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Foreign aid, recipient government's fiscal behavior, and economic growth

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Abstract

The paper investigates the nexus between foreign aid, fiscal policy and economic outcomes in a small recipient country. Foreign aid may increase not only government expenditures but also private capital, and hence improve economic growth. However, it may also discourage the recipient's tax effort. The effects of foreign aid on fiscal policy and economic growth depend on the circumstances of the recipient country, including its development level, the TFP, the efficiency of public investment, and in particular the government's concern for the population's welfare.

1 Introduction

Foreign aid is an important component of the public sector budget and becomes an important source of revenue for recipient countries.[1] It is used to finance public expenditures, both in the social sector (e.g. sanitation, education, health, etc.) and the productive sector (e.g. infrastructure, public investment, etc.). Numerous empirical investigations have attempted to shed light on the fact that foreign aid contributes to increase public expenditures in recipient countries (see, e.g., Remmer (2004), Ouattara (2006b), Feeny and McGillivray (2010), Morissey (2015)). By using cross-country data over the period 1970-1999, Remmer (2004) underlined a positive link between foreign aid and government size.[2] A positive effect of foreign aid on public investment is found in Ouattara (2006b). In particular, the findings in Ouattara (2006b), based on a sample of recipient countries over the period 1980-2000, showed that aid flows also exert a positive effect on developmental expenditure (such as health and education), but a negative effect on non-developmental expenditure (wages, salaries, and subsidies).

While there is a consensus on the positive effect of aid on the recipients' public expenditures, we observe that foreign aid's impacts on tax effort and fiscal policy, as well as economic growth, are ambiguous. Indeed, on the one hand, several empirical studies (Osei et al., 2005; Ouattara, 2006a; Combes et al., 2016) in this body of literature showed that foreign aid matters for the conduct of fiscal policy, and affects domestic borrowing.[3] For instance, Osei et al. (2005) shed light on the fact that aid was associated with improved fiscal performance in Ghana and increased its tax revenue. In particular, by using data from 59 developing countries over the period 1960-2010, Combes et al. (2016) showed that the fiscal effect of aid is stronger in countries with a low quality of governance and a low absorptive capacity. On the other hand, other studies such as Ouattara (2006b), Morissey (2015) indicated that aid did not necessarily affect tax effort and tax revenue, and aid fungibility is an obvious fact in numerous recipient countries.

The issue relative to foreign aid-public expenditures nexus in recipient countries is deeply in interaction with that of aid effectiveness. The latter is contingent on different factors in recipient countries such as quality of governance, economic vulnerability, tax effort (Burnside and Dollar, 2000; Guillaumont and Chauvet, 2001; Pham and Pham, 2019) as well as on the donor's conditionality and targets in aid allocation rules (Carter, 2014; Guillaumont and Wagner, 2014). Moreover, aid effectiveness strongly depends on the recipient government's decisions regarding the use of aid and the allocation of public expenditures.

The relationship between aid, recipient government's behavior, and economic growth is not a straightforward one and deserves to be deepened as it has important implica-

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[1] Foreign aid can reach up to 10% of GDP in low-income countries (http://www.oecd.org/dac/stats/development-aid-rises-again-in-2016-but-flows-to-poorest-countries-dip.htm)

[2] A government size is represented by a ratio of public expenditures to GDP.

[3] In general, studies examining fiscal policy care about taxes, public expenditures and also borrowing in case of the budget deficit.

tions in aid policy and donors' decisions. Questions arise as to the fungibility of aid, the recipient absorptive capacity, the manner in which aid is used, etc. Does aid reduce recipient governments' effort in financing public expenditure? If so, what is the impact of the crowding-out effect on economic outputs in a small recipient country? Is aid used to finance public investment spending promoting economic growth and social expenditures improving social welfare or is it misappropriated by corrupt governments? We observe that existing empirical studies do not give a consensus on this regard and the debate still continues. Motivated by above observations, our paper introduces a theoretical model with micro-foundations in order to examine the link between foreign aid, the recipient government's fiscal behavior, and economic growth. There are three ingredients in our model: an amount of foreign aid, a government and a representative household. A political-economic equilibrium is determined under a sequential process. First, given the government's policy, the representative agent maximizes her intertemporal utility by choosing consumption and investment which determines the production in the next period. Second, the government makes its decision regarding public services, public investment and the manner of use of aid when caring about not only the population's welfare but also its own interest.

Thanks to the tractability of our model, we can explicitly compute the equilibrium and provide full comparative statics. Our main results are the following. First, foreign aid promotes public spending (public investment and public services) but may reduce the recipient government's tax effort measured by the tax/output ratio. We also show that the negative relationship between aid flow and the tax effort is more likely to appear in low-income countries. This point is supported by empirical findings in Clist and Morrissey (2011) where they found a significant negative short-term effect of aid (in the form of grants) on the tax/GDP ratio in poor countries which have lower tax revenue and receive more aid grants.[4] Moreover, we contribute to the literature by pointing out that the optimal tax rate depends on both the aid flow and the recipient country's circumstances (households' preferences, the country's development level, the government's behavior, etc.).

Second, we show that 1\$ in foreign aid increases the recipient's government spending by an amount lower than 1\$. This fiscal effect is stronger with a higher recipient government's concern for the population's welfare, which may be interpreted as a proxy of governance quality. This insight is supported by empirical evidences in Combes et al. (2016). Moreover, we establish that the degree of aid fungibility, measured by the ratio of aid waste to total aid, decreases in the amount of foreign aid and in the quality of governance.

Third, foreign aid may have positive effects on economic growth even with aid fungibility, as it is found in several empirical studies (Ouattara, 2006b; Morissey, 2015). Two arguments may justify this result: (1) aid may enhance private capital thanks to a reduction of tax, and (2) aid may promote public investment which in turn may increase productivity. We also point out that the aid effect on economic growth positively

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[4]See Morissey (2015) for an overview concerning this issue.

depends on the recipient country's circumstances represented by its TFP, the efficiency of public investment, and especially on the government's concern for the population's welfare. In this sense, our paper contributes to the debate on the conditionality of the effect of aid on growth (Burnside and Dollar, 2000; Collier and Dollar, 2001, 2002).

From a theoretical point of view, our paper is closely related to the literature on the effectiveness of aid in a small recipient country (Charterjee et al., 2003; Charteerjee and Tursnovky, 2007; Dalgaard, 2008). In Dalgaard (2008), the foreign aid is fully used to finance public investments while Charterjee et al. (2003), Charteerjee and Tursnovky (2007) assume that only an exogenous fraction of the foreign aid is tied to investment in the stock of public infrastructure. Our paper is different from these studies in two aspects. First, we endogenize the part of foreign aid used to finance public investments by adopting a political-economic approach. Second, the fiscal effect (the tax rate) is also endogenous in our model while it is exogenous in their papers. Moreover, in our simple model, we can explicitly compute the wasted part of aid and the optimal tax rate as functions of the economy's fundamentals.

2 Framework

In this section, we describe our framework and then provide a formal definition of political-economic equilibrium. Section 3 presents our main results. Technical proofs are gathered in Appendix A.

2.1 An aid recipient economy

We consider a small economy with a representative consumer-producer and a government. There are two periods ($t = 0, 1$) and there is a single traded commodity, which can be used for either consumption or investment. Her preferences for consumption and public services are represented by the following intertemporal utility function:

$$U(c_0, H_0) + \beta U(c_1, H_1) \tag{1}$$

where $\beta \in (0, 1)$ is the discount rate. c_0 and c_1 are consumptions in periods 0 and 1. Public services in two periods are represented by H_0 and H_1. H_0 is given. For the sake of tractability, we adopt a logarithmic utility

$$U(c_t, H_t) = ln(c_t) + xln(H_t), t = 0, 1 \tag{2}$$

where x is a positive parameter measuring the weight accorded to the individual satisfaction from public services (health services, sanitation, etc.).

The output y_1 at the second period is produced following a Cobb-Douglas function:

$$y_1 = F(k_1, B_1) = Ak_1^\alpha (\psi B_1)^\gamma \tag{3}$$

where $\alpha, \gamma \in (0,1)$, k_1 and B_1 represent private and public investments at date t, respectively. Parameter A represents the TFP while ψ may be interpreted as a measure of efficiency of public investment.

We assume that the country receives an aid amount, denoted by a, at the first period. However, there is an aid waste (due to the corruption, administrative fees, etc). By consequence, there is only a part of aid a_i which is used to finance public expenditures. So, we write

$$a = a_i + a_u \tag{4}$$

The amount a_u can also be viewed as aid fungibility: aid is used to finance other spendings that the donors do not wish to support but in the recipient government's own benefit. Therefore, the ratio $\alpha_u \equiv a_u/a \in [0,1]$ may then reflect the inefficiency, corruption degree or fungibility degree in the use of aid. It is not exogenous but part of the recipient government's decision.

The government finances public investment B_1 and public services H_1 by using income tax τy_0 and a part of foreign aid a_i. The government's budget constraint is

$$B_1 + H_1 \leq \tau y_0 + a_i \tag{5}$$

2.2 Political-economic equilibrium

We study a political-economic equilibrium which results from a sequential process. At the first step, taking as given H_0, B_0, k_0, the income tax rate τ as well as the government's decision regarding public investment B_1 and public services H_1, the representative agent maximizes her utility (1) by choosing consumptions c_0, c_1 and physical capital k_1 subject to her two budget contraints:

$$c_0 + k_1 \leq (1-\tau)y_0, \quad c_1 \leq F(k_1, B_1)$$

where y_0 is the given production at the period 0 and τ is the tax rate. Solving this problem we find that

$$c_0 = \frac{1}{1+\alpha\beta}(1-\tau)y_0 \tag{6a}$$

$$c_1 = Ak_1^\alpha(\psi B_1)^\gamma = A\Big(\frac{\alpha\beta}{1+\alpha\beta}(1-\tau)y_0\Big)^\alpha(\psi B_1)^\gamma \tag{6b}$$

$$k_1 = \frac{\alpha\beta}{1+\alpha\beta}(1-\tau)y_0. \tag{6c}$$

At the second step, the government makes decision regarding the use of aid (a_i, a_u), the income tax rate τ as well as the allocation of two different categories of public expenditures H_1, B_1 by maximizing its objective function, subject to decisions taken by private sector at the first step. We assume that the government takes care of the

population's welfare, but has also its own interest which depends on aid. Then, its objective function is a weighted sum of the agent's utility and a function of wasted part of aid $W(U,V) = \delta\Big(U(c_0, H_0) + \beta U(c_1, H_1)\Big) + (1 - \delta)V(a_u)$. Parameter δ represents the weight that the government attributes to the population's utility. It can be also viewed as a proxy of governance quality. The government's optimization program is the following:

$$(P1): \quad \max_{(\tau, a_u, a_i, B_1, H_1)} \delta\Big(U(c_0, H_0) + \beta U(c_1, H_1)\Big) + (1 - \delta)V(a_u)$$

subject to constraints: (5), (6a), (6b), (6c), $a_i + a_u = a$, $a_u \in [0, a]$, and $\tau \in [0, 1]$. For the sake of tractability, we assume that $V(a_u) = ln(a_u)$.

3 Main results

We now study the properties of political-economic equilibrium. Thanks to the tractability of our framework, we can explicitly compute the equilibrium.

Proposition 1. *At the interior equilibrium, the government's decision is described by the following:*

$$\text{Expenditures: } G_1 \equiv B_1 + H_1 = \frac{y_0 + a}{1 + \frac{\frac{1}{\delta\beta} + \alpha}{x + \gamma}} \tag{7a}$$

$$B_1 = \frac{\gamma}{\gamma + x}G = \frac{\gamma(y_0 + a)}{x + \gamma + \frac{1}{\delta\beta} + \alpha} \tag{7b}$$

$$H_1 = \frac{x}{\gamma + x}G = \frac{x(y_0 + a)}{x + \gamma + \frac{1}{\delta\beta} + \alpha} \tag{7c}$$

$$\text{Tax: } \tau = 1 - \frac{(1 + \alpha\beta)}{\beta(x + \gamma + \frac{1}{\delta\beta} + \alpha)}\Big(1 + \frac{a}{y_0}\Big) \tag{7d}$$

$$\text{Use of aid: } a_i = \Big(1 - \frac{1 - \delta}{\delta\beta(x + \gamma) + 1 + \alpha\delta\beta}\Big)a - \frac{1 - \delta}{\delta\beta(x + \gamma) + 1 + \alpha\delta\beta}y_0. \tag{7e}$$

Proof. See Appendix. $\qquad\qquad\square$

We focus here on an interior solution and assume that the right hand sides (RHS) of (7d) and (7e) are positive. We can prove that, if the RHS of (7d) is negative then $\tau = 0$ at optimal (this happens when a is high enough). If the RHS of (7e) is negative then $a_i = 0$ at optimal (this happens when a is low enough).

We firstly observe a significant impact of individual preference for public services (x) on the government's decision. Indeed, if individuals attribute an important weight to public services H_1, then the government will increase the income tax rate τ. This explains a positive effect of x on overall public expenditures G_1 which is financed by tax revenue and a part of received aid. However, we observe a negative effect of x on

public investment B_1, this is consistent with a negative effect of x on economic growth g as we will show in Proposition 3.

We now present our main points concerning the impacts of foreign aid on the recipient's government behavior and its economic growth.

Proposition 2 (foreign aid and fiscal behavior). *At the political-economic equilibrium, we have the following properties.*

1. $\frac{\partial G}{\partial a} = \frac{x+\gamma}{x+\gamma+\frac{1}{\delta\beta}+\alpha} \in (0,1)$, $\frac{\partial H_1}{\partial a} = \frac{x}{x+\gamma+\frac{1}{\delta\beta}+\alpha} \in (0,1)$, and $\frac{\partial B_1}{\partial a} = \frac{\gamma}{x+\gamma+\frac{1}{\delta\beta}+\alpha} \in (0,1)$.

2. *The optimal tax rate τ is decreasing in aid flow:* $\frac{\partial\tau}{\partial a} = -\frac{(1+\alpha\beta)}{\beta(x+\gamma+\frac{1}{\delta\beta}+\alpha)}\frac{1}{y_0} < 0$.

3. $\frac{\partial a_i}{\partial a} = 1 - \frac{1-\delta}{\delta\beta(x+\gamma)+1+\alpha\delta\beta} \in (0,1)$, $\frac{\partial\alpha_u}{\partial a} = -\frac{\partial\alpha_i}{\partial a} < 0$ and $\frac{\partial\alpha_u}{\partial\delta} < 0 < \frac{\partial\alpha_u}{\partial y_0}$.

According to point 1, foreign aid promotes public spendings (H_1, B_1, G_1). Our theoretical results consolidate the empirical findings. Indeed, Feeny and McGillivray (2010) analyze the case of Papua New Guinea using the data for the period 1969 to 2000, and shows that foreign aid contributed to increase consumption and investment expenditures even it negatively affects tax revenue. A significant effect of foreign aid on the recipient fiscal policy is also supported by other empirical studies such as Osei et al. (2005), Ouattara (2006a,b), Morissey (2015). Gomanee et al. (2005) provide evidence that aid increases spending on social sectors (health, education, and sanitation). This is consistent with the fact that H_1 is increasing in aid flow (a) in our model.

Point 2 of Proposition 2 indicates that a more generous amount of aid may decrease the optimal tax rate τ and hence the tax revenue τy_0. In other words, foreign aid may reduce recipient governments' effort in the short-run. Observe that the lower the initial output y_0, the lower the ratio $\partial\tau/\partial a$. It means that the negative relationship between aid flow and the tax rate is more likely to appear in low-income countries. This is consistent with the findings in Clist and Morrissey (2011) where they found a significant negative short-term effect of aid (in the form of grants) on the tax/GDP ratio in poor countries having a lower tax revenue and receiving high aid grants.[5] Although we focus on the effect of aid, it is useful to remind that the optimal tax rate given by (7d) which is endogenous, depends on the recipient country's circumstances. In particular, it is increasing in the development level of the country (represented by the initial output y_0).

Proposition 2 also shows the effectiveness of foreign aid. Indeed, point 1 of Proposition 2 also implies that 1 dollar in aid may increase government spending G by a fraction $R_g \equiv \frac{x+\gamma}{x+\gamma+\frac{1}{\delta\beta}+\alpha} < 1$. We can observe that R_g is increasing in δ which may be interpreted as a proxy of governance quality. In this sense, the lower the quality of governance is (proxied by δ), the lower the fiscal effect of foreign aid. This insight is supported by empirical evidences in Combes et al. (2016). Moreover, point 3 shows

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[5]It should be noticed, however, that Clist and Morrissey (2011) also find no robust evidence for a negative effect of aid grants on the tax/GDP ratio. See Morissey (2015) for a review concerning this issue.

that, foreign aid is fungible when a country receives an additional amount of aid (because $\partial a_i/\partial a < 1$). However, its fungibility degree, reflected by the ratio $\alpha_u \equiv a_u/a$, is decreasing in the amount a of foreign aid (as $\partial \alpha_u/\partial a < 0$) and in the quality of governance (as $\partial \alpha_u/\partial \delta < 0$).

It is interesting to notice that, when the government only cares about the population's welfare (i.e., $\delta = 1$), there is no wasted aid ($a_u = 0$) but the value $\partial G/\partial a = R_g$ becomes $\frac{x+\gamma}{x+\gamma+\frac{1}{\beta}+\alpha} < 1$ which is still lower than 1. The reason is that part of foreign aid also goes to private capital as we will explore in the following result.

Proposition 3 (foreign aid and economic growth). *The physical capital, output of and growth rate of the recipient country are given by:*

$$k_1 = \frac{\alpha(y_0 + a)}{x + \gamma + \frac{1}{\delta\beta} + \alpha} \tag{8a}$$

$$Output: \quad y_1 = A\alpha^\alpha(\psi\gamma)^\gamma \Big(\frac{y_0 + a}{x + \gamma + \frac{1}{\delta\beta} + \alpha}\Big)^{\alpha+\gamma} \tag{8b}$$

The growth rate $g \equiv \frac{y_1}{y_0} - 1$ is increasing in aid flow (a), and

$$\frac{\partial g}{\partial a} = A\alpha^\alpha(\psi\gamma)^\gamma \frac{(\alpha + \gamma)(y_0 + a)^{\alpha+\gamma-1}}{\big(x + \gamma + \frac{1}{\delta\beta} + \alpha\big)^{\alpha+\gamma} y_0} \tag{9}$$

which is increasing in A, ψ and δ.

Proof. (8a) is obtained by combining (7d) and (6c). Since we have computed k_1 and B_1, we can easily prove (8b) by using (3). □

Proposition 3 shows the interplay between foreign aid and economic growth of the recipient country. When aid flow increases, as we have seen in Proposition 2, the optimal tax rate decreases, this implies an increase in the physical capital k_1. Moreover, foreign aid has a positive effect on the public investment B_1. By consequence, the output y_1 and hence the rate of growth are increasing functions of aid.

According to (9), we also observe that the aid effect on economic growth will be stronger when it is accompanied by a higher TFP A or higher efficiency of public investment (ψ) or a higher government's concern (δ) for the population's welfare. If we consider the recipient country's performances (proxied by ψ, A, δ) as a condition for a country to receive aid, this conditionality might help to perform the aid effect in recipient countries. This finding contributes to the debate on the conditionality of the effect of aid on growth (Burnside and Dollar, 2000; Collier and Dollar, 2001, 2002).

4 Conclusion

Our paper presents a simple and tractable model to investigate the manner in which aid is used and the endogenous fiscal policy by focusing on the recipient government's

decisions regarding tax effort and allocation of public expenditures.

In our framework, although the use of foreign aid is endogenous and chosen by the recipient government, the donors' allocation rules remain exogenous. For future research, it would be interesting to endogenize the aid allocation rules and the efficiency in the use of aid in order to understand the interaction between two sides, donors and recipient country in both static and dynamic contexts. By doing this, we will be able to study the optimal design of foreign aid following the reaction of the recipient government, in particular under incomplete information (Azam and Laffont, 2003) when hazard moral problem exists and donors have difficulties to observe strategies of the recipient government.

A   Appendix: Proof of Proposition 1

We can express the objective function of the program (P1) as follows:

$$W(U,V) = \delta\Big(U(c_0, H_0) + \beta U(c_1, H_1)\Big) + (1-\delta)V(\alpha_u a)$$
$$= w + \delta(1+\alpha\beta)ln(1-\tau) + \delta\beta\Big(\gamma ln(B_1) + xln(H_1)\Big) + (1-\delta)ln(\alpha_u)$$

where w is independent of considered variables $(\tau, \alpha_u, \alpha_i, B_1, H_1)$:

$$w \equiv \delta xln(H_0) + (1-\delta)ln(a) + \delta ln\Big(\frac{y_0}{1+\alpha\beta}\Big) + \delta\beta ln\Big(A\Big(\frac{\alpha\beta y_0}{1+\alpha\beta}\Big)^\alpha m^\gamma\Big). \qquad (A.1)$$

Thus, the problem (P1) is equivalent to the following problem

$$\max_{(\tau, \alpha_u, B_1, H_1)} \delta(1+\alpha\beta)ln(1-\tau) + \delta\beta\big(\gamma ln(B_1) + xln(H_1)\big) + (1-\delta)ln(\alpha_u) \qquad (P2)$$

subject to: $\begin{cases} B_1 + H_1 \leq \tau y_0 + (1-\alpha_u)a \\ \alpha_u \in [0,1], \tau \in [0,1] \end{cases}$

Thanks to Inada conditions, we have $1 - \lambda > 0$ and $\alpha_u > 0$ at optimal. So, we can write the Lagrange function of the optimization problem (P2) as follows

$$L = \delta(1+\alpha\beta)ln(1-\tau) + \delta\beta\big(\gamma ln(B_1) + xln(H_1)\big) + (1-\delta)ln(\alpha_u)$$
$$+ \mu(\tau y_0 + (1-\alpha_u)a - B_1 - H_1) + \lambda_1\tau + \lambda_2(1-\alpha_u) \qquad (A.2)$$

where $\lambda_1, \lambda_2 \geq 0$. The first-order conditions (FOC) are:

$$\frac{\delta(1+\alpha\beta)}{1-\tau} = \mu y_0 + \lambda_1, \quad \frac{1-\delta}{\alpha_u} = \mu a + \lambda_2, \quad \frac{\delta\beta\gamma}{B_1} = \frac{\delta\beta x}{H_1} = \mu \qquad (A.3)$$

We now focus on interior solutions (i.e., $\tau > 0$ and $\alpha_u < 1$), we have $\lambda_1 = \lambda_2 = 0$ at

optimal. So, FOCs imply that:

$$\frac{\delta(1+\alpha\beta)}{1-\tau} = \mu y_0, \quad \frac{1-\delta}{\alpha_u} = \mu a \tag{A.4}$$

The two last equations in (A.3) imply that $\mu = \frac{\delta\beta(x+\gamma)}{B_1+H_1} = \frac{\delta\beta(x+\gamma)}{G_1}$. Thus, we have

$$\tau = 1 - \frac{\delta(1+\alpha\beta)}{\mu y_0} = 1 - \frac{\delta(1+\alpha\beta)}{y_0\frac{\delta\beta(x+\gamma)}{G_1}} = 1 - \frac{(1+\alpha\beta)G_1}{y_0\beta(x+\gamma)} \tag{A.5}$$

$$\alpha_u = \frac{1-\delta}{\mu a} = \frac{1-\delta}{a\frac{\delta\beta(x+\gamma)}{G_1}} = \frac{(1-\delta)G_1}{a\delta\beta(x+\gamma)}. \tag{A.6}$$

The government's budget constraint implies that

$$G_1 = \tau y_0 + (1-\alpha_u)a = y_0\Big(1 - \frac{(1+\alpha\beta)G_1}{y_0\beta(x+\gamma)}\Big) + \Big(1 - \frac{(1-\delta)G_1}{a\delta\beta(x+\gamma)}\Big)a \tag{A.7}$$

$$\Leftrightarrow G_1\Big(1 + \frac{(1+\alpha\beta)}{\beta(x+\gamma)} + \frac{(1-\delta)}{\delta\beta(x+\gamma)}\Big) = y_0 + a \Leftrightarrow G_1 = \frac{y_0+a}{1+\frac{\frac{1}{\delta\beta}+\alpha}{(x+\gamma)}}. \tag{A.8}$$

Therefore, we can compute the tax rate

$$\tau = 1 - \frac{(1+\alpha\beta)G_1}{y_0\beta(x+\gamma)} = 1 - \frac{(1+\alpha\beta)}{\beta(x+\gamma)+\beta(\frac{1}{\delta\beta}+\alpha)}\frac{y_0+a}{y_0} \tag{A.9}$$

and the inefficiency in the use of aid

$$\alpha_u = \frac{(1-\delta)G_1}{a\delta\beta(x+\gamma)} = \frac{(1-\delta)}{a\delta\beta(x+\gamma)}\frac{y_0+a}{1+\frac{\frac{1}{\delta\beta}+\alpha}{(x+\gamma)}} = \frac{1-\delta}{\delta\beta(x+\gamma)+1+\alpha\delta\beta}\frac{y_0+a}{a}. \tag{A.10}$$

From the FOC (A.3), we can compute the value of public investment B_1 and public services H_1 as showed in equations (7b) and (7c). Finally, condition $\tau > 0$ (resp., $\alpha_i > 1$) is equivalent to the right hand side of 7d) (resp., (7e)) is positive.

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