuel" (van de Walle and Johnston, 1996, p.62). While the percentage of World Bank's projects that has been rated "likely" or better to be resilient to future risk is improving[2], still 36.2% of the projects implemented in Africa are assessed to be unlikely to sustain its benefit in the future, partly due to lack of local funds (World Bank, 2006). The reasons for the failure to cover recurrent cost is lack of recipient government's ability to monitor and control budget as well as that the required recurrent costs is too significant relative to government budgets (Hyden, 1983; van de Walle and Johnston, 1996), which could be caused by uncoordinated competition of increased claimants over limited budget (Campos

[1]World Bank (2001) describes that *aid bombardment* syndrome is "apparent in countries where the sheer volume of resources and numbers of donors, activities, and complex and inconsistent procedural requirements overwhelm the government's capacity to plan, budget, manage, monitor, and evaluate." (World Bank, 2001, p.15).

[2]The percentage of projects that has been rated "likely" or better to be resilient to future risk improved from 55.8% in exit fiscal year 1990-2000 to 76.7% in 2001-2005 (World Bank, 2006, pp.56–57).

and Pradhan, 1996; Wuyts, 1996).

The purpose of this paper is to analyze the implications of aid proliferation on aid effectiveness by focusing on recurrent costs. We consider aid proliferation as a situation in which there is excess aid relative to recurrent cost and ask the following questions: Why does aid proliferation occur? How can we resolve aid proliferation? To link the issue of aid proliferation on recurrent cost with the debate on aid effectiveness, we consider an aid-growth production function where output (development or growth) is produced by aid investment and recurrent cost. The potential inefficiency and ineffectiveness of aid on growth is caused by misallocation of the inputs; aid might have been ineffective because recurrent cost was not disbursed enough.

We show that aid proliferation occurs primary because the allocation of aid investment and recurrent cost is uncoordinated. Since the amount of aid and recurrent cost is decided by the donors and the recipient separately, and the opportunity costs are different among the parties, efficient combination of the two inputs can only be achieved by chance. Thus there is a need for a mechanism to coordinate the amount and allocation of aid and recurrent cost. We consider programme aid or budget support as such mechanism, where part of aid is allowed to be used for recurrent expenditure. We show that budget support can alleviate misallocation of inputs when the donors are not self-biased so that each donor evaluates the output from other donors and the recipient equally to her own project. However, when the donors are self-biased, even a budget support can not fully resolve the misallocation of inputs and in fact ends up with aid proliferation because budget support is underprovided. We also show that aid proliferation is exaggerated with more self-biased donors, implying that donor competition makes the problem worse.

The problem of common-pool-resources in the context of foreign aid as a donor competition over "complementary domestic resources" has been pioneered formally by Knack and Rahman (2007), which analyzes the situation in which donors compete and poaches local experts to their own aid projects and thus lowers bureaucratic quality of the recipient government. Roodman (2006) takes into account for both size and number of aid projects and shows that selfish donors who care most about the success of their own projects may have an incentive to proliferate aid projects. Since we also consider the common-pool-resource characteristics of the recipient's recurrent cost, the essential nature of our model is the same as these studies. The distinctive feature of ours is the focus on the implication of budget support in which a donor can supplement the shortage of the recipient's resources.

The remainder of the paper is organized as follows: The next section presents the basic setup of the model and discuss why optimal combination of aid and recurrent cost is not achieved in general. Section 2 deals with budget support that supplements recurrent cost and explains why such support may cause aid proliferation. Section 4 concludes.

2 The tragedy of the recurrent cost

2.1 Model

Consider N donors conducting an aid project in the recipient's country. We consider donor i's aid project production function $y_i = f^i(a_i, x_i)$ where a_i is the amount of donor i's aid and x_i is the amount of recurrent cost funded by the recipient to donor i's aid project. For example, in the case of a school project, y_i would be educational attainment, a_i is the amount of investment to schools funded by donor i's aid and x_i is the teacher's salary paid from the recipient's recurrent budget. For the educational attainment to be improved, only schools without (motivated) teachers will do little, while good teachers without school facilities would also undermine the potential efficiency of education. We also assume that $f_{ax} > 0$, that is, aid investment and recurrent cost are complementary. In order to ensure that the second order conditions of the maximization problems are satisfied, we assume that $f_{aa} > 0$, $f_{xx} > 0$ and $f_{aa}f_{xx} - (f_{ax})^2 > 0$.

The recipient allocates its recurrent budget among aid projects and its own domestic projects in order to maximize its payoff $\sum_{i=1}^{N} f^i(a_i, x_i) + g(K, X - \sum_i^N x_i)$, where g represents a production function of the recipient's own projects, K denotes the predetermined capital level of the projects and X is the total recurrent budget size. One important assumption is that the donors cannot force the recipient to pay a certain amount of recurrent costs to their own project, thus they have to take into account the recipient's best response in determining the amounts of aid.

Donors are altruistic in the sense that they enjoy utility from the development of the recipient. However, a donor may be biased and cares only for the output from its own aid project $f^i(a_i, x_i)$, or may be unbiased and equally benefit from the output from all projects, $\sum_{j=1}^{N} f^j(a_j, x_j) + g(K, X - \sum_j^N x_j)$. By using $\lambda_i \in [0, 1]$ as a parameter of donor i self-biasedness, we can write donor i's payoff as

$$f^i(a_i, x_i) + \lambda_i \left[\sum_{j \neq i}^{N} f^j(a_j, x_j) + g(K, X - \sum_{j}^{N} x_j) \right] - c_i(a_i).$$

where $c_i(a_i)$ is a convex aid cost function.

If all the donors and the recipient cooperate with each other to pool all the resources and maximize the total surplus of the projects, they will choose $(a_1, \ldots, a_N, x_1, \ldots, x_N)$ to maximize $\sum_{i=1}^{N} f^i(a_i, x_i) + g(K, X - \sum_i^N x_i) - \sum_{i=1}^{N} c_i(a_i)$. Thus the optimal outcomes are described by

$$f_a^i = f_a^j = f_x^i = f_x^j = g_x = c_i' = c_j' \quad \text{for all } i \neq j, \tag{1}$$

which means that every project has the same marginal productivity equal to the marginal cost of aid. For the purpose of the following discussion, we define two types of efficiency, *technical aid efficiency* and *resource allocative efficiency* as follows:

Definition 1 *Technical aid efficiency is achieved when $f_a^i = c_i'$, that is, the marginal productivity of aid is equal to its marginal cost. Resource allocative efficiency is achieved when*

$f_a^i = f_a^j = f_x^i = f_x^j = g_x$ for all $i \neq j$, that is, allocation of resources among the donors and the recipient is optimal.

We consider the timing of the game as follows:

- $t = 1$: Each donor decides a_i simultaneously.
- $t = 2$: The recipient determines $(x_1, \ldots, x_N)$ after observing $(a_1, \ldots, a_N)$.

For the simplicity, we first consider the case of two donors. Since there is no informational asymmetry, we can solve the problem straightforwardly by backward induction. At $t = 2$, the recipient's maximization problem is

$$\max_{x_1, x_2} \; f^1(a_1, x_1) + f^2(a_2, x_2) + g(K, X - x_1 - x_2)$$

The first order conditions imply

$$f_x^1 = f_x^2 = g_x, \tag{2}$$

that is, the recurrent cost is allocated in order to equate the marginal productivity among the donors' projects and recipient's domestic projects. This condition also means that the amount of the recurrent cost allocated to donor i's project is a function of both a_1 and a_2: $x_i = x_i(a_1, a_2)$.

Then we consider the problem of the donors at $t = 1$. Donor i maximizes its payoff taking into account for $x_i(a_1, a_2)$:

$$\max_{a_i} \; f^i(a_i, x_i(a_1, a_2)) + \lambda_i \left[f^j(a_j, x_j(a_1, a_2)) + g(K, X - x_1(a_1, a_2), x_2(a_1, a_2)) \right] - c_i(a_i).$$

The first order condition and (2) imply that

$$f_a^i + (1 - \lambda_i) f_x^i \frac{\partial x_i}{\partial a_i} - c_i' = 0. \tag{3}$$

By the recipient's first order condition (2), we can also derive

$$\frac{\partial x_i}{\partial a_i} = \frac{-f_{xa}^i}{f_{xx}^i + M_j} > 0, \tag{4}$$

where

$$M_j \equiv \frac{1}{\frac{1}{f_{xx}^j} + \frac{1}{g_{xx}}} = \frac{f_{xx}^j g_{xx}}{f_{xx}^j + g_{xx}} < 0. \tag{5}$$

By combining (3) and (4), donor i's optimal aid investment is determined by

$$f_a^i + (1 - \lambda_i) f_x \frac{-f_{xa}^i}{f_{xx}^i + M_j} - c_i' = 0. \tag{6}$$

The argument above suggests the following proposition.

Proposition 1 *(i) If a donor is self-biased, i.e., $\lambda_i < 1$, then the aid project is technically inefficient, i.e., $f_a^i \neq c_i'$. (ii) In general, resource allocative efficiency, $f_a = f_x^i = f_x^j = g_x$, is not achieved even if the donors are not self-biased, $\lambda_i = 1$ for all i.*

The first part is implied by (6). Since $f_{ax} > 0$, it turns out that $f_a^i < c_i'$, which implies that a donor will overinvest aid relative to its marginal cost if $\lambda_i < 1$. When a donor increases aid, it attracts the recurrent cost since the recipient has incentives to equate the marginal productivity among the projects. An increase of recurrent cost for one donor reduces that for other donors and hence, output of others' projects decrease. When a donor is self-biased, it weighs more on its own project than the negative externality on others. The more self-biased the donor is, the more aid it disburses and the more technically inefficient its project becomes.

The second part says that although we have $f_x^1 = f_x^2 = g_x$, $f_a \neq f_x$ is not guaranteed in general even if the donors are not self-biased. This is because there is no mechanism that optimizes the allocation of total resource $\sum_i^N a_i + X$ between investment and recurrent cost since they are decided independently by the donors and recipient. In general, it is not guaranteed that the donor's opportunity cost of aid is equivalent to the recipient's opportunity cost of recurrent cost. Thus resource allocative inefficiency remains even if the donors are not self-biased. However, when the donors are self-biased, they will tend to disburse more aid. So there is more chance of having excess aid investment relative to recurrent cost, resulting in aid proliferation.

Before proceeding, we note that we can easily extend the two donors model above to the N donors model by changing the definition of M_j to

$$M_{-i} \equiv \frac{1}{\sum_{j\neq i}^N \frac{1}{f_{xx}^j} + \frac{1}{g_{xx}}} < 0. \tag{7}$$

If the aid production functions are identical among the donors, the above equation becomes

$$\tilde{M}_{-i} = \frac{f_{xx} g_{xx}}{f_{xx} + (N-1) g_{xx}} < 0, \tag{8}$$

which approaches zero as N increases. Thus as N increase, $\frac{\partial x_i}{\partial a_i} = \frac{-f_{xa}^i}{f_{xx}^i + \tilde{M}_{-i}} > 0$ gets larger, which leads to greater distortion: the donors further overinvest in the aid, resulting in the further decrease in f_a^i and greater gap between f_a^i and c_i. So an increase in the number of donors leads to further technical aid inefficiency. This is caused by concavity of the production functions f_i. Suppose that donor i increases its aid a_i. This induces the recipient to increase x_i by reducing the recurrent costs allocated to other donors and its own. If there are only two donors, a dollar increase in x_1 requires $1/2$ dollar decreases of recurrent costs for donor j's and the recipient's projects. On the other hand, if there are 20 donors, a dollar increase in x_i can be covered by $1/20$ dollar decreases of the recurrent costs for each project (19 donors' projects and the recipient's project). The concavity of the production functions implies that the $1/20$ dollar decreases in 20 projects reduces total output less than the $1/2$ dollar decreases in two projects. Thus when there are more donors, increasing one unit of recurrent cost for donor i costs less, making $|\frac{\partial x_i}{\partial a_i}|$ and $|\frac{\partial x_i}{\partial b_i}|$ larger.

3 Mitigating aid proliferation with budget support

The argument in the previous section suggests that the efficient combination of the donor's aid investment and the recipient's recurrent cost (i.e., $f_x^i = f_a^i$) generally cannot be achieved. In practice, since the recipient's budget is generally small and unstable, it is feasible to assume and focus on the case of aid proliferation, that is, f_x^i determined by (2) is sufficiently higher than f_a^i determined by (6) (i.e., $f_x^i > f_a^i$), so the recurrent cost is sparce relative to aid investment.

In order to resolve such allocative inefficiency, we now allow the donors to disburse part of the aid as budget support that can be used as a recurrent cost to supplement the recipient's budget[3]. This works as a device to adjust the resource allocation between aid investment and recurrent cost. We consider two schemes of budget support: untied and tied. Untied budget support by donor i is given to the recipients directly and its usage is open to all donors' projects as well as the recipient's project. Conversely, the usage of tied budget support is "tied" and restricted to the projects of the funding donor.

3.1 Untied budget support

Let b_i denote the amount of budget support granted by donor i. Under the untied budget support, the recipient's total budget is $X + \sum_{i=1}^{N} b_i$. Here we explicitly deal with the case of two donors for the simplicity of the notation, but it is first necessary to change the definition of M_j to M_{-i} as in the previous section.

At $t = 2$, the recipient maximizes the following payoff with respect to (x_1, x_2),

$$\max_{x_1,x_2} \; f^1(a_1, x_1) + f^2(a_2, x_2) + g(K, X + b_1 + b_2 - x_1 - x_2).$$

The first order conditions imply

$$f_x^1 = f_x^2 = g_x. \tag{9}$$

From this condition, we can obtain

$$\frac{\partial x_i}{\partial a_i} = \frac{-f_{xa}^i}{f_{xx}^i + M_j} > 0, \quad \text{and} \tag{10}$$

$$\frac{\partial x_i}{\partial b_i} = \frac{M_j}{f_{xx}^i + M_j} > 0. \tag{11}$$

Donor i's problem at $t = 1$ is

$$\max_{a_i,b_i} \; f^i(a_i, x_i(a_i, a_j)) + \lambda_i f^j(a_j, x_j(a_i, a_j)) + \lambda_i g(K, X + b_i + b_j - x_i - x_j) - c_i(a_i + b_i).$$

The first order conditions and (9) imply that

$$f_a^i + (1 - \lambda_i) f_x^i \frac{\partial x_i}{\partial a_i} - c_i' = 0, \quad \text{and} \tag{12}$$

$$\lambda_i f_x^i + (1 - \lambda_i) f_x^i \frac{\partial x_i}{\partial b_i} - c_i' = 0. \tag{13}$$

[3]It is often the case that program aid contains a recurrent cost component (Wuyts, 1996, p.731).

Condition (12) along with equation (10) has a similar form to the case without budget support in the previous section. But this does not mean that the equilibrium levels of the aid in these two cases are identical. This is because $f^i_{ax} > 0$, which implies that the level of recurrent cost affects the marginal productivity of the aid and hence the equilibrium amount of aid. Since the donors can alleviate the recipient's resource constraint by transferring their money into the recipient's budget in the case of budget support, the equilibrium level of the recurrent cost will generally be different from the case without budget support. The equilibrium levels of the budget support and recurrent cost funded by the recipient are characterized by (13) and (9), which we will elaborate more after analyzing the case of tied budget support.

3.2 Tied budget support

The recipient's maximization problem under tied budget support at $t = 2$ is

$$\max_{x_1,x_2} f^1(a_1, x_1 + b_1) + f^2(a_2, x_2 + b_2) + g(K, X - x_1 - x_2)$$

and the first order conditions imply

$$f^1_x = f^2_x = g_x \tag{14}$$

as in the case of the untied budget support. From this condition, we can obtain

$$\frac{\partial x_i}{\partial a_i} = \frac{-f^i_{xa}}{f^i_{xx} + M_j} > 0, \quad \text{and} \tag{15}$$

$$\frac{\partial x_i}{\partial b_i} = \frac{-f^i_{xx}}{f^i_{xx} + M_j} < 0. \tag{16}$$

While the expression of $\frac{\partial x_i}{\partial a_i}$ is the same as in the case of untied budget support, that of $\frac{\partial x_i}{\partial b_i}$ is different and has a negative sign. In the case of untied budget support, the money is transferred to the recipient's budget and then allocated to each project. Thus an increase in b_i expands the total resource available for all the projects as recurrent cost, resulting in increase in both x_i and x_j, $j \neq i$. On the other hand, if a donor provides tied budget support which can be used only for its own project, then the recipient's optimal behavior is to reduce x_i and allocate it to other projects in order to equate the marginal productivity of the recurrent costs among each project. This is why the sign of $\frac{\partial x_i}{\partial b_i}$ in the case of tied budget support is opposite to that in the case of untied budget support.

The donor i's problem at $t = 1$ is

$$\max_{a_i,b_i} f^i(a_i, x_i(a_i, a_j) + b_i) + \lambda_i f^j(a_j, x_j(a_i, a_j) + b_j) + \lambda_i g(K, X - x_i - x_j) - c_i(a_i + b_i),$$

and the first order conditions and (14) imply

$$f^i_a + (1 - \lambda_i) f^i_x \frac{\partial x_i}{\partial a_i} - c'_i = 0, \quad \text{and} \tag{17}$$

$$f^i_x + (1 - \lambda_i) f^i_x \frac{\partial x_i}{\partial b_i} - c'_i = 0. \tag{18}$$

Notice that the donor i's first order conditions with respect to a_i (12) and (17) are identical. The first order conditions with respect to b_i (13) and (18) also turn out to be identical since after substituting $\frac{\partial x_i}{\partial b_i}$ and rearranging, both of (13) and (18) can be written as

$$f_x^i \left(\frac{\lambda_i f_{xx}^i + M_j}{f_{xx}^i + M_j} \right) - c_i' = 0. \tag{19}$$

This establishes the proof of equivalence of untied budget support and tied budget support.

Proposition 2 *Untied budget support and tied budget support generate the equivalent outcomes.*

This result is due to fungibility of the recurrent budget X. Even if the usage of budget support is tied to a particular donor's project, the recipient can adjust the allocation of its own budget X between the recurrent cost of that project and other donors' projects as well as its own project in order to equate the marginal productivity of the recipient's recurrent cost among all projects. Provided the equivalence result between two budget support schemes, we henceforth make our argument based on the case of tied budget support.

The donor's first order conditions (17) and (18) imply that if the donors are not self-biased, $\lambda_i = 1$ for all i, then $f_a^i = f_x^i = g_x = c_i'$ for all i: both the technical efficiency and resource allocative efficiency is achieved. So budget support can potentially resolve aid proliferation and improve its effectiveness.

Proposition 3 *If a donor is not self-biased, then both technical and resource allocative efficiency are achieved with budget support.*

However, if a donor is self-biased, $\lambda_i < 1$, then these efficiencies are not achieved in general. As for technical inefficiency, it is straightforward from the first order condition of (17) that aid is overinvested relative to its marginal cost. On the other hand, comparison between (17) and (18) implies that if $\frac{\partial x_i}{\partial a_i}$ and $\frac{\partial x_i}{\partial b_i}$ are identical, then the resource allocative efficiency, $f_a^i = f_x^i$, is achieved. But this cannot be the case since $\frac{\partial x_i}{\partial a_i} > 0$ while $\frac{\partial x_i}{\partial b_i} < 0$ under the tied budget support scheme. Thus we obtain $f_a^i < c_i < f_x^i$, which implies that the aid is excessive relative to the recurrent cost. Also, from (8), we can see that an increase in the number of symmetric donors enlarges $\frac{\partial x_i}{\partial a_i}$ and $\frac{\partial x_i}{\partial b_i}$, further exacerbating technical inefficiency and resource allocative inefficiency.

Proposition 4 *If a donor is self-biased, then there is aid proliferation even with budget support. Aid proliferation gets worse if a donor is more self-biased (i.e., smaller λ_i) and if there are more donors.*

There will be more aid and less budget support under these two conditions. This is because the donor's budget support crowds out the recipient's recurrent budget, i.e., $\frac{\partial x_i}{\partial b_i} < 0$ in the case of tied budget support. If donor i is not self-biased, then it fully accounts for the increased outputs of other donors' and recipient's project so its incentive to grant budget support is not affected. However if donor i is self-biased, then such reallocation of recurrent costs will decrease the output from its own project and therefore, keeps it from providing b_i. In the case of untied budget support, aid proliferation occurs because part of its grant will be used for other donors' projects which the donor does not fully account for, leading to lower levels of budget support in the equilibrium.

Finally, we elaborate the determination of b_i. As clear from (17) and (18), the net benefit of reallocating one unit of donor i's resources from a_i to b_i is $f_x^i + (1-\lambda_i) f_x^i \frac{\partial x_i}{\partial b_i} - \left[f_a^i + (1-\lambda_i) f_x^i \frac{\partial x_i}{\partial a_i} \right]$, or

$$f_x^i - f_a^i - (1-\lambda_i) f_x^i \frac{f_{xx} - f_{ax}}{f_{xx} + M_j},$$

where $f_x^i - f_a^i$ is positive by assumption and the last term is negative. This shows that the assumption of $f_x^i > f_a^i$ does not guarantee a positive level of budget support. This is because reallocation of resources from the aid to (tied) budget support affects the recipient's behavior: a decrease in a_i induces the recipient to reduce x_i and moreover, an increase in tied budget support also gives the recipient an incentive to reduce it further. Thus the donors provide budget support only if f_x^i is sufficiently larger than f_a^i or $f_x^i - f_a^i > (1-\lambda_i) f_x^i \frac{f_{xx} - f_{ax}}{f_{xx} + M_j}$, which is likely to occur when recurrent cost is sufficiently scarce relative to aid.

3.3 Tied budget support with discretion

The analyses above assume that the donors have no stages after the recipient determines the amount of recurrent cost allocated to its project. This corresponds to the case in which the donors can make precommitments to their decisions. Now we consider the case in which the donors have discretion and can convert part of the aid investment to the recurrent budget after the recipient decision of x_i. For example, suppose donor i disbursed a_i and b_i for a school project. However, after observing recurrent cost disbursed by the recipient to be too small to efficiently operate the school due to lack of teachers and supplies, the donor will have an incentive to convert part of a_i to recurrent budget in order to pay wages for teachers and required staff. Formally, we consider a game which proceeds as follows:

- $t = 1$: Each donor decides a_i and b_i simultaneously.
- $t = 2$: The recipient determines $(x_1, \ldots, x_N)$ after observing $(a_1, \ldots, a_N)$ and $(b_1, \ldots, b_N)$.
- $t = 3$: Each donor can convert $t_i \geq 0$ from the aid investment to the recurrent budget with per unit cost $\epsilon_i \geq 0$.

Let $\delta_i = 1 - \epsilon_i$. If the donor converts t_i from the aid investment to the recurrent budget, then the recurrent budget increases by δt_i. $\delta_i < 1$ corresponds to the cases where conversion of money from aid investment to recurrent budget incurs cost such as administrative procedure, replanning of the project and so on. As with the previous discussions, we explicitly deal with the case of two donors, but all the analyses can be extended to the case of N donors with a minor change. At $t = 3$, the donor will determine the amount of conversion $t_i \geq 0$ in order to maximize

$$f^i(a_i - t_i, x_i + b_i + \delta t_i) + \lambda_i f^j(a_j - t_j, x_j + b_j + \delta t_j)$$
$$+\lambda_i g(K, \bar{X} - x_1 - x_2) - c_i(a_i + b_i).$$

The first order condition of this problem can be written as

$$-f_a^i + \delta f_x^i = 0. \tag{20}$$

Let t_i^* denote the optimal conversion of aid. Condition (20) implies that t_i^* depends only on x_i and is unaffected by x_j. Also note that if δ_i is small (or ϵ is large), t_i^* becomes zero. We exclude such cases by assuming that ϵ is sufficiently small.

At $t = 2$, the recipient will optimizes (x_1, x_2) given (t_1, t_2):

$$\max_{x_1,x_2} \; f^1(a_1 - t_1(x_1), x_1 + b_1 + \delta t_1(x_1)) + f^2(a_2 - t_2(x_2), x_2 + b_2 + \delta t_2(x_2)) + g(K, \bar{X} - x_1 - x_2)$$

The first order conditions and (20) imply

$$f_x^1 = f_x^2 = g_x, \tag{21}$$

The recipient allocates its recurrent budget in order to equate its marginal productivities among the projects given (t_1, t_2). Notice that this condition holds given t_i, or explicitly, $f_x^1(a_1 - t_1^*, x_1 + b_1 + \delta t_1^*) = f_x^2(a_2 - t_2^*, x_2 + b_2 + \delta t_2^*) = g_x(K, \bar{X} - x_1 - x_2)$. Thus the marginal productivities among the projects are not equalized at $t = 2$, when the conversion of resources from the aid budget to the recurrent budget by the donors has not yet occurred. Since the recipient expects donor i to convert t_i^* from the aid budget to the recurrent budget, which reduces f_x^i, the recipient invests more into its own domestic project: $f_x^1(a_1, x_1 + b_1),\ f_x^2(a_2, x_2 + b_2) > g_x(K, \bar{X} - x_1 - x_2)$.

At $t = 1$, donor i optimizes (a_i, b_i) by solving

$$\max_{a_i,b_i} \; f^i(a_i - t_i, x_i + b_i + \delta t_i) + \lambda_i f^j(a_j - t_j, x_j + b_j + \delta t_j)$$
$$+\lambda_i g(K, \bar{X} - x_1 - x_2) - c_i(a_i + b_i).$$

The first order conditions and (21) imply

$$f_a^i + (1 - \lambda_i) f_x^i \frac{\partial x_i}{\partial a_i} - c_i' = 0, \quad \text{and} \tag{22}$$

$$f_x^i + (1 - \lambda_i) f_x^i \frac{\partial x_i}{\partial b_i} - c_i' = 0. \tag{23}$$

Define

$$M_j^{disc} \equiv \frac{1}{\frac{1}{R_j} + \frac{1}{g_{xx}}} < 0,$$
$$R_i \equiv f_{xx}^i + \frac{dt_i}{dx_i}(-f_{ax}^i + \delta f_{xx}^i),$$

where

$$\frac{dt_i}{dx_i} = \frac{f^i_{ax} - \delta f^i_{xx}}{f^i_{aa} - 2\delta f^i_{ax} + \delta^2 f^i_{xx}} < 0. \tag{24}$$

Then from (20) and (21), we can obtain

$$\frac{\partial x_i}{\partial a_i} = \frac{-f^i_{xa}}{R_i + M^{disc}_j}, \tag{25}$$

$$\frac{\partial x_i}{\partial b_i} = \frac{-f^i_{xx}}{R_i + M^{disc}_j}. \tag{26}$$

Since $f^i_{xx} < R_i < 0$ and $M_j < M^{disc}_j < 0$,[4] we can derive $\frac{\partial x_i}{\partial a_i} > 0$ and $\frac{\partial x_i}{\partial b_i} < 0$.

We can show that if δ_i is close to 1, then the optimal b_i approaches zero. That is, if a donor can convert a_i to recurrent cost without depreciation, then it does not precommit the amount of budget support b_i at $t = 1$. To see this, consider the extreme case of $\delta_i = 1$. Then the recipient's optimization in (20) becomes $f^i_a = f^i_x$ and (22) and (23) can be written as

$$f^i_x + (1 - \lambda_i) f^i_x \frac{\partial x_i}{\partial a_i} = c'_i, \quad \text{and} \tag{27}$$

$$f^i_x + (1 - \lambda_i) f^i_x \frac{\partial x_i}{\partial b_i} = c'_i. \tag{28}$$

But (27) and (28) cannot be compatible since $\frac{\partial x_i}{\partial a_i} > 0$ and $\frac{\partial x_i}{\partial b_i} < 0$. The left hand side of (27) expresses the marginal benefit of increasing a_i while that of (28) is the marginal benefit of increasing b_i. These two expressions imply that by keeping $a_i + b_i$ constant, donor i can always gain additional benefit by reducing b_i and increasing a_i. This argument suggests that the donor would choose $b_i = 0$. The optimal a_i is determined by (27). The logic behind this is as follows: since $\frac{\partial x_i}{\partial a_i} > 0$ and $\frac{\partial x_i}{\partial b_i} < 0$, the donor has an incentive to allocate all resources toward the aid investment in order to attract the recipient's recurrent budget. [5]

If $\delta_i = 1$, we can obtain $f^i_a = f^j_a = f^i_x = f^j_x = g_x$ for all $i \neq j$, the resource allocative efficiency. On the other hand, (27) implies $f^i_a \neq c'_i$, that is, the technical efficiency cansnot be achieved. Whether the total aid provided $(a_i + b_i)$ or total output produces is larger or smaller in the case of discretion than precommitment is ambiguous without specifying functional forms.

In the case of N donors, all the arguments go through only by changing the definition of M^{disc}_j to

$$M^{disc}_{-i} \equiv \frac{1}{\sum^N_{j \neq i} \frac{1}{R_j} + \frac{1}{g_{xx}}} < 0.$$

[4] $R_i < 0$ is ensured by the assumption that $f_{aa} > 0$, $f_{xx} > 0$ and $f_{aa} f_{xx} - (f_{ax})^2 > 0$. To see this, substitute $\frac{dt_i}{dx_i}$ into $R_i = f'_{xx} + \frac{dt_i}{dx_i}(-f^i_{ax} + \delta f^i_{xx})$. Then we can obtain $R_i = \frac{f^i_{xx} f^i_{aa} - (f^i_{ax})^2}{f^i_{aa} - 2\delta_i f^i_{ax} + \delta_i f^i_{xx}}$ and the assumptions above imply $R_i < 0$.

[5] In general, if $\delta > 1 + (1 - \lambda_i) \frac{f^i_{ax} - f^i_{xx}}{R_i + M^{disc}_j}$ for any positive value of b_i, then b_i is set to be zero. This condition is derived by comparing the marginal benefit of a_i, $f^i_a + (1 - \lambda_i) f^i_x \frac{\partial x_i}{\partial a_i}$, and that of b_i, $f^i_x + (1 - \lambda_i) f^i_x \frac{\partial x_i}{\partial b_i}$.

Proposition 5 *If a donor can convert part of its aid to recurrent cost without depreciation, after the recipient allocating its recurrent budget, the resource allocative efficiency is achieved but technical efficiency still cannot be obtained if $\lambda_i < 1$. If a donor's conversion of aid to recurrent cost incurs cost, then resource allocation efficiency is not ensured. The comparison of total aid and total output between the case of precommitment and discretion is ambiguous.*

4 Conclusion

Recent empirical studies reveal that effectiveness of aid on growth is ambiguous. This paper considered aid proliferation as potential cause that undermines aid effectiveness. While aid proliferation has attracted practioneers and researchers attention to harm aid effectiveness through raising transaction costs, this paper sheds light on it's common pool property and that too many aid (projects) and donors will reduce the amount of recurrent cost allocated to each aid projects. Since aid projects can only produce benefits sustainably when sufficient recurrent costs are suitably disbursed with investment, shortage of recurrent cost will result in low aid productivity.

Based on a simple model that incorporates aid and recurrent costs as complements to produce development and growth, we showed that optimal allocation of aid and recurrent cost can not be achieved in general because donors and recipient allocate aid and recurrent cost separately, and their opportunity costs are different in general. Donor's budget support or programme aid can be a potential device to supplement the shortage of recipient's recurrent cost and to alleviate the misallocation of inputs. However, when the donors are self-biased, budget support induces aid proliferation because it crowds out the recipient's recurrent budget or substitutes it to other donors, and therefore causes underprovision of budget support relative to aid. Moreover, aid proliferation is shown to be worse with more donors.

The budget support in our model can be interpreted as any support by the donor to supplement the shortage of recipient's resources. For example, the recipient's resource may be "governance" or "capacity" and the donor's support can be "capacity building". These supports can be understood as a voluntary provision of public goods. The essence is that as long as the recipient's complementary domestic resources have the nature of common-pool-resources, donor's (voluntary) support would be underprovided whenever donors are not fully altruistic, which is well-known in the public good literature. Adding exclusion of other donors and the recipient from consuming the donor's support, as in the case of tied budget support, can not mitigate the problem when the recipient can divert its budget. So, our model can be seen as an application of the voluntary provision of public goods literature to the context of foreign aid and budget support, while Knack and Rahman (2007) is an application of the problem of common-pool-resource or the "tragedy of the commons".

Several further studies are required to deepen our understanding on aid effectiveness. We have assumed that shortage of recurrent cost relative to aid investment undermines aid effectiveness but this needs to be confirmed empirically. A possible way to test this is to run a aid-growth regression including the ratio of average aid per donor to recipient's revenue as one of the explanatory variables. Moreover, our theory predicts that aid/revenue ratio increases with more donors. It may also be interesting to check this, taking in to consideration that numbers of donors may be endogenous so that one needs to identify whether an increase of aid/revenue ratio is caused by donor competition or by recipient characteristics (fragile countries may be aid-dependent).

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