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Aid and Taxation: Exploring the Relationship Using New Data

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Summary

This paper examines cross-country evidence concerning the relationship between aid and taxation using a new dataset compiled by the International Centre for Tax and Development (ICTD), and including some extensions to the empirical specification common in the literature. We are unable to replicate the key findings of Gupta et al. (2004) and Benedek et al. (2012), that there is a negative effect of grants on tax effort while loans are positively associated with revenue, and find no support for the broader claim that aid reduces tax effort. In general we find that there is no consistent significant relationship between aid and tax performance. In the specifications where they are significant, net aid, grants and loans are usually positively associated with government revenue, although the significance is often weak and the results are not robust to alternative specifications and estimators. When the analysis is restricted to a sub-sample of Sub-Saharan African countries, the positive effect of loans persists but other aid variables are insignificant.

Keywords: foreign aid; government revenue; taxation.

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Contents

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Acronyms

AsiaPac	Asia and the Pacific
DAC	Development Assistance Committee
FE	Fixed Effects
FGLS	Feasible Generalised Least Squares
GDP	Gross Domestic Product
GFS	Government Finance Statistics
GMM	Generalised Method of Moments
GRD	Government Revenue Dataset
IFC	International Finance Corporation
ICTD	International Centre for Tax and Development
IMF	International Monetary Fund
LAC	Latin America and the Caribbean
MENA	Middle East and North Africa
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
PCSE	Panel Corrected Standard Errors
SAP	Structural Adjustment Programme
SSA	Sub-Saharan Africa

Introduction

Over the past decade many studies have explored the impact of aid on tax effort (defined as the tax/GDP or the revenue/GDP ratio) in recipient countries. Most claim that aid discourages tax effort across countries (Remmer 2004; Gupta et al. 2004; Bräutigam and Knack 2004; Knack 2009; Benedek et al. 2012). The most influential of these is Gupta et al. (2004) from the International Monetary Fund (IMF), which not only finds that aid reduces tax effort across countries, but also argues that the composition of aid matters – that loans, which need to be repaid, encourage collection, but grants discourage tax effort. Responding to subsequent challenges to these initial findings (Clist and Morrissey 2011, see Section 1 below), Benedek et al. (2012) replicate and expand the initial study using a more up to date and complete dataset covering the years 1980-2009. The new study further explores the robustness of the sample to selection bias, finding that the results are robust across samples, though the negative impact of aid on tax effort is larger in weak institutional environments. However, the robustness of these findings remains strongly open to question owing to concerns about both the quality of the data employed, and whether Benedek et al. (2012) are accurately capturing the behavioural relationship of interest. This paper seeks to address each of these problems in turn and, upon doing so, finds that across a wide range of possible specifications there is no robust evidence of a significant relationship between foreign aid (in aggregate, as grants or as loans) and domestic tax collection, with most results pointing towards, if anything, a positive relationship between aid and grants.

In addressing the limitations of earlier studies, the first innovation is the use of much improved – and much more transparent – cross-country data on tax collection in developing countries, drawn from the newly-created International Centre for Tax and Development's Government Revenue Dataset (ICTD GRD). The general limitations of data from the widely-used IMF Government Finance Statistics (GFS) are relatively well known, as it suffers from widespread missing data and deals inconsistently with resource revenues. Benedek et al. (2012) have attempted to overcome this limitation through reliance on an internal IMF database that combines data from multiple sources in order to achieve better coverage, but Clist (2014) finds significant errors in their data owing to improper merging of sources that employ inconsistent definitions. While the ICTD GRD similarly merges data from multiple data sources, it contains more than 20 per cent more observations for developing countries than the internal IMF database, and, more critically, it is substantially more accurate through careful data merging using a consistent approach to distinguish between tax and non-tax revenue.

Alongside this improved data, we take steps to capture aspects of the relationship between aid and tax effort not addressed by Benedek et al. (2012), in particular by accounting for the effects of imports and non-tax revenue. In low-income countries, taxes on imports are often an important source of revenue. However, as aid provides foreign currency that can be used to pay for imports it can directly affect the value of imports. This should be accounted for in identifying any effect of aid on tax effort, and we do so by estimating the value of imports not financed by aid. Equally important in shaping tax collection in developing countries is the role of resource rents, which are often an important (but perhaps not transparent) source of revenue and have been shown elsewhere to discourage tax effort (Bornhorst et al. 2008). In the ICTD GRD, revenue from natural resources is consistently classified as non-tax revenue, and we are, in turn, able to account for non-tax revenue as part of our model of tax effort, unlike previous studies.

Benedek et al. (2012) do not address the principal concern raised by Clist and Morrissey (2011) about earlier work by Gupta et al. (2004): that because any effect of aid is behavioural, it will take a number of years to affect tax effort and is indirect (so mediating variables should be accounted for). Clist and Morrissey (2011) note specifically that the tax

effort specification is capturing a structural relationship: tax/GDP is the tax rate(s) times the tax base(s) over GDP, and the equation is estimated with proxy variables. Furthermore, this is an essentially contemporaneous relationship: taxes collected in the current year are largely determined by tax rates and bases in that year (although some, especially corporate taxes, are collected with a lag). In fact, as IFC (2009) shows, the proportion of total aid that is directly targeted at improving tax administration is very small; specifically, in 2005, out of an aid budget of US$7.1 billion for administration, economic policy and public sector financial management, only 1.7 per cent was devoted to tax-related assistance. However policies associated with aid (conditionality) can still affect the tax/GDP ratio in a variety of ways (through the rates, bases or collection efficiency), but any effect of aid on tax effort (i.e. how the amount of aid received influences the incentive to raise taxes) is behavioural and can therefore only be observed over a reasonable amount of time.

We correspondingly follow Clist and Morrissey (2011) in using longer lags in order to capture the fact that sustained changes in tax collection are likely to occur only over the medium term. This is especially true in low-income countries where low revenue is likely to encourage high levels of aid, and sustained improvements in revenue performance have been difficult to achieve, with collection outcomes shaped by deep-seated historical factors (Keen and Simone 2004; Teera and Hudson 2004; Mkandawire 2010; Morrissey and Torrance 2013). The message is not necessarily that a particular lag length is right, but, rather, that the causal pathway from higher aid to changes in tax collection is highly complex, and potentially highly variable, and thus raises important challenges of model specification, particularly when looking at cross-country data.

This paper is organised as follows. Section 1 provides an outline of the existing literature and motivation for the paper. Section 2 describes the data used in the analysis, while Section 3 provides a summary of the attempts to replicate the result of Gupta et al. (2004) and Benedek et al. (2012). The behavioural specification is described in Section 4, with the empirical estimation and results. Conclusions and directions for further research are in Section 5.

1 Background and literature review

A number of studies have challenged the finding of a negative impact of aid on tax effort, raising questions about both the robustness of the results and model specification (Prichard et al. (2012) provide a comprehensive review). Gupta (2007) and Teera and Hudson (2004) report a negligible impact of aid on total government revenue; Clist and Morrissey (2011) report no robust negative relationship and a possible positive impact of aid on taxation since 1985; Brun et al. (2009) report that the impact of aid on tax effort is contingent on institutions, with a negative impact in weak institutional environments, but a positive effect in developing countries with stronger institutions. Carter (2013) shows, using more flexible econometric techniques (panel time series and group fixed effects estimators), that the previous results are not robust. Even from a country case study approach there is a lack of consensus, with both evidence of a positive and negative relationship having been observed (Morrissey forthcoming).

These divergent results reflect differences in data and specification, collectively working to cast major doubt on the robustness of claims about a consistently negative impact of aid on tax effort. Nevertheless, Benedek et al. (2012), building on Gupta et al. (2004), claim that the negative result is robust and base this claim on the use of a Generalised Method of Moments (GMM) estimator. While GMM estimators can address inherent endogeneity problems that may afflict the aid-tax relationship under certain conditions, Carter (2010) argues that the required conditions are unlikely to be met in the current context. Furthermore, Clist (2014)

observes that GMM exacerbates the problem of combining inconsistent data from different sources, because changes in sources between years can generate large apparent changes in tax/GDP (due solely to the source) and these are then built in to the instruments used in GMM. Thus, the GMM results in Benedek et al. (2012) cannot be considered reliable.

Clist and Morrissey (2011) address the effect of aid loans and grants on tax effort using data for eighty-two developing countries over the period 1970-2005, and find no robust evidence for a negative effect of aid grants on the tax/GDP ratio. While they do replicate the Gupta et al. (2004) results, they argue that these are due to a misspecification of the relationship of interest. Specifically, Gupta et al. (2004) identify a contemporaneous correlation between aid and reduced tax collection – higher aid, especially grants, is associated with lower tax/GDP – but this is to be expected as the poorest countries tend to have lower tax/GDP ratios, and, partly for this reason, tend to receive more aid, particularly in the form of grants. They also note that because tax/GDP ratios exhibit persistence over time, lagging aid one or two years may not account for this endogeneity.

Clist and Morrissey (2011) also highlight the need to consider the multiple pathways through which aid may shape tax outcomes, and thus to assess carefully what conclusion can be drawn from existing results. Studies of aid and tax effort assume a behavioural impact of aid on taxation: because aid provides revenue, governments are less willing to expend effort in the collection of tax revenue. This may appear reasonable as taxes are not popular so there is a political cost incurred by increasing tax revenue. However, Morrissey (2013) argues that there are also political costs associated with aid, such as dependency and conditionality, and it is not evident that governments necessarily prefer aid to domestic tax revenue. Furthermore, the aid-tax relationship is confounded by the potential of policies associated with aid (conditionality and technical assistance) to have effects on tax revenue (on rates, bases or collection). The controls that are generally included in tax effort studies to proxy for the tax base (such as agriculture and industry shares in the economy, GDP, imports and exports) cannot adequately account for these policy effects. In simple terms, aid is likely to influence tax performance through multiple channels (behavioural effects, conditionality/policy and technical assistance); these effects may be in opposing directions, and may be difficult to distinguish from each other.

The tax effects of policy reforms are potentially very significant, but are difficult to identify with confidence. Clist and Morrissey (2011) find that in the past fifteen to twenty years low-income aid recipients have managed to increase tax ratios, suggesting the policies associated with aid may have supported increasing tax/GDP ratios. This may not only reflect the influence of policies targeting tax performance, as aid projects that shape broader outcomes, such as growth or institutional quality, may equally influence tax collection. Although reforms promoted and supported by donors may have significant effects on tax policy and administration, this need not translate into an observable increase in tax revenue; Moore (2014) documents major reforms in anglophone SSA but little evidence of sustained increases in revenue. Some policies associated with aid tend to reduce tax revenue; economic liberalisation has typically been a component of conditional lending (aid increases), and such reform episodes are generally associated with tax revenue reductions (Baunsgaard and Keen 2005; Aizenman and Jinjarak 2009). In this way, aid conditionality may actually generate a negative association between aid/GDP and tax/GDP ratios in the short run. This may help to explain why some studies find a negative correlation between aid and tax ratios, but in this case that relationship is *not* due to a behavioural effect of aid reducing tax effort.

Brun et al. (2009) also highlight the need to account for endogeneity. While high levels of aid (grants) may affect levels of tax collection, it may equally be that levels of tax collection in recipient countries shape aid flows, particularly with low tax collection driving higher levels of needed aid funding. Accounting for endogeneity, they find a statistically significant positive effect of aid levels on tax effort. Brun et al. (2009) also try to capture the impact of aid on tax

collection, contingent on the quality of institutions: countries with weak institutions may be more susceptible to a negative impact of aid on tax collection, whereas aid may affect tax performance indirectly through its effect on institutions. They include various measures of institutional and democratic quality into a standard tax effort regression, and find that the impact of aid on tax effort is not affected by either corruption or democracy, but the impact of aid is positive in countries with high-quality bureaucracy.

Despite a commonly-held view, propagated by the IMF, that aid discourages tax effort, the preponderance of recent evidence suggests that this result is not robust. There is recent evidence that the impact is context-specific and may even have become positive, and it is on this evidence that this study builds.

2 Data

Though rarely discussed, a key factor underlying continued disagreement within the literature on aid and tax effort has been the poor quality of, and often lack of transparency in, government revenue data, which has reduced the reliability, comparability and replicability of existing studies. Clist (2014) highlights the centrality of poor quality data to the results reported by Benedek et al. (2012). In some ways, even more striking is that some earlier studies have employed *total government revenue* as the dependent variable in their analyses, owing to greater data availability, despite the fact that theory focuses only on *tax revenue* – and that there is no reason to expect aid to affect the other major components of government revenue.[1]

The analysis here overcomes these problems by relying on the new Government Revenue Dataset (GRD) from the International Centre for Tax and Development (ICTD), which provides data on total government revenue, tax revenue and non-tax revenue covering the period 1970-2010 (Prichard et al. 2014). The ICTD data is compiled by meticulously combining data from the major international databases, as well as IMF Article IV reports. Critically, it systematically distinguishes between resource and non-resource sources of taxation, thus allowing us to construct a tax revenue variable *exclusive* of natural resource revenue, while including all resource revenue in the non-tax revenue category. This is analytically critical, as theory only predicts that aid should affect non-resource taxation, and ours is the first study to employ a dependent variable that precisely matches this prediction.

By thus combining alternative datasets but ensuring consistency across sources, the ICTD dataset achieves dramatically improved data coverage, particularly during the period 1990-2010 when the ICTD dataset contains 70 per cent more observations than the IMF GFS for developing countries. The sample consists of data for 122 developing countries: forty-five from sub-Saharan Africa (SSA), sixteen from the Middle East and North Africa (MENA), twenty-six from Asia and the Pacific (AsiaPac), and thirty-five from Latin America and the Caribbean (LAC) (listed in Appendix 1).[2] Data on GDP per capita and the share of agriculture, industry, imports and exports as a percentage of GDP are from the World Bank's *World Development Indicators*. Data on net aid, grants and loans as a percentage of GDP are sourced from the Organisation for Economic Co-operation and Development's Development Assistance Committee (OECD DAC). The description of variables and summary statistics are provided in Appendices 2 and 3 respectively.

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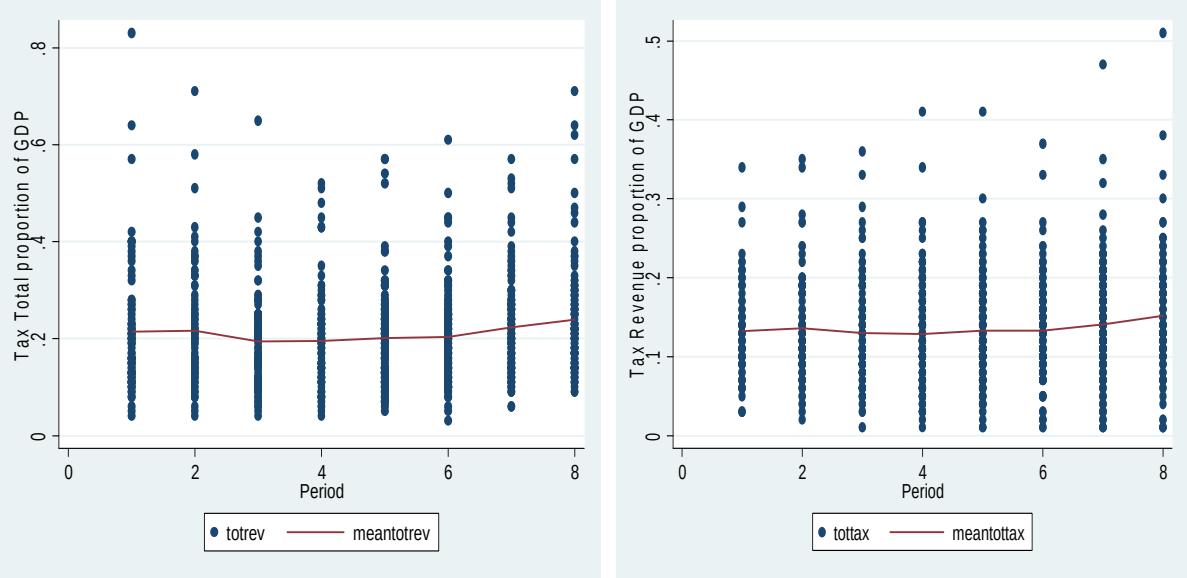
1 Total government revenue primarily comprises tax revenue and non-tax revenue, with natural resource rents being the main component of the latter. There is no compelling reason to think that a government would reduce revenue collection from natural resource firms in response to larger aid flows.

2 European transition economies and those established from the former Yugoslavia are excluded, given that they have few annual observations in terms of revenue or aid, which limits their inclusion when the panel is averaged. Some former Soviet Union countries are included under the AsiaPac heading where there is revenue and aid data (usually from 1990).

Whilst initial, exploratory analyses were carried out using an annual panel dataset, in order to address potential weaknesses of the data, such as volatility, missing observations and other inaccuracies generally associated with annual data, particularly in a developing country context, we create a panel with eight periods of four-year averaged data. This implies that when we lag aid it is for the previous four-year period.

Looking at Figure 1, there is an evident variation among countries in the sample in terms of total revenue/GDP and tax/GDP ratios. Broadly speaking the pattern of the data is similar between total revenue and tax, although the latter is generally at much lower values. There does seem to be evidence of a narrowing in the variation of both ratios over time, although outliers are still present and typically represent small states, many of which display higher rates than other countries in the sample. Since the mid-1990s (period 6) a visible increase in total revenue/GDP and tax revenue/GDP can be noted.

Figure 1 Total revenue/GDP and total tax/GDP scatter plots, by period

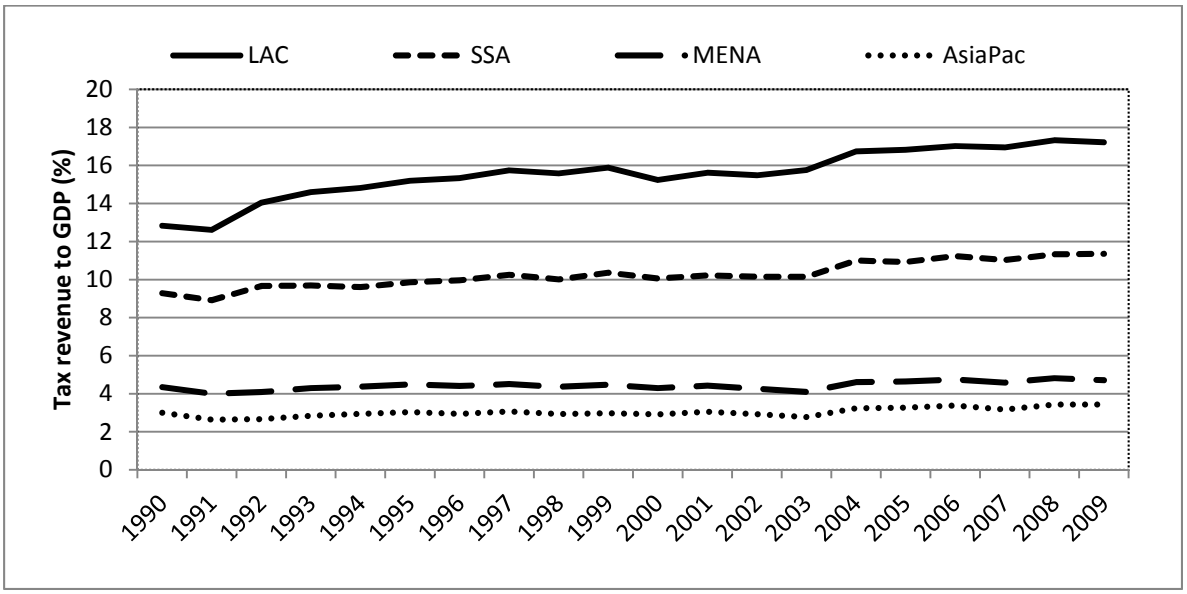


Source: ICTD GRD (2014).

Figure 2 shows a discrepancy in tax/GDP ratios between developing country regions over the period 1990-2009.[3] While Latin America and the Caribbean (LAC) has made the most visible improvement over the entire period, all regions have seen increases in revenue in the 2000s. The dispersion of net aid/GDP over the period 1980-2010 is shown by the box plot in Figure 3. The first half of the period saw an increase in the range of net aid/GDP rates (between the 25th and 75th percentile), but since 1994 (period 4) a reduction has been observed in the variance as well as in the median value. The box-plot whiskers show evidence of outliers.

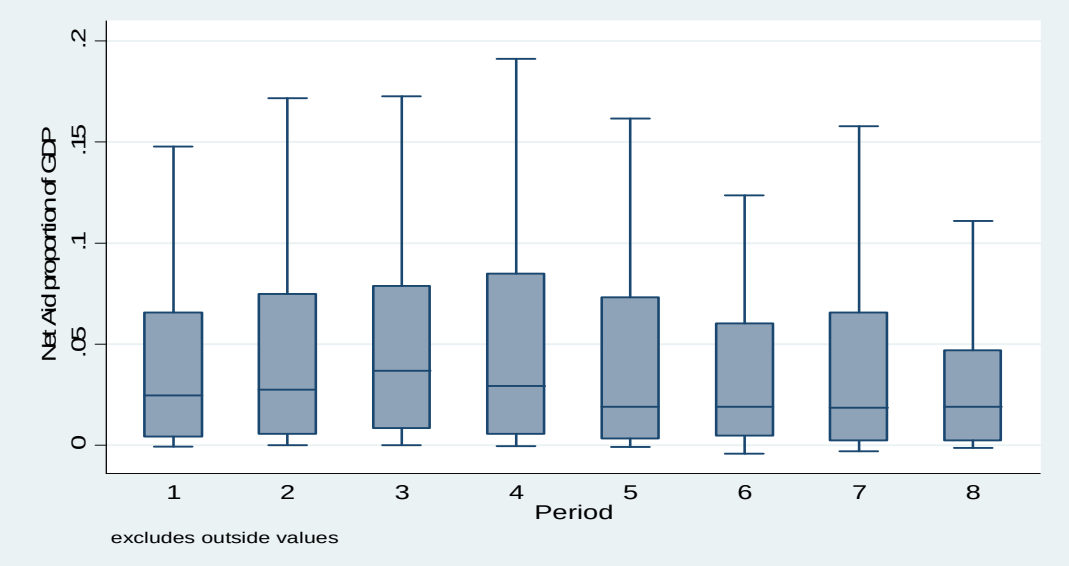
[3] Data is displayed only for 1990-2009 in order to ensure relative consistency in the sample, and to make the region averages comparable over time. More frequent missing data earlier, and in 2010, leads to larger changes in the sample, and distorts any meaningful comparison.

Figure 2 Total tax/GDP, 1990-2009, by region



Source: ICTD GRD (2014).

Figure 3 Net aid/GDP (as a proportion), 1980-2010

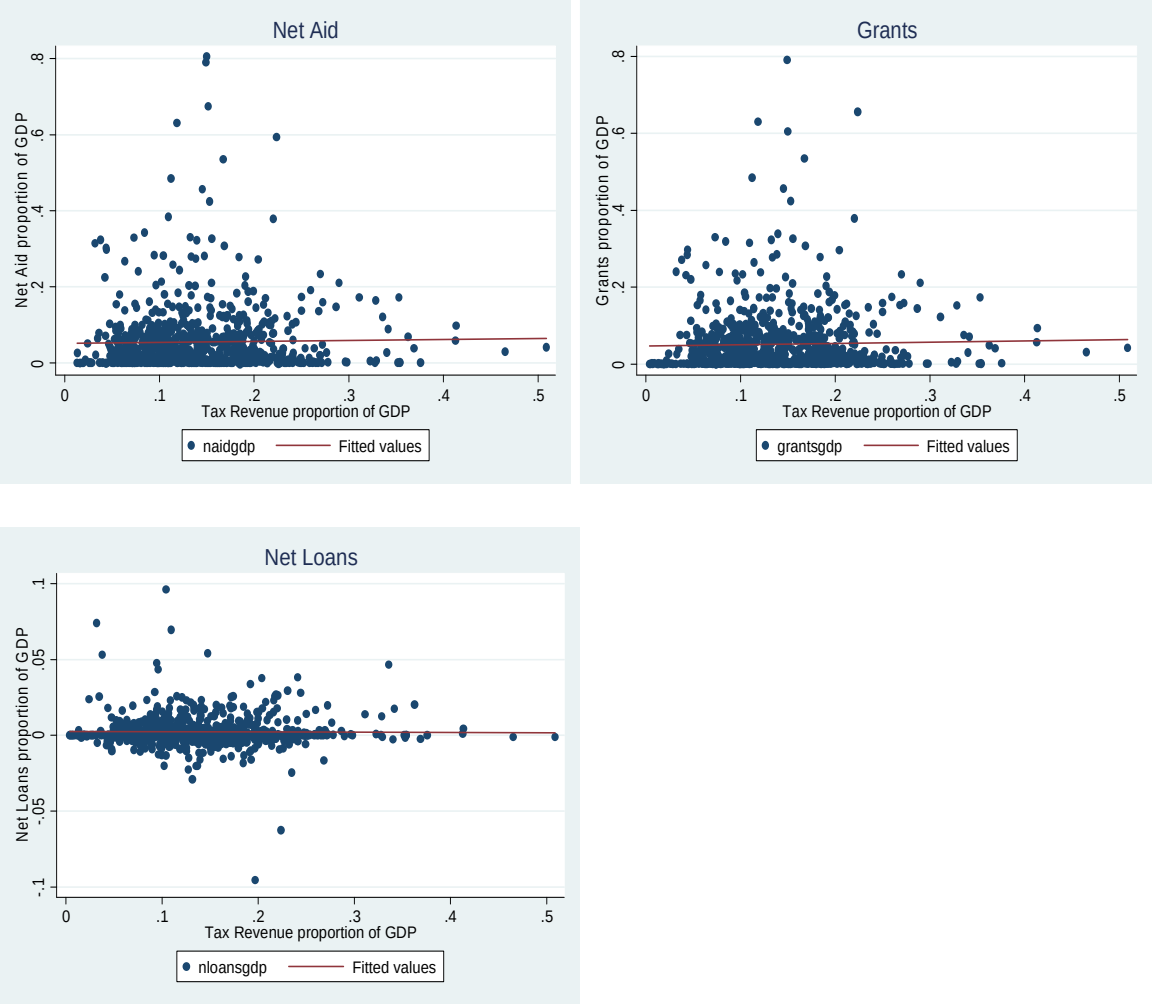


Note: The box plot: whiskers indicate the maximum and minimum, the line in the box is the median and the size of the box indicates the distribution between the 25th and 75th percentile.

Source: ICTD GRD (2014).

As a first step in understanding the relationship between aid and revenue, simple scatter plots are shown in Figure 4. Pairwise correlations find no evidence of a relationship between the aid variables and total or tax revenue, although a positive correlation is found between net loans, grants and non-tax revenue (see Appendix 4).

Figure 4: Aid and tax revenue scatter plots (as a proportion of GDP), 1970-2010



Source: ICTD GRD (2014).

3 Baseline results and replication

3.1 Initial investigations

Using total and tax revenue data from the ICTD GRD, we attempt to replicate the main results of Gupta et al. (2004) and Benedek et al. (2012) with some minor adjustments. In line with the former we use fixed effects (FE) estimators; in contrast to the latter we do not apply GMM (Carter, 2013 provides a detailed discussion of the limitations of GMM in this context),[4] but we do test panel time series methods by employing a feasible generalised least squares (FGLS) estimator and a panel corrected standard errors (PCSE) model. Despite these authors using an aggregated measure of trade openness, we include imports and exports separately as independent variables, following Clist and Morrissey (2011).

Although results from a variety of estimators are reported, FE is likely to be an appropriate estimator for a number of reasons. First, heterogeneity is likely to characterise the data: it is

[4] While we do not report GMM results for this reason, we did run GMM estimates and found that the broad pattern of our results is unchanged – no consistent and significant relationship between aid and tax effort.

reasonable to expect that any effect of aid on tax performance will be influenced by unobserved country-specific factors, so FE is suitable. Second, country studies suggest that the effect of aid on tax is often limited or negligible (Morrissey forthcoming), so heterogeneity is unlikely to be correlated with the variables or errors in the FE model. Third, there is also limited evidence that developing countries are able to smooth volatile tax revenue (von Haldenwang et al. 2013), so panel FE is appropriate if sub-period averages are used to smooth tax/GDP series. Finally, tax/GDP series tend to exhibit persistence with year-on-year variation due to shocks that are not smoothed, so it is not evident that a dynamic estimator is required.

Following the literature we estimate the following baseline model:

$$Ln(TR_{it}) = \beta_0 + \beta_1 gdppc_{it} + \beta_2 agr_{it} + \beta_3 ind_{it}$$

$$+ \boldsymbol{\beta_4\, imports_{it}} + \boldsymbol{\beta_5\, exports_{it}} + \boldsymbol{\beta_6 Aid_{it}} + \boldsymbol{\beta_7 Aid_{it}^2} + \boldsymbol{\varepsilon_{it}} \qquad (1)$$

The dependent variable *TR* is the ratio of tax revenue to GDP. *Aid* and *Aid*^{2} are the variables of primary interest. Three measures are used (all as ratios of GDP): net aid (*net_aid*) in total and disaggregated into grants (*grants*) and net loans (*net_loans*).

The other variables are considered controls and account for the 'tax handle' of the economy, i.e. the factors that determine tax capacity: income is measured by GDP per capita (*gdppc*) in current US dollars and expected to have a positive coefficient (β_1>0) – the larger the economy, the better off its citizens, the higher the expected revenue from taxation, and the higher the demand for public services. In addition it is also often taken as a proxy for administration and compliance capacity. *Agr* and *ind* are the share of agriculture and industry in the economy as a percentage of GDP, respectively. As agriculture tends to be organised on a more informal, subsistence basis, a negative relationship with tax revenue (β_2<0) is anticipated as collection and enforcement of tax policy is difficult. The opposite is true for the industrial sector, which is more formal and urban-based, thus a positive relationship with tax revenue (β_3>0) is expected. Trade taxes have historically been a dominant contributor to government revenue in SSA, and, in spite of liberalisation, remain important.[5] As a result we include imports (*imports*) and exports (*exports*) as shares of GDP, and we expect the coefficients to be positive (β_4>0; β_5>0).[6]

As a starting point, Table 1 provides estimates without lagging aid. The control variables *agr*, *ind* and *imports* are statistically significant with expected signs, but the GDP variables and *exports* are insignificant. None of the core aid variables are statistically significant.[7]

[5] The average applied tariff in 2007 in low-income countries was 12 per cent in comparison to the global average of 8.8 per cent - UNCTAD TRAINS database <http://r0.unctd.org/trains_new/database.shtm>.

[6] Imports and exports are easy to tax as they are recorded at the border. However, lower tax rates may increase trade, so revenue may decline with openness.

[7] We do not try to interpret any significant coefficient on the squared term when the corresponding aid term is insignificant; there is no clear economic interpretation and these results probably indicate the presence of outliers. Similar results are obtained using Ordinary Least Squares (OLS) and random effects, but the Hausman test favours fixed over random effects (results available on request).

Table 1 Aid and revenue regressions: fixed effects estimator

	No aid	Net aid	Net loans	Grants	Grants and net loans
gdppc	0.002 (0.52)	0.001 (0.26)	0.002 (0.49)	0.003 (0.60)	0.002 (0.58)
agr	-0.012 (7.34)***	-0.012 (7.18)***	-0.012 (7.09)***	-0.013 (7.34)***	-0.012 (7.11)***
ind	-0.007 (4.45)***	-0.007 (4.23)***	-0.007 (4.45)***	-0.007 (4.23)***	-0.007 (4.21)***
imports	0.003 (2.77)***	0.002 (2.37)**	0.003 (2.79)***	0.003 (2.88)***	0.003 (2.91)***
exports	-0.001 (0.92)	-0.001 (0.89)	-0.001 (1.01)	-0.002 (1.36)	-0.002 (1.46)
net_aid		0.268 (0.82)			
net_aid^2		-0.723 (1.51)			
net_loans			-0.784 (0.94)		-0.793 (0.95)
net_loans^2			-4.839 (0.32)		-6.369 (0.42)
grants				0.351 (1.02)	0.381 (1.09)
grants^2				-1.066 (1.87)*	-1.109 (1.93)*
_cons	-1.720 (22.07)***	-1.699 (21.46)***	-1.721 (21.98)***	-1.727 (22.14)***	-1.729 (22.04)***
F	13.85	9.89	10.08	10.57	8.39
P	0.00	0.00	0.00	0.00	0.00
R^2	0.10	0.10	0.10	0.11	0.11
N	752	725	752	752	752

Notes: The dependent variable is ln(tax/gdp); panel of 4-year averages; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F-test (*F*) is that all variables are jointly significant; *P* is the probability of rejection. The GDPpc variable is multiplied by 1000 so the coefficients are within four decimal places.

Source: ICTD GRD (2014).

To address the potential endogeneity between aid and revenue, we experiment using a number of lag lengths (one and two periods, which equate to 4 and 8 years) – results are reported for the shorter lag, as the aid variables are generally statistically insignificant when using the longer lag.[8] As shown in Table 2, net aid has a positive effect on tax revenue when lagged by one period; the negative significant squared aid term indicates declining marginal benefits to tax from increased aid. In practice the importance of the negative squared term is modest: the magnitude of the coefficients indicates that the net effect of aid becomes negative only when aid reaches an essentially extreme 69 per cent of GDP.

When aid is disaggregated into grants and loans, the former is positive and statistically significant, both on its own and when included with the loans variables, with a quadratic effect on tax revenue. As with the results for aggregate aid – and all the results to follow – the substantive impact of the quadratic term is small enough that the aggregate effect of grants on tax revenue only becomes negative at exceptionally high, generally implausible, levels of aid. Meanwhile, the coefficient on net loans is statistically insignificant, both on its own and when included alongside the grants variables. Overall, the size of the coefficients on the lagged aid variables are both more significant and larger than those on the

[8] These results are available on request from the authors.

contemporaneous aid variables, while implying a more positive relationship between aid and tax revenue in all cases.

Table 2: Aid (lagged) and tax revenue regressions: fixed effects estimator

	Net aid	Grants	Net loans	Grants and net loans
gdppc	0.005 (1.00)	0.004 (0.98)	0.005 (1.25)	0.005 (1.18)
agr	-0.013 (6.96)***	-0.012 (6.91)***	-0.012 (6.92)***	-0.012 (6.97)***
ind	-0.005 (3.16)***	-0.006 (3.56)***	-0.006 (3.30)***	-0.006 (3.35)***
imports	0.003 (2.62)***	0.003 (3.05)***	0.003 (2.77)***	0.003 (2.86)***
exports	-0.002 (1.38)	-0.002 (1.31)	-0.002 (1.45)	-0.002 (1.50)
net_aid	0.698 (2.20)**			
net_aid^2	-1.014 (2.10)**			
net_loans		-0.635 (0.82)		-0.588 (0.75)
net_loans^2		22.948 (1.78)*		18.800 (1.42)
grants			0.685 (2.07)**	0.585 (1.72)*
grants^2			-1.117 (1.99)**	-1.012 (1.79)*
_cons	-1.758 (21.29)***	-1.758 (21.92)***	-1.783 (22.15)***	-1.776 (22.00)***
F	9.81	9.67	9.88	7.91
P	0.00	0.00	0.00	0.00
R^2	0.11	0.11	0.11	0.11
N	665	687	687	687

Notes: The dependent variable is ln(tax/gdp); panel of 4-year averages; * p<0.1; ** p<0.05; *** p<0.01. The F-test (*F*) is that all variables are jointly significant; *P* is the probability of rejection. The GDPpc variable is multiplied by 1000 so the coefficients are within four decimal places.

Source: ICTD GRD (2014).

Taking into account the time series characteristics of the panel dataset, in Table 3 we re-estimate the model using feasible generalised least squares (FGLS), with both a common and panel specific AR(1)[9] process being applied. When aid is measured contemporaneously the aid variables are statistically insignificant (when grants and loans are included individually and then together) for both AR(1) processes.[10] When aid is lagged by one period, the net aid variable is positive, statistically significant and quadratic in effect when a panel specific AR(1) process is applied, implying a positive overall relationship between aid and taxation at all plausible levels of aid dependence. Net loans and grants show no statistical significance with either process. Re-estimating the model using panel corrected standard errors (PCSE) we find that all aid variables remain statistically insignificant whether lagged or contemporaneous. The control variables are statistically significant at the 1 per cent level and this is robust to specification.[11]

[9] An AR(1) process is given by: $X_t = c + \varphi X_{t-1} + \varepsilon_t$ where ε_t is a white noise process with zero mean and constant variance σ_t^2.

[10] These results are available on request from the authors.

[11] These results are available on request from the authors.

Table 3 Aid (lagged) and tax revenue regressions: FGLS estimator

	1 Common AR(1)	2 Common AR(1)	3 PS AR(1)	4 PS AR(1)
gdppc	-0.011 (2.24)**	-0.007 (1.64)	-0.000 (0.09)	-0.001 (0.24)
agr	-0.015 (9.37)***	-0.015 (8.51)***	-0.013 (11.61)***	-0.012 (11.50)***
ind	-0.009 (5.77)***	-0.008 (5.17)***	-0.009 (7.89)***	-0.009 (8.29)***
imports	0.005 (5.15)***	0.006 (6.01)***	0.005 (5.64)***	0.006 (7.18)***
exports	-0.003 (2.45)**	-0.005 (3.63)***	-0.002 (1.64)	-0.002 (2.03)**
net_aid	0.588 (1.67)*		0.533 (2.00)**	
net_aid^2	-0.746 (1.36)		-0.913 (2.35)**	
net_loans		-0.006 (0.01)		-1.099 (1.55)
net_loans^2		26.601 (2.03)**		39.029 (3.42)***
grants		0.356 (0.92)		0.314 (1.11)
grants^2		-0.870 (1.39)		-0.912 (1.85)*
_cons	-1.610 (19.38)***	-1.670 (19.32)***	-1.743 (28.49)***	-1.787 (30.13)***
Chi^2	143.95	133.75	305.53	335.44
P	0.00	0.00	0.00	0.00
N	664	687	664	687

Notes: The dependent variable is ln(tax/gdp); panel of 4-year averages; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F-test (*F*) is that all variables are jointly significant; *P* is the probability of rejection. The GDPpc variable is multiplied by 1000 so the coefficients are within four decimal places. The Chi^2 test (Chi^2) that all variables are jointly significant; *P* is the probability of rejection. Aid variables lagged by 1 period (4 years). AR(1) process as specified in text.

Source: ICTD GRD (2014).

How do these results compare to those in Gupta et al. (2004) and Benedek et al. (2012)? The signs and statistical significance of the coefficients on the control variables are similar, although the trade variable is split into imports and exports as a share of GDP. The coefficient on exports is not as robust as that on imports, but negative when significant; *ceteris paribus*, increased exports do not generate revenue (the negative sign is consistent with many countries eliminating taxes on exports). When a composite trade variable is used (imports and exports as a percentage of GDP) it is generally insignificant.[12] Turning to the aid variables, Gupta et al. (2004) find that the aggregated aid variable, or net aid, is negatively signed. This is contrary to our findings of no effect using contemporaneous variables, and a positive and significant effect when using (more appropriate) lagged aid variables. We similarly fail to replicate the main result of their paper of a negative and quadratic effect of grants (where we find a positive or no effect) and a positive and quadratic effect of loans on revenue (where we do not find any statistical significance). Benedek et al. (2012) also find a negative sign on the net aid and grants variables, although without a quadratic effect. Again, our results contradict their results, as we find a generally positive effect in both cases. Similar to our investigations they find no significant effect on the loans variable.

[12] These results are available on request from the authors.

3.2 Further robustness tests

As per Benedek et al. (2012) and Clist and Morrissey (2011), we undertake a series of robustness checks to investigate further the possible relationship between aid and tax revenue.[13]

3.2.1 Region

On splitting the sample into the three regions – Sub-Saharan Africa (SSA), Latin America and the Caribbean (LAC) and Asia and the Pacific (AsiaPac) – the only robust result that emerges is that the shares of agriculture (*agr*) and industry (*ind*) to GDP are important correlates of tax revenue. Interestingly though, in all regions the coefficient on *ind* is negative. While seemingly counter-intuitive, this is driven by the construction of our variables: in developing countries resource production is often a major share of industrial production, but our tax variable is entirely exclusive of resource revenue. These results hold whether the model is estimated using panel fixed effects (FE) or FGLS (with panel specific AR(1)), as well as with contemporaneous and lagged measures of aid. With the former, there is some evidence that grants have a positive impact on tax revenue in the cases of SSA and LAC.

3.2.2 Decade

Estimating the model with the sample split by decades – 1980s, 1990s, 2000s – does not yield particularly strong results either. However, in the 2000s, when estimating using FGLS, loans are associated with a negative effect on tax revenue, both when aid is measured contemporaneously and lagged.

3.2.3 Structural break – 1980s?

Clist and Morrissey (2011) find evidence of a structural break in the relationship between aid and tax revenue, with grants having a statistically significant and positive effect after the 1980s and the implementation of structural adjustment programmes (SAPs).[14] This is investigated here in two ways: the first including a dummy variable capturing the decade of the 1980s, which is subsequently interacted with the aid variables, and the second by splitting the sample into two sub-samples, 1980-1990 and 1990-2010.

Using the first method and estimating using FGLS (and panel specific standard errors), whilst the coefficient on grants is positive the dummy variable is statistically insignificant, as are the interaction terms between the dummy variable and the aid variables. All variables of interest are statistically insignificant when the model is estimated using panel fixed effects. On splitting the panel into the two sub-periods we are able to replicate the result of Clist and Morrissey (2011), and find a positive effect of grants on tax revenue in the post-1980s period; however this is only the case when the variable is lagged by one period. This result does hold though when the model is estimated by either FE or FGLS.

3.2.4 Total revenue

In the literature, tax revenue has often been proxied by total government revenue given a lack of data availability. In our analysis the coverage of tax-specific data is better than has been used previously, but as an additional robustness check we re-estimate the models above using total government revenue as a proportion of GDP as the dependent variable. We find that the results are broadly unchanged relative to those that have been described

[13] These results are available on request from the authors.

[14] The explanation being that, with the focus on structural adjustment by the Bretton Woods institutions, policy reform, together with the technical assistance associated with grant aid, had a positive effect on revenue.

above. The only substantially different finding is of a positive effect of loans when the model is estimated using FGLS and a panel-specific AR(1) process. [15]

3.2.5 Non-tax revenue

Previous studies have found that higher non-tax revenue (primarily from natural resource wealth) reduces tax collection (Bornhorst et al. 2008). However, owing to poor quality data, non-tax revenue has generally not been incorporated into studies of aid and tax effort. Drawing on the ICTD dataset we are able to account for non-tax revenue; the *ntr* variable comprises taxes, royalties and other revenue from natural resources, revenue from state-owned enterprises and additional fees and charges, with revenue from natural resources the primary component. The variable is available for 121 countries in our sample and causes only a very modest reduction of the sample size.

Equation (1) is re-estimated including non-tax revenue (*ntr*). The results reported in Table 4 are estimated using, in turn, pooled OLS, fixed-effects and FGLS (with panel specific AR(1) process). Across all the estimates, the non-tax revenue variable has a negative and significant effect on tax revenue, while in all cases the magnitude of the effect is larger than the effect of any of the individual aid variables. Across each of the estimates we find a positive effect of grants on tax revenue, and a relatively negligible negative coefficient on the quadratic term. The magnitude and significance of the positive effect of grants is larger than in the earlier estimates, suggesting the importance of adding non-tax revenue to the model. The aid term is similarly positive across all of the new estimates, and similarly larger than in the earlier estimates, while the quadratic term is significant only for the fixed-effects model. Finally, the loans term is insignificant in all cases.

[15] These results are available on request from the authors.

Table 4 Non-tax revenue and tax revenue regressions

	OLS	OLS	FE	FE	GLS	GLS
gdppc	-0.013 (2.45)**	-0.007 (1.97)**	0.006 (1.13)	0.005 (1.30)	-0.014 (3.25)***	-0.010 (2.52)**
agr	-0.016 (10.35)***	-0.016 (10.79)***	-0.012 (6.74)***	-0.012 (6.80)***	-0.014 (12.90)***	-0.015 (12.41)***
ind	0.001 (0.63)	0.002 (1.04)	-0.004 (2.25)**	-0.004 (2.49)**	-0.004 (2.94)***	-0.004 (2.87)***
imports	0.008 (5.89)***	0.008 (6.46)***	0.002 (2.32)**	0.003 (2.64)***	0.004 (5.39)***	0.005 (6.38)***
exports	-0.002 (1.52)	-0.003 (2.18)**	-0.001 (1.03)	-0.001 (1.19)	0.001 (0.83)	-0.001 (0.69)
ntr	-3.148 (9.64)***	-3.489 (9.64)***	-0.740 (2.45)**	-0.712 (2.40)**	-2.765 (19.93)***	-2.999 (22.27)***
net_aid	1.176 (2.56)**		0.704 (2.21)**		0.896 (3.10)***	
net_aid^2	-1.040 (1.44)		-0.916 (1.89)*		-0.676 (1.49)	
grants		1.587 (3.26)***		0.589 (1.73)*		0.806 (2.70)***
grants^2		-2.256 (3.11)***		-0.952 (1.68)*		-1.072 (2.20)**
net_loans		0.269 (0.20)		-0.463 (0.59)		0.294 (0.42)
net_loans^2		22.062 (0.80)		19.340 (1.45)		22.006 (1.97)**
_cons	-1.895 (21.06)***	-1.909 (21.67)***	-1.764 (21.03)***	-1.780 (21.70)***	-1.746 (28.24)***	-1.747 (27.20)***
F/Chi^2	54.98	47.91	9.06	7.46	486.72	861.40
P	0.00	0.00	0.00	0.00	0.00	0.00
R2	0.44	0.43	0.12	0.12	.	.
N	649	671	649	671	648	671

Notes: Dependent variable is ln(taxrev/gdp); 4-year average panel; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. Panel specific AR(1) process applied in GLS analysis. The Chi^2 test (Chi^2) that all variables are jointly significant; *P* is the probability of rejection. Coefficient of variable Y=Y*1000. Aid variables lagged by 1 period (4 years). AR(1) process as specified.

Source: ICTD GRD (2014).

4 Aid and imports

A particular limitation with specification (1) is that no allowance is made for direct channels through which aid may affect tax revenue, such that aid is related to other explanatory variables. Imports are a particular concern because aid is received in the form of foreign exchange and is therefore important for financing imports; Morrissey (2005: 1150) argues it is no coincidence that for SSA countries on average the aid/GDP ratio is close to the trade deficit (M-X)/GDP ratio. To the extent that some aid finances imports and some imports are directly financed by aid, the inclusion of both aid and imports as explanatory variables may bias coefficient estimates. The empirical problem is not simply that two of the posited explanatory variables, imports (determining tariff revenue) and aid (affecting effort), are correlated. More importantly, the nature of the relationship between the two variables may vary across countries in a manner related to the importance of aid: given export earnings (to pay for imports), a higher aid/GDP ratio will permit a higher import/GDP ratio that, given tariffs, affects the revenue/GDP ratio. To minimise any bias on the estimated coefficients of the two variables it is necessary to address their relationship to each other.

The issue is complicated by the fact that some donors use aid to finance their exports to recipients, either directly (tied aid) or indirectly (through political and commercial links). Furthermore, as argued in Carter (2013), imports by the donor (e.g. for aid projects) are often exempt from tariffs. It is not possible to identify direct donor-financed imports in the aid or import data, but we can try to distinguish the aid-financed component of imports. The first step is to test that aid is a determinant of imports by estimating a simple relationship (results in Appendix 5).

$$M_t = f(A_t, X_t, Y_t) \quad (2)$$

Exports are consistently positive and significant as we would expect, and on average account for about three-quarters of imports. There is a negative relationship between per capita income and imports; as aid diminishes with the level of income, this suggests that M/GDP rises slower than X/GDP as countries GDPpc rises. The coefficient on net aid is positive and significant, supporting the proposition that aid helps to finance imports (by providing foreign exchange). The estimates separating grants and net loans show opposing results: grants have a positive effect on imports, whilst net loans a negative effect; the magnitude of both of these coefficients decreasing as the lag increases. The difference in sign is likely to reflect the fact that when loans are given to recipient governments they are often accompanied by requirements for tightening fiscal policy, and thus a reduction in expenditure, which would have an impact on borrowing.

Having established that aid is a significant determinant of imports when we include control variables, the second step is to ‘purge’ *M* of the effect of aid (for each country). This can be done by estimating generated regressors (Gomanee et al. 2005). Initially, estimate the predicted value for *M* as a function of aid:

$$M_t\hat{} = c + aA_t + e \quad (3)$$

Using these predicted values we then construct generated regressors, i.e. the value of imports that is not attributable to aid:

$$M_t^* = M_t\hat{} - A_t \quad (4)$$

Using the generated variables, M_t*, we estimate the following equation (for lagged aid and *M**):

$$Ln(R_t) = \beta_0 + \beta_1 A_{it-1} + \beta_2 M^*_{it-1} + X_{it} + \varepsilon_{it} \quad (5)$$

In estimating (5) we use the three aid variables (net aid, grants, net loans) individually with M* before estimating the full model. We exclude the quadratic terms, as they complicate estimation of this more complex model, and are substantively unimportant in the earlier results. The log of tax revenue/GDP is our dependent variable. The appropriate lag structure is no longer obvious as M* can be interpreted as imports not financed by aid (hence generally financed by exports). If M* is not lagged it will be correlated with X so coefficient estimates are biased, whereas if M* is lagged it refers to the period prior to tax revenue (so does not capture tariffs in the relevant period). As import/GDP ratios tend to be more stable in developing countries than export/GDP ratios, especially for primary commodity exporters, we test both options. Results are provided in Table 5 (no lag) and Table 6 (lagged) and are only illustrative.

Table 5 Aid regressions using generated regressors – dependent variable *ln(tax/gdp)*

	Net aid	**Grants**	**Net loans**	**Grants and net loans**
net_aid	-0.227 (1.30)			
grants		-0.190 (1.03)		-0.226 (1.22)
net_loans			-1.501 (1.77)*	-1.656 (1.94)*
M*	-0.000 (0.36)	0.000 (0.29)	-0.000 (0.21)	0.000 (0.25)
exports	-0.000 (0.24)	-0.001 (0.65)	-0.000 (0.40)	-0.001 (0.82)
_cons	-2.051 (54.17)***	-2.090 (55.13)***	-2.086 (55.54)***	-2.075 (53.71)***
F	0.72	0.43	1.17	1.24
P	0.54	0.73	0.32	0.29
N	758	789	789	789

Notes: Dependent variable is ln(tax/gdp); 4-year average panel; * p<0.1; ** p<0.05; *** p<0.01. The F test (F) that all variables are jointly significant; P is the probability of rejection.

Source: ICTD GRD (2014).

Table 6 Aid (lagged) regressions using generated regressors – dependent variable *ln(tax/gdp)*

	Net aid	Grants	Net loans	Grants and net loans
net_aid	0.078 (0.44)			
grants		0.108 (0.56)		0.115 (0.59)
net_loans			-1.051 (1.38)	-1.043 (1.37)
M*	0.001 (0.69)	0.001 (0.73)	0.001 (0.84)	0.001 (0.71)
exports	-0.000 (0.04)	-0.000 (0.14)	-0.000 (0.37)	-0.000 (0.28)
_cons	-2.111 (53.98)***	-2.126 (54.74)***	-2.114 (54.96)***	-2.117 (53.83)***
F	0.25	0.30	0.78	0.63
P	0.00	0.00	0.00	0.00
N	686	708	708	708

Notes: Dependent variable is ln(tax/gdp); 4-year average panel; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F test (F) that all variables are jointly significant; *P* is the probability of rejection. Aid variables lagged by 1 period (4 years).
Source: ICTD GRD (2014).

When aid is measured both contemporaneously (Table 5) and lagged by one period (Table 6), the net aid and grants variables are statistically insignificant. The coefficient on loans is insignificant when lagged by one period, though it is negative and weakly significant when it is contemporaneous with the tax variable. The generated regressor for imports (M*) is insignificant in both specifications.

As further tests of the robustness of these results, we also run tests employing total revenue/GDP as the dependent variable. The results are similar: all of the aid variables are insignificant, though all have a positive sign (see Appendix 6). We then split the sample into two – one that represents SSA and the other that includes all other regions. We re-run the estimates, with *ln(tax/gdp)* as the dependent variable, and again find that all of the aid variables are statistically insignificant (see Appendix 7 and Appendix 8).

5 Conclusions

This paper contributes to the literature on the relationship between aid and government (tax) revenue by revisiting standard estimates using the new ICTD Government Revenue Dataset, a panel dataset that covers the period 1980-2010 for up to 121 developing countries. We are unable to replicate the findings of Gupta et al. (2004) and Benedek et al. (2012) for a negative effect of aid or grants on tax effort. In general our results are consistent with Clist and Morrissey (2011); we find some support for the result that the effect of aid has become positive since the 1980s. We find no consistent robust relationship between aid, in total or when separating grants and loans, and tax performance. Where we do find significant coefficients these are positive for net aid and for grants, whereas for loans they are generally negative. Unlike many studies we also account for non-tax revenue explicitly, and find that all of the results become stronger and more positive, again finding a positive and significant effect of aid and grants in many specifications. Meanwhile, there is a clear negative relationship between non-tax revenue and tax revenue, suggesting the importance of this addition to the model. Extending the literature, we attempt to account for the inherent

relationship between aid and imports, and after this adjustment all of the results on the aid variables are again insignificant.

The analysis shows that there appears to be either no relationship between aid and government revenue or a positive one, but results for aid are not robust. The safest inference is that there is no consistent cross-relationship between aid and tax effort, and in particular no evidence to justify claims that grants reduce tax effort whereas aid loans encourage tax effort (if anything we come close to finding the reverse). The principal justification for cross-country regression analysis is to see if there are general patterns or empirical regularities. Our conclusion is that in respect of aid and tax effort there are no general cross-country patterns. One simple reason may be that heterogeneity is far more important than any underlying common tendency. One source of such heterogeneity comes from pooling countries that are in fact very different, and even restricting the sample to high aid recipients only, such as SSA countries, does not generate stronger results (heterogeneity persists).

In many ways the lack of significant findings is, in fact, highly intuitive. Aid may affect tax collection through many channels, some of them conflicting. While foreign aid may reduce the urgency of revenue needs, it may also have countervailing positive effects on tax collection through the effects of technical assistance, conditionality and public spending. More broadly, the prediction that aid will reduce domestic tax collection flows from the assumption that aid acts as a substitute for domestic tax collection, much like natural resource wealth. However, from the perspective of recipient governments foreign aid is frequently a poor substitute for domestic tax revenue, while the aggregate category foreign aid disguises enormous diversity in the particular purposes to which aid is directed. While some particular types of aid may in some circumstances discourage tax effort, it is relatively unsurprising that there would be no aggregate effect when several very distinct elements are lumped together. For this reason analysis at the individual country level or ensuring that only similar countries are pooled, while taking account of the diversity of aid, offers the best prospects for future research.

Appendices

Appendix 1 Sample country list

Sub-Saharan Africa (SSA)	Middle-East and North Africa (MENA)	Asia and the Pacific (AsiaPac)	Latin America and the Caribbean (LAC)
1. Angola	1. Algeria	1. Afghanistan	1. Antigua and Barbuda
2. Benin	2. Bahrain	2. Bangladesh	2. Argentina
3. Botswana	3. Djibouti	3. Bhutan	3. Aruba
4. Burkina Faso	4. Iran, Islamic Rep.	4. Brunei Darussalam	4. Bahamas, The
5. Burundi	5. Jordan	5. Cambodia	5. Barbados
6. Cameroon	6. Kuwait	6. China	6. Belize
7. Cape Verde	7. Lebanon	7. Fiji	7. Bolivia
8. Central African Republic	8. Libya	8. India	8. Brazil
9. Chad	9. Morocco	9. Indonesia	9. Chile
10. Comoros	10. Oman	10. Kiribati	10. Colombia
11. Congo, Dem. Rep.	11. Qatar	11. Lao PDR	11. Costa Rica
12. Congo, Rep.	12. Saudi Arabia	12. Malaysia	12. Cuba
13. Equatorial Guinea	13. Syrian Arab Republic	13. Mongolia	13. Dominica
14. Eritrea	14. Tunisia	14. Myanmar	14. Dominican Republic
15. Ethiopia	15. United Arab Emirates	15. Nepal	15. Ecuador
16. Gabon	16. Yemen, Rep.	16. Pakistan	16. El Salvador
17. Gambia, The		17. Palau	17. Grenada
18. Ghana		18. Papua New Guinea	18. Guatemala
19. Guinea		19. Philippines	19. Guyana
20. Guinea-Bissau		20. Samoa	20. Haiti
21. Kenya		21. Solomon Islands	21. Honduras
22. Lesotho		22. Sri Lanka	22. Jamaica
23. Liberia		23. Thailand	23. Mexico
24. Madagascar		24. Timor-Leste	24. Nicaragua
25. Malawi		25. Tonga	25. Panama
26. Maldives		26. Vanuatu	26. Paraguay
27. Mali			27. Peru
28. Mauritania			28. St. Kitts and Nevis
29. Mauritius			29. St. Lucia
30. Mozambique			30. St. Vincent and the Grenadines
31. Namibia			31. Suriname
32. Niger			32. Trinidad and Tobago
33. Nigeria			33. Uruguay
34. Rwanda			34. Venezuela, RB
35. Senegal			
36. Seychelles			
37. Sierra Leone			
38. South Africa			
39. Sudan			
40. Swaziland			
41. Tanzania			
42. Togo			
43. Uganda			
44. Zambia			
45. Zimbabwe			

Appendix 2 Variables and data sources

Variable name	Variable description	Data source
revenue	Government revenue excluding grants, % of GDP	ICTD database
tax_revenue	Tax revenue, % of GDP	ICTD database
non_tax_rev	Non-tax revenue, % of GDP	ICTD database
agr	Share of agriculture (value added), % of GDP	World Bank, World Development Indicators (WDI)
ind	Share of industry (value added), % of GDP	World Bank, WDI
gdppc	GDP per capita, current US$	World Bank, WDI
imports	Total imports, % of GDP	World Bank, WDI
exports	Total exports, % of GDP	World Bank, WDI
icrgav	ICRG Corruption Index averaged over 1970-2010	International Country Risk Guide (ICRG), Political Risk Services
net_aid	Net aid (excluding repayments on principal), proportion of GDP	OECD-DAC and authors' calculations
grants	Grants, proportion of GDP	OECD-DAC and authors' calculations
net_loans	Net loans (excluding repayments), proportion of GDP	OECD-DAC and authors' calculations

Appendix 3 Summary statistics

Variable	N	Mean	S.D.	Min.	Max.
revenue	872	0.21	0.11	0.03	0.83
tax_revenue	837	0.14	0.07	0.01	0.51
non_tax_rev	817	0.07	0.10	$0.00e^{-06}$	0.79
gdppc	908	2989.80	5645.01	95.72	70844.41
agr	872	21.11	15.10	0.29	82.85
ind	871	29.06	13.94	4.99	94.3
imports	902	43.85	24.16	0.15	203.20
exports	902	35.29	22.00	0.18	159.90
icrgav	663	2.53	0.67	0.55	4.08
net_aid	870	0.05	0.09	-0.004	0.81
grants	908	0.05	0.08	-0.001	0.79
net_loans	908	$2.21e^{-03}$	0.01	-0.10	0.10

Appendix 4 Pairwise correlations

	revenue	tax_revenue	non_tax_rev	net aid	grants	net_loans
revenue	1.0000					
tax_revenue	*0.3072	1.0000				
non_tax_rev	*0.7965	*-0.3286	1.000			
net_aid	-0.0009	0.0318	-0.0415	1.0000		
grants	-0.0271	0.0361	*-0.0632	*0.9579	1.0000	
net_loans	-0.0316	-0.0152	-0.0418	*0.1682	0.0310	1.0000

Note: *indicates statistical significance at the 10% level

Appendix 5 Exploratory regression results – imports

Relationship between imports and net aid

	1 Net aid	2 Net aid	3 Net aid 1 period lag	4 Net aid 2 period lag	5 Net aid & net aid lagged
net_aid	56.134 (8.55)***	81.606 (6.37)**			57.483 (3.93)**
net_aid^2		-45.092 (2.31)*			-6.163 (0.26)
net_aid_lag			46.390 (3.50)**		21.147 (1.49)
net_aid^2_lag			1.754 (0.09)		2.256 (0.10)
net_aid_2lag				-8.683 (0.59)	
net_aid^2_2lag				42.676 (1.83)	
exports	0.770 (25.31)***	0.762 (24.99)**	0.679 (20.00)**	0.664 (16.63)**	0.711 (21.50)**
gdppc	-0.001 (4.71)***	-0.001 (4.27)**	-0.001 (3.29)**	-0.001 (4.01)**	-0.000 (2.38)*
_cons	16.621 (13.00)***	15.812 (11.96)**	19.218 (13.54)**	22.226 (13.80)**	16.193 (11.15)**
F	226.52	172.26	109.76	70.91	88.00
P	0.00	0.00	0.00	0.00	0.00
N	842	842	736	628	729

Notes: Dependent variable is *imports* (imports/GDP); 4-year average panel; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F test (F) that all variables are jointly significant; *P* is the probability of rejection. Coefficient of variable Y=Y*1000. Aid variables lagged by 1 period (4 years), and 2 periods (8 years).

Source: ICTD GRD (2014).

Relationship between imports and grants

	1 Grants	2 Grants	3 Grants 1 period lag	4 Grants 2 period lag	5 Grants & grants lagged
grants	66.119 (10.02)***	76.481 (5.93)**			52.510 (3.69)**
grants^2		-19.904 (0.94)			-0.182 (0.01)
grants_lag			54.841 (4.17)**		25.736 (1.88)
grants^2_lag			1.617 (0.07)		19.222 (0.84)
grants_2lag				15.078 (1.00)	
grants^2_2lag				-18.637 (0.72)	
exports	0.749 (25.46)***	0.746 (25.17)**	0.651 (20.10)**	0.624 (16.26)**	0.689 (21.76)**
gdppc	-0.000 (3.88)***	-0.000 (3.76)**	-0.000 (2.86)**	-0.000 (3.24)**	-0.000 (2.62)**
_cons	15.713 (13.04)***	15.452 (12.49)**	18.929 (14.67)**	22.075 (14.61)**	16.119 (12.22)**
F	235.10	176.51	117.89	69.20	93.87
P	0.00	0.00	0.00	0.00	0.00
N	876	876	764	650	764

Notes: Dependent variable is *imports* (imports/GDP); 4-year average panel; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F test (F) that all variables are jointly significant; *P* is the probability of rejection. Coefficient of variable Y=Y*1000. Aid variables lagged by 1 period (4 years), and 2 periods (8 years).

Source: ICTD GRD (2014).

Relationship between imports and net loans

	1 Net Loans	2 Net Loans	3 Net Loans 1 period lag	4 Net Loans 2 period lag	5 Net loans & net loans lagged
net_loans	-69.620 (2.25)**	-126.460 (3.85)**			-100.121 (3.02)**
net_loans^2		2,731.984 (4.69)**			2,765.422 (4.48)**
net_loans_lag			-97.417 (2.88)**		-100.000 (2.97)**
net_loans^2_lag			-436.562 (0.77)		6.477 (0.01)
net_loans_2lag				-48.049 (1.39)	
net_loans^2_2lag				612.823 (1.09)	
exports	0.704 (22.52)***	0.701 (22.76)**	0.629 (18.70)**	0.624 (16.41)**	0.621 (18.61)**
gdppc	-0.001 (4.68)***	-0.001 (4.66)**	-0.000 (3.70)**	-0.000 (3.43)**	-0.000 (3.76)**
_cons	21.179 (17.78)***	21.046 (17.90)**	23.195 (18.17)**	22.811 (15.87)**	23.343 (18.31)**
F	180.86	144.92	97.86	69.63	71.35
P	0.00	0.00	0.00	0.00	0.00
N	876	876	764	650	764

Notes: Dependent variable is *imports* (imports/GDP); 4-year average panel; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F test (F) that all variables are jointly significant; *P* is the probability of rejection. Coefficient of variable Y=Y*1000. Aid variables lagged by 1 period (4 years), and 2 periods (8 years).

Source: ICTD GRD (2014).

Appendix 6 Aid regressions using generated regressors

	Net aid	Grants	Net loans	Grants & net loans
net_aid	0.103			
	(0.66)			
grants		0.148		0.159
		(0.93)		(0.99)
net_loans			0.483	0.626
			(0.67)	(0.87)
M*	-0.003	-0.003	-0.002	-0.003
	(3.00)***	(2.90)***	(2.47)**	(2.90)***
exports	0.007	0.007	0.006	0.007
	(6.68)***	(6.70)***	(6.55)***	(6.69)***
_cons	-1.823	-1.817	-1.809	-1.820
	(55.52)***	(56.77)***	(56.33)***	(55.47)***
F	16.91	16.84	15.95	12.64
P	0.00	0.00	0.00	0.00
N	785	817	817	817

Notes: Dependent variable is ln(rev/gdp); 4-year average panel; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F test (F) that all variables are jointly significant; *P* is the probability of rejection. Coefficient of variable Y=Y*1000. Aid variables lagged by 1 period (4 years), and 2 periods (8 years).

Source: ICTD GRD (2014).

Appendix 7 Aid regressions using generated regressors – SSA sample

	Net aid	Grants	Net loans	Grants & net loans
net_aid	0.285			
	(1.02)			
grants		0.427		0.479
		(1.42)		(1.58)
net_loans			-0.983	-1.149
			(0.91)	(1.07)
M*	-0.000	-0.001	-0.000	-0.001
	(0.35)	(0.49)	(0.06)	(0.50)
exports	0.001	0.001	0.001	0.001
	(0.79)	(0.89)	(0.47)	(0.65)
_cons	-2.177	-2.180	-2.144	-2.167
	(37.36)***	(38.30)***	(37.98)***	(37.38)***
F	0.52	0.88	0.46	1.090
P	0.00	0.00	0.00	0.00
N	276	280	280	280

Notes: Dependent variable is ln(rev/gdp); 4-year average panel; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F test (F) that all variables are jointly significant; *P* is the probability of rejection. Aid variables lagged by 1 period (4 years). Sample limited to SSA.

Source: ICTD GRD (2014).

Appendix 8 Aid (lagged) regressions using generated regressors – SSA excluded from sample

	Net aid	Grants	Net loans	Grants & net loans
net_aid	-0.131 (0.56)			
grants		-0.195 (0.76)		-0.208 (0.81)
net_loans			-0.926 (0.83)	-1.012 (0.90)
M*	-0.001 (1.34)	0.002 (1.51)	0.001 (1.31)	0.002 (1.48)
exports	-0.001 (0.94)	-0.002 (1.18)	-0.001 (1.02)	-0.002 (1.21)
_cons	-2.070 (38.80)***	-2.092 (39.18)***	-2.097 (39.72)***	-2.087 (39.71)***
F	0.68	0.96	0.81	0.83
P	0.00	0.00	0.00	0.00
N	410	428	428	428

Notes: Dependent variable is ln(rev/gdp); 4-year average panel; * $p<0.1$; ** $p<0.05$; *** $p<0.01$. The F test (F) that all variables are jointly significant; *P* is the probability of rejection. Aid variables lagged by 1 period (4 years). Sample excludes SSA.
Source: ICTD GRD (2014).

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