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# The Fiscal Impact of Foreign Aid in Rwanda:

## A Theoretical and Empirical Analysis

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## Abstract

The inflow of large quantities of foreign aid into Rwanda since 1994 can have potential adverse effects such as aid dependency via a significant negative effect on tax efforts and on public investments. This paper carries out a theoretical and empirical study to examine these issues. The theoretical part develops a model in which the recipient government decides on the optimal level of tax and optimally allocates total government revenue between current expenditure and public investment. The theoretical model makes it possible to empirically test whether an increase in aid is likely to reduce the

optimal tax rate and the proportion of public expenditure allocated to public investment. The econometric analysis uses time series data on Rwanda to show, in line with other studies in the literature, a negative relationship between increased aid and the tax rate; but the magnitude of the effects are extremely small. In the case of Rwanda, reforms to the tax administration and expansion of the tax base have had mitigating effects. As far as the effect on public investment, the overall effect was negative in the past; however, since 1995 the direction of this effect has changed.

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# **The Fiscal Impact of Foreign Aid in Rwanda: A Theoretical and Empirical Analysis**

By

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## **1. Introduction**

This paper examines the impact of aid flows on fiscal policy in Rwanda. A tremendous amount of aid has been transferred to the country to assist in rebuilding the infrastructure and institutions that were destroyed in 1994. As the country moved from a period of reconstruction and stabilization toward sustained growth, total overseas development assistance (ODA) as a share of GDP averaged 29.7 percent and dropped from 95 percent in 1994 to 19.2 percent in 2004. Between 2005 and 2006, total ODA averaged just over 14 percent of GDP. However, over the past decade, foreign direct investment as a share of GDP averaged only 0.23 percent of GDP, while average savings as a share of GDP was -1.4 percent, highlighting the importance of ODA in sustaining the growth experienced over the past decade.

With the new G-8 initiative on debt forgiveness and an increased focus of donors on the poorest countries, particularly those in Africa, there are good indications that the level of support to Rwanda is likely to be scaled up. Over the period, 2007 to 2020, aid flows could double to as much as 30 percent of GDP, provided the government continues to maintain sound policies. This would give rise to a substantial inflow of aid to the economy, while domestic revenue would likely remain below 20 percent of GDP.

To ensure that these high levels of aid lead to sustained growth and macro stability, it is useful to evaluate the impact of aid on key policy variables, particularly related to fiscal policy. In this study we will assess the fiscal impact of aid in Rwanda through an econometric analysis of historical trends over the past, and the impact of these trends on key variables of fiscal policy in Rwanda, over the period 1980 - 2004.

The theoretical and empirical literature to be discussed below shows that aid can undermine revenue mobilization. This implies that if aid discourages tax effort, it can perpetuate or even increase aid dependency. Thus, we will examine whether this is the case in Rwanda. Has aid discouraged tax effort? Secondly, we shall examine if aid has a negative effect on the proportion of public expenditure allocated to public investment. Following the seminal work of Heller (1975), there is now a substantial theoretical and empirical literature on the fiscal consequences of foreign aid (see, for example, Mosley et al., 1987; Binh and McGillivray, 1993; Feyzioglu et al., 1998; Franco-Rodriguez et. al.; 1998, Swaroop et al., 2000).<sup>1</sup> This literature examines the effect on foreign aid on tax revenue and public investment.<sup>2</sup> On the theoretical side, most models work with variants of the framework developed by Heller (1975) in which the government's objective function is quadratic in a number of macro variables such as the difference between the level of public investment and its target value, the difference between tax revenue and its target value, and so on. This choice of the objective function is somewhat ad hoc. On the empirical side, the literature covers time-series country studies, cross-country studies, and also panel data analysis. Although there are some exceptions, on the whole, the literature indicates that aid has a negative effect on tax revenue, but not so on public investment.

This paper contributes to this expanding literature in two ways. First of all, we develop a different theoretical framework based on microeconomic and welfare-theoretic principles with distortionary and revenue-raising effects of taxes. The government in our framework uses the tax rate and the allocation of total expenditure between current

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<sup>1</sup> See McGillivray and Mossissey (2004) for a review of the literature.

<sup>2</sup> There is also the broader literature on aid fungibility; fiscal channels being one of many ways in which full effects of aid may not be realized. See, for example, Khilji and Zampelli (1994), Pack and Packi (1994), Feyzioglu et al. (1998), and Lahiri and Raimondos-Møller (2004) for the issue of aid fungibility.

expenditure and public investments as instruments for maximizing inter-temporal utility. We also distinguish between private and public investments. On the empirical side, we focus on a country in Africa, namely Rwanda, which has drawn very little attention in the literature, but has received large amounts of foreign aid particularly since 1994. Rwanda has also gone through a significant change in terms of policy regime since 1994. Thus, it would be interesting to examine if the fiscal effect of aid has changed qualitatively due to a new policy environment. Finally, whereas the bulk of the literature examines the effect of aid on the *levels* of tax revenue and public investment, in this paper we focus on – in both the theoretical and the empirical part -- the effect on the *rate* of taxation and the *proportion* of total government expenditure that is allocated to public investment.

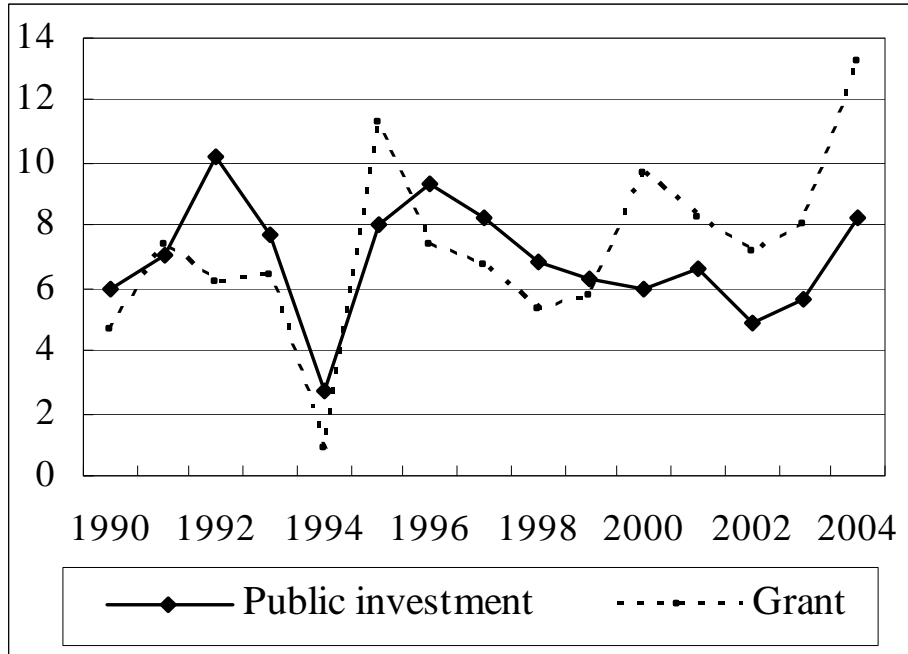
The paper proceeds first by outlining a theoretical model that will enable an examination of the fiscal effects of increased aid. Regression analysis is used to examine the effect of increased aid on key fiscal variables.

## **2. The Importance of Aid in Rwanda**

The importance of aid in Rwanda stems from it being the main source of capital flows and financing for investments (given the extremely low levels of foreign direct investment), as well as its impact on macroeconomic stability. In the balance of payments, capital flows are primarily capital grants and net borrowing (on concessional terms), and aid is the major source of finance for the budget. In addition, aid funds have led to increased liquidity in the economy which has required close monitoring and management to maintain macroeconomic stability. Surges in foreign aid, following the

1994 crisis, resulted in increases in M2 (narrow money) and large changes in nominal GDP and inflation.

**Figure 1: Public Investment is Defined by Availability of Donor Grants  
1994-2004 (percent of GDP)**



Source: World Development Indicators and IMF, as cited in World Bank (2007).

These changes were due to several factors. First, the government introduced new notes and coins, which had the effect of devaluing the national currency by 45 percent. Second, there was a huge increase in the amount of currency in circulation in a situation where people were forced to keep their money in very liquid form. These factors contributed to an average rate of growth of narrow money of 11.4 percent over the period 2000-04 (and contrasts with a growth rate of 14.8 percent during 1990-99, and 3.9 percent over the period 1980-89).

Given the high level of liquidity arising from the large inflow of aid, the government's approach to sterilizing the excess liquidity also has had an impact on fiscal

policy. To control inflation and the growth in the money supply, the government has resorted to the sales of treasury bills. This has resulted in an increase in domestic debt from a level of less than 5 percent of GDP, over the past two years, to 6 percent in 2006. World Bank (2007) reports that there was some indication of potential crowding out of the private sector, as credit to the economy and net credit to government displayed moved together in a counter-cyclical fashion, between 1998 and 2003. Up until 2003, this counter-cyclical trend between the two series (credit to the economy and government), was more pronounced because t-bills were used mainly to finance the budget. Between 2002 and 2004, shortfalls in budget support, coupled with increased spending (i.e. on elections), contributed to increased sales of t-bills, as a means of financing the budget. Since 2005, sales of foreign exchange have become an increasingly important instrument for sterilization of excess liquidity. However, given government's concern on the potential effects of exchange rate appreciation on exports, emphasis has been placed on the use of t-bill sales as a tool for monetary management. In the past year or so, however, increased liquidity in the commercial banks, arising from buoyant activity in the NGO sector (as demonstrated through increased disbursements to project accounts), has provided an additional source of liquidity and therefore eliminated the countercyclical trend between credit to the economy and government. As a result, the two series have moved in a pro-cyclical fashion since 2005 (see Quarshie 2007).

The evidence, on the face of it, indicates that increased aid flows have not adversely affected the level of revenue and that expenditure has been mainly on priority poverty reduction areas. Revenue as a share of GDP has increased steadily since 1998 from around 10 percent to just over 14 percent of GDP in 2006. In case of priority



expenditure, Table 1 shows that there has been an increase in allocation to priority areas since 1998 (both during the period of decline in aid, between 2002 and 2003, and from 2004-2005 when aid flow increased again).

**Table 1: Rwanda: Priority Spending, 1998-2005**  
(In percentage of GDP)

	1998	1999	2000	2001	2002	2003	2004	2005
Total Budget	18.9	19.7	18.7	21.0	21.3	21.9	25.2	26.2
Total priority expenditure of which:	2.8	3.9	5.3	5.3	6.4	6.9	7.0	8.4
Education	2.2	3.2	3.5	3.5	3.6	3.8	3.9	3.9
Health	0.4	0.5	0.7	0.7	0.8	0.8	0.8	0.9
Agriculture	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.4
Export promotion	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5
Transport and communication	0.0	0.0	0.1	0.1	0.4	0.5	0.4	0.9
Infrastructure(Energy and water)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Common Development Fund	0.0	0.0	0.0	0.0	0.1	0.3	0.3	0.3
Other*	0.2	0.2	0.2	0.9	0.5	1.0	1.3	1.3

*Source:* Rwandese authorities and World Bank (2007).

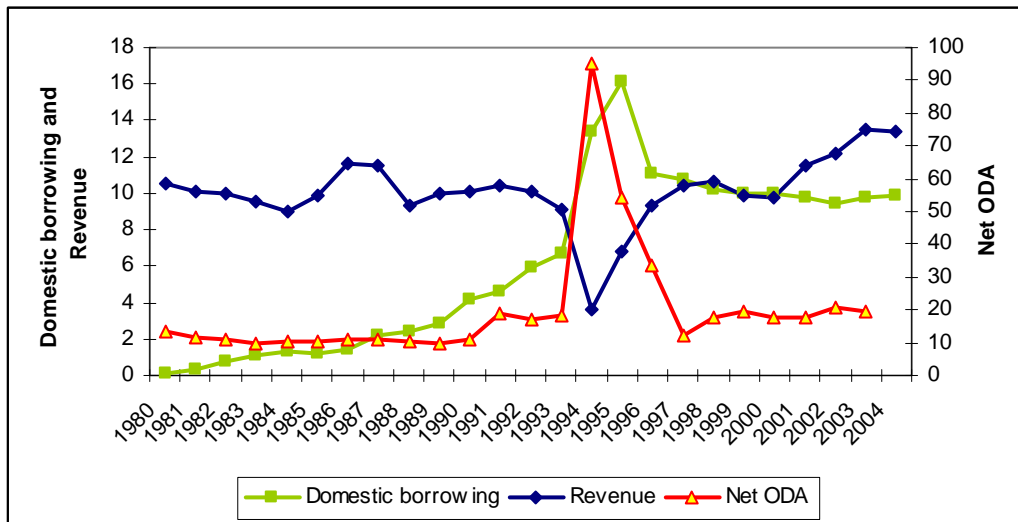
\* This category includes spending on internal affairs, local government, commerce, and youth and sports.

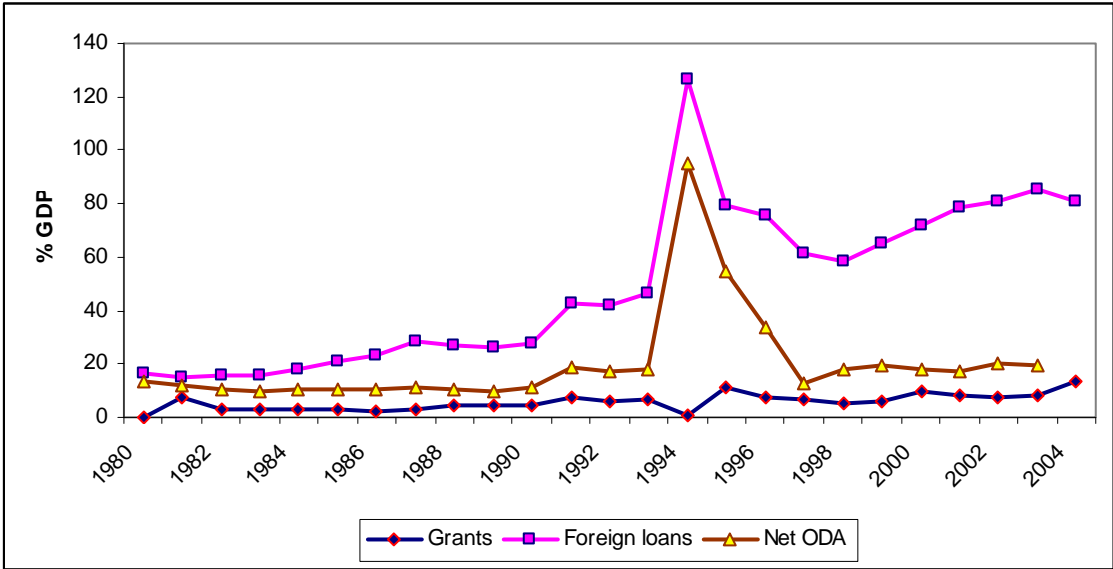
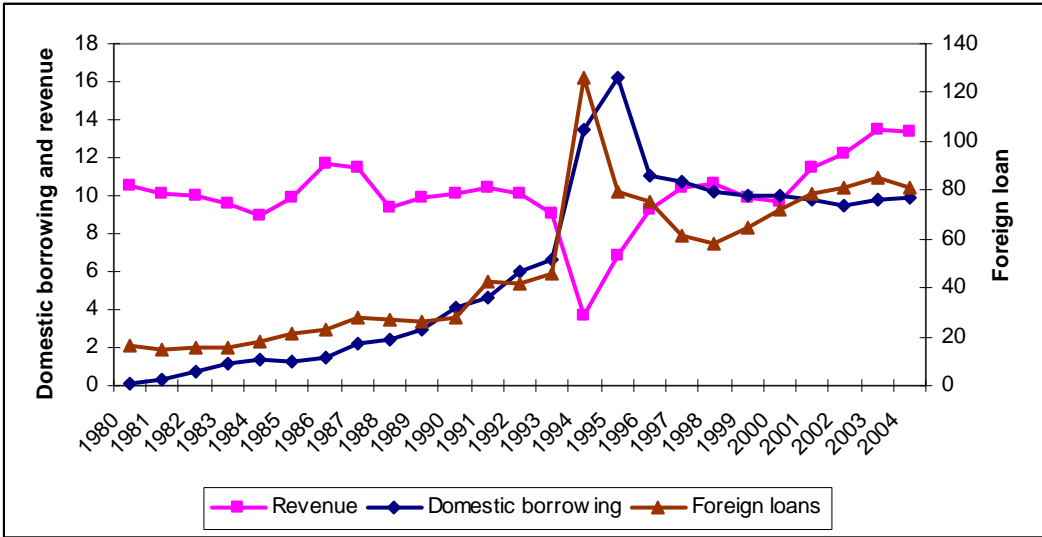
In addition, since 1998, the government has adopted reforms to improve the efficiency of tax administration and revenue. The Rwanda Revenue Authority, charged with tax collection, was established in 1997. Four years later, the value-added-tax was implemented and a year later, in 2002, the tax code was revised. The result was that government revenue, estimated at about 13 percent of GDP in 1992, and which had fallen to below 4 percent in 1994, began to increase gradually to reach an average of around 10 percent per annum between 1996 and 2001. By 2002, revenues stood at 12.2 percent of GDP, reflecting the increase in the VAT rate from 15 to 18 percent, and the substantial strengthening of revenue administration. Revenue as a share of GDP rose further in the following years and is now just under 15 percent. Thus, the increased share of tax

revenue out of GDP reflect past reforms, and further reforms that took place from 2003, including the taxation of in-kind benefits.

The discussion above, along with the data in Table 1 and the trend in revenue (compared to that of foreign aid), shown in Figure 2 below, suggest that increased aid has not adversely affected tax revenue and spending for poverty reduction. It may however, have increased the level of domestic borrowing. Aid has been spent on the priority areas identified in the government's Poverty Reduction Strategy. To examine the marginal impact of aid on these variables, the next section elaborates a theoretical model which is then estimated econometrically in section 4.

**Figure 2: Trend in Foreign Aid (including Grants and Loans), Domestic Revenue and Borrowing, 1980-2004**





Source: World Development Indicators and authors' calculation.

Note: Grants to government include unrequited, non-repayable, noncompulsory government receipts from other governments or international institutions. Foreign loans represent debt outstanding and disbursed. Net ODA disbursements equal gross ODA disbursements less principal repayments (amortization) of previous ODA loans. All variables are given as a ratio of GDP

### 3. A Theoretical Model

We consider an open economy lasting two periods, 1 and 2. Since we do not consider any issue related to trade, for simplicity, we assume that it produces one final (consumption) good per period. The second-period price is taken as the numeraire, and we denote by  $p$  the relative price of the good in the first period.

There are two types of capital: private and public. The economy starts at  $t=1$  with  $\bar{K}$  units of private capital. At  $t=1$ , the private sector adds to this through investment,  $I$ , which becomes available at  $t=2$ .

The government derives its revenue in period 1 from three sources: from foreign aid  $T$ , from consumption tax at the rate  $\tau$ , and from lump-sum tax  $L$ . A fraction  $\lambda$  of government revenue is used to accumulate public capital. The remaining  $(1-\lambda)$  fraction of government revenue is used to produce a public good ( $g$ ) which gives utility to the people. This expenditure can be thought of as a recurring or social expenditure. The economy starts at time  $t=1$  with  $\bar{F}$  amounts of public capital. At  $t=1$ , the government adds to this through public investment,  $F$ , which becomes available at  $t=2$ . Public investment can be thought as development expenditure such as infrastructural development.

On the demand side of the economy, utility level  $u$ , as previously noted, is positively affected by the provision of public good. The inter-temporal expenditure function  $E(p(1+\tau), 1/(1+r), g, u)$  denotes the minimum expenditure (in present value) required to achieve a given level of utility  $u$  at constant consumer prices and public good provision level.  $r$  is the rate of interest. The partial derivative of the expenditure function

with respect to  $u$ ,  $E_u$ , denotes the reciprocal of the marginal utility of income.<sup>3</sup> Since public good increases household utility, the partial derivative of the expenditure function with respect to  $g$ ,  $E_g$ , is negative and  $-E_g$  denotes the households' *marginal willingness to pay for the public good* (e.g., see Chao and Yu, 1999). That is, a higher level of public good consumption requires a lower level of spending on private goods to mitigate its positive effects so that a constant level of utility is maintained. The expenditure function is assumed to be strictly convex in  $g$ , i.e.  $E_{gg} > 0$ . That is, a higher level of public goods provision reduces the households' marginal willingness to pay for the public good. It is also assumed that  $E_{gu} < 0$ , i.e. a higher level of utility increases the households' marginal willingness to pay for the public good. Formally,

**Assumption 1**  $E_{gu} < 0$ ,  $E_{gg} > 0$ .

The production side of the economy in periods 1 and 2 are given by the 'restricted' revenue function  $R^1(p, g)$  and a normal revenue function  $R^2(1, \bar{K} + I, \bar{F} + F)$  respectively, as functions of the producers' price of the aggregate good and factor endowments.<sup>4</sup>

The period-2 revenue function is a standard one. However, the restricted revenue function in period 1 which gives the value of private outputs, needs further explanations. Let  $v (= v^p + v^s)$  denote the vector of total factor endowments in period 1, where  $v^p$  and

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<sup>3</sup> The partial derivative of the expenditure function with respect to a price gives the compensated demand function for that good. Also  $E_{pp}$  where  $E_{pp} = (\partial^2 E / \partial (p(1 + \tau))^2)$ . For more properties of the expenditure function see Dixit and Norman (1980).

<sup>4</sup>The endowments of all factors other than private and public capital are omitted as they do not vary in our analysis. The partial derivative of a revenue function with respect to a price gives the supply function of the good, and that with respect to an endowment of a factor gives the price of that factor.  $R_{ii} \leq 0$  for  $i=K, F$ . For properties of the revenue function see Dixit and Norman (1980).

$v^s$  are respectively the vectors of factors used in the production of the private goods and the public good. The country's maximum value of production of private goods is denoted by a restricted gross domestic product, or restricted revenue function,  $\bar{R}^1(p, v^p)$ , defined as:

$$\bar{R}^1(p, v^p) = \max_x \{px : x \in T(v^p)\},$$

where  $T(v^p)$  is the private sectors aggregate technology set, and  $x$  is net output of the private good. Under the assumption of constant returns to scale in public good production and that the public sector competes with the private sector in factor markets, the cost-minimization problem in the public sector yields a unit cost function of producing the public good  $C_w^g(w)$ , where  $w$  is the vector of factor prices and is given by

$$w = \bar{R}_{v^p}^1(p, v^p).$$

It is well known from the properties of the unit cost function that the demand for factors of production in the public sector,  $v^g$ , is equal to  $C_w^g(w)g$  (e.g., see Abe, 1992; Hatzipanayotou *et al.*, 2002). Therefore,

$$v^p = v - C_w^g(w)g = v - C_w^g(\bar{R}_{v^p}^1(p, v^p))g.$$

Solving the above equation for  $v^p$ , we get  $v^p = v^p(p, g, v)$ , and since  $v$  does not vary in our analysis, we define the restricted revenue function as

$$R^1(p, g) = \bar{R}_{v^p}^1(p, v^p(p, g, v)).$$

It is well known (e.g. Abe, 1992) that  $-R_g^1 [= -(\partial R / \partial g)] = C^g(w)$ , the unit cost of producing the public good. For the rest of the analysis, for simplicity, we assume that  $R_{gg} = 0$ .<sup>5</sup>

Having done the ground work, the economy can now be described by the following equations:

$$E(p(1+\tau), \frac{1}{1+r}, g, u) + I = R^1(p, g) - L + (1-\lambda)G + \frac{1}{1+r} \cdot R^2(1, \bar{K} + I, \bar{F} + F), \quad (1)$$

$$G = \tau p E_p + T + L, \quad (2)$$

$$F = \lambda G \quad (3)$$

$$(1-\lambda)G = -R_g^1 g, \quad (4)$$

$$R_K^2 = 1+r, \quad (5)$$

$$\begin{aligned} B &= p(1+\tau)E_p + I - R^1(\cdot) - L + (1-\lambda)G \\ &= \frac{R^2(\cdot) - E_1}{1+r}, \end{aligned} \quad (6)$$

where  $E_1$  denote the partial derivative of  $E$  with respect to the second argument and it represents the private consumption in the second period.

Equation (1) describes the inter-temporal budget constraint for the representative consumer. Total discounted present value of consumptions expenditure (left hand side) is equal to the sum of total factor income from private production in period 1 (first term on the right hand side), factor income from the public sector in period 1 (third term), and

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<sup>5</sup> This assumption implies that changes in  $g$  which change factor supplies available to produce private goods, do not affect its unit cost of production. It is to be noted that most of our results will go through when  $R_{gg}$  is not zero (the more general assumption is that  $R_{gg} \leq 0$  (see Abe 1995 for the properties of the restricted revenue function when  $R_{gg}$  is negative).

discounted value of factor income in period 2 (fourth term), minus lump-sum taxes paid (second term). Equation (2) says that government revenue in period 1 is equal to the sum of consumption tax revenue, foreign aid and lump-sum taxes. Public investment in period 1 is a fraction  $\lambda$  of government revenue (equation (3)). Equation (4) states that the total amount allocated for the production of public good in period 1 (left hand side) is equal to the total cost of producing the public good (right hand side). Private investment  $I$  is determined optimally by the representative consumer by setting  $\partial u/\partial I=0$ , yielding equation (5). Finally, equation (6) defines the amount of borrowing that the representative consumer makes in period 1: it is defined either to be its excess consumption expenditure over income in period 1, or equivalently to be its discounted value of excess income over expenditure in period 2.

This completes the description of the model. The six equations (1)-(6) determine six endogenous variables in  $u, g, G, I, F$ , and  $B$ . The policy instruments are  $\tau, L$  and  $\lambda$ , and the exogenous variables include  $T, r$  and the price  $p$ .

### 3.1. Optimal Policies

Having developed the model in the preceding section, we shall now characterize the optimal policies. Since a government's ability to raise lump-sum taxes is usually limited (see, for example, Wilson, 1991), we shall take lump-sum tax  $L$  to be exogenous and determine optimal values of consumption tax rate  $\tau$  and allocation parameter (between public good production (social expenditure) and public investment)  $\lambda$ .

Before proceeding further, it may be useful to state a few assumptions. First we assume that the public good and the taxed private good are taken to be independent in



consumption, and all the adjustments of a change in the public good provision (at a given utility level) fall on the numeraire good (see Wilson (1991, p.159) for a discussion on the separability between public and private goods). Second, we assume that income effect does not fall on the taxed consumption good (see, for example, Keen, 1987; Lahiri and Raimondos-Møller, 1998). Finally, we assume that private and public capital are complements. Formally,

**Assumption 2**  $E_{pg} = E_{pu} = 0$ ,  $R_{KF}^2 > 0$ .

Differentiating (1)-(5), we get:

$$E_u du = -E_g dg - pE_p d\tau + \frac{R_F^2}{1+r} dF, \quad (7)$$

$$dG = p(E_p + \tau pE_{pp})d\tau + dT, \quad (8)$$

$$dF = Gd\lambda + \lambda dG, \quad (9)$$

$$-R_g^1 dg = -Gd\lambda + (1-\lambda)dG, \quad (10)$$

$$dI = \frac{R_{KF}^2}{R_{KK}^2} \cdot dF. \quad (11)$$

Equation (7) says that welfare is positively related to the level of public good  $g$  and of public capital  $F$ , but decreases with consumption tax  $\tau$  because of a decrease in consumers' surplus. Note the welfare does not depend directly on the level of private investment  $I$  as it is optimally chosen by the private sector (envelope theorem). An increase in foreign aid  $T$  increases total government expenditure  $G$  (equation (8)). An increase in  $\tau$  has two opposite effects on  $G$ : it raises tax revenue for every unit of initial consumption level, but it also reduces the level of consumption and thus the level of tax revenue for a given level of the tax rate. An increase in  $\lambda$  increases public investment by

diverting funds from social expenditure (first term in (9)). An increase in  $G$  increases public investment for a given level of  $\lambda$  (second term in (9)). An increase in  $G$  also increases the level of public good provision  $g$  (social expenditure) for a given level of  $\lambda$  (second term in (10)). An increase in  $\lambda$  decreases  $g$  by allocating less of public expenditure to social expenditure. Finally, equation (11) shows that an increase in public investment increases the level of private investment if the two types of investments are complementary, i.e., if  $R_{KF}^2 > 0$ .

We now examine how the policy parameters  $\lambda$  and  $\tau$ , and the level of foreign aid  $T$  affects welfare. For this, substituting (8)-(11) in (7), we derive:

$$\begin{aligned}
E_u du = & -G \left[ \frac{E_g}{R_g^1} - \frac{R_F^2}{1+r} \right] d\lambda + \left[ \frac{(1-\lambda)E_g}{R_g^1} + \frac{\lambda R_F^2}{1+r} \right] dT \\
& + p \left[ (E_p + \tau p E_{pp}) \left\{ \frac{(1-\lambda)E_g}{R_g^1} + \frac{\lambda R_F^2}{1+r} \right\} - E_p \right] d\tau
\end{aligned} \tag{12}$$

An increase in  $\lambda$  has two opposite effects on welfare: it decreases the provision of public good and increases public investment. An increase in foreign aid  $T$ , for a given level of  $\lambda$ , increases both the provision of public good and the level of public investment, and thus it has unambiguous positive effect on welfare. An increase in  $\tau$  has two effects. First, it reduces consumers' surplus and thus welfare. This is the marginal cost of consumption tax. The second effect is via its effect on tax revenue. It increases tax revenue, i.e., if  $p(E_p + \tau p E_{pp}) > 0$ , and then it has the same positive effect as foreign aid via increases in both the provision of public good and the level of public investment. This is the marginal benefit of consumption tax.

From (12), setting  $\partial u/\partial\lambda=\partial u/\partial\tau=0$  and simplifying, we get the following two first order condition for the determination of the optimal values of  $\tau$  and  $\lambda$ :

$$\frac{E_g}{R_g^1} = \frac{R_F^2}{1+r}, \quad (13)$$

$$\frac{\tau\varepsilon_p}{1+\tau} = 1 - \frac{1+r}{R_F^2}, \quad (14)$$

where  $\varepsilon_2$  ( $= -E_{pp}p(1+\tau)/E_p = -(\partial E_p/\partial(p(1+\tau))) \cdot (p(1+\tau)/E_p)$ ), is the compensated price elasticity of demand for good 2.

The left hand side of (13) gives the marginal cost (decrease in social spending) of increasing  $\lambda$  and the right hand side the benefits (increase in public investment). Since in a poor country, the rate of return to public capital is high and the marginal willingness to pay for a public good is low, one would expect the optimal value of  $\lambda$  to be rather small in order for optimality condition (13) to hold. From (14) it also follows that here there will be under provision of the public good as compared to the Samuelsonian rule ( $E_g = R_g^1$ ) if and only if  $R_F^2 > R_K^2 = 1+r$ .

The optimality condition for  $\tau$  is similar to the well-known inverse-elasticity rule of optimal commodity taxation under a revenue constraint (see, for example, Diamond and Mirrlees, 1971). Since there are two possible use of government revenue here and the allocation between the two is also optimal, the exact formula for optimal commodity taxation is somewhat different from the ones found in the literature. Since an increase in consumption tax increases, *inter alia*, public capital, the rate of return to public capital is positively related to the level of optimal consumption tax. This observation will be shown to have some important implications for the effect of foreign aid on public investment.

### 3.2. Fiscal Impacts of Foreign Aid

Having characterized the optimal values of  $\tau$  and  $\lambda$  in the preceding section, in this section we shall examine the effect of an exogenous change in the level of foreign aid on the optimal values of  $\tau$  and  $\lambda$ , private investment  $I$ , public good provision  $g$ , public investment  $F$ , and the level of borrowing  $B$ . These will tell us how foreign aid affects tax efforts, recurring expenditure, development expenditure, private investment, and borrowing.

Differentiating (13) and (14) and using (8)-(14), we get:<sup>6</sup>

$$\alpha_{11}d\lambda + \alpha_{12}d\tau = \alpha_{13}dT, \quad (15)$$

$$\alpha_{21}d\lambda + \alpha_{22}d\tau = \alpha_{23}dT, \quad (16)$$

where

$$\alpha_{11} = \frac{G}{E_g} \left[ E_{gg} - \frac{(R_g^1)^2 \Delta_2}{R_{KK}^2 (1+r)} \right] < 0, \quad \Delta_2 = R_{KK}^2 R_{FF}^2 - (R_{KF}^2)^2 > 0,$$

$$\alpha_{12} = -\frac{pE(1+r)}{R_F^2 E_g} \left[ (1-\lambda)E_{gg} + \frac{\lambda(R_g^1)^2 \Delta_2}{R_{KK}^2 (1+r)} \right], \quad \alpha_{13} = \frac{\lambda(R_g^1)^2 \Delta_2}{R_{FF}^2 E_g (1+r)} - \frac{E_{gu}}{E_u} > 0,$$

$$\alpha_{21} = \frac{G\Delta_2}{(R_F^2)^2 R_{KK}^2} < 0, \quad \alpha_{22} = \frac{(1-\lambda)pE_p(1+r)\Delta_2}{(R_F^2)^3 R_{KK}^2} - \frac{\varepsilon_p}{(1+\tau)^2} < 0, \quad \alpha_{23} = \frac{(1-\lambda)\Delta_2}{(R_F^2)^3 R_{KK}^2} < 0.$$

Solving (15) and (16) simultaneously, we derive:

$$\Delta \frac{d\lambda}{dT} = -\frac{\alpha_{13}\varepsilon_p}{(1+\tau)^2} + \frac{\eta_u p \lambda E_p (1+r) \Delta_2}{g(R_F^2)^3 R_{KK}^2} + \frac{\lambda(1-\lambda)pE_p(1+r)\Delta_2 \eta_g}{g(R_F^2)^3 R_{KK}^2} < 0, \quad (17)$$

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<sup>6</sup>Note that  $\Delta_2 > 0$  as revenue functions must be negative semi-definite in factor endowments. The fact that  $\alpha_{11} < 0$  and  $\alpha_{22} < 0$  go toward confirming that the second-order conditions for the government's optimization problem are satisfied. See also see the sentence below (18).

$$\Delta \frac{d\tau}{dT} = \frac{G\Delta_2}{(R_F^2)^2 R_{KK}^2 g} [\lambda\eta_g - \eta_u] \quad (18)$$

where  $\eta_u = -(\partial E_u / \partial g)(g / E_u) > 0$  and  $\eta_g = -(\partial E_g / \partial g)(g / E_g) > 0$ , and  $\Delta = a_{11}a_{22} - a_{12}a_{21} > 0$  in order for the second order condition for the government's optimization problem to be satisfied.  $\eta_u$  is the home country's marginal propensity to pay for the public good,  $\eta_g$  is the elasticity of the marginal willingness to pay for the public good with respect to the public good provision.

From assumptions 1 and 2, it follows that  $d\lambda/dT < 0$ . That is, an increase in foreign aid will raise the proportion of government revenue going to the production of public good and reduce the proportion going to public investment. Formally,

**Proposition 1** *An increase in foreign aid would reduce the proportion of government revenue that is allocated for public investment.*

The above result can be explained intuitively as follows. Since  $E_{gu} < 0$  (assumption 2), an increase in foreign aid increases the marginal cost of increasing  $\lambda$  (given by the left hand side of (1)). Foreign aid, by increasing public investment for given value of  $\lambda$ , also reduces the marginal benefit since  $R_{FF}^2 < 0$ .<sup>7</sup> Therefore, an increase in  $T$  unambiguously decreases the optimal level of  $\lambda$ .

Turning now to the effect on tax efforts, from (18) we find that an  $d\tau/dT < 0$  if and only if  $\lambda\eta_g > \eta_u$ . That is, if this condition is satisfied, an increase in foreign aid decreases tax efforts. In the special case of preferences where

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<sup>7</sup>There are second round effects which are dominated by these initial direct effects. For example, an foreign aid-induced increase in  $F$  increases domestic investment which increases marginal cost of  $\beta$  since  $R_{KF}^2 > 0$  (assumption 2).

$E(p(1+\tau), 1/(1+r), g, u) = E(p(1+\tau), 1/(1+r), u - f(g))$  with  $f' > 0 > f''$ ,<sup>8</sup> it can be verified that  $\eta_g = \eta_u - (gf''/f')$  and thus when the optimal level of  $\beta$  is large (which is expected to be the case, as argued before) the condition is indeed satisfied.

Our result on tax effort is stated formally in the following proposition.

**Condition 1**  $\lambda\eta_g > \eta_u$

**Proposition 2** *Under condition 1, an increase in foreign aid reduces the optimal level of consumption tax rate.*

The above proposition can be explained as follows. The direct effect of an increase in  $T$  is to reduce the optimal value of  $\tau$ . An increase in  $T$ , for a given level of  $\lambda$ , increases government budget and therefore public investment  $F$ . This reduces the rate of return to public investment  $R_F^2$  and therefore the right hand side of (14) (the marginal benefit of  $\lambda$ ). However, there is an indirect effect which works via changes in  $\lambda$ . As we have seen above, an increase in  $T$  reduces the optimal level of  $\lambda$  — the proportion of government budget allocated to public investment, and this increases  $R_F^2$  and thus increases the optimal level of  $\tau$ . It can be verified that the magnitude of this indirect effect increases with  $\eta_u$  and decreases with  $\eta_g$ . An increase in  $T$  increases  $g$  and therefore  $E_g$ , reducing marginal cost of  $\lambda$  (left hand side of (13)). The magnitude of this reduction depends on the magnitude of  $\eta_g$ . An increase in  $T$  also increases  $u$  reducing  $E_g$  and therefore increasing the marginal cost of  $\lambda$ . The magnitude of this increase

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<sup>8</sup>This will be the case if the utility function is additively separable in private and public consumption.

depends on the magnitude of  $\eta_u$ . It so happens that the direct effect of an increase in  $T$  dominates the indirect effect if and only condition 1 is satisfied.

Differentiating (4) we find

$$-R_g^1 dg = -Gd\lambda + \frac{(1-\lambda)pE_p(1+r)}{R_F^2} d\tau + (1-\lambda)dT. \quad (19)$$

Substituting (17) and (18) in (19), we obtain

$$(-R_g^1) \cdot \frac{dg}{dT} = (1-\lambda) - \frac{G\alpha_{13}\varepsilon_p}{(1+\tau)^2} - \frac{\eta_u pE_p(1+r)\Delta_2}{(R_F^2)^3 R_{KK}^2 g} > 0. \quad (20)$$

That is, an increase in  $T$  unambiguously increases the provision of public good. Even though the effect of  $T$  on  $\tau$  and therefore tax revenue is ambiguous, the effect of a foreign aid-induced increase in  $1-\lambda$  dominates.

Tuning to the effect of public investment, differentiating (5) and (14) we get:

$$\Delta_2 dF = \frac{R_{KK}^2 (R_F^2)^2 \varepsilon_p}{(1+\tau)^2} d\tau. \quad (21)$$

Thus, under condition 1, an increase in  $T$  increases  $F$  and therefore from (11) private investment  $I$ . Formally,

**Proposition 3** *An increase in foreign aid increases the provision of public good, and under condition 1, also increases both public and private investments.*

As noted before, the optimal level of  $\tau$  is positively related to the rental rate of public capital  $R_F^2$  which in turn is negatively related to the level of public capital. Thus, under condition 1, the level of public investment increases via a decrease in the consumption tax rate. Finally, since public and private capital are assumed to be complementary, foreign aid also decreases private investment via a decrease in public

investment. An increase in foreign aid reduces tax efforts under condition 1, i.e., crowd out tax revenue but not to the full amount and therefore both social expenditure and public investment increase. Note that since  $F=\lambda G$ , an increase in  $T$  must increase total government expenditure  $G$  as it increases  $F$  and decreases  $\lambda$ .

As for the effect on borrowing, differentiating (6), we get:

$$(1+r)dB = R_K^2 dI + R_F^2 dF - p_2 E_{1p} d\tau - E_{1g} dg - E_{1u} du, \quad (22)$$

where from (12)-(14) we have:

$$E_u du = \frac{R_F^2}{1+r} dT. \quad (23)$$

Since both private and public investments go up as a result of foreign aid, period-2 income go up on these counts. These effects are given by the first two terms on the right hand side of (22). Since foreign aid decreases consumption tax in period 1 and thus the consumer price in that period, it shifts some private consumption from period 2 to period 1, reducing expenditure in period 2. This effect is given by the third term on the right hand side of (22). The penultimate term on the right hand side of (22) will also increase borrowing comes via an increase in social expenditure. An increase in  $g$  must reduce private consumption in order to keep utility constant. Since we assume that the effect of an increase in  $g$  falls entirely on the numeraire good (assumption 2),  $E_{1g} < 0$ . All these effects will tend to increase net income over expenditure in period 2 and therefore the demand for borrowing in period 1. The last term gives the positive income effect on period-2 expenditure, since foreign aid unambiguously increases inter-temporal real income given by  $u$  (equation (23)). This is the only term which will reduce the demand



for borrowing. It may be reasonable to assume that this effect will be dominated by the other positive effect on borrowing.

#### 4. Empirical Analysis

In this section we develop and test an empirical framework suitable to analyze two of the hypothesis derived from our theoretical model. The key predictions of the theoretical model are that an increase in aid reduces the tax efforts of the government (proposition 2) and the proportion of public expenditure that is spent on public investment (proposition 1). Using a time series data set for Rwanda, we will test these two hypotheses in the context of an econometric model derived as a reduced form of the theoretical model.

We consider linear regressions of the form:

$$\begin{aligned}
 PUBINV / TOTEXP = & \beta_0 + \beta_1 ODA / GDP + \beta_2 EXP / GDP + \beta_3 LAB \\
 & + \beta_4 DUMMY(96+) + \beta_5 (ODA / GDP) * DUMMY(96+) + \varepsilon_1
 \end{aligned} \tag{24}$$

$$\begin{aligned}
 TAXREV / GDP = & \beta_7 + \beta_7 ODA / GDP + \beta_8 EXP / GDP + \beta_9 LAB \\
 & + \beta_{10} DUMMY(96+) + \beta_{11} (ODA / GDP) * DUMMY(96+) + \varepsilon_2,
 \end{aligned} \tag{25}$$

where

$PUBINV/TOTEXP$  = Public investment as a percentage of total public expenditure,

$TAXREV/GDP$  = Tax revenue as a percentage of GDP,

$ODA/GDP$  = Overseas development assistance as a percentage of GDP,

$EXP/GDP$  = Exports as a percentage of GDP,

$LAB$  = Labor force (number of people who meet the ILO definition of the economically active population),

DUMMY(96+) = Takes the value 1 for 1996 onward, and zero otherwise.

PUBINV/TOTEXP represents the variable  $\lambda$ , TAXREV/GDP is a proxy for the tax rate  $\tau$ , and ODA/GDP is foreign aid T, in our theoretical analysis. We have added other explanatory variables such as EXP/GDP and LAB as control variables. As mentioned before, the economy of Rwanda went through very significant changes after the genocide of 1994; in particular many of the changes in terms of the policy regime came into effect in 1996. Thus, the qualitative effect of aid on the endogenous variables can be different after 1996 compared to what it was before then. To capture this effect we have included an intercept dummy (DUMMY(96+)) as well as a slope dummy that interact with ODA/GDP. Based on proposition 1 and 2, we expect a negative signs for both  $\beta_1$  and  $\beta_7$ .

Before discussing the results, it is useful to discuss the data.

### *Description of Data*

The data used in this study come from the World Development Indicators (WDI, 2006). Table 2 summarizes the mean, median and standard deviation of the variables used in the regression. As can be seen from the above table, all the variables display fair degree of variations.

**Table 2: Descriptive Statistics of the Variables**

	PUBINV/TOTEXP	TAXREV	ODA/GDP	LAB	EXP/GDP
Mean	40.81	9.85	20.29	2.99	8.32
Median	39.42	10.08	17.24	2.82	7.65
Maximum	60.29	12.67	95.05	4.18	14.44
Minimum	19.23	3.62	9.54	2.28	5.15
Std. Dev.	10.31	1.92	18.3	0.59	2.71
Skewness	0.21	-1.32	3.12	0.75	0.66
Kurtosis	2.55	5.81	12.65	2.29	2.29

Before we commence on model estimation, we need to determine the stationarity nature of the variables of interest. In view of that, we begin our analysis by performing unit root test for each variable using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. While we are doing the ADF test we pick the lag length on the augmentation term based on whether the exclusion of lagged term causes serial correlation in the test equation's error term. As for the PP test, on the other hand, we use a truncation lag of one given the fact that the frequency of our data is annual.

**Table 3: Results of Dickey-Fuller test**

Variable	ADF ( Levels)	ADF ( Differences)	PP ( Levels)	PP (Differences)	Critical value (5%)
PUBINV/TOTEXP	-2.91	-6.8**	-2.91	-9.77**	-3.61
TAXREV	-1.79	-4.64**	-1.79	-4.64**	-3.74
ODA/GDP	-2.91	-7.26**	-2.89	-8.75**	-3.58
LAB	-2.91	-6.8**	-2.91	-9.77**	-3.61
EXP/GDP	-1.79	-4.64**	-1.79	-4.64**	-3.74

Note: ADF is the augmented Dickey Fuller test and PP is Phillips-Perron test. The null hypothesis is that the series is non-stationary. The asterisks (\*\*) represent a rejection of the null hypothesis at 5% level. PubInv represents public investment as a share of total government expenditure, TaxRev is the ratio of tax revenue to GDP, PubInv\_T is  $PUBINV/(100-PUBINV/TOTEXP)$ , TAXREV\_T is  $TAXREV/(100-TAXREV)$ , ODA is the ratio of official development assistance to GDP, Labor is total labor force and Export is the ratio of total exports in GDP.

Table 3 presents the estimated ADF statistics. All variables appear to have at least one unit root, since the nonstationarity test is not rejected for these variables in levels. To check for a second unit root we carried out a further unit root tests on first differences of the variables. When the variables are differenced once, all of the ADF statistics are significant at one percent level. Now, we can proceed with the analysis under the assumption that no variable contains more than one unit root and the first difference of each variable is stationary. Table 2 includes columns that describe the value for the test

statistics and the critical values for rejecting or accepting the null hypothesis of a unit root. Both the ADF and PP unit root test results suggest that all variables are non-stationary at 1% level, and integrated of order one I(1). Therefore, we use first differences of the variables in our estimations.

### ***Empirical results***

Table 4 presents results from the estimation of the basic regression equations (24) and (25).<sup>9</sup> LAB and EXP/GDP were included separately in both regressions as control variables. Since the explanatory variable ODA/GDP can itself be endogenous – a country receiving more aid in response to its economic difficulties – we run OLS as well IV (2SLS) regressions where the variable ODA/GDP is instrumented with its lagged value and all other explanatory variables as instruments. As the results show, the coefficient of ODA/GDP is consistently negative and significant at 99% confidence level. Our finding on the effect of foreign aid on tax efforts is consistent with many other studies, cross-section and time series for other countries (see, for example, McGillvary and Morrissey (2004)).

The value of the coefficient of D(ODA\_GDP) in PUBINV/TOTEXP equations is roughly -0.31 and that in TAXREV/GDP equations is -0.06. This means that one percentage point increase in ODA/GDP results in a reduction in PUBINV/TOTEXP by 0.31 percentage points and in TAXREV/GDP by 0.06 percentage points. Thus, effects are significant but very small.

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<sup>9</sup> Since the values of our dependent variables are between 0 and 100, we also run the regression after transforming the dependent variables into  $(\text{TAXREV}/\text{GDP})/(100-(\text{TAXREV}/\text{GDP}))$  and  $(\text{PUBINV}/\text{TOTEXP})/(100-(\text{PUBINV}/\text{TOTEXP}))$ . The results which are similar to those in table 4 are presented in table 5.

The other interesting finding is that the estimated coefficient of  $(ODA/GDP)*DUMMY(96+)$  is significant and positive for  $PUBINV/TOTEXP$  equations, and positive but insignificant for  $TAXREV/GDP$  equations. The magnitude of the coefficient  $(ODA/GDP)*DUMMY(96+)$  in the  $PUBINV/GDP$  equations is +0.30 meaning that the effect of  $ODA/GDP$  on  $PUBINV$  after 1996 is not significant.

To summarize, we find that aid inflow is negatively associated with the government's tax efforts in the sense that it reduced the average tax rate (as measured by the share of total tax revenue to GDP). It also had a small negative effect on the ratio of public expenditure going into public investment until 1995, but aid has had virtually no effect on the ratio of public expenditure going into public investment since 1996. This seems to imply that aid inflows during (and post) policy reform period (1996-2004) was efficient in a sense that it had a positive contribution to development projects through public resource allocation.

**Table 4: Estimates of the Fiscal Impact of Aid**  
**Sample: 1981-2004**

Dependent Variable	D(PUBINV/TOTEXP)				D(TAXREV/GDP)			
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Equation No.	1	2	3	4	5	6	7	8
Constant	0.69 (0.29)	1.32 (0.53)	0.87 (0.76)	1.38 (0.99)	-0.1 (0.39)	-0.0911 (0.390)	-0.03 (0.13)	-0.03 (1.40)
D(EXP/GDP)			1.16*** (2.54)	1.33*** (2.58)			0.10 (1.25)	0.11 (1.40)
D(LAB)	-25.54 (1.62)	-31.45 (1.61)			-0.85 (0.55)	-0.91 (0.60)		
D(ODA/GDP)	-0.32*** (3.56)	-0.53*** (6.05)	-0.31*** (3.15)	-0.6*** (13.19)	-0.06*** (26.78)	-0.07*** (7.78)	-0.06*** (18.54)	-0.07*** (6.50)
Dummy(96+)	3.50 (0.68)	3.99 (0.78)	-1.98 (0.89)	-2.56 (1.09)	-0.7 (1.38)	0.71 (1.37)	0.44 (1.07)	0.43 (1.14)
D(ODA/GDP)* Dummy(96+)	0.27 (1.40)	0.49*** (2.77)	0.32* (1.82)	0.61*** (4.40)	0.0006 (0.03)	0.003 (0.13)	0.0008 (0.33)	0.001 (0.36)
R-Squared	0.41	0.24	0.46	0.16	0.72	0.72	0.73	0.73
F-Statistics	3.34	1.97	7.2	3.81	12.24	5.36	13.02	5.39
D-W	1.91	2.23	1.81	2.12	2.02	2.03	1.89	1.9
S.E.	7.76	8.84	5.77	7.17	0.88	0.88	0.86	0.86

\*\*\* Significant at 99% confidence level

\*\* Significant at 95% confidence level

\* Significant at 90% confidence level

Instruments in the IV method are: Constant, D(ODA/GDP)(-1), Dummy(96+), D(ODA/GDP)\* Dummy(96+), and either D(LAB) or D(EXP/GDP). Notations: PUBINV\_TOTEXP is Public investment to total government expenditure (recurrent public expenditure plus public investment) ratio (multiplied by 100). TAXREV is tax revenue to GDP ratio (multiplied by 100). D(.) denotes first difference. ODA\_GDP is ODA to GDP ratio (multiplied by 100). ODA\_GDP\_Dummy is in fact D(ODA\_GDP) times the dummy variable for 1996-2005. PUBINV\_T is PUBINV/(100-PUNINV). TAXREV\_T is TAXREV(100-TAXREV)

**Table 5: Estimates of the Fiscal Impact of Aid**  
**Sample: 1981-2004**

Dependent Variable	D((PUBINV/TOTEXP) (100-(PUBINV/TOTEXP)))				D((TAXREV/GDP)/(100-(TAXREV/GDP)))			
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Regression Method	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Equation No.	9	10	11	12	13	14	15	16
Constant	0.01 (0.14)	0.026 (0.33)	0.02 (0.65)	0.04 (0.89)	-0.001 (0.42)	-0.001 (0.42)	-0.001 (0.156)	-0.0004 (0.15)
D(EXP/GDP)			0.04*** (2.65)	0.05*** (2.72)			0.001 (1.25)	0.001 (1.38)
D(LAB)	-0.72 (1.31)	-0.86 (1.47)			-0.01 (0.51)	-0.01 (0.55)		
D(ODA/GDP)	-0.01*** (3.17)	-0.01*** (4.94)	-0.01*** (2.8)	-0.01*** (10.09)	-0.001*** (28.72)	-0.001*** (7.39)	-0.001*** (18.18)	-0.001*** (6.1)
Dummy(96+)	0.11 (0.64)	0.12 (0.71)	-0.06 (1.13)	-0.07 (1.32)	0.01 (1.33)	0.009 (1.32)	0.01 (1.06)	0.01 (1.15)
D(ODA/GDP)* Dummy(96+)	0.005 (1.001)	0.01** (2.18)	0.01* (1.66)	0.01*** (2.72)	-2.66E-05 (0.13)	-6.92E-06 (0.03)	6.35E-05 (0.23)	7.33E-05 (0.24)
R-Squared	0.25	0.13	0.39	0.19	0.68	0.68	0.7	0.7
F-Statistics	1.62	1.19	5.43	3.77	10.23	4.62	10.98	4.66
D-W	1.92	2.14	1.81	2.04	2.00	2.01	1.87	1.87
S.E.	0.25	0.27	0.18	0.20	0.01	0.01	0.01	0.01

\*\*\* Significant at 99% confidence level

\*\* Significant at 95% confidence level

\* Significant at 90% confidence level

Instruments in the IV method are: Constant, D(ODA/GDP)(-1), Dummy(96+), D(ODA/GDP)\* Dummy(96+), and either D(LAB) or D(EXP/GDP). Notations: PUBINV\_TOTEXP is Public investment to total government expenditure (recurrent public expenditure plus public investment) ratio (multiplied by 100). TAXREV is tax revenue to GDP ratio (multiplied by 100). D(.) denotes first difference. ODA\_GDP is ODA to GDP ratio (multiplied by 100). ODA\_GDP\_Dummy is in fact D(ODA\_GDP) times the dummy variable for 1996-2005. PUBINV\_T is PUBINV/(100-PUNINV). TAXREV\_T is TAXREV(100-TAXREV)

## 5. Conclusion

Rwanda has made major strides toward a sustained economic recovery following the genocide of 1994 and the subsequent formation of a civilian government. The inflow of large quantities of foreign aid into Rwanda has made the extent of recovery and growth possible. However, scaled-up foreign aid can have some potential adverse effects such as aid dependency. This may particularly happen if aid has a significant negative effect on tax efforts of the government and on public investments. In this paper, we carry out a theoretical and empirical study to examine the above issues as a first step toward designing the interventions to support the effective use of aid. The results from the paper hopefully provide insights to the effective use of aid to support growth.

The theoretical part develops an optimizing model in which the recipient government decides on the optimal level of tax and optimally allocates total government revenue (tax revenue and foreign aid) between current expenditure and public investment. Our theoretical prediction is that an increase in aid is likely to reduce the optimal tax rate and the proportion of public expenditure allocated to public investment.

The empirical analysis uses time series data on Rwanda, to estimate that an increase in aid is associated with a reduced average tax rate in Rwanda, but the magnitude of the effect is very small. A 1 percentage point increase in aid to GDP ratio has reduced the rate of taxation by only 0.05 percentage point. It would appear that the reforms put in place to strengthen the efficiency of revenue administration have mitigated the impact of ODA. As for public investment, we find that an increase in aid also had a negative effect on the proportion of public expenditure allocated to public investment



until 1995, although the effect is again not very large: a one percentage point increase in aid to GDP ratio reduces the proportion of public expenditure allocated to public investment by 0.3 percentage points. However, since 1995 the direction of this effect has changed. The pattern of government spending and reforms adopted indicate that there was strong political will to adopt appropriate measures and policies to mitigate the potential adverse fiscal effects of aid. As a result, in the case of Rwanda, as far as fiscal effects are concerned, foreign aid does not seem to have had a negative impact, particularly since 1995.

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