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**Working Paper**

## Aid disaggregation, endogenous aid and the public sector in aid-recipient economies: Evidence from Côte d'Ivoire

WIDER Discussion Paper, No. 2003/15

**Provided in Cooperation with:**

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*Suggested Citation:* Mavrotas, George; Ouattara, Banzoumana (2003) : Aid disaggregation, endogenous aid and the public sector in aid-recipient economies: Evidence from Côte d'Ivoire, WIDER Discussion Paper, No. 2003/15, ISBN 9291904139, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki

This Version is available at:

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World Institute for Development Economics Research

Discussion Paper No. 2003/15

**Aid Disaggregation, Endogenous  
Aid and the Public Sector  
in Aid-Recipient Economies:  
Evidence from Côte d'Ivoire**

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and Bazoumana Ouattara<sup>2</sup>

February 2003

**Abstract**

The present paper examines the impact of different aid types, namely project aid, programme aid, technical assistance and food aid on the fiscal sector of the aid-recipient economy by using time-series data for Côte d'Ivoire over the period 1975–99. Empirical results obtained by estimating correctly the solution of the theoretical model show that when a single value (or aggregated) for aid is used, foreign aid is fully consumed in the case of Côte d'Ivoire. However, results obtained under the assumption of aid heterogeneity clearly suggest that the government responds differently according to the nature of the aid inflows. Our approach sheds plenty of light on how the aid-recipient government reacts to different categories of foreign aid inflows and the empirical findings clearly demonstrate the importance of the aid disaggregation approach for delving deeper into aid effectiveness issues.

Keywords: foreign aid, aid effectiveness, aid disaggregation, fiscal response literature, Côte d'Ivoire

JEL classification: F35

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This study has been prepared within the UNU/WIDER project on New Directions in Development which is directed by Tony Addison.

## Acknowledgements

The present paper draws on an earlier version which was written while both authors were based at the University of Manchester. We would like to thank Mark McGillivray for helping us with the estimation task by kindly sending his TSP workfile as well as Jean-Louis Grolleau at the OECD-DAC Office for helpful advice on the data front. The usual disclaimer applies.

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UNU World Institute for Development Economics Research (UNU/WIDER)  
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

Camera-ready typescript prepared by Janis Vehmaan-Kreula at UNU/WIDER  
Printed at UNU/WIDER, Helsinki

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ISSN 1609-5774  
ISBN 92-9190-412-0 (printed publication)  
ISBN 92-9190-413-9 (internet publication)

## 1 Introduction

Recent years have witnessed a revived interest in aid effectiveness issues. New research in this area by Boone (1996), the World Bank (*Assessing Aid* 1998) and Burnside and Dollar (2000) to mention the most influential studies have taken the debate on new ground with emphasis on the important aid-policy-institutions-growth nexus. However, one of the key criticisms of the above ‘aid-growth’ literature is that it fails to recognize explicitly that aid is given primarily to governments in aid-recipient countries, and hence any impact of aid on the macroeconomy will depend on government behaviour, in particular how fiscal decisions on taxation and expenditure are effected by the presence of aid. This is exactly what motivates the so-called ‘fiscal response’ literature i.e. modelling how the impact of aid is mediated by public sector behaviour.<sup>1</sup> The analysis of fiscal response is particularly important because it helps to open one of the many black boxes of the ‘aid-growth’ nexus. Along these lines, *Assessing Aid* (1998) fails to address the above important issue by not considering the ‘broader context’ of fiscal response (McGillivray and Morrissey 2000; Beynon 2002 and Mavrotas 2002a).

Moreover, a major problem with the existing literature on aid effectiveness is the neglect of the heterogeneous character of aid inflows. It has been correctly argued that aid is heterogeneous and each of its components exerts different macroeconomic effects on the aid-recipient economy. The use of a single figure for aid, a typical feature of the aid effectiveness literature,<sup>2</sup> cannot capture the above aid heterogeneity, thus leading to aggregation bias in the empirical ‘evidence’ reported (Cassen 1994; Mavrotas 2002a; Mavrotas and Ouattara 2003). As an important study has put it:

A simple correlation between aid and economic performance has obvious weaknesses, because aid is heterogeneous. For example, programme and project aid take effect over different periods of time. Food aid has a separate function, directly supporting consumption but potentially easing both savings and foreign exchange constraints. Technical co-operation also bears fruit over a variety of time periods, typically the long-term (Cassen 1994: 15).

There are two further relevant points regarding the aid disaggregation issue: Firstly, because of different conditions relating to each in different countries (e.g. the state of aid co-ordination may vary among aid recipients), there is an extra reason to expect different effects of aid in each country – the *ceteris paribus* assumptions of the econometrics of aid may be disturbed by such considerations. Secondly, within an endogenous fiscal response framework<sup>3</sup> if the government attaches different utility to each category of aid, using a single figure of aid would lead to aggregation bias in the results and conclusions reached.

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<sup>1</sup> The term is attributed to White (1992).

<sup>2</sup> Notable exceptions are Levy (1987), Mavrotas (2002a), Mavrotas (2002b) and Mavrotas and Ouattara (2003). Note, however, that Levy adopted a different aid-disaggregation approach namely ‘anticipated’ vs ‘unanticipated’ aid.

<sup>3</sup> This means that aid is endogenized in the government utility function.

The present paper examines the impact of different aid types, namely project aid, programme aid, technical assistance and food aid on the fiscal sector of the aid-recipient economy by using time-series data for Côte d’Ivoire over the period 1975–99. The data on disaggregated aid flows was constructed with the help of the OECD-DAC Office in Paris. We estimate a theoretical model recently developed by Mavrotas and Ouattara (2003) which extends the model developed by Mavrotas (2002a) on the following grounds: firstly, a new variable, food aid, is included in the model, apart from project aid, programme aid and technical assistance; secondly, all four aid variables used in the model are endogenized following Franco-Rodriguez *et al.* (1998); thirdly, also in line with Franco-Rodriguez *et al.* (1998) the budget constraints are specified in a way to avoid over-restriction and full fungibility. Finally, in addition to the structural equations, the reduced form equations are derived; this allows us to evaluate the total impact of the different components of aid on the public sector of the aid-recipient.

Apart from reasons related to data availability, Côte d’Ivoire makes a very interesting case study in view of the growing importance of aid for the Ivorian economy in recent years. Aid flows to the country and their share in total aid flows to sub-Saharan African countries have followed a steady build up over the period 1975–99. Furthermore, the use of ODA flows as a main source of finance coincides with the period the country started to experience economic difficulties. In other words, one could argue that aid to Côte d’Ivoire has been endogenous – a key feature of the model employed in the present paper. Finally, and most importantly, the proportions of each of the main types of aid (project aid, programme aid, technical assistance and food aid) have fluctuated substantially during the period of the study, thus, suggesting that an aid disaggregation approach is much more appropriate to examine aid effectiveness in the country, compared to the use of aggregated aid.

The rest of the paper is organized as follows. In section 2 we present the theoretical model which we subsequently estimate by using time-series data on Côte d’Ivoire covering the period 1975–99. Data and econometric methodology issues are the subject of section 3. In section 4 we estimate the direct impact of the different aid categories whereas in section 5 our focus is on the estimation of the total impact of aid types on the fiscal sector of the economy. The economic interpretation of the results obtained is the subject of section 6. The last section concludes the paper.

## 2 The model

As in Mavrotas and Ouattara (2003) the model assumes that the recipient government aims at maximizing a utility function that can be represented as:

$$U = f(I_g, G, T, B, A_1, A_2, A_3, A_4) \quad [1]$$

where  $I_g$  is public investment capital expenditure,  $G$  is government recurrent expenditure,  $T$  represents tax and non-tax revenue,  $B$  is government borrowing from all sources,  $A_1$  is project aid from all donors,  $A_2$  represents programme aid from all sources,  $A_3$  stands for technical assistance and  $A_4$  is food aid from all donors.

It is assumed that the government is a rational utility-maximizer setting annual targets for each fiscal variables and tries to reach these targets. Following Mosley *et al.* (1987),

Binh and McGillivray (1993) and more recently Mavrotas (2002a) this behaviour can be represented by a utility function without the linear terms, as below:

$$\begin{aligned}
U = & \alpha_0 - \frac{\alpha_1}{2}(I_g - I_g^*)^2 - \frac{\alpha_2}{2}(G - G^*)^2 - \frac{\alpha_3}{2}(T - T^*)^2 \\
& - \frac{\alpha_4}{2}(A_1 - A_1^*)^2 - \frac{\alpha_5}{2}(A_2 - A_2^*)^2 - \frac{\alpha_6}{2}(A_3 - A_3^*)^2 \\
& - \frac{\alpha_7}{2}(A_4 - A_4^*)^2 - \frac{\alpha_8}{2}(B - B^*)^2
\end{aligned} \tag{2}^4$$

where the starred variables represent the exogenous target variables,  $\alpha_i > 0$  for  $i = 1, \dots, 8$ . The  $\alpha_i$ 's represent the relative weights given to different terms in the utility function and, without loss of generality, may be normalized so that they sum up to unity. If the government meets all its targets, the maximum unconstrained would be  $\alpha_0$ .

A distinctive feature of the above model is that it endogenizes the four main components of foreign aid (project aid, programme aid, technical assistance and food aid). Aid variables are endogenized following Franco-Rodriguez *et al.* (1998) who rightly argued that aid disbursement is influenced by the recipient and, therefore, should be considered as a government policy variable.

We then assume, following Franco-Rodriguez *et al.* (1998) that the government maximizes utility function [2] subject to the following budget constraints:

$$I_g + G = B + T + A_1 + A_2 + A_3 + A_4 \tag{3}$$

$$G \leq \rho_1 T + \rho_2 A_1 + \rho_3 A_2 + \rho_4 A_3 + \rho_5 A_4 + \rho_6 B \tag{4}$$

where  $0 \leq \rho_i \leq 1$  and  $i = 1, 2, \dots, 6$ . The assumption underlying the budget constraint represented by Equation [3] is that government total spending (investment + consumption) must equal the sum of borrowing, tax and non-tax revenues and the different types of foreign aid. In other words, the government is assumed to run a balanced-budget. The rationale for the second constraint (Equation [4]) is that external forces (donors or domestic interest groups) will determine the way the government allocates its resources i.e. the  $\rho$ s in Equation [4] will be imposed on the government or those setting the targets and allocating revenue. Consequently, there will be no guarantee that the targets are met even if total revenue equals total expenditure (Franco-Rodriguez *et al.* 1998).

Contrary to many previous studies in the fiscal response literature, we also include borrowing in the specification of the second budget constraint. Some previous studies have assumed that the government prefers not to borrow for consumption purposes, as it is costly in relative terms. However, such restriction, in our view, should be the outcome of the estimation results i.e. if the government does not borrow to finance consumption

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<sup>4</sup> It is clear from this equation that the government utility is maximized when all targets are met, with the maximum being  $\alpha_0$ .

then the coefficient of B in equation [4] would not be significantly different from zero (i.e.  $\rho_6 = 0$ ).

In what follows, the model solution is derived. This involves deriving both structural and reduced-form equations. For this purpose, the Lagrangean is applied to the maximization problem, as below:

$$\begin{aligned}
L = & \alpha_0 - \frac{\alpha_1}{2}(I_g - I_g^*)^2 - \frac{\alpha_2}{2}(G - G^*)^2 - \frac{\alpha_3}{2}(T - T^*)^2 \\
& - \frac{\alpha_4}{2}(A_1 - A_1^*)^2 - \frac{\alpha_5}{2}(A_2 - A_2^*)^2 - \frac{\alpha_6}{2}(A_3 - A_3^*)^2 \\
& - \frac{\alpha_7}{2}(A_4 - A_4^*)^2 - \frac{\alpha_8}{2}(B - B^*)^2 \\
& + \lambda_1(I_g + G - B - T - A_1 - A_2 - A_3 - A_4) \\
& + \lambda_2(G - \rho_1 T - \rho_2 A_1 - \rho_3 A_2 - \rho_4 A_3 - \rho_5 A_4 - \rho_6 B)
\end{aligned} \tag{5}$$

where  $\lambda_1$  and  $\lambda_2$  are the Lagrange multipliers.

Turning the inequality sign into an equality and taking the first derivatives with respect to the endogenous variables and the multipliers leads to the following first order conditions:

$$\frac{\partial L}{\partial I_g} = -\alpha_1(I_g - I_g^*) + \lambda_1 = 0 \tag{6}$$

$$\frac{\partial L}{\partial G} = -\alpha_2(G - G^*) + \lambda_1 + \lambda_2 = 0 \tag{7}$$

$$\frac{\partial L}{\partial T} = -\alpha_3(T - T^*) - \lambda_1 - \lambda_2 \rho_1 = 0 \tag{8}$$

$$\frac{\partial L}{\partial A_1} = -\alpha_4(A_1 - A_1^*) - \lambda_1 - \lambda_2 \rho_2 = 0 \tag{9}$$

$$\frac{\partial L}{\partial A_2} = -\alpha_5(A_2 - A_2^*) - \lambda_1 - \lambda_2 \rho_3 = 0 \tag{10}$$

$$\frac{\partial L}{\partial A_3} = -\alpha_6(A_3 - A_3^*) - \lambda_1 - \lambda_2 \rho_4 = 0 \tag{11}$$

$$\frac{\partial L}{\partial A_4} = -\alpha_7(A_4 - A_4^*) - \lambda_1 - \lambda_2 \rho_5 = 0 \tag{12}$$

$$\frac{\partial L}{\partial B} = -\alpha_8(B - B^*) - \lambda_1 - \lambda_2 \rho_6 = 0 \tag{13}$$

$$\frac{\partial L}{\partial \lambda_1} = I_g + G - B - T - A_1 - A_2 - A_3 - A_4 = 0 \quad [14]$$

$$\frac{\partial L}{\partial \lambda_2} = G - \rho_1 T - \rho_2 A_1 - \rho_3 A_2 - \rho_4 A_3 - \rho_5 A_4 - \rho_6 B = 0 \quad [15]$$

Like Heller (1975), Mosley *et al.* (1987), Gang and Khan (1991) and others we assume *ex ante* that the target for borrowing ( $B^*$ ) is equal to zero. Solving the first-order conditions yields to following system of structural equations:

$$\begin{aligned} I_g &= (1 - \rho_1)\beta_1 I_g^* + (1 - \rho_1)\beta_2 G^* \\ &+ (1 - \rho_1)[1 - (1 - \rho_1)\beta_1 - \rho_1\beta_2]T^* \\ &+ [(1 - \rho_2) - (1 - \rho_1)(1 - \rho_2)\beta_1 - (1 - \rho_1)\rho_2\beta_2]A_1 \\ &+ [(1 - \rho_3) - (1 - \rho_1)(1 - \rho_3)\beta_1 - (1 - \rho_1)\rho_3\beta_2]A_2 \\ &+ [(1 - \rho_4) - (1 - \rho_1)(1 - \rho_4)\beta_1 - (1 - \rho_1)\rho_4\beta_2]A_3 \\ &+ [(1 - \rho_5) - (1 - \rho_1)(1 - \rho_5)\beta_1 - (1 - \rho_1)\rho_5\beta_2]A_4 \\ &+ [(1 - \rho_6) - (1 - \rho_1)(1 - \rho_6)\beta_1 - (1 - \rho_1)\rho_6\beta_2]B \end{aligned} \quad [16]$$

$$\begin{aligned} G &= \rho_1\beta_1 I_g^* + \rho_1\beta_2 G^* + \rho_1[1 - (1 - \rho_1)\beta_1 - \rho_1\beta_2]T^* \\ &+ [\rho_2 - \rho_1(1 - \rho_2)\beta_1 - \rho_1\rho_2\beta_2]A_1 \\ &+ [\rho_3 - \rho_1(1 - \rho_3)\beta_1 - \rho_1\rho_3\beta_2]A_2 \\ &+ [\rho_4 - \rho_1(1 - \rho_4)\beta_1 - \rho_1\rho_4\beta_2]A_3 \\ &+ [\rho_5 - \rho_1(1 - \rho_5)\beta_1 - \rho_1\rho_5\beta_2]A_4 \\ &+ [\rho_6 - \rho_1(1 - \rho_6)\beta_1 - \rho_1\rho_6\beta_2]B \end{aligned} \quad [17]$$

$$\begin{aligned} T &= \beta_1 I_g^* + \beta_2 G^* + [1 - (1 - \rho_1)\beta_1 - \rho_1\beta_2]T^* \\ &- [(1 - \rho_2)\beta_1 + \rho_2\beta_2]A_1 \\ &- [(1 - \rho_3)\beta_1 + \rho_3\beta_2]A_2 \\ &- [(1 - \rho_4)\beta_1 + \rho_4\beta_2]A_3 \\ &- [(1 - \rho_5)\beta_1 + \rho_5\beta_2]A_4 \\ &- [(1 - \rho_6)\beta_1 + \rho_6\beta_2]B \end{aligned} \quad [18]$$

$$\begin{aligned} A_1 &= \beta_3 I_g^* + \beta_4 G^* - [(1 - \rho_1)\beta_3 + \rho_1\beta_4]T \\ &+ [1 - (1 - \rho_2)\beta_3 - \rho_2\beta_4]A_1^* \\ &- [(1 - \rho_3)\beta_3 + \rho_3\beta_4]A_2 \\ &- [(1 - \rho_4)\beta_3 + \rho_4\beta_4]A_3 \\ &- [(1 - \rho_5)\beta_3 + \rho_5\beta_4]A_4 \\ &- [(1 - \rho_6)\beta_3 + \rho_6\beta_4]B \end{aligned} \quad [19]$$



$$\begin{aligned}
A_2 = & \beta_5 I_g^* + \beta_6 G^* - [(1 - \rho_1)\beta_5 + \rho_1\beta_6]T \\
& - [(1 - \rho_2)\beta_5 + \rho_2\beta_6]A_1 \\
& + [1 - (1 - \rho_3)\beta_5 - \rho_3\beta_6]A_2^* \\
& - [(1 - \rho_4)\beta_5 + \rho_4\beta_6]A_3 \\
& - [(1 - \rho_5)\beta_5 + \rho_5\beta_6]A_4 \\
& - [(1 - \rho_6)\beta_5 + \rho_6\beta_6]B
\end{aligned} \tag{20}$$

$$\begin{aligned}
A_3 = & \beta_7 I_g^* + \beta_8 G^* - [(1 - \rho_1)\beta_7 + \rho_1\beta_8]T \\
& - [(1 - \rho_2)\beta_7 + \rho_2\beta_8]A_1 \\
& - [(1 - \rho_3)\beta_7 + \rho_3\beta_8]A_2 \\
& + [1 - (1 - \rho_4)\beta_7 - \rho_4\beta_8]A_3^* \\
& - [(1 - \rho_5)\beta_7 + \rho_5\beta_8]A_4 \\
& - [(1 - \rho_6)\beta_7 + \rho_6\beta_8]B
\end{aligned} \tag{21}$$

$$\begin{aligned}
A_4 = & \beta_9 I_g^* + \beta_{10} G^* - [(1 - \rho_1)\beta_9 + \rho_1\beta_{10}]T \\
& - [(1 - \rho_2)\beta_9 + \rho_2\beta_{10}]A_1 \\
& - [(1 - \rho_3)\beta_9 + \rho_3\beta_{10}]A_2 \\
& - [(1 - \rho_4)\beta_9 + \rho_4\beta_{10}]A_3 \\
& + [1 - (1 - \rho_5)\beta_9 - \rho_5\beta_{10}]A_4^* \\
& - [(1 - \rho_6)\beta_9 + \rho_6\beta_{10}]B
\end{aligned} \tag{22}$$

$$\begin{aligned}
B = & \beta_{11} I_g^* + \beta_{12} G^* - [(1 - \rho_1)\beta_{11} + \rho_1\beta_{12}]T \\
& - [(1 - \rho_2)\beta_{11} + \rho_2\beta_{12}]A_1 \\
& - [(1 - \rho_3)\beta_{11} + \rho_3\beta_{12}]A_2 \\
& - [(1 - \rho_4)\beta_{11} + \rho_4\beta_{12}]A_3 \\
& - [(1 - \rho_5)\beta_{11} + \rho_5\beta_{12}]A_4
\end{aligned} \tag{23}$$

with

$$\begin{aligned}
\beta_1 = \frac{\alpha_1(1 - \rho_1)}{\theta_1}, \beta_2 = \frac{\alpha_2\rho_1}{\theta_1}, \beta_3 = \frac{\alpha_1(1 - \rho_2)}{\theta_2}; \beta_4 = \frac{\alpha_2\rho_2}{\theta_2}; \beta_5 = \frac{\alpha_1(1 - \rho_3)}{\theta_3}; \beta_6 = \frac{\alpha_2\rho_3}{\theta_3}; \\
\beta_7 = \frac{\alpha_1(1 - \rho_4)}{\theta_4}; \beta_8 = \frac{\alpha_2\rho_4}{\theta_4}; \beta_9 = \frac{\alpha_1(1 - \rho_5)}{\theta_5}; \beta_{10} = \frac{\alpha_2\rho_5}{\theta_5}; \beta_{11} = \frac{\alpha_1(1 - \rho_6)}{\theta_6}; \beta_{12} = \frac{(\alpha_2\rho_6)}{\theta_6}
\end{aligned}$$

where

$$\begin{aligned}
\theta_1 = \alpha_1(1 - \rho_1)^2 + \alpha_2\rho_1^2 + \alpha_3; \theta_2 = \alpha_1(1 - \rho_2)^2 + \alpha_2\rho_2^2 + \alpha_4; \\
\theta_3 = \alpha_1(1 - \rho_3)^2 + \alpha_2\rho_3^2 + \alpha_5; \theta_4 = \alpha_1(1 - \rho_4)^2 + \alpha_2\rho_4^2 + \alpha_6; \\
\theta_5 = \alpha_1(1 - \rho_5)^2 + \alpha_2\rho_5^2 + \alpha_7; \theta_6 = \alpha_1(1 - \rho_6)^2 + \alpha_2\rho_6^2 + \alpha_8
\end{aligned}$$

However, the above structural equations only capture the partial effects of the aid variables to the extent that they ignore the indirect feedbacks, operating through the simultaneous system formed by Equations [16] to [23]. To capture the total impacts (direct and indirect), which are crucial for policy purposes, it is important to derive the reduced-form equations. Simultaneously solving the preceding structural equations and expressing each endogenous variable in terms of the exogenously determined variables the reduced-form equation can be obtained as follows:

$$I_g = \delta_1 I_g^* + \delta_2 G^* + \delta_3 T^* + \delta_4 A_1^* + \delta_5 A_2^* + \delta_6 A_3^* + \delta_7 A_4^* \quad [24]$$

$$G = \delta_8 I_g^* + \delta_9 G^* + \delta_{10} T^* + \delta_{11} A_1^* + \delta_{12} A_2^* + \delta_{13} A_3^* + \delta_{14} A_4^* \quad [25]$$

$$T = \delta_{15} I_g^* + \delta_{16} G^* + \delta_{17} T^* + \delta_{18} A_1^* + \delta_{19} A_2^* + \delta_{20} A_3^* + \delta_{21} A_4^* \quad [26]$$

$$A_1 = \delta_{22} I_g^* + \delta_{23} G^* + \delta_{24} T^* + \delta_{25} A_1^* + \delta_{26} A_2^* + \delta_{27} A_3^* + \delta_{28} A_4^* \quad [27]$$

$$A_2 = \delta_{29} I_g^* + \delta_{30} G^* + \delta_{31} T^* + \delta_{32} A_1^* + \delta_{33} A_2^* + \delta_{34} A_3^* + \delta_{35} A_4^* \quad [28]$$

$$A_3 = \delta_{36} I_g^* + \delta_{37} G^* + \delta_{38} T^* + \delta_{39} A_1^* + \delta_{40} A_2^* + \delta_{41} A_3^* + \delta_{42} A_4^* \quad [29]$$

$$A_4 = \delta_{43} I_g^* + \delta_{44} G^* + \delta_{45} T^* + \delta_{46} A_1^* + \delta_{47} A_2^* + \delta_{48} A_3^* + \delta_{49} A_4^* \quad [30]$$

$$B = \delta_{50} I_g^* + \delta_{51} G^* + \delta_{52} T^* + \delta_{53} A_1^* + \delta_{54} A_2^* + \delta_{55} A_3^* + \delta_{56} A_4^* \quad [31]$$

where the  $\delta$ s represent complex combinations of  $\rho$ s and  $\alpha$ s, not reported here for reasons related to economy of space.<sup>5</sup>

From the estimation of each  $\delta$  we could deduce the total impact of aid of each type of aid on the other endogenous variables. This requires that we first estimate the structural equations and then insert these estimates into the reduced-form equations.

In view of the centrality of the aid disaggregation approach in the present paper, it will be also useful to present the results of the same model, but, this time, with aggregated aid, so that useful comparisons can be drawn at the estimation stage later on. This is what we do next.

The model with aggregated aid retains the same assumptions as the previous one; the only difference being that now it is assumed that aid is aggregated rather than disaggregated. It is, therefore, assumed that the government maximizes the following utility function:

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<sup>5</sup> The full mathematical workings are reported in Mavrotas and Ouattara (2003). They are also available from the authors upon request.

$$U = \alpha_0 - \frac{\alpha_1}{2}(I_g - I_g^*)^2 - \frac{\alpha_2}{2}(G - G^*)^2 - \frac{\alpha_3}{2}(T - T^*)^2 - \frac{\alpha_4}{2}(A - A^*)^2 - \frac{\alpha_5}{2}(B - B^*)^2 \quad [32]$$

with  $\alpha_i > 0$ .

Similarly, this utility function is maximized subject to the following two constraints:

$$I_g + G = B + T + A \quad [33]$$

$$G \leq \rho_1 T + \rho_2 A + \rho_3 B \quad [34]$$

with  $0 \leq \rho_i \leq 1$ .

Turning the inequality in [33] into an equality sign, applying the Lagrangean to the maximization problem and partially differentiating it with respect to each endogenous variable and the two Lagrange multipliers gives the following set of first-order conditions:

$$\frac{\partial L}{\partial I_g} = -\alpha_1(I_g - I_g^*) + \lambda_1 = 0 \quad [35]$$

$$\frac{\partial L}{\partial G} = -\alpha_2(G - G^*) + \lambda_1 + \lambda_2 = 0 \quad [36]$$

$$\frac{\partial L}{\partial T} = -\alpha_3(T - T^*) - \lambda_1 - \lambda_2 \rho_1 = 0 \quad [37]$$

$$\frac{\partial L}{\partial A} = -\alpha_4(A - A^*) - \lambda_1 - \lambda_2 \rho_2 = 0 \quad [38]$$

$$\frac{\partial L}{\partial B} = -\alpha_5(B - B^*) - \lambda_1 - \lambda_2 \rho_3 = 0 \quad [39]$$

$$\frac{\partial L}{\partial \lambda_1} = I_g + G - B - T - A = 0 \quad [40]$$

$$\frac{\partial L}{\partial \lambda_2} = G - \rho_1 T - \rho_2 A - \rho_3 B = 0 \quad [41]$$

Assuming that the borrowing target is set equal to zero we can derive the structural equations as follows:<sup>6</sup>

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<sup>6</sup> It is, perhaps, worth mentioning that some of the parameters reported here are different to those reported in Franco-Rodriguez *et al.* (1998). However, recent work by McGillivray and Ahmed (1999),

$$\begin{aligned}
I_g &= (1 - \rho_1)\beta_1 I_g^* + (1 - \rho_1)\beta_2 G^* \\
&\quad + (1 - \rho_1)[1 - (1 - \rho_1)\beta_1 - \rho_1\beta_2]T^* \\
&\quad + [(1 - \rho_2) - (1 - \rho_1)(1 - \rho_2)\beta_1 - (1 - \rho_1)\rho_2\beta_2]A \\
&\quad + [(1 - \rho_3) - (1 - \rho_1)(1 - \rho_3)\beta_1 - (1 - \rho_1)\rho_3\beta_2]B
\end{aligned} \tag{42}$$

$$\begin{aligned}
G &= \rho_1\beta_1 I_g^* + \rho_1\beta_2 G^* + \rho_1[1 - (1 - \rho_1)\beta_1 - \rho_1\beta_2]T^* \\
&\quad + [\rho_2 - \rho_1(1 - \rho_2)\beta_1 - \rho_1\rho_2\beta_2]A \\
&\quad + [\rho_3 - \rho_1(1 - \rho_3)\beta_1 - \rho_1\rho_3\beta_2]B
\end{aligned} \tag{43}$$

$$\begin{aligned}
T &= \beta_1 I_g^* + \beta_2 G^* + [1 - (1 - \rho_1)\beta_1 - \rho_1\beta_2]T^* \\
&\quad - [(1 - \rho_2)\beta_1 + \rho_2\beta_2]A \\
&\quad - [(1 - \rho_3)\beta_1 + \rho_3\beta_2]B
\end{aligned} \tag{44}$$

$$\begin{aligned}
A &= \beta_3 I_g^* + \beta_4 G^* - [(1 - \rho_1)\beta_3 + \rho_1\beta_4]T \\
&\quad + [1 - (1 - \rho_2)\beta_3 - \rho_2\beta_4]A^* \\
&\quad - [(1 - \rho_3)\beta_3 + \rho_3\beta_4]B
\end{aligned} \tag{45}$$

$$\begin{aligned}
B &= \beta_5 I_g^* + \beta_6 G^* - [(1 - \rho_1)\beta_5 + \rho_1\beta_6]T \\
&\quad - [(1 - \rho_2)\beta_5 + \rho_2\beta_6]A
\end{aligned} \tag{46}$$

where

$$\beta_1 = \frac{(\alpha_1 - \rho_1)}{\theta_1}, \beta_2 = \frac{\alpha_2 \rho_1}{\theta_1}, \beta_3 = \frac{\alpha_1(1 - \rho_2)}{\theta_2}; \beta_4 = \frac{\alpha_2 \rho_2}{\theta_2}; \beta_5 = \frac{\alpha_1(1 - \rho_3)}{\theta_3}$$

and

$$\theta_1 = \alpha_1(1 - \rho_1)^2 + \alpha_2 \rho_1^2 + \alpha_3; \theta_2 = \alpha_1(1 - \rho_2)^2 + \alpha_2 \rho_2^2 + \alpha_4;$$

$$\theta_3 = \alpha_1(1 - \rho_3)^2 + \alpha_2 \rho_3^2 + \alpha_5$$

The system of structural equations [42] to [46] can then be solved through to obtain the reduced-form equations as follows:<sup>7</sup>

$$I_g = \delta_1 I_g^* + \delta_2 G^* + \delta_3 T^* + \delta_4 A^* \tag{47}$$

$$G = \delta_5 I_g^* + \delta_6 G^* + \delta_7 T^* + \delta_8 A^* \tag{48}$$

Franco-Rodriguez (2000) and more recently McGillivray (2002) confirm that the structural equations [41] to [45] are rightly derived.

<sup>7</sup> Again, as in the previous case of the model with disaggregated aid, the full mathematical workings regarding the calculation of  $\delta$ s can be found in Mavrotas and Ouattara (2003). They are also available from the authors on request.

$$T = \delta_9 I_g^* + \delta_{10} G^* + \delta_{11} T^* + \delta_{12} A^* \quad [49]$$

$$A = \delta_{13} I_g^* + \delta_{14} G^* + \delta_{15} T^* + \delta_{16} A^* \quad [50]$$

$$B = \delta_{17} I_g^* + \delta_{18} G^* + \delta_{19} T^* + \delta_{20} A^* \quad [51]$$

### 3 Data sources and estimation methodology

All data used in the present paper covers the period 1975–99. The data are in billion of CFA francs at 1995 prices. One important contribution of the present paper is the use of disaggregated aid disbursements, in four main types (project aid, programme aid, technical assistance and food aid), for the first time in the aid effectiveness literature. Although, technical assistance and food aid disbursements are available from the OECD-DAC sources, it is only very recently that the OECD-CRS has started to construct data on project aid and programme aid for most aid-recipient countries.

The data used comes from various sources. The data on foreign aid are obtained from the OECD; therefore, the definition of aid in this study is based on the OECD's concept of aid i.e. official development assistance (ODA). Aid (meaning aggregate aid), technical assistance (A3) and food aid (A4) data have all been obtained from the OECD-DAC online database. Project aid (A1) and programme aid (A2), are not obtainable in disbursement form. With the help of the OECD-CRS, it was possible to construct these two series for Côte d'Ivoire for the period of 1975 to 1999.<sup>8</sup> These series were constructed with the help of the CRS by drawing on its database and the DAC database. CRS data on programme aid and project aid, which exist in commitments form, have been transformed into disbursements by applying their percentage share (in total project + programme aid commitments) to total of net aid disbursements from DAC minus food aid and technical assistance. The targets for the aid variables, as pointed earlier, are represented by their commitment values. These aid figures cover assistance for all donors.

Data on Government Consumption (G), Public Investment (Ig) and Government Revenue (T) have been obtained from the *Ministère de l'Économie et des Finances* and from the *African Live Database*.

The other variables used in the derivation of the targets are Income (Y, GDP at market prices), Private Investment (Ip), Exports (X) and Imports (M). Data for the above variables were obtained from the *Ministère de l'Économie et des Finances* and supplemented with data from the World Bank (2001) World Development Indicators (WDI).<sup>9</sup> The data on borrowing (B) represents the public sector borrowing requirement,

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<sup>8</sup> The main reason for starting in 1975 and not earlier is that food aid data from the OECD started to be available from that year.

<sup>9</sup> It is important to note that there is consistency between the data provided by the Ivorian authorities and other sources such as the WDI.

which is obtained as a residual from the balanced budget constraints represented by equations [3] and [33].<sup>10</sup>

One of the assumptions of fiscal response models is that the policy makers in the aid-recipient economy set their fiscal targets each year and try to reach them subject to some budget constraints. These models, therefore, assume that the targets are exogenously determined. However, obtaining these targets is one of the major problems faced by most fiscal response studies. If these series could be obtained directly from government sources they could be used in the estimation process. But, unfortunately, this is not the case and the established practice in the fiscal response literature has been to approximate the targets (Gang and Khan 1991; Khan and Hoshino 1992; Otim 1996; Franco-Rodriguez *et al.* 1998; McGillivray and Ahmed 1999; Franco-Rodriguez 2000; Mavrotas 2002a and McGillivray 2002).<sup>11</sup> In the present paper, the targets were derived from a cointegrating regression of vectors of exogenous regressors on each actual variable. Subsequently, the fitted values obtained from these regressions were taken as approximations of the target values in line with the established practice in the fiscal response literature (see above).

The target for public investment ( $I_g^*$ ) was obtained by regressing  $I_g$  on private investment ( $I_p$ ). In the case of government consumption ( $G$ ), the target variable was derived by regressing  $G$  on its value in the previous year. Government revenue ( $T$ ) was obtained by regressing  $T$  on income ( $Y$ ) and aid commitments ( $A_c$ ).<sup>12</sup> Finally, following Franco-Rodriguez *et al.* (1998) and others, the targets for the aid variables are set equal to their commitments value. This approach seems sensible given that the government will start bargaining based on these commitments made by donors. During the bargaining process between donors and the government, the latter would try to convince the former to release the amount of aid committed. Overshooting this target is unlikely, as this would imply that the government could spend more money than it has been allocated.<sup>13</sup> There is no reason also to believe that the government will undershoot this target. Donors may not release the full amount of these commitments, but the rational government would attempt to get all commitments to be disbursed.

Turning to the estimation of the structural equations, the non-linear Three Stage Least Squares (N3SLS) estimation technique is used. This procedure is appropriate for two reasons. Firstly, the system of simultaneous equations, formed by the structural equations [16]–[23] and [42]–[46], although linear in the variables, is not linear in the parameters. Secondly, the models contain cross-equation restrictions with respect to the  $\rho$ s and  $\beta$ s; the N3SLS technique takes into account these restrictions and, provides more efficient estimates, using all the information available. In the second stage of

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<sup>10</sup> This is the methodology adopted by Franco-Rodriguez *et al.* (1998), McGillivray and Ahmed (1999), Franco-Rodriguez (2000) and McGillivray (2000).

<sup>11</sup> Needless to say, this is an important area for future research.

<sup>12</sup> Full details of the estimation results related to the derivation of the target variables are available from the authors on request.

<sup>13</sup> However, it is important to stress that in cases where the amount of aid committed in previous years has experienced some delays in being disbursed, disbursements for that year may be higher than the commitments for the same year. Also, if for a given year emergency funds with long term development goal are made available to the country disbursements may be greater than commitments.

estimation, the system formed by the estimates of the above structural equations is solved through to obtain the reduced-form equation.<sup>14</sup>

#### 4 Results from the estimation of the structural equations

The focus of this section is to empirically test the model presented in section 2 using the targets approximated in the previous section and time-series data for Côte d'Ivoire for the period 1975–99.

##### 4.1 Examination of the estimated parameters

Table 1 reports estimates of the structural equations parameters for both aggregated and disaggregated aid. These estimates are crucial for the derivation of both the direct and total impact of the aid variables. For this reason, before we compute these different impacts, it might be useful to analyse these estimates to see whether they are consistent with the theoretical models presented in section 2. Firstly, let us start from the estimates of the parameters of the constraints equations [4] and [34]. By definitions the  $\rho$ s are the proportions of government resources allocated to consumption. Consequently, their estimates are expected to lie within the range [0,1]. The zero corresponds to a situation where no share of the resource in question is allocated to consumption, and one when the resource are fully devoted to consumption. Yet, looking at the estimates of these parameters, reported in previous studies, reveals some inconsistencies between the theoretical model and the empirical results. In some studies some of the reported  $\rho$ s are negative. In other studies some of these estimates are greater than one.  $\rho_i < 0$  means that the government allocates negative proportion of the revenue concerned to consumption; whilst  $\rho_i > 1$  would imply more than 100 per cent of the revenue concerned is used for consumption purpose. However, neither of these two cases makes sense. The second important point concerns the  $\beta$ s. By definition they must be positive. To see why let us recall the  $\beta$ s derived from the model with aggregated aid in section 2.

$$\beta_1 = \frac{\alpha_1(1-\rho_1)}{\theta_1}; \beta_2 = \frac{\alpha_2\rho_1}{\theta_1}; \beta_3 = \frac{\alpha_1(1-\rho_2)}{\theta_2}; \beta_4 = \frac{\alpha_2\rho_2}{\theta_2}; \beta_5 = \frac{\alpha_1(1-\rho_3)}{\theta_3}; \beta_6 = \frac{\alpha_2\rho_3}{\theta_3}$$

$$\theta_1 = \alpha_1(1-\rho_1)^2 + \alpha_2\rho_1^2 + \alpha_3;$$

$$\theta_2 = \alpha_1(1-\rho_2)^2 + \alpha_2\rho_2^2 + \alpha_4$$

$$\theta_3 = \alpha_1(1-\rho_3)^2 + \alpha_2\rho_3^2 + \alpha_5$$

The  $\rho$ s are proportions, and, thus,  $0 \leq \rho_i \leq 1, i=1,2,3$ . Furthermore, the  $\alpha$ s (parameters of the government's utility function), by assumption, are greater than zero, as this will ensure diminishing utility if the government tries to deviate from the targets. These two points combined clearly indicate that the  $\theta$ s must be positive. Nevertheless, some studies have derived negative  $\beta$ s, thus overlooking this important point.

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<sup>14</sup> This was achieved using the software *Mathematica 4*.

The implications of these shortcomings are quite serious. Looking at the structural equations [16]–[23] and [42]–[46] it is clear that the impact of each type of revenue, and hence aid, on the different categories of expenditure is determined by the combination of the  $\rho$ s and  $\beta$ s. In other words, failing to rightly derive the parameters will affect the direction of these impacts. Consequently, the estimates of the parameters of the reduced-form equations, which are obtained by solving the system of structural equations, will be also unreliable, thus leading to misleading policy conclusions.

The results reported in Table 1 capture well the above analysis. Indeed, the estimates of the  $\rho$ s are now consistent with the theoretical model. Also the estimates of the  $\beta$ s parameters are all positive as expected. In what follows we confidently interpret the results since our econometric estimates are consistent with the theoretical model.

Table 1: Estimates of the structural equations parameters

Parameters	Estimates	Standard Errors
Aggregated Aid		
$\rho_1$	0.717***	0.0065
$\rho_2$	1.000***	0.0031
$\rho_3$	0.885***	0.0033
$\beta_1$	0.439***	0.0021
$\beta_2$	0.899***	0.0026
$\beta_3$	0.482***	0.0023
$\beta_4$	0.486***	0.0018
$\beta_5$	0.882***	0.0019
$\beta_6$	1.020***	0.0065
Disaggregated Aid		
$\rho_1$	0.503***	0.0013
$\rho_2$	0.331***	0.0034
$\rho_3$	0.421***	0.0047
$\rho_4$	1.000***	0.0372
$\rho_5$	1.000***	0.0036
$\rho_6$	0.517***	0.0018
$\beta_1$	0.479***	0.0010
$\beta_2$	0.460***	0.0011
$\beta_3$	0.060***	0.0021
$\beta_4$	0.082***	0.0020
$\beta_5$	0.401***	0.0016
$\beta_6$	0.539***	0.0017
$\beta_7$	0.007***	0.0026
$\beta_8$	0.007***	0.0026
$\beta_9$	0.090***	0.0022
$\beta_{10}$	1.390***	0.0032
$\beta_{11}$	0.686***	0.0041
$\beta_{12}$	0.666***	0.0016

Note: \*\*\* the coefficients are significantly different from zero at 1 per cent level, respectively.



## 4.2 Interpretation of the constraint equations parameter estimates

The results for aggregated aid (top part of Table 1) show that, overall, most government resources are allocated to consumption. In terms of the constraint [34], the estimate for  $\rho_1$  indicates that around 72 per cent of tax and other recurrent revenue is used to finance government consumption. Turning to foreign aid, the estimate of  $\rho_2$  suggests that aid is fully used for consumption purposes in the case of Côte d'Ivoire. From the estimate  $\rho_3$  it is clear that the Ivorian government allocates about 89 per cent of borrowing to consumption. It follows from these results that the shares of tax revenue, aid, and borrowing used to support public investment are 28 per cent, 0 per cent, and 11 per cent, respectively. This suggests that foreign aid is highly fungible in the context of Côte d'Ivoire.

The results with disaggregated aid tell us a different story. The share of tax and other recurrent revenue directed to consumption is about 50 per cent. The results in Table 1 also show that about 33 and 42 per cent of project aid and programme aid, respectively, are allocated to consumption, thus, implying that programme aid is more used to finance consumption compared to project aid. The estimate of  $\rho_4$  reveals that technical assistance is fully consumed.<sup>15</sup> Food aid also appears to be fully consumed, according to the estimate of  $\rho_5$ . Finally, according to  $\rho_6$ , the share of borrowing directed towards consumption is 52 per cent.

The above findings are quite interesting indeed. On the basis of the results using aid as a single value (as done by most aid effectiveness studies), the obvious conclusion would be that the government used foreign aid for consumption purposes, and no aid flows at all were channelled to investment. Consequently, it might be fair to argue that foreign aid is highly fungible in the case of Côte d'Ivoire. In the light of this evidence, *Assessing Aid* would argue that donors should reduce their assistance and increase support for policy dialogue until they are convinced that their funds will not be fully consumed (World Bank 1998: 61).

However, the disaggregation of aid in different components shows that, although high fungibility remains an issue for some types of aid (see for instance technical assistance and food aid), project aid and programme aid (which constitutes more than half of all aid disbursements to the country over the period of study), are directed towards investment projects. Therefore, the policy recommendation of *Assessing Aid* to cut back financing is short sighted, as it fails to tell donors which type of foreign aid is likely to be fungible.

## 4.3 Interpretation of the structural equations

As pointed out earlier, the structural equations show the direct impact of each type of revenue on different expenditure categories. These impacts are obtained by substituting the  $\rho$ s and  $\beta$ s, from Table 1, in the structural equations [16]–[23] and [42]–[46].<sup>16</sup> For

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<sup>15</sup> This finding confirms results reported in Mavrotas (2002a), in the context of India, where all technical assistance is allocated to consumption.

<sup>16</sup> These calculations were done using *Mathematica 4*.

each endogenous variable, aggregated and disaggregated aid results are presented jointly to allow comparisons. The obtained results are represented by equations [51]–[63] below.

#### Investment

$$I_g = -0.254A - 0.085B + 0.254G^* + 0.124I_g^* + 0.065T^* \quad [51]$$

$$I_g = 0.433A_1 + 0.344A_2 - 0.230A_3 - 0.230A_4 + 0.245B + 0.230G^* + 0.240I_g^* + 0.265T^* \quad [52]$$

#### Government Consumption

$$G = 0.355A + 0.255B + 0.645G^* + 0.315I_g^* + 0.166T^* \quad [53]$$

$$G = 0.093A_1 + 0.184A_2 + 0.770A_3 + 0.770A_4 + 0.285B + 0.230G^* + 0.240I_g^* + 0.265T^* \quad [54]$$

#### Government Revenue

$$T = -0.899A - 0.83B + 0.899G^* + 0.439I_g^* + 0.231T^* \quad [55]$$

$$T = -0.473A_1 - 0.472A_2 - 0.460A_3 - 0.460A_4 - 0.470B + 0.460G^* + 0.480I_g^* + 0.530T^* \quad [56]$$

#### Aid Disbursement

$$A = 0.514A^* - 0.486B + 0.486G^* + 0.483I_g^* - 0.485T \quad [57]$$

$$A_1 = 0.933A_1^* - 0.068A_2 - 0.080A_3 - 0.080A_4 - 0.070B + 0.080G^* + 0.060I_g^* - 0.070T \quad [58]$$

$$A_2 = -0.907A_1 + 0.545A_2^* - 0.530A_3 - 0.530A_4 - 0.468B + 0.530G^* + 0.400I_g^* - 0.465T \quad [59]$$

$$A_3 = -0.007A_1 - 0.006A_2 + 0.993A_3^* - 0.008A_4 - 0.005B + 0.007G^* + 0.008I_g^* - 0.006T \quad [60]$$

$$A_4 = 0.519A_1 - 0.636A_2 - 1.390A_3 + 0.390A_4^* - 0.766B + 1.390G^* + 0.090I_g^* - 0.740T \quad [61]$$

#### Borrowing

$$B = -1.020A + 1.020G^* + 0.882I_g^* - 0.981T \quad [62]$$

$$B = -0.683A_1 - 0.682A_2 - 0.670A_3 - 0.670A_4 + 0.670G^* + 0.690I_g^* - 0.680T \quad [63]$$

The main focus in the present paper is on the incremental impact of endogenous changes in the aid variables. These impacts, and the mechanisms through which they operate, are summarized in Table 2. The results related to investment and consumption are rather mixed. When aggregated aid figures are used the direct impact on investment is negative whilst, the impact on consumption is positive. Particularly, increasing aid by 1000 Francs leads to 254 Francs decrease in investment and 355 Francs increase in government consumption. This implies that foreign aid to Côte d'Ivoire is pro-consumption, a result also confirmed by the estimate of the constraint equation [34].

Table 2: Direct incremental impacts of aid variables

Impact	Mechanism	Estimate
Investment		
$A$ on $I_g$	$[(1 - \rho_2) - (1 - \rho_1)(1 - \rho_2)\beta_1 - (1 - \rho_1)\rho_2\beta_2]$	-0.254
$A_1$ on $I_g$	$[(1 - \rho_2) - (1 - \rho_1)(1 - \rho_2)\beta_1 - (1 - \rho_1)\rho_2\beta_2]$	0.433
$A_2$ on $I_g$	$[(1 - \rho_3) - (1 - \rho_1)(1 - \rho_3)\beta_1 - (1 - \rho_1)\rho_3\beta_2]$	0.344
$A_3$ on $I_g$	$[(1 - \rho_4) - (1 - \rho_1)(1 - \rho_4)\beta_1 - (1 - \rho_1)\rho_4\beta_2]$	-0.230
$A_4$ on $I_g$	$[(1 - \rho_5) - (1 - \rho_1)(1 - \rho_5)\beta_1 - (1 - \rho_1)\rho_5\beta_2]$	-0.230
Consumption		
$A$ on $G$	$[\rho_2 - \rho_1(1 - \rho_2)\beta_1 - \rho_1\rho_2\beta_2]$	0.355
$A_1$ on $G$	$[\rho_2 - \rho_1(1 - \rho_2)\beta_1 - \rho_1\rho_2\beta_2]$	0.093
$A_2$ on $G$	$[\rho_3 - \rho_1(1 - \rho_3)\beta_1 - \rho_1\rho_3\beta_2]$	0.184
$A_3$ on $G$	$[\rho_4 - \rho_1(1 - \rho_4)\beta_1 - \rho_1\rho_4\beta_2]$	0.770
$A_4$ on $G$	$[\rho_5 - \rho_1(1 - \rho_5)\beta_1 - \rho_1\rho_5\beta_2]$	0.771
Revenue		
$A$ on $T$	$-[(1 - \rho_2)\beta_1 + \rho_2\beta_2]$	-0.899
$A_1$ on $T$	$-[(1 - \rho_2)\beta_1 + \rho_2\beta_2]$	-0.473
$A_2$ on $T$	$-[(1 - \rho_3)\beta_1 + \rho_3\beta_2]$	-0.472
$A_3$ on $T$	$-[(1 - \rho_4)\beta_1 + \rho_4\beta_2]$	-0.460
$A_4$ on $T$	$-[(1 - \rho_5)\beta_1 + \rho_5\beta_2]$	-0.460
Borrowing		
$A$ on $B$	$-[(1 - \rho_2)\beta_5 + \rho_2\beta_6]$	-1.020
$A_1$ on $B$	$-[(1 - \rho_2)\beta_{11} + \rho_2\beta_{12}]$	-0.683
$A_2$ on $B$	$-[(1 - \rho_3)\beta_{11} + \rho_3\beta_{12}]$	-0.682
$A_3$ on $B$	$-[(1 - \rho_4)\beta_{11} + \rho_4\beta_{12}]$	-0.670
$A_4$ on $B$	$-[(1 - \rho_5)\beta_{11} + \rho_5\beta_{12}]$	-0.670

Disaggregating aid, however, shows a different picture. Project aid and programme aid have a positive direct incremental impact on public investment whereas the impacts of technical assistance and food aid are negative. An increment of 1000 Francs in project aid and programme aid disbursements is associated with an increase of around 433 and 344 Francs, respectively, on public investment; this implies that the direct impact of project aid on public investment is greater in magnitude compared to that of programme aid. In contrast, increases in technical assistance and food aid disbursements by 1000 Francs reduce public investment by 230 and 231 Francs, respectively.

With regard to consumption, all forms of aid have a direct positive impact. Increasing the disbursements of project aid and programme aid, for instance, by 1000 Francs leads respectively to 93 and 184 Francs rise in public consumption. The impact of project aid on consumption is half that of programme aid, thus confirming the above findings, namely that project aid is more likely to increase investment and programme aid consumption. Turning to the direct impacts of technical assistance and food aid, the results seem to indicate that increasing their disbursements by 1000 Francs would result to an increase in consumption by almost 800 Francs. The magnitude of the impacts of technical assistance and food aid suggests that these two types of aid are highly fungible, compared to project and programme aid. This finding is confirmed by the estimates of the constraint equation parameters [4].<sup>17</sup>

The direct impacts related to government recurrent revenue appear to support the widespread concern that aid may decrease taxation in recipient countries, whether aid is disaggregated or not. Increasing aid disbursements by 1000 Francs results in almost 900 Francs reduction in tax and other recurrent revenue. The same increase in each category of aid is also associated with a fall of just under 500 Francs in tax revenue. Similar conclusions are reached with borrowing. Every increase in aid is matched by almost the same decrease in borrowing, *ceteris paribus*. The direct impact of the different types of aid on borrowing is also negative. Every 1000 Francs in the disbursements of these types of aid is associated with more than 650 Francs reduction in public sector borrowing. These results suggest that government would substitute borrowing for aid.

It might also be interesting to see how the aid variables impact on each other, particularly in the model with disaggregated aid. Structural equations [57]–[61] provide the answer to this question. Equation [58] shows that the direct impact of programme aid, technical assistance and food aid on project aid is negative. In other words, increasing disbursements of these three types of aid would result in a reduction in project disbursements. However, it is worth pointing out that these impacts are relatively small in magnitude. Turning to Equation [59], the results indicate that a 1000 Francs increase in project aid is associated with a 907 Francs decrease in programme assistance; this implies that project and programme aid are used as alternative tools of financing in the context of Côte d'Ivoire. Technical assistance and food aid disbursements exert a small negative direct impact on programme aid disbursements. The estimate of the technical assistance equation (Equation [60]) shows that project, programme and food aid disbursements barely affect technical assistance disbursements. The results related to the equation of food aid (Equation [61]) imply that food aid disbursements are affected by the disbursements of the other three types of aid. In particular, the results seem to indicate that increasing technical assistance disbursements will be associated with a considerable reduction in food aid disbursements.

The fiscal response model can also be used to show how changes in other government revenue i.e. tax and borrowing, affect the aid variables. These impacts are captured in Equations [57] to [61]. Equation [57] shows that increasing tax revenue and borrowing by 100 Francs will reduce aid disbursements by almost 500 Francs. Project aid disbursements do not appear to respond to any of these changes, as it appears in Equation [58]. In contrast, from Equation [59] it can be seen that programme aid is

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<sup>17</sup> The estimates of the parameters of the above constraint equation show that technical assistance and food aid are fully allocated to government consumption.

reduced by almost half of the increase in taxation and borrowing. Technical assistance barely responds to changes in taxation and borrowing, according to Equation [60]. Food aid on the contrary, appears to respond negatively to changes in taxation and borrowing as shown by Equation [61].

## 5 Estimating the total impact of aid variables: reduced-form equations results

As emphasized earlier, the preceding results are only partial to the extent that they do not take into account indirect feedbacks, working through the simultaneous system of structural equations. Hence, it is more interesting to look at the total (direct and indirect) impact of the aid variables; this is because, as far as policy implications are concerned, only the total impacts matter.

Using *Mathematica 4* to solve the structural equations, obtained in the previous section, leads to the following reduced-form equations where each endogenous variable is expressed in terms of the targets. As previously done, for each endogenous variable both aggregated and disaggregated aid results will be presented to facilitate comparisons.

### Investment

$$I_g = -0.196A^* + 0.196G^* - 0.108I_g^* + 0.173T^* \quad [64]$$

$$I_g = -0.958A1^* + 0.244A2^* + 0.367A3^* + 0.367A4^* - 0.367G^* + 0.536I_g^* - 0.049T^* \quad [65]$$

### Government Consumption

$$G = 0.170A^* + 0.83G^* + 0.957I_g^* - 0.149T^* \quad [66]$$

$$G = 1.477A1^* - 0.067A2^* - 0.531A3^* - 0.531A4^* + 1.531G^* - 0.270I_g^* - 0.131T^* \quad [67]$$

### Government Revenue

$$T = -0.289A^* + 0.289G^* - 1.616I_g^* + 1.250T^* \quad [68]$$

$$T = -0.431A1^* - 0.163A2^* + 0.129A3^* + 0.129A4^* - 0.129G^* + 0.375I_g^* + 0.877T^* \quad [69]$$

### Aid Disbursement

$$A = 1.023A^* - 0.023G^* + 0.137I_g^* - 0.022T^* \quad [70]$$

$$A1 = 0.935A1^* - 0.010A2^* + 0.022A3^* + 0.021A4^* - 0.022G^* + 0.033I_g^* - 0.006T^* \quad [71]$$

$$A2 = -1.528A1^* + 0.894A2^* + 0.229A3^* + 0.229A4^* - 0.229G^* + 0.348I_g^* - 0.060T^* \quad [72]$$

$$A3 = -0.004A1^* - 0.001A2^* + 1.001A3^* + 0.001A4^* - 0.001G^* + 0.003I_g^* - 0.001T^* \quad [73]$$

$$A4 = 2.553A1^* - 0.155A2^* - 1.868A3^* - 0.868A4^* + 1.868G^* - 1.085I_g^* - 0.391T^* \quad [74]$$

### Borrowing

$$B = -0.761A^* + 0.761G^* + 2.327I_g^* - 1.204T^* \quad [75]$$

$$B = -1.024A1^* - 0.387A2^* + 0.322A3^* + 0.322A4^* - 0.322G^* + 0.900I_g^* - 0.289T^* \quad [76]$$

The total impacts of total aid and different forms of aid (which is the central focus of the present paper) on the endogenous variables are summarized in Table 3. Regarding public investment, Table 3 shows that the total aid impact (on public investment) is negative. An increase of 1000 Francs in foreign aid results in a reduction in public investment by 196 Francs. When the total impact of each type of aid is considered it becomes apparent that the fall in public investment may have been caused by project aid which exerts a negative impact. Every 1000 Francs increase in project aid is met by a reduction of 958 Francs in public investment. In contrast, for the same increase in programme aid, public investment responds with an increase of 224 Francs. Increases in technical assistance and food aid are also associated with an increase in public investment.

Table 3: Total impact of aid variables

	A*	A1*	A2*	A3*	A4*
lg	-0.196	-0.958	0.244	0.367	0.368
G	0.170	1.477	-0.067	-0.531	-0.531
T	-0.289	-0.413	-0.163	0.129	0.129
B	-0.761	-1.024	-0.387	0.322	0.323
A	1.023	-	-	-	-
A1	-	0.935	-0.010	0.022	0.022
A2	-	-1.528	0.894	0.229	0.229
A3	-	-0.004	-0.001	1.001	0.001
A4	-	2.553	-0.155	-1.868	0.868

The results related to consumption seem also to reveal a mixed picture. The total impact of aggregated aid on government consumption is a reduction of 170 Francs for very 1000 Francs increase in aid. The disaggregation of aid, however, sheds more light on the origin of this increase. From Table 3 it is clear that changes in project aid are associated with positive changes in consumption. Moreover, the results indicate that the total impact of a 1000 Francs increase in project aid is an increase in government consumption by 1477 Francs, that is, more than the increase in aid. By contrast, programme aid, technical assistance and food aid do not appear to increase government consumption.

With respect to taxation, the results reported in Table 3 show that the total impact of aggregated aid on government revenue is negative. Project and programme aid also exert a total negative impact on taxation effort. The magnitude of their impacts suggests that project aid reduces taxation more than programme aid. Regarding technical assistance and food aid there is no evidence that these two types of aid are associated with a reduction in government taxation effort.

From the results related to borrowing, it emerges that aid inflows are met by a reduction of more than 75 per cent in borrowing, for every increase in aid. When aid disaggregation enters the picture, the results indicate that borrowing decreases considerably with increases in programme aid. Technical assistance and food aid increases, however, do not appear to reduce public sector borrowing.

Table 3 also shows the total impacts of the different aid categories on each other. Project aid responds negatively (though slightly) to changes in programme aid, technical assistance and food aid. Programme aid, on the other hand, is affected significantly by changes in the other three types of aid. Also, it is notable from Table 3 that the total impact of project aid on programme aid is greater than unity. Technical assistance barely responds to changes in the other types of aid. Finally, results related to food aid show that increases in project aid will more than double food aid disbursements, whilst programme aid and technical assistance affect negatively these disbursements.

## **6 Economic interpretation of the empirical results**

From the above analysis it is clear that the nature of the impact of foreign aid on the government's policy variables depends on the type of aid one is looking at. In what follows we try to explore the economic rationale behind these different impacts. For this purpose, the directions of both direct and total impacts of the aid variables on public investment, government consumption, government revenue and borrowing are summarized in Table 4.

Starting with project aid, its direct impact on public investment is positive. This is not surprising given that part of project aid (investment projects schemes) is intended to increase and/or improve the recipient stock of physical capital (OECD 2000: 47). The positive impact may also come from the externalities generated by the financing of specific projects. For example, communication and transport projects might provide settings that would crowd in public investment. To understand the total impact of project aid on investment, it is necessary to understand its impact on government consumption. From Table 4 it is clear that both the direct and total impacts of project aid on consumption are positive. However, it is worth pointing out the fact that the direct impact is negligible,<sup>18</sup> thus implying that government consumption does not respond to changes in project aid. This is not surprising given that donors have, to some extent, control over the way these funds are used.

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<sup>18</sup> Results in Table 3 show the direct impact of project aid on consumption is almost zero.

Table 4: Summary of direct and total impacts of aid variables on investment, consumption, tax revenue and borrowing

	Aid	Project aid	Programme aid	Technical assistance	Food aid
Ig	-	+	+	-	-
	(-)	(-)	(+)	(+)	(+)
G	+	+	+	+	+
	(+)	(+)	(-)	(-)	(-)
T	-	-	-	-	-
	(-)	(-)	(-)	(+)	(+)
B	-	-	-	-	-
	(-)	(-)	(-)	(+)	(+)

Note: The signs in brackets represent the total impact of the aid variables.

The total positive impact of project aid on consumption may occur for two reasons. Firstly, if the costs of maintenance (recurrent costs) of the project were left to the recipient government then the financing of these costs would appear in its account as consumption. Given that the government will be faced with responsibility of financing the costs of several projects it is clear that resources will shift away from public investment, thus, causing its decline. Secondly, even if donors accept to finance the recurrent costs (because they fear the projects will be unsustainable), this will show up (if properly accounted for) in the government accounts as an increase in consumption (White 1998: 70). The first case is more likely to apply to Côte d'Ivoire, where the government had undertaken ambitious projects in the 1970s which needed to be sustained at the expense of public investment. Therefore, increasing project aid further will raise government consumption and decrease public investment.

With regard to programme aid, its direct impacts on investment and consumption are positive. Programme aid includes sub-headings such as World Bank/IMF structural adjustment and other general programme and commodity assistance (import, budget and balance-of-payments support etc.). The provision of these funds is generally based on the prerequisite that the recipient agrees to some policy conditions. The basic rationale for giving programme aid is that the recipient's economy suffers from constraints on recurrent expenditure (intermediate and consumer imports, government consumption etc.), so that existing resources are under-utilized,<sup>19</sup> thus making additional investment worthless (White 1998). Programme aid is therefore disbursed to help the recipient increase its capacity utilization. As a direct result investment and consumption will increase. However, one of the main characteristics of the adjustment and stabilization programmes was that government has to cut public expenditure and more particularly government consumption. This could explain why the total impact of programme aid on

<sup>19</sup> For example, hospitals lack materials, roads are crumbling, factories are inoperative, etc.



government consumption is negative. With regard to the total impact on investment one should expect a negative relationship given that privatization and therefore private investment was one of the conditions imposed on the government before programme aid was disbursed. The positive impact of programme aid (on public investment) here, may have its origin on its indirect impact (on private investment).<sup>20</sup>

The direct impact of technical assistance and food aid on public investment is negative whereas their total impact is positive. The negative effect may be explained by the fact that these forms of aid operate in the way that their impact is not straightforward. Food aid, for example, needs to be monetized in some cases, a process which may take some time to materialize. Technical assistance also may take some time before its impact is visible. Food aid includes supplies and transport of food, cash for food and intermediate products (fertilizers, seed, etc.). Aid, by financing these costs (which the government might have undertaken), will release additional funds (from existing resources) that can be used to finance public investment, explaining why its total impact is positive. The positive impact of food aid on public investment may also come from its nutritional contribution, as this may help increase labour efficiency. Technical assistance is ‘the provision of know-how in the form of personnel, training, research and associated costs’ (OECD 2000: 12). As such, it is expected that the total impact of technical assistance on investment will be positive as it provides the recipient with the expertise to achieve efficiency.

The direct impact of both types of aid on government consumption is positive. In the context of technical assistance this may be caused by the fact that it provides better training for the existing staff and produces new graduates to whom the government might have to pay higher wages. Consequently the wage bill of the government will increase and this will show up as an increase in consumption. Food aid may increase consumption by providing the government with additional funds generated from the disbursements of cash for food or from selling the supply of food received from donors. Their total impact, however, appears to be negative. As far as technical assistance is concerned, one explanation might be that some governments refrain from spending on education where it is believed that education grants will be made available. Furthermore, the contribution of aid-recipient governments in the salaries of experts is very often insignificant. Concerning food aid, as argued by Colding and Pinstруп-Anderson (2000), when food aid is used for feeding projects some governments cut back on education expenditure more or less in equal amount of the food aid, which might explain why its total impact on government consumption is negative.

The finding concerning the total impact of technical assistance and food aid raises a rather important issue. The two types of aid appear to be fully used for consumption purposes, as results in Table 1 seem to suggest. In the light of this evidence, someone might argue that donors should cut back these type of finances until they are convinced that the aid-recipient government does not use them for consumption purposes. However, the finding that the total impact of technical assistance and food aid on consumption is negative suggests that fungibility might not be a sign of fiscal indiscipline after all. By fully allocating technical assistance and food aid to

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<sup>20</sup> It has been previously shown (see the derivation of targets) that private investment explained public investment.

consumption, the Ivorian government uses its own resources for other purposes. In short, what matters is the total impact of aid monies and not their direct impact.

As far as tax revenue is concerned, the direct impact of all forms of aid is negative. This seems to confirm the widespread concern that aid transfers may reduce taxation effort. Regarding the total impact of the aid variables two cases seem to emerge. Firstly, increases in programme and project aid are associated with reductions in government revenue. This indicates that, government would prefer to use aid money for its expenditure rather than increase taxes. In the case of project aid one explanation might be that the government does not judge it essential to increase taxation effort given that the funds necessary to finance specific projects will come from aid. In the case of programme aid the reduction in taxes also makes sense. Adjustment and stabilization policies associated with programme aid favour a market approach to the economy. Taxation in this approach is seen as distortionary and therefore should be minimized. This negative relationship between these types of aid inflows and government revenue suggests that there has been aggregate fungibility, which signals a weak fiscal discipline. However, after all, a reduction in the taxation effort may not be a bad thing. A reduction in taxation effort may be beneficial to the private sector or individual households. In the case of the private sector this might lead to an increase in private investment, which may crowd in public investment. If the reduction in taxation benefits individuals this has the potential of increasing domestic consumption or domestic savings. Furthermore, a reduction in taxation may help to avoid social unrests, which many developing countries have witnessed in recent years. In the second scenario, food aid and technical assistance inflows do not seem to be associated with any decrease in taxation. This is perhaps due to the nature of these types of aid; they are not ready-cash which the government can use if needed to replace tax revenue.

Table 4 also shows some similarity between tax revenue and borrowing vis-à-vis aid inflows. All forms of aid exert a direct negative impact on borrowing, that is, the government would reduce borrowing for each additional Franc of each of these types of aid. With regard to the total impact, two scenarios occur. Firstly, programme aid and project aid reduce borrowing. Given that borrowing is expensive compared to aid it makes sense to assume that the government would substitute borrowing for these two forms of aid. Secondly, technical assistance and food aid, as in the case with taxation, do not appear to stop the government from borrowing. This might be explained by what has been argued earlier regarding the nature of technical assistance and food aid.

## **7 Conclusions and policy recommendations**

In this paper we estimated a fiscal response model based on aid disaggregation and aid endogeneity for Côte d'Ivoire using time series data over the period 1975–99. Our approach sheds plenty of light on how the government react to different categories of foreign aid inflows (project aid, programme aid, technical assistance and food aid).

We also emphasized that it is crucial to derive empirical estimates which are consistent with the theoretical models developed, an issue overlooked by previous literature on fiscal response. We have shown that the estimates of the parameters of the constraint equations (related to the consumption equations) must lie between [0–1], as they represent the share of each type of revenue allocated to public consumption.

Furthermore, the  $\beta$ s, which are the other parameters crucial in the computation of the incremental impact of the revenue variables, must be positive in line with their theoretical definitions. Failing to recognize these may lead to misleading conclusions.

The results obtained by estimating correctly the solution of the theoretical model, show that when a single value (or aggregated) aid is used, foreign aid is fully consumed in the context of Côte d'Ivoire. The direct incremental impact of aid inflows on the fiscal variables is an increase in government consumption and a decrease in public investment, tax revenue and borrowing. With respect to the total impact of aid (obtained from the estimate of the reduced-form equations) aid inflows appeared to increase consumption and reduce investment, tax revenues and borrowing, though these impacts are lower in magnitude compared to the direct impact.

However, results obtained when taken into account the heterogeneous aspect of foreign aid show that the government responds differently according to the nature of the aid inflows. Technical assistance and food aid are mainly directed towards financing consumption whilst project aid and programme aid are used for investment purposes. With respect to the total incremental impacts of the different categories of aid on the government fiscal variables, particularly investment and consumption, the evidence is that project aid and programme aid behave differently. Changes in project aid affect negatively public investment whereas its impact on government consumption is positive. In contrast, programme aid affects positively public investment and negatively consumption. Technical assistance and food aid changes are associated with positive changes in public investment and negative changes in government consumption. This, finding, therefore, suggests that fungibility might not be a bad thing, as often painted.

The findings concerning taxation are quite interesting, indeed. Food aid and technical assistance do not appear to reduce taxation effort. This alone is a robust finding which challenges the widespread view that aid inflows encourage the government to abandon its tax collection efforts. We have argued that this might not be a negative outcome after all, as a reduction in taxation effort could benefit the private sector and individual households. Similar findings are reached with borrowing. Project aid and programme aid inflows reduce borrowing contrary to technical assistance and food aid.

What are the policy recommendations that can be drawn from the above evidence? The first and obvious recommendation is that all those involved in the aid business should be aware of the potential aggregation bias associated with most previous aid effectiveness studies, and, therefore, re-evaluate the policy lessons drawn from studies such as Boone (1996), Burnside and Dollar (2000) and *Assessing Aid* (World Bank 1998), to mention some of the most influential recent studies in this area. For example, contrary to the suggestions of *Assessing Aid*, not all types of foreign aid are fungible. The second recommendation which seems to stem from our work is that coordination among donors regarding the delivery of project aid in particular and the sustainability of individual projects are vital for aid effectiveness. For instance, in the case of Côte d'Ivoire the initial impact of project aid on public investment was positive, as expected. However, problems related to the management of these projects paired with the difficulties of the government in financing their recurrent costs has contributed to the decline in public saving and thus public investment. Furthermore, coordination might help improve the efficiency of project aid, thereby reducing the dependence of public investment on aid inflows. Another important policy implication arising from the present paper is that increasing the grant element of project aid and programme aid could help developing

countries achieve several important goals: firstly, as our results indicate, both project and programme aid may reduce taxation effort. Although this has been traditionally perceived as a negative aspect of aid inflows, a reduction in tax revenue may not be a bad thing after all; if the reduction benefits the private sector then this could help boost private saving. Tax reduction may also be used to achieve income distribution if targeted at the poorest part of the population. This can be achieved by reducing their income tax or by removing excessive tax on basic needs.<sup>21</sup> Secondly, in the case of borrowing, increasing the grant share of project aid and programme aid could help Côte d'Ivoire and many aid recipients alleviate their debt burden, which constitutes a major development constraint in most of these countries. This process would in turn generate additional funds that could be used to stimulate the domestic economy, rather than being used for debt service purposes.

Foreign aid is currently moving to new directions in view of recent developments such as the UN Conference on *Financing Development* in Monterrey in April 2002, the Millennium Development Goals, the need to increase the amount of aid, the role of institutions in aid effectiveness, and overall the need to re-invent the aid architecture. The present paper sends *inter alia* an important signal to the donor community: understanding *how* aid works, and in particular, *how different types of aid work* is of paramount importance for our better understanding of aid effectiveness issues and for designing policies aiming at improving further aid effectiveness. Having said this, the present work clearly suggests the need for further work in this area, within the context of the aid disaggregation approach, at the country, regional and global level so that important generalizations can be drawn.

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<sup>21</sup> In 1990, an attempt by the Ivorian government to increase the tax on the price of basic food such as rice and bread was responsible for the first ever major social unrest in the country which have been costly both economically and socially.

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