Is Aid Unfriendly to Tax? African Evidence of Heterogeneous Direct and Indirect Effects

Djedje Hermann Yohou, Michaël Goujon, Bertrand Laporte, Samuel Guerineau

CENTRE D'ETUDES
ET DE RECHERCHES
SUR LE DEVELOPPEMENT
INTERNATIONAL

SÉRIE ÉTUDES ET DOCUMENTS

Is Aid Unfriendly to Tax? African Evidence of Heterogeneous Direct and Indirect Effects

Hermann Djédjé Yohou

Michaël Goujon

Bertrand Laporte

Samuel Guerineau

Études et Documents n° 8

May 2016

To cite this document:

Yohou H. D., Goujon M., Laporte B., Guerineau S. (2016) "Is Aid Unfriendly to Tax? African Evidence of Heterogeneous Direct and Indirect Effects", *Études et Documents,* n° 8, CERDI.
http://cerdi.org/production/show/id/1811/type_production_id/1

CERDI
65 BD. F. MITTERRAND
63000 CLERMONT FERRAND – FRANCE
TEL. + 33 4 73 17 74 00
FAX + 33 4 73 17 74 28
www.cerdi.org

The authors

Hermann Djédjé Yohou

PhD Student in Economics, CERDI – Clermont Université, Université d'Auvergne, UMR CNRS 6587, 63009 Clermont-Ferrand, France and Université Félix Houphouët Boigny, Abidjan, Côte d'Ivoire.
E-mail: dher.yohou@gmail.com

Michaël Goujon

Associate Professor (MCF), CERDI – Clermont Université, Université d'Auvergne, UMR CNRS 6587, 63009 Clermont-Ferrand, France.
E-mail: michael.goujon@udamail.fr

Bertrand Laporte

Associate Professor (MCF), CERDI – Clermont Université, Université d'Auvergne, UMR CNRS 6587, 63009 Clermont-Ferrand, France.
E-mail: bertrand.laporte@udamail.fr

Samuel Guerineau

Associate Professor (MCF), CERDI – Clermont Université, Université d'Auvergne, UMR CNRS 6587, 63009 Clermont-Ferrand, France.
E-mail: samuel.guerineau@udamail.fr

Corresponding author: Hermann Djédjé Yohou

This work was supported by the LABEX IDGM+ (ANR-10-LABX-14-01) within the program "Investissements d'Avenir" operated by the French National Research Agency (ANR).

Études et Documents are available online at: http://www.cerdi.org/ed

Director of Publication: Vianney Dequiedt
Editor: Catherine Araujo Bonjean
Publisher: Mariannick Cornec
ISSN: 2114 - 7957

Abstract

We explore the heterogeneous effects together with the transmission channels of aid on tax revenues in 47 African countries over 1990-2011 using a panel smooth threshold regression model and two alternative tax datasets from IMF and ICTD. We find that aid enhances tax revenues with decreasing returns for a threshold of 6.3% and 23% of GNI for total taxes and non-resource taxes respectively. Aid effect varies across countries and over time, but, on average, is positive. Moreover, we evidence that aid conditions the impact of the level of development, trade, institutions and resource wealth on tax.

Keywords
Foreign aid, Taxation, Revenues, Tax data, Nonlinearities, Africa.

JEL codes
F35, H20, C23, O55

Acknowledgment

We are grateful to Mario Mansour, Dora Benedek, Ernesto Crivelli, Sanjeev Gupta and Priscilla Muthoora from the International Monetary Fund (IMF) for providing data access. Thanks go to Patrick Guillaumont, Véronique Thelen, Simone Bertoli, Thierry Yogo, Diallo Ibrahima and Rasmané Ouedraogo for helpful comments and discussions.

1 Introduction

Financing development remains a great challenge as witnessed at the UN Third International Conference held in Addis Ababa on 13-16 July 2015 where were advocated the use of all sources of finance - public, private, domestic and international - together with the implementation of effective policies. The mobilization of these different sources of finance raises the question of whether they are independent, or complements or substitutes. Recently, the relation between aid and tax in developing countries has particularly received a great attention. The question is of great importance as these countries are highly reliant on foreign aid and short of domestic resources to support the funding of pro poor spending. Sub-Sahara African countries are a very illustrative case, being the most reliant on foreign aid (aid to gdp of 10.8% on average) and, with a tax to GDP ratio of 16%, far to reach the 20% target as suggested by the United Nations to achieve the Millennium Development Goals (UN, 2011). The issue is hence whether aid discourages domestic resources mobilization in the recipient countries. It is obviously a big challenge to give a clear-cut answer. Indeed, aid is directed to governments which use it to finance expenditure which in turn can promote tax compliance and growth. A big concern is how the recipient governments behave in presence of heavy reliance on aid. If all the state policy outcomes depend on foreign assistance, the possibility to be more responsive to donors than to the citizens is likely acute. This may weaken a proper development of internal democratic institutions and leads to a low level of tax compliance and revenues.

No consensus emerges from the existing empirical literature. Benedek et al. (2012) and Gupta et al. (2003) show that aid harms tax effort. Ouattara (2006), Teera and Hudson (2004) find that aid has no effect on tax revenues while Clist and Morrissey (2011), Clist (2014) and Carter (2013) find some positive effects. Besides the debate on data quality, three main arguments can explain this ambiguity. First, aid composition matters. Aid loans may have positive effects as they are to be repaid unlike grants for which negative effects are expected. But empirical results on aid composition are also mixed (Gupta et al., 2003; Benedek et al., 2012; Clist and Morrissey, 2011; Clist, 2014). Second, heterogeneities among countries play a critical role. In particular, countries with sound policies and institutions tend to exhibit a positive link between aid and tax revenues (Brun et al., 2011b,a). However, Yohou et al. (2016) show that it would be misleading to not strongly account for the heterogeneities among countries even if they share identical macroeconomic policies.

Third, some authors debate the econometric specification and emphasize that results

are sensitive to samples (Moss et al., 2006; Moore et al., 2007; Carter, 2013; Clist, 2014; Alonso and Garcimartín, 2011). In fact, most of studies suggest that the aid-tax relationship is nonlinear by introducing a square term of aid. In particular, the echoed works of Benedek et al. (2012) and Gupta et al. (2003) as well as Clist and Morrissey (2011) show a positive sign for the square terms of overall ODA and grants against a negative sign for loans. In other words, overall aid and grants present increasing returns meaning that their negative effects may be offset if their levels are sufficient. By contrast, the positive effect of loans will be offset if they are too important. In more recent papers, Morrissey et al. (2014) and Clist (2014) find exceptional large levels of aid respectively at 69% and 65% of GDP beyond which the effect of aid becomes negative.

This paper offers a unique but simple empirical threshold framework that addresses thoroughly the issues of heterogeneities and the form of aid-tax relationship. It brings three major innovations focusing on 47 African countries over the period 1990-2011. First, drawing from the previous studies, we argue that the impact of aid on tax revenues is not homogenous, but depends on the degree of aid reliance.

However, the assessment of the heterogeneous effects here differs significantly from that of existing studies. As noted above existing studies model nonlinearity by a square term or sub samples. By doing so, they explicitly assume that the nonlinear impact of aid is constant through the entire time span and homogenous between countries. This is not helpful to catch for example some effects of a learning-by-doing process in aid schemes management and the efficiency of some particular policies implemented at a certain point of time. We do believe that the impact of aid for the same country can gradually improve, as the aid allocation and management improve. One important example in recent years is the framework created by the mechanism of the HIPC initiative which has enhanced to a certain extent the conditionality related to good governance and has improved the targeting of areas to be primarily funded. Therefore, we reasonably assume that aid effects are not constant over time and across countries. We then depart from the existing literature by using a Panel Smooth Threshold Regression (PSTR) approach to account for such time and individual heterogeneous aid effects.

Second the PSTR is also helpful to address the issue of the usually-evoked but less explored mediating effect of aid through the other tax potential factors. As suggested by Carter (2013) and Morrissey et al. (2014), aid has some potential indirect effects through some variables, generally included in aid-tax equation, that are related to tax bases and collection efficiency (income per capita, institutions, imports etc.). This idea is also supported by the aid effectiveness literature. This suggests that the single

estimate of aid may hide some part of the real effect of aid on tax revenues.

Third, existing aid-tax studies test the relationship between aid and total tax revenue not exclusive of resource revenues. This is an imperfect approximation since the main question of aid-tax relationship is how aid modulates state-society relationships represented by the state reliance on non-resource tax revenue. We then take advantage of the two advanced and competing tax datasets from International Monetary Fund (IMF) and International Center for Taxation and Development (ICTD). Instead of focus on the dispute about their superiority over each other, we rather hang on their original definitions to highlight the theoretical relationship of interest. While IMF dataset documents the total tax revenue, the dataset from ICTD conversely provides data on total tax excluding resource revenue.

Our main finding is that aid has a country specific and time-varying effect depending on the deviation from a certain threshold level of aid estimated at 6.3% and 23% of GNI with IMF total tax revenue and ICTD non-resource revenues, respectively. Beyond these thresholds, aid has a positive effect with diminishing returns for larger aid. For the entire sample, it results in a positive effect. Considering ICTD non-resource taxes, our results support the evidence that larger aid enhances the positive effects of trade openness and of the level of development but hampers that of institutions while worsening the resource curse. Conversely with IMF total tax revenues, larger aid lowers the positive effect of the level of development while increases those of trade openness and of the manufacture sector.

The remainder of the paper is organized as follow. Section 2 reviews the aid-tax literature. Section 3 describes data and methodology. Section 4 presents the results. Section 5 concludes.

2 Related literature

The recent studies on aid-tax specifically use a single relationship in which aid is one of the tax determinants beside the degree of openness, the level of development, the quality of institutions, the level of inflation etc. The results are very controversial. Gupta et al. (2003) and Benedek et al. (2012) find that aid lowers tax revenue on the one hand. On the other hand, grants are pervasive whereas loans are efficient because they must be repaid. These findings are strongly challenged by Clist and Morrissey (2011), Clist (2014) and Morrissey et al. (2014) who provide no evidence of a negative impact of neither aid nor grants. They question also the quality of tax data used by the two former works and find that their conclusion are driven by a break due to data

compilation from multiple sources. By using different datasets including those of Gupta et al. (2003) and Benedek et al. (2012), they conclude that results of Gupta et al. (2003) and Benedek et al. (2012) are not robust. Using dataset of Mansour and Keen (2009), Bhushan and Samy (2012) find that aid does not significantly impact tax in general and in sub-Saharan Africa over the period 1972-2008.

One prior concern about the ability of foreign aid to promote tax performances tends to emphasize on its potential harmful effects on the recipient institutions. Taxation is the core of state building since it demands more accountability from state towards its citizen. Foreign assistance can then reduce the dependence of recipient governments on their own citizen (Knack, 2009). It results in an increase in the accountability towards the funders rather than towards the citizen and a more probable social contract deterioration. To the extent that institutions matter for tax collection, foreign aid then hinders tax performances. Bräutigam and Knack (2004) give econometric support that aid damages the quality of governance and the tax collection while Knack (2009) shows that aid reduces governments' incentives to develop efficient tax system. Azam et al. (1999) provide theoretical evidence that aid discourages governments to adopt good policies and to develop an efficient system of public revenue and expenditure in the long run.

In spite of these detrimental effects, aid may also contribute to institutional building and tax performances. The aid-disbursement conditionalities on good governance and economic reforms and associated technical assistance in tax administration may be successful. Tavares (2003) finds that aid decreases corruption. Brun et al. (2011b) find that IMF programs have a positive impact on the public revenue mobilization through improvements of the technical administrations in charge of the definition and implementation of the tax reforms.

However, it tends to be broadly established that these positive effects emerge when the recipient governments adopt good practices and have clear development agendas (Bräutigam and Knack, 2004). In contrast of the previous studies, the ad hoc assumption is implicitly made that the quality of institutions and policies of the recipient countries are the main driver of aid effectiveness, the reverse causality being controlled by an instrumental variable approach. Hence, Brun et al. (2011b) find that IMF programs work better if the quality of domestic administration is good. Especially, they argue that the programs are less effective in sub-Saharan Africa countries because of the poor quality of their institutions. Gupta et al. (2003) exhibit that decline in revenues completely offsets the increase in grants in countries experiencing high levels of corruption. Benedek et al. (2012) come to similar results and show that poor institutional

quality worsens the negative effect of aid on tax revenues. Focusing on WAEMU countries through a PSTR approach, Yohou et al. (2016) show that aid efficiency requires a minimum level of government stability.

The empirical literature is aware that the inconclusiveness on aid-tax relationship is due to shortcomings in data quality on tax revenues and econometric specification. Even if IMF, OECD and think thanks like ICTD regularly update and correct existing data, primary data quality remains a challenge given low domestic institutional development.

Various improvements of the econometric specification have been suggested. Carter (2013) points that empirical studies should markedly control for the endogeneity of aid and heterogeneities both in aid effects and in countries' tax structures. Some previous studies deal with some of these concerns. Benedek et al. (2012) decompose total tax revenues in various components: value added tax (VAT), excise and income tax and trade tax. This does not change their main conclusion that aid has harmful effects on taxation except the positive impact on trade taxes. The results of Morrissey et al. (2014) are based on the non resource tax revenues while Bhushan and Samy (2012) also use the tax to GDP ratio excluding both trade and resource taxes. Control for endogeneity has been done in many ways with contrasting results. Brun et al. (2011a) and Brun et al. (2011b) use an instrument based on Tavares (2003), and find a positive effect, while Benedek et al. (2012) concludes to a negative effect out of a GMM estimation. Using the initial income and population and lagged values of aid as instruments in 2SLS estimations also produces a negative effect in Gupta et al. (2003) and Bräutigam and Knack (2004) while Bhushan and Samy (2012) do not find any statistically effect. The issue of endogeneity remains quite unsolved as this is the case in the broader aid effectiveness literature, as detailed in Guillaumont and Wagner (2014).

Regarding heterogeneities, countries present diverse experiences in terms of supporting tax policy and tax administration reforms which can affect aid-tax relationship (Benedek et al., 2012; Prichard et al., 2013a). Three strategies are actually employed to control heterogeneity in aid-tax relationship. The first one is single country study using time series. This strategy yields also mixed results. Franco-Rodriguez et al. (1998) find a negative relationship between aid and tax effort for Pakistan. Franco-Rodriguez (2000) and Osei et al. (2005) shows a positive effect of aid on tax in Costa Rica and Ghana respectively. This approach is limited by the low number of observations and the difficulty to make a comparison among countries which is essential in aid effectiveness literature. The second and most used strategy is panel data to account for both the individual and temporal dimensions. The third is PSTR. We proceed with a formalization of the ways heterogeneity is taken into account in the literature, to show the

advantage of the PSTR approach following Destais et al. (2007).

Let us consider a simple cross-section model of the relationship between aid and taxation like that used by Bräutigam and Knack (2004) and Knack (2009):

$$tax_i = \alpha + \beta aid_i + X_i + \epsilon_i \tag{1}$$

$i = 1, ...N.$ where tax_i is the taxation index for the i^{th} country of the sample of N countries for the average period studied and aid the aid measure. X_i are control variables, the other determinants of tax. α and β are constants for the period and ϵ_i is $i.i.d.(0, \sigma_\epsilon^2)$. This simple model exhibits that the (long term) impact of aid is the same for all the countries and given by β. This strong assumption can be partially circumvented by introducing dummy variables and pooling countries by classes. Another drawback of cross-section model is that the number of observations is limited. Panel data analysis, by contrast, makes use of larger samples and reduces the problem of multicollinearity among the explanatory variables and the effects of missing or unobserved variables (Hsiao, 2014).

A simple form of panel specification is:

$$tax_{it} = \alpha + \beta aid_{it} + X_{it} + \epsilon_{it} \tag{2}$$

where ϵ_{it} is $i.i.d.(0, \sigma_\epsilon^2)$; t denotes time period with $t = 1, ...T$. However, this model does not still allow for heterogeneity. Heterogeneity of the constant α can be introduced through country fixed effect.

$$tax_{it} = \alpha_i + \beta aid_{it} + X_{it} + \epsilon_{it} \tag{3}$$

The individual effects α_i capture the influence of country-specific time-invariant variables like tax system administration capacity or structural characteristics. However, this allows heterogeneity of the average level of tax only.

These panel specifications can then be improved by including dummy variables for subgroups of countries sharing some specific economic characteristics or institutional arrangements. Gupta et al. (2003) add a dummy for oil exporters. Benedek et al. (2012) and Bhushan and Samy (2012) include a full set of time dummies. Brun et al. (2011b) interact their variable of interest (IMF program) with a dummy for sub-Saharan African countries.

A more general accounting for heterogeneity is to split the sample into subgroups. As robustness tests, regressions are then run on these sub-samples to catch whether

the effects differ from those of the whole of sample and across the sub-samples. The guiding criteria are either the membership to a specific region, or the countries are situated above or under a certain cutoff of a specific economic or institutional variable or time period. Gupta et al. (2003) split their sample by quartiles according to ICRG corruption index. Their results suggest that grants have a stronger negative effect on tax effort in the most corrupt countries. Adopting the same approach, Benedek et al. (2012) distinguish the type of aid, and country groups by income and regions. For instance, the resulting estimations show a negative relationship for total aid and ODA grants in Africa and Asia and Pacific. Loans have significant negative effects only in Africa. Restricting their sample over the period 1985-2005, Clist and Morrissey (2011) take into account a structural break in the aid-tax relationship, giving grants a statistically significant and positive effect. Morrissey et al. (2014) find evidence that grants have a positive impact in the cases of Sub-Saharan Africa and Latin America and Caribbean. Second, splitting the sample into two sub-samples, 1980-1990 and 1990-2010 they come to the same conclusion of Clist and Morrissey (2011).

The sub-sample approach with panel data provides more insight on the heterogeneity in aid effects on tax revenues. Nevertheless, the previous critics against the use of dummy variables are also valid for the sub-sample technique. It estimates an average effect of aid for a particular sub-group. Moreover,the choice of the cutoff is often discretionary and arbitrary. It does not allow a country to move from a group to another. It implies that the distribution of each group is the same relative to the chosen threshold variable. This strong assumption may result in a meaningless estimate of aid impact if, for instance, the degree of political commitment in reforms differs across countries of the same group and over time. In addition, Hansen (1999) shows that the ad hoc sample splitting may pose serious inference problems.

Another approach to account for the heterogeneous effect of aid is to allow for non-linearity in the form of increasing or decreasing returns. Determining potential aid thresholds from which aid effect shifts has important policy implications. Indeed, if aid has a positive effect on taxation but with decreasing returns above a certain cutoff of aid, then the absorptive capacity of aid is limited. The resulting straight policy implication is to not exceed this cutoff. Adversely, a negative effect with increasing returns means that countries need a big push in aid to reverse the effect. The opposition between *absorption capacity* and *big push* is at the core of the debate on aid-development relationship. It is usual to check such nonlinearities by including aid and its square term

in the regressions as follows:

$$tax_{it} = \alpha + \beta aid_{it} + \rho aid_{it}^2 + X_{it} + \epsilon_{it} \quad (4)$$

For instance, in Gupta et al. (2003), and in Benedek et al. (2012), the square term coefficient is positive for total aid and grants, but rarely significant for loans. By contrast, Clist (2014) find a positive effect with decreasing returns for all types of aid (total, grants and loans). Morrissey et al. (2014) find decreasing returns for grants and total aid against positive ones for loans. However, both studies find that the scope of decreasing returns is modest since the net effect of aid becomes negative only at exceptional turning points of 69% of GDP (Morrissey et al., 2014) and 65% of GDP (Clist, 2014).

Moreover, the use of the quadratic specification has a number of caveats, since the nonlinearity shape is arbitrary and do not allow modeling multiple turning points.

Lastly, the aid-tax literature is inconclusive also because aid could affect both directly and indirectly tax revenues *via* several potential factors. As we state above policies associated with aid may potentially affect tax rates, bases and tax collection. According to Morrissey et al. (2014), right-hand side variables in tax equation that aim at proxying tax base like agriculture and industry shares, GDP, imports and exports cannot adequately account for these policy effects. Morrissey et al. (2014) and Carter (2013) show how it is hard to make distinction between behavioral, conditionality/policy and technical assistance effects. For instance, the liberalization reforms, supported by aid conditionality, have induced tax reductions but also a growth revival which may potentially generate tax revenue increase.

The empirical results on these potential channels are mixed. A typical illustration is that of the level of development, proxied by GDP or GDP per capita. Economic growth, human capital development and infrastructures are engines of development and they are likely supported by aid through budget support. However, impacts of aid on these factors are likely to be nonlinear and heterogeneous across countries (Elbadawi, 1999; Fielding and Gibson, 2013; Dalgaard and Hansen, 2001; Hadjimichael et al., 1995; Kourtellos et al., 2007; Kalyvitis et al., 2012; Guillaumont and Guillaumont-Jeanneney, 2009). This obviously cannot be captured by the estimate of a single average value of the aid coefficient (Gomanee et al., 2005).

In short, as stated by Carter (2013) simple panel specifications cannot capture nonlinearities and heterogeneities in direct and indirect impacts of aid on tax. Thus, while Carter (2013) uses a Pooled Mean Group (PMG)estimators that allows for hetero-

geneities in the short run responses and intercepts but imposes a common long run relationship, we here adopt a more general approach with the PSTR estimator on a reduced-form model.

3 Data and specification

3.1 Model specification

We use a Panel Smooth Transition Regression (PSTR) specification that was recently developed by González et al. (2005) and Fok et al. (2005). It is a generalization of the Panel Threshold Regression (PTR hereafter) approach of Hansen (1999) in which the coefficients of a reduced-form model are function of the value of a transition variable. A number of recent papers have used this approach to examine how the individual coefficients of an interest variable vary smoothly over time according to a threshold variable. On aid-tax issue, only Yohou et al. (2016) have used PSTR. Considering a basic case of two regimes and a single transition function, the PSTR model takes the following form:

$$tax_{it} = \mu_i + \beta_0 x_{it} + \beta_1 x_{it} g(A_{it}; \gamma; A) + u_{it} \tag{5}$$

The vector x_{it} includes the aid variable A and the other traditional factors. β_0 and β_1 are two vectors of parameters to be estimated. They capture the direct impact of x on tax and the indirect, conditional on aid, non-linear, impact of x on tax, respectively. μ_i denotes the fixed individual effects while u_{it} the idiosyncratic error and g is the transition function.

The transition function is a continuous function of the threshold variable given by the following logistic function (Granger and Teräsvirta, 1993; González et al., 2005):

$$g(A_{it}; \gamma; A) = \left[1 + \exp(-\gamma \prod_{j=1}^{m} (A_{it} - A_j))\right]^{-1} \tag{6}$$

where $A\ (A_1, \ldots, A_m)'$ is an m-dimensional vector of location (threshold) parameters and the estimated term γ measures the slope of the transition function or the sharpness of the regime shift. The effect of x on tax revenue for country i at time t results from its direct and aid-conditional effects. It is given by:

$$\frac{\partial tax_{it}}{\partial x_{it}} = \beta_0 + \beta_1 g(A_{it}; \gamma; A); g \in [0, 1] \tag{7}$$

However, the expression of aid effect is slightly different from that of the equation 7 since the threshold variable q_{it} is a function of aid. It equals to:

$$\frac{\partial tax_{it}}{\partial A_{it}} = \beta_0 + \beta_1 g(A_{it};\gamma;A) + \beta_1 \frac{\partial g(A_{it};\gamma;A)}{\partial A_{it}} A_{it} \tag{8}$$

As equations 7 and 8 show, the size of coefficients β_0 and β_1 cannot be directly interpreted at the first stage of the estimation only their respective signs make sense because there are as many values of each estimates between β_0 and $\beta_0 + \beta_1$ as the number of country-year observations. However, when the value of the slope γ equals zero, the transition function reduces to a constant. The model becomes a standard linear model with individual effects, *i.e.* constant and homogeneous coefficients. If γ tends towards infinity, the transition function becomes an indicator function and the PSTR model in (1) reduces to the two-regime PTR model of Hansen (1999) in the case where $m = 1$, for instance. When $m \succ 1$ and γ tends to infinity, the number of regimes remains two but the function switches between zero and one (Colletaz et al., 2006).

3.2 Estimation and tests of specification

The estimation procedure consists in eliminating the individual effects μ_i by removing country-specific means and applying nonlinear least squares to the transformed model. González et al. (2005) propose the following procedure: i) testing the linearity against the PSTR model (or testing homogeneity against the PSTR alternative), ii) determining the number, r, of transition functions, that means the number of extreme regimes which is equal to $r + 1$. The test of homogeneity in PSTR model can be done by testing: $H_0 : \gamma = 0$ or $H_0 : \beta_1 = 0$. However under the null hypothesis, the tests are non-standard since the PSTR model contains unidentified nuisance parameters. This identification problem is circumvented by replacing $g(aid_{it};\gamma;aid)$ by its first-order Taylor expansion around $\gamma = 0$ and to test an equivalent hypothesis based on the auxiliary regression:

$$tax_{it} = \mu_i + \beta_0^* x_{it} + \beta_1^* x_{it} A_{it} + ... + \beta_m^* x_{it} A_{it}^m + u_{it}^m \tag{9}$$

The linearity test against PSTR is then equivalent to testing $H_o^* : \beta_1^* = ... = \beta_m^* = 0$. The corresponding F-statistic is then defined by:

$$LMF = \frac{(SSR_0 - SSR_1)/mk}{SSR_0/(TN - N - mk)} \sim F(mk, TN - N - m(k+1)) \tag{10}$$

where SSR_0 is the panel sum of squared residuals under H_0, and SSR_1, the panel

sum of squared residuals with regimes. k is the number of explanatory variables, T is the number of years and N the number of countries. The test of homogeneity is also used to determine sequentially the number of transitions. The null hypothesis that the model is linear at a predetermined significance level α is tested. If it is rejected, a two-regime PSTR model is estimated. If the two-regime at turn is rejected a three-regime is estimated. The testing procedure continues until the first acceptance of the null hypothesis of no remaining heterogeneity. At each step of the sequential procedure, the significance level must be reduced by a constant factor $0 \prec \tau \prec 1$ in order to avoid excessively large models.

There remains a crucial question about the issue of endogeneity caused by a simultaneity or double-causality since low tax level countries may then benefit from higher aid. The use of instrumental variables in aid-tax studies provides contrasting results according to the instruments used as argued by Clist and Morrissey (2011). We avoid such sensitivity to instruments by not using any instrumentation for a couple of reasons. First, Fouquau et al. (2008) and Béreau et al. (2012) argue that a PSTR limits the potential endogeneity issue since there is a specific value of the parameter for each level of threshold variable. For comparison purpose, they use the generalized method moments (GMM) estimation with interaction terms and a PSTR corrected for endogeneity and a "standard" PSTR. They find that the results derived from the corrected PSTR are close to those of non corrected PSTR and both are superior to the former. Second and most importantly, Yu (2013) and Yu and Phillips (2014) demonstrate that in threshold regressions, both the threshold point and the threshold effect do not need any instrumentation in order to be identified. The need for extra randomness in the regressors is averted by the discontinuity structure of the cutoff itself which supplies identifying information for the parametric coefficients. In particular, the former author shows that 2SLS estimators in threshold models with endogeneity are inconsistent. Obviously, it would be imprudent to generalize this conclusion to PSTR model even if the latter and the instrumental variable threshold models are close to the pioneer model of Hansen (1999). Consequently, we lag aid (as suggest Clist and Morrissey (2011)) and all the variables. The reference paper of González et al. (2005) adopts a similar approach.

3.3 Data and the model variables

Most existing studies use either total government revenues or total tax revenues as the left-hand side variable. However, the real concern of the political economy literature is how aid does affect the state-citizen-relationship. Then, reliance on non-resource tax revenues is rather the most appropriate measure (Prichard et al., 2013b). In addition,

there is no theoretical argument that aid leads a government to cut natural resource revenues.

We use two tax effort measures from the two advanced competing datasets from the fiscal affairs department of International Monetary Fund kindly provided by Benedek et al. (2012) (IMF henceforth) and from the newly government revenue dataset developed by Prichard et al. (2014) through the International Center for Taxation and Development (ICTD henceforth). ICTD dataset builders claim that they have greatly improved data in terms of coverage and accuracy in comparison with the dataset used by Benedek et al. (2012) especially. However, the updated IMF tax dataset has also benefited from critical improvements taking advantage of the updated work of Mansour (2014). Moreover, tax data definitions differ between the two datasets. IMF tax variable is the ratio of total tax revenues excluding social contributions and grants as percentage of GDP while ICTD tax variable additionally excludes non tax revenues (mainly composed of resource revenues). To our knowledge, only Morrissey et al. (2014) make use of non-resource government revenues data.

Regarding the right hand side variables, we follow the standard empirical literature on aid-tax issue (Gupta, 2007; Gupta et al., 2003; Teera and Hudson, 2004; Morrissey et al., 2014; Yohou et al., 2016), and we select the most prominent mediating factors. Hence the set of variables includes the quality of institutions, the level of development, the sectoral composition of the economy, the trade openness and the resource rent wealth.

Strong institutions are beneficial to tax collection and implementation of tax reforms in a sustained effort. Good institutions can create lower and bearable tax rates while expanding the bases through growth notably, improving the collection efficiency. On the contrary, in a weak institutions country, where the level of corruption is high for instance, the trust in government may collapse leading to lower incentives to pay taxes. The noxious effects of rent-seeking on tax performances are well established. Aid conditionality including some obligations to run specific tax reforms or to improve governance may then potentially strengthen the positive effects of the level of institutional quality on tax capacity. The institutional quality variable is taken from Kunčič (2014) who has summarized more than 30 institutional quality indexes around three major components including legal, political and economic institutions. We use the average of the three sub-indices. We then avoid an arbitrary choice of a specific institutional quality indicator as Gupta et al. (2003), Benedek et al. (2012) and Brun et al. (2011b) have done.

GNI per capita is a proxy of the level of development of a country. Higher income

countries has a more monetized economy and efficient tax administration (Agbeyegbe et al., 2006). A higher level of development is also positively associated with a higher relative demand for income elastic public goods and services (Bird et al., 2008) and so with a higher capacity and compliance to pay taxes. Even if this is always debated, we assume that aid can promote growth and, given that it supports many administration tax reforms and assistance, that aid can affect the impact of the national income on tax.

The sectoral composition of the economy is usually captured by two variables: the share of value added of industry and/or value added of agriculture in GDP. Given that the statistical distribution of the industry ratio is mostly influenced by the distribution of mining and oil in the African sample, and the high correlation of this ratio with other control variables, we prefer to use the share of manufacturing excluding mining and oil in the total value added and the share of agricultural value added in the total value added. Data are from The United Nations Statistics Division (UNSD) of the Department of Economic and Social Affairs (DESA) (UNDATA henceforth). It is usually assumed that the agriculture or rural sector is more difficult to tax than the industrial (or urban) sector. A higher agriculture (industrial) share is then negatively (positively) correlated with tax. Besides the controversies on absorptive capacity and the effects on private investment, aid may sustain the domestic effort in expanding those sectors without creating additional government revenues. Simply, government may substitute aid for taxes raised from these sectors in order to encourage their development. This is not bad *per se* since it may satisfy the final objective of aid. However it is of concern when it is a systematic response to lobbies claiming tax exemptions notably when the government expects a higher support from donors. For these reasons, we assume that larger aid may hinder the contribution of sectoral composition to tax effort.

Trade openness, measured by the ratio of the sum of imports and exports to GDP, is expected to be positively related to tax, as trade taxes would be easier to collect than other taxes.This enhancing effect might somewhat crumble with the liberalization and fiscal transition reforms accompanying aid. Agbeyegbe et al. (2006) have provided an interesting explanation on this issue. Trade liberalization has involved the replacement of quantitative barriers with import duties which would have generated higher trade tax revenues depending on the level of duties and impact on imports value. Subsequent fiscal transition reforms have reduced import duties and trade tax revenues in favor of VAT and other domestic taxes. The net effect of aid on tax through liberalization and reforms, trade openness, tax and customs administration, is then uncertain.

Natural resource wealth is alternatively captured by the ratio of non-tax revenue

to GDP and the sum of oil and gas rents ratios to GDP. A strand of the resource curse literature gives a similar role to aid and natural resources. The resource curse literature suggests that resource windfalls impede democracy and thus deteriorate the social contract leading to tax collection, lower the incentives to build state capacity for collecting taxes and providing services (Knack, 2009). One can expect that aid and technical assistance, and associated tax reforms for instance, may influence the effect of natural resources on tax, for a given level of natural resources.

Regarding the aid variable, we select the usual ratio of aid-to-gross national income. It refers to the total net official disbursement flows (net of repayment of principal) according to the Development Assistance Committee (DAC) definition of official development assistance. Data on aid, GNI per capita, oil-gas rents and trade variables are from the World Development Indicators (WDI) of the World Bank. Constrained by data availability, our study covers an unbalanced panel of 47 out of the 54 African countries over the period 1990-2011. [1]

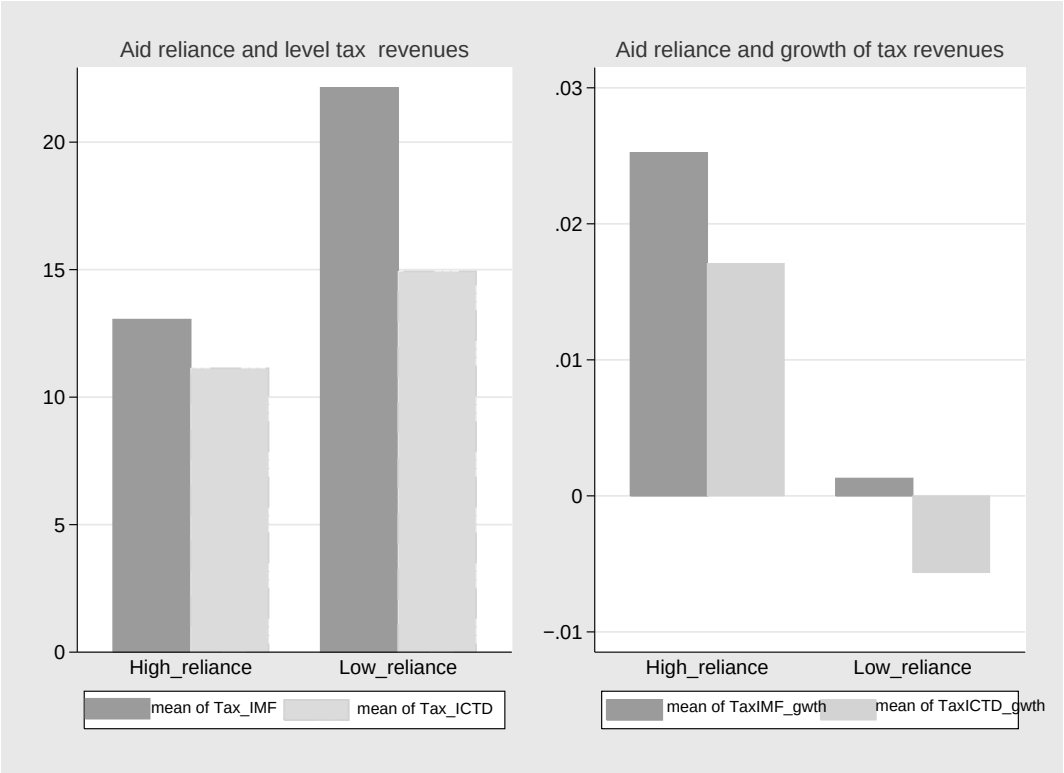
Descriptive statistics

Table 6 in appendix reports the main descriptive statistics. The average tax level in Africa is relatively low in comparison with the other developing countries and OECD countries. It stands at about 18 % and 13% of GDP for the total tax revenues (Tax-IMF) and the non-resource tax revenues (Tax-ICTD) respectively. High values of standard deviations indicate a huge variability in our sample. Meanwhile, aid reliance is high standing at more than 10% of GNI. As for tax revenues, the standard deviations of aid variables also indicate important disparities across countries. Aid-tax relationship also differs greatly at a first glance. Some countries show low aid reliance and poor non-resource tax revenues (Algeria, Angola) but high total tax performances. Benin and Central African Republic have almost the same aid reliance (about 11% of GNI) but exhibit contrasting total tax performances (about 14% and 8% of GDP respectively).

Figure 1 plots the simple relationship between aid and tax revenue or change in tax revenue according to the degree of aid reliance for both tax effort measures. Roughly imposed here, high (low) aid reliance countries are those where aid-to-GNI ratio is higher (lower) than the sample average. The figure shows that high reliance is negatively associated with tax-to-GDP level, but positively with tax-to-GDP growth, signaling

[1] Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo Republic, Cote d'Ivoire, Egypt Arab Republic, Equatorial Guinea, Ethiopia, Gabon, Gambia, The Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe. Excluding countries are mostly conflict countries: Djibouti, Eritrea, Liberia, Libya, Sao Tome and Principe, Somalia and South Sudan.

Figure 1: Aid reliance and tax performances over 1990-2011



Source: Authors from WDI, IMF, ICTD. Notes: Mean is the mean of the variable. *gwth* denotes the growth of the variable.

the complexity of the relationship. This may suggest that initially aid-reliant countries are not necessarily the least performing in improving tax collection through time. Consequently, accounting for time-varying relationship between aid and tax may be a requisite.

Pairwise correlations from table 7 show that total tax revenue (IMF) is positively correlated with its usual determinants, except with aid and agriculture. Yet, the non-resource tax variable (ICTD) is negatively associated with natural resource wealth. Aid tends to be associated with the other tax determinants, except agriculture import. The high correlation between some tax determinants signals a potential multicollinearity bias.

4 Results

4.1 Tax maximizing overall aid rate

We start with simple PSTR regressions before testing for aid-conditional channels of the impact of aid on tax. Details of these exploratory results are not reported to save space and are available on request. First, a simple PSTR regression of tax on aid only evidences a non-linearity but estimated coefficients are insignificant throughout the regimes, suggesting the need to include additional control variables. Second, we add control variables (openness, GNI per capita, manufacture, agriculture, institutions, resources) in a simple way, with no interaction with aid. Results still suggest a very marginally significant non-linearity. Third, we gradually enter aid variable and interaction between aid and controls. In some cases, we do not find any non-linearity.

Table 1 then reports the conclusive results of the fourth step, where we add interaction between aid and each control, alternatively (maintaining the others as simple controls), for both ICTD and IMF measures of tax. We here exclude single aid variable to explore only indirect conditional to aid controlling for the effects of the other tax factors. Roughly, we find that increasing aid improves the effect of trade openness and of GNI per capita on tax, but worsens the effect of resource wealth. Generally, the other controls have the expected coefficient signs. Openness, GNI per capita and institutions affect positively and significantly tax effort while agriculture and manufacture effects are statistically insignificant. As expected, resource wealth increases IMF-total taxes and lowers ICTD-non-resource taxes.

We now use the general PSTR specification presented above where all right-hand side variable impacts are conditional on aid thresholds. We used various specifications, log-log, semi-log and so on, to check the sensitivity of our results to specification and/or outliers. The results are similar to those reported in Tables 2 to 4.

For both tax variables, 5 to 6 specifications are proposed to check the robustness of the results. The first specification is the most standard specification without resource wealth as control. Following Treviño and Thomas (2013), the second specification includes resource wealth. The third and fourth specifications address Clist and Morrissey (2011) suggestion to disentangling and replacing trade by import and export openness, respectively (alternatively to avoid multicollinearity). We do not report estimates for IMF-tax revenue with exports that have no economic sense. The following specification excludes the "single" aid variable from regressions to keep sight on potential shifts on the other determinants effects if the direct aid effect is not accounted for. The last one deals with the issue of potential collinearity posed by the agriculture variable.

Table 1: Aid, tax factors and Tax effort: Individual variable conditional effect

Channel	Openness		GNI per capita		Resource revenue	
Model	Tax-ICTD	Tax-IMF	Tax-ICTD	Tax-IMF	Tax-ICTD	Tax-IMF
Threshold (ODA/GNI)	0.7303***	17.2082***	0.8393***	13.8132***	6.9195***	-
Slope parameter (γ)	1605.52***	95.5630***	0.4996***	47.0784***	3128.3407***	-
β_0: *Channel*	-0.0438***	0.0049	0.7636	4.6099***	-0.1636***	-
	(0.0154)	(0.0084)	(0.6564)	(0.8043)	(0.0306)	
β_1: *Channel*g*($A_{it}; \gamma; A$)	0.0537***	0.0111**	1.5695***	0.4780***	-0.0398*	-
	(0.0149)	(0.0056)	(0.3616)	(0.1797)	(0.02133)	-
Control variables:						
Openness			0.0077*	0.0156**	0.0089**	-
			(0.0041)	(0.00627)	(0.0041)	-
GNI per capita (log)	2.3130***	5.0332***			2.5847***	-
	(0.5422)	(0.7886)			(0.5554)	-
Manufacture	-0.0752	-0.0469	-0.0662	-0.0378	-0.0860*	-
	(0.0475)	(0.0679)	(0.0475)	(0.0680)	(0.0477)	-
Agriculture	0.0354	0.0205	0.0324	0.0226	0.0361	-
	(0.0297)	(0.0447)	(0.0296)	(0.04466)	(0.0299)	-
Institutions (log)	2.4268***	2.9304***	2.3932***	2.8588***	2.4865***	-
	(0.4471)	(0.6551)	(0.4459)	(0.6550)	(0.4490)	-
Resource taxes	-0.1976***		-0.2212***			-
	(0.0250)		(0.0255)			
Oil and Gas		0.1624***		0.1582***		-
		(0.0251)		(0.0250)		
AIC criterion	1.8469	2.5484	1.8407	2.5449	1.8572	-
Schwartz criterion	1.8938	2.5962	1.8876	2.5927	1.9041	-
Number of observations	926	905	926	905	926	-

Notes: Independent variables are lagged. * significant at 10%, **significant at 5%, *** significant at 1%.
Standard deviation in parentheses.

Table 2: Tests for linearity and remaining nonlinearity

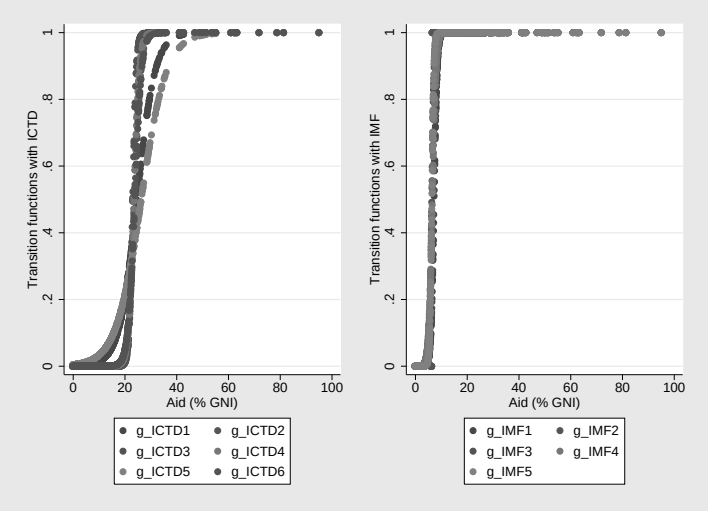
Variable	Tax-IMF					Tax-ICTD					
Model	1	2	3	4	5	1	2	3	4	5	6
Number of location parameters	1	1	1	1	1	1	1	1	1	1	1
Wald test											
H_0: $r = 0$ *versus* H_1: $r = 1$	31.861	36.175	35.288	35.317	35.965	84.360	58.538	55.048	62.129	68.008	58.722
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
H_1: $r = 1$ *versus* H_1: $r = 2$	9.978	11.569	11.615	7.510	9.030	5.128	3.000	3.301	3.744	6.579	2.100
	(0.126)	(0.116)	(0.114)	(0.185)	(0.172)	(0.527)	(0.885)	(0.856)	(0.879)	(0.474)	(0.910)
Fischer test											
H_0: $r = 0$ *versus* H_1: $r = 1$	5.191	5.068	4.939	6.936	5.884	14.561	8.405	7.873	7.828	9.867	9.849
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
H_1: $r = 1$ *versus* H_1: $r = 2$	1.565	1.550	1.557	1.413	1.413	0.801	0.400	0.440	0.435	0.879	0.327
	(0.154)	(0.147)	(0.145)	(0.217)	(0.207)	(0.569)	(0.903)	(0.877)	(0.900)	(0.522)	(0.923)
LR test											
H_0: $r = 0$ *versus* H_1: $r = 1$	32.420	36.916	35.993	36.023	36.698	88.277	60.393	56.684	64.224	70.528	60.589
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
H_1: $r = 1$ *versus* H_1: $r = 2$	10.032	11.643	11.690	7.541	9.075	5.142	3.004	3.306	3.752	6.601	2.103
	(0.123)	(0.113)	(0.111)	(0.183)	(0.169)	(0.526)	(0.885)	(0.855)	(0.879)	(0.472)	(0.910)

Notes: p-values in parentheses.

Table 2 reports the results for linearity and no remaining nonlinearity tests with one location parameter ($m = 1$) because the tests of the existence of two thresholds are rejected.[2] Whatever the tax effort measure and the specification considered, the three tests strongly reject the null hypothesis of linearity at the level of 1% between tax revenues and aid. It then questions the accuracy of most of the recent aid-tax empirical findings that do not show such a relationship, especially for Africa, like those of Bhushan and Samy (2012), Benedek et al. (2012), Clist (2014) and Clist and Morrissey (2011). Moreover, tests do not reject the null hypothesis of one transition function against two for all specifications and tax effort variables. They indicate that the nonlinearity or cross-country heterogeneity and time variability of aid-tax revenues relationship are properly featured by a small number of extreme regimes.

Figure 2 displays the graphs of the transition functions for both tax revenues from the equation 5. Except for the IMF-model 2, the relative low values of the slope parameters show that the transition function is suitably featured by a PSTR structure. However, results from ICTD-models record the lowest values of the slope parameters suggesting that aid effects are more gradual for non-resource tax revenues compared to total tax revenues. From IMF-models, the slope parameter of the transition function ranks between 1.5 and 2.6 except in the second specification which exhibits the exceptional value of 1192.1. From the ICTD models, the lowest and the highest slope values are 0.20 and 1.49 respectively.

Figure 2: Transition functions



Source: Authors' estimations

[2]Results for $m = 2$ are available on request.

Tables 3 and 4 report the estimates of the final PSTR models for IMF and ICTD tax variables (IMF-models and ICTD-models), respectively. As noted above, at this step only the signs of the estimated parameters are interpretable, not their values. For each specification, β_0 measures the direct effect on tax of the corresponding variable whereas the aid-conditional effect is measured by β_1. A positive (negative) value of β_1 indicates an increase (a decrease) in the aid or the channel impact with the value of the threshold variable.

Our results point three major lessons. First, the nonlinearity between aid and tax collection cannot be reduced to a limited number of regimes with different estimates. Second, they confirm that the approaches consisting in grouping countries, using subsamples or modeling the nonlinearity by a quadratic term of aid are unsatisfactory. They heavily underestimate the pattern of the heterogeneities across countries and over time. Third, the nonlinearity between aid and tax must account for the transmission channels through the effect of aid on the relationship between tax and its other determinants.

The estimated threshold stands at about 6.3% of GNI for the total tax revenue against 23% for non-resource tax revenue. For both tax effort measures, the aid coefficient β_0 is significantly positive while β_1 is significantly negative excepted for ICTD-models 2, 3 and 6. This implies that the positive effect of aid decreases when the flows of aid increase with respect to the estimated threshold. Interestingly, the turning point in the aid-non-resource tax relationship is relatively high compared to that of the aid-total tax relationship (as table 6 shows), suggesting that only a substantial high level of aid higher than the sample average of the aid-to-GNI ratio can dampen the social bargaining between state and citizen.

However, irrespective of the tax effort measure, our results do not support the evidence that the impact of aid on tax shifts at exceptionally high and implausible levels of aid as found by Clist (2014) and Morrissey et al. (2014).

Regarding the indirect effects, they vary depending on the channel considered and to some extent on the tax measure. Meanwhile the signs associated with β_0 for each factor are in line with the literature and our preliminary results.

Table 3: PSTR aid-IMF total taxes (% of GDP) in African countries

	IMF1		IMF2		IMF3		IMF4		IMF5	
Threshold (ODA/GNI)	7.1857		6.3433		6.317		6.5244		6.3467	
Slope	1.7665		1192.1		2.4144		1.5119		2.6448	
	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1
Aid	0.0096**	-0.0090*	0.0146***	-0.0140***	0.0112**	-0.0106**			0.0122**	-0.0116**
	(0.0047)	(0.0046)	(0.0049)	(0.0049)	(0.0051)	(0.0051)			(0.0048	(0.0047)
Openness	0.0006***	0.0004	0.0007***	0.0006**			0.0008***	0.0006*	0.0008***	0.0006*
	(0.0002)	(0.0003)	(0.0003)	(0.0003)			(0.0003)	(0.0003)	(0.0003	(0.0003)
Import					0.0009**	0.0002				
					(0.0004)	(0.0004)				
GNI per capita (log)	0.2064***	-0.0870***	0.1774***	-0.0742**	0.1614***	-0.0504	0.1492***	-0.0509	0.1682***	-0.0623*
	(0.0309)	(0.0357)	(0.0311)	(0.0351)	(0.0316)	(0.0360)	(0.0295)	(0.0363)	(0.0307	(0.0360)
Manufacture	-0.0191***	0.0164***	-0.0185***	0.0159***	-0.0195***	0.0170***	-0.0207***	0.0181***	-0.0195 ***	0.0169***
	(0.0037)	(0.0036)	(0.0037)	(0.0035)	(0.0039)	(0.0038)	(0.0039)	(0.0039)	(0.0039	(0.0038)
Agriculture	-0.0013	-0.0007	0.0009	0.0001	0.0004	-0.0001				
	(0.0016)	(0.0012)	(0.0755)	(0.0666)	(0.0017)	(0.0012)				
Institutions (log)	0.2121***	0.0681	0.2171***	0.0355	0.2530***	0.0009	0.2674***	-0.0469	0.2337***	0.0047
	(0.0768)	(0.0701)	(0.0017)	(0.0011)	(0.0764)	(0.0683)	(0.0743)	(0.0627)	(0.0758	(0.0669)
Oil and Gas			0.0035***	0.0004	0.0036***	0.0012	0.0030***	0.0010	0.0032***	0.0008
			(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0008)	(0.0008)	(0.0008)	(0.0008)
AIC	-4.687		-4.780		-4.756		-4.776		-4.779	
BIC	-4.616		-4.700		-4.675		-4.716		-4.708	
Observations	905		905		905		905		905	

Note: All independent variables are lagged. *, **, *** significant at 10%, 5% and 1% respectively. Mauritania is excluded because of a critical level of missing data. The dependent variable is the log of the ratio of total tax revenue to GDP. Standard deviation in parentheses.

Table 4: PSTR aid-ICTD non-resource taxes (% of GDP) in African countries

	ICTD1		ICTD2		ICTD3		ICTD4		ICTD5		ICTD6	
Threshold (ODA/GNI)	24.6485		23.6777		23.0085		23.4754		26.2719		23.782	
Slope	0.2895		0.8452		1.4941		0.9626		0.2066		0.7767	
	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1
Aid	0.0549*	-0.0466	0.0491**	-0.0405	0.0494**	-0.0534**	0.0509**	-0.0465*			0.0484**	-0.0343
	(0.0294)	(0.0284)	(0.0235)	(0.0259)	(0.0236)	(0.0266)	(0.0236)	(0.0260)			(0.0235)	(0.0253)
Openness	0.0094**	0.0812***	0.0114***	0.0657***							0.0118***	0.0622***
	(0.0038)	(0.0097)	(0.0035)	(0.0075)							(0.0035)	(0.0074)
Import					0.0130***	0.0759***	0.0096**	0.0723***	0.0055	0.0655***		
					(0.0032)	(0.0086)	(0.0041)	(0.0097)	(0.0044)	(0.0112)		
Export							0.0174	0.0416	0.0174	0.0815*		
							(0.0166)	(0.0273)	(0.0174)	(0.0441)		
GNI per capita (log)	1.8806***	2.2019	2.8707***	3.7619***	2.8653***	3.4410***	2.8672***	3.5630***	2.3731***	6.5873***	2.9659***	4.4805***
	(0.4630)	(1.5872)	(0.5163)	(1.0818)	(0.5019)	(0.9912)	(0.5025)	(1.0628)	(0.5004)	(1.6654)	(0.5231)	(0.9792)
Manufacture	-0.0972	-0.0026	-0.0935	-0.0653	-0.0888	-0.0206	-0.0951	-0.0510	-0.1046*	-0.0630	-0.0901	-0.0787
	(0.0649)	(0.0822)	(0.0627)	(0.0604)	(0.0627)	(0.0549)	(0.0602)	(0.0603)	(0.0603)	(0.0785)	(0.0632)	(0.0576)
Agriculture	-0.0104	0.1253***	-0.0156	0.0402	-0.0213	0.0410*	-0.0131	0.0402	-0.0196	0.0060		
	(0.0212)	(0.0432)	(0.0209)	(0.0262)	(0.0210)	(0.0247)	(0.0220)	(0.0257)	(0.0228)	(0.0428)		
Institutions (log)	7.3385***	-9.7585***	7.1767***	-8.5804***	7.2763***	-7.6487***	7.0225***	-8.1543***	7.5883***	-12.3667***	7.1376***	-8.6366***
	(1.6425)	(1.9303)	(1.5781)	(1.4928)	(1.5917)	(1.3531)	(1.5706)	(1.4932)	(1.6452)	(2.1368)	(1.5716)	(1.5082)
Resource revenues			-0.1454***	-0.2575***	-0.1392***	-0.1063*	-0.1510***	-0.2043**	-0.1475***	-0.3712***	-0.1449***	-0.3161***
			(0.0247)	(0.0649)	(0.0254)	(0.0551)	(0.0315)	(0.0817)	(0.0325)	(0.1098)	(0.0247)	(0.0591)
AIC	1.815		1.776		1.781		1.781		1.779		1.771	
BIC	1.885		1.855		1.86		1.87		1.858		1.841	
Observations	926		926		926		926		926		926	

Note: All independent variables are lagged. *, **, *** significant at 10%, 5% and 1% respectively. Standard deviation in parentheses.

Trade openness has a statistically positive effect on both tax measures at 1 or 5% level. Its aid-conditional effect exhibits a positive and significant sign across the specifications. Similar results emerge from specifications with import openness but not with export openness that does not show a robust effect. Our results confirm those of Morrissey et al. (2014) and support the assumption of "aid absorption" mechanism as argued by Aiyar and Ruthbah (2008) and Carter (2013). Aid causes import directly when donors and recipients pay for imports and indirectly when the dollars are sold by the recipient central bank to domestic importers.

Results on agriculture are less robust. While not significant in the IMF-models, a significant positive effect is found in only two ICTD-models. By contrast, manufacture shows a robust effect with IMF-models. Its effect is negative but higher aid induces a positive effect. This little evidence of the sectoral effect may result from a combination of domestic policies that grants a lot of tax exemptions and aid support toward the private sector. If the former policies tend to inhibit the contribution of the private sector to tax, the second by encouraging its development allows the private sector to be compliant with taxes.

We find that higher GNI per capita enhances significantly tax performances irrespective of the tax measure. However, the aid-conditional effect of GNI per capita is positive on non-resource tax but negative on total tax. Institutional quality also affects positively tax revenues. However, there is no evidence of any effect of the institutional quality in upper aid regimes when considering total tax revenues. By contrast, increase in aid tends to lower institution effect on non-resource tax. A higher resource wealth is associated with higher total tax revenues and this effect is not affected with larger aid flows. Conversely, higher resource wealth harms non-resource tax significantly and this negative effect is also significantly worsened when aid increases in respect with the estimated threshold. Hence our results indicate that the arguments of Bräutigam and Knack (2004), Knack (2009) and Azam et al. (1999) that larger aid and/or resource rents are noxious to institutions in promoting taxation hold only when one considers the non-resource tax revenues. Our results are also in line with the findings of Treviño and Thomas (2013) that exhibit a negative effect of resource wealth on taxation for Sub-Saharan Africa.

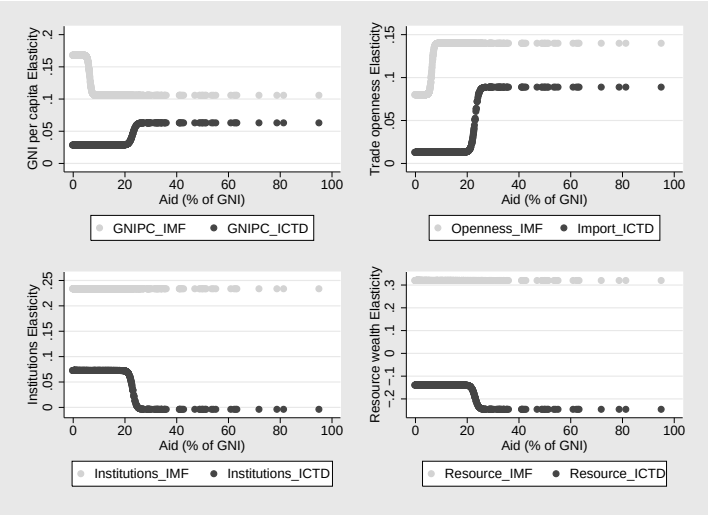
So far the PSTR helps to highlight the heterogeneous aid effects across countries and over time according to aid deviation from its estimated threshold. We now turn to an exploration of country-specific results where the actual impact of aid is determined by the actual location of the country, given by the actual aid receipts, which can change over time, relatively to aid threshold.

4.2 Country-specific elasticities

Figure 3 displays GNI per capita, openness, institutions and resources elasticities of tax that are functions of the level of aid-to-GNI from IMF-model 5 and ICTD-model 3 using equation 7. Table 5 reports for each country the average over the period of these estimated elasticities.[3]

For the entire group and the entire period, the aid-elasticity of tax, given the observed levels of aid, is positive, equaling 0.33 for IMF-total tax and 0.03 for ICTD-non-resource tax. At least 74% of the countries of our sample has registered a positive effect of aid on domestic revenue mobilization. This result is in line with some existing findings especially Gupta (2007) and Clist (2014) that evidence a small positive effect. However, 12 and 7 out of the 47 countries exhibit a negative elasticity with IMF-model and ICTD model respectively.

Figure 3: Factor elasticities of tax

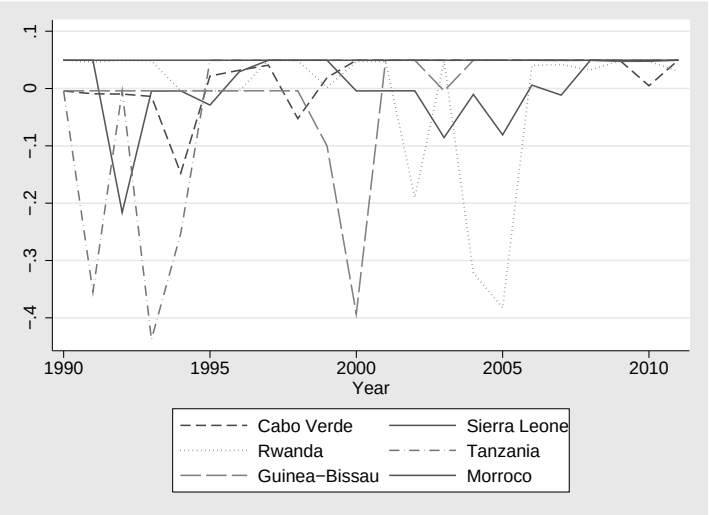


Source: Authors' estimations

However these averaged elasticities hide changes over time as Figure 4 illustrates for 6 countries. The negative aid-elasticities in Tanzania, Rwanda, Guinea-Bissau are mainly due to the past inefficiencies that recent progress can not curb. The aid-elasticity for Morocco tends to be constant, that for Cabo Verde is positive since 1999 while that for Sierra Leone is very erratic.

[3] As we use log of tax revenue for IMF-models, the coefficients of the independent variables have been multiplied by 100, except GNI per capita and institution which are already in log to ease comparison between the size of the coefficients. For ICTD-models, the coefficients GNI per capita and institution have been divided by 100.

Figure 4: Time-varying country-specific aid-elasticities of ICTD-non-resource tax, selected countries



Source: Authors' estimations

Similar analysis with the other factor-elasticities of tax are derived from equation 7. Except institutions and resource wealth in IMF-model which exhibit homogenous elasticity across countries when β_1 statistically equals 0, Table 5 highlights heterogeneous effects. On average, an increase of 1% of GNI per capita is associated with a 0.13% or a 0.03% increase in tax in IMF and ICTD-model respectively.

A 1-point higher quality of institutions is associated with a 0.23 point and 0.07 point increase in tax in IMF-total tax and ICTD-non-resource tax respectively. While resource wealth-elasticity of IMF-total tax is homogenous and positive across countries, the resource-wealth-elasticity of ICTD-non-resource tax is heterogeneous, depends on aid levels compared to thresholds, but is negative for every countries, with a sample average of -0.15 (a 1% increase in resource-wealth lowers non-resource tax by 0.15%).

Table 5: Country-specific average factor-elasticities of tax over 1990-2011

	Aid		Openness		GNI pc		Institutions		Resource wealth	
Country	IMF	ICTD	IMF	ICTD	IMF	ICTD	IMF	ICTD	IMF	ICTD
Algeria	1.2200	0.0494	0.0800	0.0130	0.1682	0.0287	0.2337	0.0728	0.3200	-0.1392
Angola	0.3069	0.0273	0.1000	0.0147	0.1474	0.0294	0.2337	0.0710	0.3200	-0.1416
Benin	0.0100	0.0494	0.1399	0.0130	0.1060	0.0287	0.2337	0.0728	0.3200	-0.1392
Botswana	1.0234	0.0494	0.0822	0.0130	0.1659	0.0287	0.2337	0.0728	0.3200	-0.1392
Burkina Faso	-0.0775	0.0236	0.1395	0.0149	0.1064	0.0295	0.2337	0.0709	0.3200	-0.1418
Burundi	-0.0640	-0.0474	0.1378	0.0596	0.1082	0.0498	0.2337	0.0258	0.3200	-0.2044
Cabo verde	0.0600	0.0193	0.1400	0.0304	0.1059	0.0365	0.2337	0.0552	0.3200	-0.1636
Cameroon	0.1856	0.0494	0.0937	0.0130	0.1540	0.0287	0.2337	0.0728	0.3200	-0.1392
Central African Republic	-0.2556	0.0483	0.1346	0.0131	0.1115	0.0287	0.2337	0.0727	0.3200	-0.1393
Chad	-0.5582	0.0492	0.1305	0.0130	0.1158	0.0287	0.2337	0.0728	0.3200	-0.1392
Comoros	-0.1868	0.0425	0.1375	0.0165	0.1085	0.0302	0.2337	0.0692	0.3200	-0.1441
Congo, Dem. Rep.	0.5121	0.0276	0.1105	0.0176	0.1366	0.0307	0.2337	0.0681	0.3200	-0.1457
Congo, Rep.	0.4674	0.0282	0.1055	0.0226	0.1417	0.0330	0.2337	0.0631	0.3200	-0.1527
Cote d'Ivoire	0.2122	0.0451	0.1076	0.0132	0.1395	0.0287	0.2337	0.0726	0.3200	-0.1395
Egypt, Arab Rep.	0.9684	0.0494	0.0885	0.0130	0.1594	0.0287	0.2337	0.0728	0.3200	-0.1392
Equatorial Guinea	0.6587	0.0255	0.0998	0.0307	0.1476	0.0367	0.2337	0.0549	0.3200	-0.1640
Ethiopia	-0.1606	0.0490	0.1390	0.0130	0.1070	0.0287	0.2337	0.0727	0.3200	-0.1392
Gabon	1.2044	0.0494	0.0801	0.0130	0.1681	0.0287	0.2337	0.0728	0.3200	-0.1392
Gambia, The	-0.0738	0.0470	0.1262	0.0165	0.1202	0.0302	0.2337	0.0693	0.3200	-0.1440
Ghana	-0.2058	0.0494	0.1256	0.0130	0.1208	0.0287	0.2337	0.0728	0.3200	-0.1392
Guinea	-0.3444	0.0494	0.1263	0.0130	0.1201	0.0287	0.2337	0.0728	0.3200	-0.1392
Guinea-Bissau	0.0600	-0.0019	0.1400	0.0521	0.1059	0.0464	0.2337	0.0334	0.3200	-0.1939
Kenya	0.5758	0.0494	0.0997	0.0130	0.1477	0.0287	0.2337	0.0728	0.3200	-0.1392
Lesotho	-0.2010	0.0494	0.1151	0.0130	0.1318	0.0287	0.2337	0.0728	0.3200	-0.1392
Madagascar	0.0954	0.0330	0.1322	0.0194	0.1140	0.0315	0.2337	0.0664	0.3200	-0.1481
Malawi	0.0600	-0.0557	0.1400	0.0505	0.1059	0.0457	0.2337	0.0349	0.3200	-0.1918
Mali	0.0600	0.0268	0.1400	0.0173	0.1059	0.0306	0.2337	0.0684	0.3200	-0.1452
Mauritania		0.0092		0.0241		0.0337		0.0616		-0.1548
Mauritius	1.2198	0.0494	0.0800	0.0130	0.1682	0.0287	0.2337	0.0728	0.3200	-0.1392
Morocco	1.0802	0.0494	0.0805	0.0130	0.1677	0.0287	0.2337	0.0728	0.3200	-0.1392
Mozambique	0.0600	-0.0865	0.1400	0.0627	0.1059	0.0512	0.2337	0.0227	0.3200	-0.2088
Namibia	0.8069	0.0494	0.0832	0.0130	0.1649	0.0287	0.2337	0.0728	0.3200	-0.1392
Niger	0.0575	0.0317	0.1400	0.0163	0.1059	0.0302	0.2337	0.0694	0.3200	-0.1439
Nigeria	0.8926	0.0494	0.0845	0.0130	0.1635	0.0287	0.2337	0.0728	0.3200	-0.1392
Rwanda	0.0600	-0.0105	0.1400	0.0280	0.1059	0.0355	0.2337	0.0576	0.3200	-0.1603
Senegal	-0.2932	0.0494	0.1388	0.0130	0.1072	0.0287	0.2337	0.0728	0.3200	-0.1392
Seychelles	0.6605	0.0494	0.0876	0.0130	0.1603	0.0287	0.2337	0.0728	0.3200	-0.1392
Sierra Leone	0.0600	0.0010	0.1400	0.0449	0.1059	0.0431	0.2337	0.0407	0.3200	-0.1838
South Africa	1.2200	0.0494	0.0800	0.0130	0.1682	0.0287	0.2337	0.0728	0.3200	-0.1392
Sudan	0.5363	0.0494	0.0921	0.0130	0.1556	0.0287	0.2337	0.0728	0.3200	-0.1392
Swaziland	1.2063	0.0494	0.0801	0.0130	0.1681	0.0287	0.2337	0.0728	0.3200	-0.1392
Tanzania	0.0599	-0.0097	0.1400	0.0235	0.1059	0.0334	0.2337	0.0622	0.3200	-0.1539
Togo	0.4104	0.0494	0.1157	0.0130	0.1311	0.0287	0.2337	0.0728	0.3200	-0.1392
Tunisia	1.2198	0.0494	0.0800	0.0130	0.1682	0.0287	0.2337	0.0728	0.3200	-0.1392
Uganda	0.0598	0.0443	0.1400	0.0165	0.1059	0.0302	0.2337	0.0692	0.3200	-0.1441
Zambia	-0.1818	-0.0295	0.1360	0.0345	0.1100	0.0384	0.2337	0.0510	0.3200	-0.1694
Zimbabwe	0.3491	0.0494	0.1066	0.0130	0.1406	0.0287	0.2337	0.0728	0.3200	-0.1392
Mean	0.3269	0.0303	0.1147	0.0202	0.1322	0.0319	0.2337	0.0655	0.3200	-0.1494

Notes: The elasticities are calculated according to the formula of the equation 7, except for aid (equation 8) and results from IMF-model 5 and ICTD-model 3 regressions. Elasticities of institutions and resource wealth with IMF are invariant since the associated β_1 are insignificant.

In sum, in African countries, the levels of aid are such that they do not hinder direct effects of aid and transmission channels effects to tax, except in the case of resource wealth to non-resource tax. We do not report here our preliminary results based on the grants-loans decomposition of aid as this is not the primary focus of this paper, but they do not alter significantly our main conclusions and are available on request.

5 Conclusion

We examine the effects of foreign aid on tax performances for 47 African countries over 1990-2011 using two tax revenue measures: total tax revenue from IMF and non-resource tax revenues from ICTD. As originally discussed, the ICTD non-resource tax measure would better portray the State-citizens contract and then the State bargaining trade-off between tax and aid.

We assume that the effects of aid on tax vary across countries and over time and that they depend on aid levels. We also explore the impact of aid on the effects of other usual determinants on tax.

Using Panel Smooth Threshold Regressions, our results show a huge heterogeneity in aid effects across African countries and over time. Aid has an enhancing effect but with diminishing returns when its level becomes increasingly high relative to the estimated threshold of aid. The estimated turning points are 6.3% and 23% for total taxes and non-resource taxes respectively. Computing the country-specific aid-elasticities of tax, we find that, on average and in the majority of African countries, aid has a positive effect on domestic tax mobilization. We however find more reasonable results in line with the theoretical expectations with ICTD-non-resource tax variable, suggesting that the choice of the tax measure is quite important. For instance, larger aid beyond specific thresholds strengthens the positive effect of the level of development and trade openness (including import) and induces a positive effect of agriculture although marginally. Meanwhile, larger aid is reducing the institutions and worsening the resource curse effects on tax. However, the estimated thresholds are high compared to the actual flows so that aid has not substantially shifted the first impact (in the first regime) of each factor.

In short, our results indicate that the negative effect found in the literature is overestimated and does not match with the case of African countries when one strongly accounts for country and time-varying heterogeneities as well as transmission channel. Providing also the best interpretation of the relationship of interest is also helpful to suggest appropriate policy recommendations.

Bibliography

Agbeyegbe, T. D., J. Stotsky, and A. WoldeMariam (2006): "Trade liberalization, exchange rate changes, and tax revenue in Sub-Saharan Africa," *Journal of Asian Economics*, 17, 261–284.

Aiyar, S. S. and U. H. Ruthbah (2008): "Where Did All the Aid Go? An Empirical Analysis of Absorption and Spending," *IMF Working Papers*, 08/34, 1–34.

Alonso, J. A. and C. Garcimartín (2011): "Does aid hinder tax efforts? More evidence," *CREDIT Research Paper*, 11/04.

Azam, J.-P., S. Devarajan, and S. A. O'Connell (1999): "Aid dependence reconsidered. Washington, DC: World Bank," *Policy Research Working Paper*, 2144.

Benedek, D., E. Crivelli, S. Gupta, and P. S. Muthoora (2012): "Foreign Aid and Revenue: Still a Crowding Out Effect?" *IMF Working Paper*, WP/12/186.

Béreau, S., A. L. Villavicencio, and V. Mignon (2012): "Currency misalignments and growth: a new look using nonlinear panel data methods," *Applied Economics*, 44, 3503–3511.

Bhushan, A. and Y. Samy (2012): "Aid and Taxation: Is Sub-Saharan Africa Different?" *North-South Institute Research Report*, May.

Bird, R. M., J. Martinez-Vazquez, and B. Torgler (2008): "Tax effort in developing countries and high income countries: The impact of corruption, voice and accountability," *Economic Analysis and Policy*, 38, 55–71.

Bräutigam, D. A. and S. Knack (2004): "Foreign Aid, Institutions, and Governance in Sub-Saharan Africa," *Economic Development and Cultural Change*, 52, 255–285.

Brun, J.-F., G. Chambas, and S. Guerineau (2011a): "Aide et mobilisation fiscale dans les pays en développement," *Jumbo*, Octobre 2007-21, 1–53.

Brun, J.-F., G. Chambas, and B. Laporte (2011b): "IMF programs and tax effort What role for institutions in Africa?" *CERDI Etudes et Documents*, 2010.33.

Carter, P. (2013): "Does Foreign Aid Displace Domestic Taxation?" *Journal of Globalization and Development*, 4, 1–47.

Clist, P. (2014): "Foreign Aid and Domestic Taxation: Multiple Sources, One Conclusion," *ICTD Working Paper*, 20.

Clist, P. and O. Morrissey (2011): "Aid and tax revenue: signs of a positive effect since the 1980s," *Journal of International Development*, 23, 165–180.

Colletaz, G., C. Hurlin, et al. (2006): "Threshold effects of the public capital productivity: an international panel smooth transition approach," *Document de Recherche du Laboratoire d'Economie d'Orléans*, 2006-1.

Dalgaard, C.-J. and H. Hansen (2001): "On aid, growth and good policies," *Journal of Development Studies*, 37, 17–41.

Destais, G., J. Fouquau, and C. Hurlin (2007): "Economic development and energy intensity: a panel data analysis," *The Econometrics of Energy Systems*, 5, 98–120.

Elbadawi, I. A. (1999): "External aid: help or hindrance to export orientation in Africa?" *Journal of African Economies*, 8, 578–616.

Fielding, D. and F. Gibson (2013): "Aid and Dutch Disease in Sub-Saharan Africa," *Journal of African Economies*, 22, 1–21.

Fok, D., D. Van Dijk, and P. H. Franses (2005): "A multi-level panel STAR model for US manufacturing sectors," *Journal of Applied Econometrics*, 20, 811–827.

Fouquau, J., C. Hurlin, and I. Rabaud (2008): "The Feldstein–Horioka puzzle: a panel smooth transition regression approach," *Economic Modelling*, 25, 284–299.

Franco-Rodriguez, S. (2000): "Recent developments in fiscal response with an application to Costa Rica," *Journal of International Development*, 12, 429–441.

Franco-Rodriguez, S., O. Morrissey, and M. McGillivray (1998): "Aid and the public sector in Pakistan: evidence with endogenous aid," *World Development*, 26, 1241–1250.

Gomanee, K., S. Girma, and O. Morrissey (2005): "Aid and growth in Sub-Saharan Africa: accounting for transmission mechanisms," *Journal of International Development*, 17, 1055–1075.

González, A., T. Teräsvirta, and D. v. Dijk (2005): "Panel smooth transition regression models," *SSE/EFI Working Paper Series in Economics and Finance*, 604.

Granger, C. W. and T. Teräsvirta (1993): "Modelling Non-Linear Economic Relationships," *Oxford University Press:*.

Guillaumont, P. and S. Guillaumont-Jeanneney (2009): "Accounting for vulnerability of African countries in performance based aid allocation," *African Development Bank Group Working Papers Series*, 103,October.

Guillaumont, P. and L. Wagner (2014): "Aid Effectiveness for Poverty Reduction: Lessons from Cross-country Analyses, with a Special Focus on Vulnerable Countries," *Revue d'Economie du Développement*, 22, 217–261.

Gupta, A. (2007): "Determinants of tax revenue efforts in developing countries," *IMF Working Papers*, WP/07/184, 1–39.

Gupta, S., B. J. Clements, A. Pivovarsky, and E. R. Tiongson (2003): "Foreign Aid and Revenue Response Does the Composition of Aid Matter?" *IMF Working Paper*, WP/03/176.

Hadjimichael, M. T., D. Ghura, M. Muehleisen, R. Nord, and E. M. Ucer (1995): "Sub-saharan Africa Growth, savings, and investment, 1986-93," *IMF Occasional Paper*, 118.

Hansen, B. E. (1999): "Threshold effects in non-dynamic panels: Estimation, testing, and inference," *Journal of Econometrics*, 93, 345–368.

Hsiao, C. (2014): *Analysis of panel data*, vol. 54, Cambridge University Press.

Kalyvitis, S., T. Stengos, and I. Vlachaki (2012): "Are Aid Flows Excessive or Insufficient? Estimating the Growth Impact of Aid in Threshold Regressions," *Scottish Journal of Political Economy*, 59, 298–315.

Knack, S. (2009): "Sovereign rents and quality of tax policy and administration," *Journal of Comparative Economics*, 37, 359–371.

Kourtellos, A., C. M. Tan, and X. Zhang (2007): "Is the relationship between aid and economic growth nonlinear?" *Journal of Macroeconomics*, 29, 515–540.

Kunčič, A. (2014): "Institutional quality dataset," *Journal of Institutional Economics*, 10, 135–161.

Mansour, M. (2014): "A Tax Revenue Dataset for Sub-Saharan Africa: 1980-2010," *FERDI Working Papers*, I19.

Mansour, M. and M. Keen (2009): "Revenue mobilization in sub-saharan Africa: challenges from Globalization," *IMF Working Papers*, WP/09/157, 1–47.

Moore, M., S. Unsworth, C. Knowles, and N. Hickman (2007): *How does taxation affect the quality of governance?*, vol. 280, Institute of Development Studies at the University of Sussex.

Morrissey, O., W. Prichard, and S. Torrance (2014): "Aid and Taxation: Exploring the relationship using new data," *ICTD Working Paper*, 21.

Moss, T. J., G. Pettersson, and N. Van de Walle (2006): "An Aid-Institutions Paradox? A Review Essay on Aid Dependency and State Building in Sub-Saharan Africa," *Center for Global Development Working Paper*, 11–05.

Osei, R., O. Morrissey, and T. Lloyd (2005): "The fiscal effects of aid in Ghana," *Journal of International Development*, 17, 1037–1053.

Ouattara, B. (2006): "Aid, debt and fiscal policies in Senegal," *Journal of International Development*, 18, 1105–1122.

Prichard, W., J.-F. Brun, and O. Morrissey (2013a): "Donors, Aid and Taxation in Developing Countries–An Overview," *ICTD Research in Brief*, 4.

Prichard, W., A. Cobham, and A. Goodall (2014): "The ICTD Government Revenue Dataset," *ICTD Working Paper*, 19.

Prichard, W., P. Salardi, and P. Segal (2013b): "Taxation, Non-Tax Revenue and Democracy: New Evidence Using New Cross-Country Data," *ICTD Working Paper*, 23.

Tavares, J. (2003): "Does foreign aid corrupt?" *Economics Letters*, 79, 99–106.

Teera, J. M. and J. Hudson (2004): "Tax performance: a comparative study," *Journal of International Development*, 16, 785–802.

Treviño, J. and A. H. Thomas (2013): "Resource Dependence and Fiscal Effort in Sub-Saharan Africa," *IMF Working Papers*, 13/188.

UN (2011): "Foreign Aid as a Catalyst to Improving Domestic Revenue Mobilization," Tech. rep., United Nations for Economic and Social Council-Office for ECOSOC Support and Coordination Department of Economic and Social Affairs.

Yohou, H. D., M. Goujon, and W. Ouattara (2016): "Heterogeneous Aid Effects on Tax Revenues: Accounting for Government Stability in WAEMU Countries," *Journal of African Economies. doi: 10.1093/jae/ejw003*, 25, 1–31.

Yu, P. (2013): "Inconsistency of 2SLS estimators in threshold regression with endogeneity," *Economics Letters*, 120, 532–536.

Yu, P. and P. C. B. Phillips (2014): "Threshold Regression with Endogeneity," *Cowles Foundation Discussion Paper No. 1966. Available at SSRN: http://ssrn.com/abstract=2533013 or http://dx.doi.org/10.2139/ssrn.2533013.*

A Appendix

Table 6: Summary statistics

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**	**N**	**Source**
Tax_IMF(% of GDP)	18.164	9.664	3.6	61.5	978	IMF
Tax_ICTD(% of GDP)	13.207	7.808	0.6	62.829	1033	ICTD
Non-tax revenue(% of GDP)	6.057	8.588	0	50.096	1032	ICTD
Aid(% of GNI)	10.819	10.751	-0.253	94.946	1030	WDI
Openness (% of GDP)	74.69	47.952	10.748	531.737	1021	WDI
Import(% of GDP)	42.704	32.701	7.066	424.817	1021	WDI
Export(% of GDP)	31.986	20.587	3.188	124.393	1021	WDI
Real GNI per capita	1335.942	2027.638	93.3	17266.491	1033	WDI
Manufacture(% of total value added)	10.918	6.718	0.097	41.12	1034	UNDATA
Agriculture(% of total value added)	24.604	14.441	1.379	56.795	1034	UNDATA
Institutions (Average)	41.3	13	8.5	83.3	1015	Kunčič (2014)
Oil-Gas Rents (% of GDP)	6.441	15.173	0	84.657	1007	WDI

Table 7: Cross-correlation table

Variables	Tax_IMF	Tax_ICTD	Non-tax	Aid	Openness	Import	Export	GNI pc	Manuf	Agri	Institutions	Oil-Gas
Tax_IMF	1.000											
Tax_ICTD	0.533***	1.000										
Non-tax	0.652***	-0.145***	1.000									
Aid	-0.404***	-0.226***	-0.320***	1.000								
Openness	0.513***	0.304***	0.390***	-0.168***	1.000							
Import	0.366***	0.335***	0.203***	-0.016	0.939***	1.000						
Export	0.612***	0.176***	0.587***	-0.366***	0.838***	0.599***	1.000					
GNI pc	0.495***	0.273***	0.424***	-0.389***	0.341***	0.181***	0.506***	1.000				
Manuf	-0.012	0.385***	-0.347***	-0.140***	0.017	-0.005	0.048	0.010	1.000			
Agri	-0.703***	-0.426***	-0.515***	0.486***	-0.5019***	-0.328***	-0.648***	-0.595***	-0.208***	1.000		
Institutions	0.183***	0.393***	-0.066**	-0.157***	0.008	-0.032	0.069**	0.281***	0.135***	-0.306***	1.000	
Oil-Gas	0.486***	-0.293***	0.791***	-0.241***	0.326***	0.125***	0.538***	0.237***	-0.326***	-0.382***	-0.257***	1.000